Setting up an APD clinic
Structure of an APD clinic

Doris-Eva Bamiou
National Hospital for Neurology and Neurosurgery and
Institute of Child Health (UCL)
Great Ormond Street Children’s Hospital
Lecture Outline

- What is the need?
- How can it be diagnosed?
- How can it be managed?
- Clinic Structure
- Final comments
1. What is the need?

- Definition – is it a disorder?
- Aetiology
- Prevalence
- Specific populations
Auditory Processing Disorder

APD results from impaired neural function and is characterized by poor recognition, discrimination, separation, grouping, localization, or ordering of non-speech sounds. It does not solely result from a deficit in general attention, language or other cognitive processes.

http://www.thebsa.org.uk/apd/Home.htm#working\%20def May 2007
Is it a disorder?
Guidelines for inclusion in DSM III (1980)

• at least 50 published articles pertaining to the diagnosis (with at least 50% of these to be empirical)
• specified diagnostic criteria, with available assessment to treatment linkages
• at least two empirical studies conducted by independent groups showing Kappa coefficients $\geq .70$
• the proposed diagnostic category represents a syndrome of frequently co-occurring symptoms and
• there are at least two independent studies demonstrating that this diagnostic category is separate and distinct from other diagnoses.
Aetiology of APD

• 1. Neurological conditions
  – stroke, hypoxia (e.g. prematurity), head trauma
  – brain tumours
  – meningitis
  – epilepsy
  – adrenoleukodystrophies, multiple sclerosis
  – genetic
  – heavy metal exposure
• 2. Auditory deprivation/Delayed CNS maturation
  – Glue ear, other types of hearing loss, idiopathic
• 3. Other Developmental Disorders
  – ADD, Dyslexia, Specific Language Impairment, Autism
• 4. Age related changes
• 5. “Positive” disorders of auditory processing
  – tinnitus, musical hallucinations

Bamiou et al., 2001; Griffiths, 2002
Aetiology of APD in the paediatric GOSH APD clinic

Diagnosis of APD in
- 28:53 referrals (TS) – 53%
- 33:44 referrals (DEB) – 75%
- Overall: 61:97 – 63% positive diagnosis

- No risk factors identified in 9: 61 (15%)
  - 4: 28 TS
  - 5: 33 DEB

Bamiou, Dawes, Sirimanna
APD risk factors in GOSH sample

• Developmental disorders – 20%
• Family history of similar difficulties/developmental disorders – 20%
• Genetic Neurological – 11.5%
• Acquired CANS damage – 10%
• Glue ear history – 28%
• No risk factor identified – 15%

• *If you are paying attention, 1 case is missing...*

Bamiou, Dawes, Sirimanna
Prevalence

- ~7% in paediatric population (estimated prevalence by Musiek & Chermak, also found on 400 children screened by IHR – D Moore, personal communication)
- in the elderly: 10- 20% in normal (Cooper and Gates, 1991) or >80% in audiological population (Stach et al., 1990)
- ? In younger adults?
- Strong epidemiological data lacking
Specific populations: Stroke

• Around 150,000 new cases per year in the UK
• Most common cause of severe disability

• (C)APD well documented in stroke, e.g., Griffiths et al., 1999; Bamiou et al., 2006.

• Own data: 52 year old TV/theatre director
  – presenting complaint: auditory difficulties re prosody and music appreciation
  – minor episode of (resolved) weakness.
  – Diagnosis: minor stroke (resolved), (C)APD due to a right auditory cortex lesion.

• Hearing complaints were the main symptoms for which the patient sought help
Hearing and stroke

- Stroke unit pts screened 10 days after admission
- Sound repetition test in the ward

- 41% failed test
- Screened vs. charted impairment: 86% would have been missed if not screened for.

- “findings support systematic screening for cognitive and perceptual domains known to influence functional performance, even when such deficits are not immediately apparent”

Hearing and stroke. What are the implications?

