Auditory processing disorder: Evidence for intervention

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OVERVIEW

(C)APD
1. Your approach to APD
2. Current evidence for intervention
   a. Environmental modifications
   b. Compensatory strategies
   c. Direct intervention
3. The decisions are yours to make as a well informed clinician and researcher
### ASHA (2005)

**Definition**

APD refers to difficulties in the perceptual processing of auditory information in the central nervous system, as demonstrated by poor performance in one or more of the following skills:

- sound localization and laterization
- auditory discrimination
- auditory pattern recognition
- temporal aspects of audition, including temporal integration, temporal discrimination (e.g., temporal gap detection)
- temporal ordering and temporal masking
- auditory performance in competing acoustic signals (including dichotic listening), and
- auditory performance with degraded acoustic signals.

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### ASHA (2005)

Although APD may coexist with, lead to, or be associated with disorders of higher order language, cognition or related factors, it is not the result of such disorders.

- Individuals suspected of having (C)APD frequently present with one or more behavioral characteristics
- List of behaviours is illustrative, not exhaustive & not exclusive to (C)APD
- **Behaviors not specifically diagnostic of (C)APD**
(C)APD put too simply

Attention

Memory

Cognition

(Central) Auditory Processing

Speech, language, reading, writing, learning
(C)APD INTERVENTION

• Ambiguous and controversial

• **Team** approach is important

• Rationale is based on **neural plasticity** of the maturing nervous system (appropriate stimulation enables plasticity and possibly extends critical learning periods)

• **Avoid “one size fits all”** rehabilitation, be specific to the individual
Figure 2. The management tripod. Without *all* three legs, the tripod will not stand, and without strategies from each category management will not be effective.
Levels of evidence (ASHA, 2004)

Ia  Well-designed meta-analysis of >1 randomised control trial

Ib  Well-designed randomised controlled study

IIa Well-designed controlled study without randomisation

IIb  Well-designed quasi-experimental study

III  Well-designed nonexperimental studies e.g., correlational & case studies

IV  Expert committee report; consensus conference, clinical experience of respected authorities
Figure 2. The management tripod. Without *all* three legs, the tripod will not stand, and without strategies from each category management will not be effective.
ENVIRONMENTAL MODIFICATION

- Preferential classroom seating
- Reduction of extraneous noise
- Acoustic modifications
- Assistive listening devices
- MUST BE APPROPRIATE FOR THE INDIVIDUAL

Bellis (2003) provides a detailed list of EMs and explains each EM in detail
Environmental modifications - FM systems

- Teacher wears a wireless microphone attached to a small body-worn transmitter
- There may or may not be a base receiver that receives the signal
- Teacher’s voice is transmitted to an earphone system worn by individual students or to speakers placed around the room
- Aims to improve signal-to-noise ratio (SNR)
Environmental modifications - FM systems

• Personal FM systems
  – Lemos (2009)
    • 20 studies, 3 level III & 17 level IV; results +ve but no control groups
  – Johnson et al. (2009)
    • Level III; improved performance on AP, academic & psychosocial measures
    • But language confounds in AP measure & control group only in pre-treatment phase
  – Hanschmann et al. (2010)
    • Level III; improved sentence in noise performance for both children with APD & controls
    • Again, language confounds

Verdict: clear prima facie value in improving SNR. Some evidence emerging that this affects AP but higher level evidence needed ([C]APD was mostly “ASHA-like”)}
Recent promising FM literature


- 38 children with dyslexia, 19 used a classroom FM system for 1 year
- The FM group showed reduced variability of subcortical responses to sound, which was linked to increases in reading and phonological awareness

- Response consistency before FM use predicted phonological awareness gains after FM use
- ALDs can improve the neural representation of speech & affect reading-related skills by enhancing acoustic clarity & attention, reducing variability in auditory processing
Figure 2. The management tripod. Without *all* three legs, the tripod will not stand, and without strategies from each category management will not be effective.
COMPENSATORY STRATEGIES

- Active listening
- Metacognitive strategies
- Linguistic and meta-linguistic strategies
- MUST BE APPROPRIATE FOR THE INDIVIDUAL

- Bellis (2003) provides a detailed list of CSs & explains each CS in detail
Compensatory strategies

• CSs seek to improve the listener’s ability to take control of his or her own situation, i.e. to actively try to compensate for his or her own difficulties

• While CSs have prima facie value, it should not be assumed that other improvements will immediately follow

Verdict: no studies directly investigating the effects (if any) of CSs on (C)APD
Recent promising CS literature
Figure 2. The management tripod. Without *all* three legs, the tripod will not stand, and without strategies from each category management will not be effective.
DIRECT INTERVENTION

• AUDITORY TRAINING: includes training to hear differences in sounds and words, teaching to pick out sounds or words when there is background noise, teaching to use rhythm and temporal cues in speech

• Many intervention programs and several commercial packages available

• MUST BE APPROPRIATE FOR THE INDIVIDUAL

• Bellis (2003) provides a detailed list of DIs and explains each DI in detail
Direct intervention - auditory outcomes

• Fey et al. (2011): 6 studies, level IIb & most level III

• McArthur (2009): 6 studies, Levels Ib-III

• Loo et al. (2010): 21 studies, levels Ib-III

• More recently
  – Cameron & Dillon (2011): LiSN & Learn
Verdict: The evidence that direct auditory interventions improve AP in school-age children with APD with or without spoken language, reading, or learning difficulties, compared to no treatment or placebo treatments, is:

- suggestive-to-compelling for interventions involving nonspeech and/or simple speech stimuli (noncomputer or computer-based),
- suggestive for Earobics, and
- equivocal for Fast ForWord.

The evidence that AIT has no effect on AP is suggestive.

(In the short-term, in school aged children, where [C]APD was mostly “ASHA-like”)

Direct intervention - auditory outcomes
If you treat the (C)APD with AP therapy (non-speech and simple speech training) ... Can we fix it? Can we find it?
Recent promising DI-AO literature

- Auditory evoked potentials

McPherson (1996)
Recent promising DI-AO literature

Auditory evoked potentials – examples of recent work from Nina Kraus’s NWU lab only ...

2014
Kraus, Anderson. Music benefits across the lifespan: Enhanced processing of speech in noise. Hear Rev
Kraus. 20Q: Noise, aging and the brain - how experience and training can improve communication. AudiologyOnline

2013
Strait, O’Connell, Parbery-Clark, Kraus. Biological impact of preschool music classes on processing speech in noise. Developmental Cognitive Neuroscience.

2012
Kraus. Biological impact of music and software-based auditory training. J of Comm Dis
Song, Skoe, Banai, Kraus. Training to improve hearing speech in noise: Biological mechanisms. Cereb Cortex

2011
Tierney, Parbery-Clark, Skoe, Kraus. Frequency-dependent effects of background noise on subcortical response timing. Hear Res
Parbery-Clark, Strait, Kraus. Context-dependent encoding in the auditory brainstem subserves enhanced speech-in-noise perception in musicians. Neuropsychologia
Anderson, Kraus. Neural encoding of speech and music: Implications for hearing speech in noise. Seminars in Hearing
Anderson, Parbery-Clark, Han-Gyol, Kraus. A Neural Basis of Speech-in-Noise Perception in Older Adults. Ear Hear
Parbery-Clark, Marmel, Bair, Kraus. What subcortical-cortical relationships tell us about processing speech in noise. Eur J Neurosci

2010
Anderson, Kraus. Sensory-Cognitive Interaction in the Neural Encoding of Speech in Noise: A Review. JAAA
Chandrasekaran, Kraus. Music, Noise-Exclusion, and Learning Music Percept

2009
Chandrasekaran, Hornickel, Skoe, Nicol, Kraus. Context-dependent encoding in the human auditory brainstem relates to hearing speech in noise: Implications for developmental dyslexia. Neuron
Hornickel, Skoe, Nicol, Zecker, Kraus. Subcortical differentiation of voiced stop consonants: relationships to reading and speech in noise perception. PNAS
Parbery-Clark, Skoe, Kraus. Musical experience limits the degradative effects of background noise on the neural processing of sound. J Neurosci
Parbery-Clark, Skoe, Lam, Kraus. Musician enhancement for speech in noise. Ear Hear

2008 and earlier
Russo, Nicol, Zecker, Hayes, Kraus. Auditory training improves neural timing in the human brainstem. Behav Brain Res
Warrier, Johnson, Hayes, Nicol. Learning impaired children exhibit timing deficits and training-related improvements in auditory cortical responses to speech in noise. Exp Brain Res

Bradlow, Kraus, Hayes. Speaking clearly for children with learning disabilities: Sentence perception in noise. JSLHR
Recent promising DI-AO literature


- Children with dichotic L-ear deficits (such asymmetries called amblyaudia)

- Intensive training using dichotic verbal material presented in the sound field
  - Output from R-speaker initially 20-30 dB HL lower than L-speaker, resulting in excellent L-ear performance
  - Intensities adaptively adjusted throughout training in 1, 2, and 5-dB steps (performance kept high)

- Phase I (n=8) and II (n=13): significant gains in dichotic performance (L-ear particularly but also R-ear)

- ARIA is a feasible training approach for improving a larger than normal interaural asymmetry on dichotic listening tasks

- Significant improvements in language comprehension and word recognition in phase II suggests ARIA may also facilitate language skills in some children
If you treat the (C)APD with AP therapy (non-speech and simple speech training) ...

If a problem here leads to ...

A problem here
If you treat the (C)APD with AP therapy (non-speech and simple speech training) ... 

Will we fix this?

If we fix this?
Direct intervention – language outcomes

• Fey et al. (2011): 19 studies, level IIb & most level III

• McArthur (2009): 6 studies, Levels Ib-III

• Loo et al. (2010): 21 studies, levels Ib-III

• More recently
Verdict: The evidence is suggestive to compelling that direct auditory interventions including computer-based interventions involving nonspeech and/or simple speech training and Fast ForWord do not improve spoken language and/or reading skills in school-age children with spoken language and/or reading disorders with or without APD, compared to no treatment or placebo treatments.

The evidence is suggestive that Earobics improves phonological awareness skills in this patient population.

(In the short-term, in school aged children, where [C]APD was mostly “ASHA-like”)
If you treat the (C)APD with AP therapy (non-speech and simple speech training) ... 

If we fix it?

No short-term improvement in these problems but may be better positioned to fix these problems ... all is not lost (McArthur et al., 2008)
Recent promising DI-LO literature

Emilie Lam, PhD candidate at Flinders University, Australia

Dr Willem van Steenbrugge, Dr Christopher Lind & Dr Sarosh Kapadia, Supervisors

The effectiveness of auditory perceptual and phonological training in remediating reading difficulties in children with Auditory Processing Disorder (APD)
The relative contribution of (C)AP to language

• Has long been debated (e.g., Rees, 1973)
• Recent reviews suggest contribution may not be as significant as previously thought, in the short-term in the school-age child
• McArthur et al. (2008) hypothesize that:
  • improving AP (nonspeech and simple speech) may not immediately improve language and reading in children with SLI and SRD because improving AP may simply ready the auditory system for learning
  • improving language and reading skills may require further intervention that specifically targets language and reading
  • a distinction is needed between being ready to learn language and reading versus learning language and reading
An analogy ...
Perhaps the last word should go to ...

- Medwetsky (2011):
  - “It is not enough to label an individual with APD, SLI, or dyslexia because the processing difficulties may be due to different underlying deficits. Consequently, any intervention based on a global diagnosis may or may not work for a specific individual, depending on the alignment of the intervention and the specific processing difficulties being encountered” (p. 292).
How should I manage (C)APD?

The decision is **yours to make as a well informed clinician**

Regardless of which approach/position you take, be knowledgeable of which **historical approach(es)** it favours its theoretical constructs its underlying assumptions & its evidence as these will determine how you manage (C)APD in your clinic
The many ways of saying
"Thank You"

xièxiè  "Thank You"  SPASIBO
GRACIAS  Grazie  Mahalo
Merci  Danke  WA-DØ
Arigato  Thanyawaad  Asante
References


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