- Study to evaluate factors associated with functional decline in older patients with stroke living in the community
- Minimum Data Set for Home Care (MDS-HC) instrument
- All patients admitted to home care programs after a post-acute rehabilitation program

- Pt with hearing impairment (OR 1.83, 95% CI, 1.02–3.29) more likely to decline in physical functioning after 1 year

- “hearing impairment might represent an important limitation in participation of the patient in the post-acute rehabilitation programs with the consequence of lower level of physical performance”

Landi et al., European Journal of Neurology 2006, 13: 17–23
Specific populations: prematurity

- Premature babies: high risk for hypoxia/ischemia. At term: birth asphyxia


- Poorer language comprehension and auditory discrimination (Jansson-Verkasalo et al., 2004)

- Research: Neuroprotection with a low dose of Erythropoietin in rats with neonatal hypoxia-ischemia (McLure et al., 2006)

- Prematurity and hypoxia/ischaemia can lead to APD. Language and auditory processing ought to be assessed
Specific populations: the older adult

- Hearing in the elderly (Pichora-Fuller and Singh 2006) interaction of
  - age-related changes in peripheral hearing (cochlear & neural)
  - central auditory processing
  - cognitive processing

- Deficits in temporal processing, speech recognition (Gordon-Salant and Fitzgibbons, 2001), interhemispheric transfer (Bellis and Wilber, 2001)

- Rehabilitation plan ought to be informed by central auditory & cognitive assessment (Kricos, 2006; Pichora-Fuller and Singh 2006)

- Research: Role of drugs e.g. aspirin, GABA supplementation
2. How can it be diagnosed?

- Multidisciplinary assessment
- Current tests
- Additional assessments
- What the future holds
Integrating Information for Diagnosis

• “(C)APD: a deficit in neural processing of auditory stimuli that is not due to higher order language, cognitive, or related factors. However, (C)APD may lead to or be associated with difficulties in higher order language, learning, and communication functions.” ASHA, 2005

• Case History.
• Examination.
• Observation of auditory behaviours.
• **Audiologic test procedures- behavioural and electrophysiological**
• Speech and Language tests
• Psychology Assessment
• ADHD checklist (by 2 individuals)
Diagnosis of APD requires a multidisciplinary assessment

- Detailed audiometry (including tympanometry, acoustic reflexes, OAEs and suppression and ABR) to check peripheral hearing and auditory neuropathy/dyssynchrony
- APD tests should include ≥ 2 non-speech & speech tests
- Tests of language, cognition (e.g. verbal and non-verbal reasoning), and short term auditory memory
- Other: observation of the child in the classroom record of academic attainment etc

What type of test is required?

Which purpose will the test will be used for?
Examples:
• To screen for APD
• To identify/characterize specific auditory deficits
• To quantify the functional correlate /APD related disability
• To monitor disease progress
• To monitor outcome of intervention
• ? Site of lesion/DD with AN
Auditory Neuropathy – the psychophysical deficits

- Speech perception can be severely disrupted (Starr et al., 2000; Zeng et al., 2001).

- Minimal effects on loudness discrimination, pitch discrimination at high frequencies, and sound localization with ILD.

- Significant impairment of pitch discrimination at low frequencies, temporal tasks, sound localization with ITDs. (Zeng et al., 2005)

- 8 year old girl, seen for (C)APD assessment.
  - PTA fluctuates, but within normal.
  - ABR only wave V present & delayed.
  - Raised/absent acoustic reflexes
  - strong OAEs, poor suppression of OAEs.
  - Abnormal gaps-in-noise, random gap detection
  - normal dichotic digits and frequency pattern test.
  - Family history of late onset hearing loss - ?AN?
Behavourial Test Categories
(ASHA, 2005)

• Binaural Interaction tests
• Dichotic tests
• Monaural Low Redundancy Speech Tests
• Temporal tests
• Auditory discrimination tests
Test battery at GOSH and NHNN

• Baseline: PTA, OAEs (+ suppression), tymps and acoustic reflexes, ABR, speech in quiet

• Central auditory tests:
  – Dichotic Digits (F Musiek, Auditec)
  – Frequency and duration Pattern Tests (F Musiek, Auditec)
  – Gaps in Noise Test (F Musiek)
  – Random Gap Detection (Auditec)
  – Masking level Difference (Auditec)
  – Speech tests include the filtered words and auditory figure ground of SCAN-C (Keith) and a speech in babble test for adults (normed at the NHNN)
Additional assessments

- Children: An Ed Psych report and SLT report is a prerequisite to the child being offered an appt
- CHAPS questionnaire sent to be filled in by parents + teacher prior to appt
- Other: ADD referral, brain MRI as indicated

- Adults: referred for formal psychometry (incl verbal & non verbal skills, auditory + visual memory) after visit to the clinic. Kramer’s questionnaire (currently validated as MSc project). Additional as indicated (+ brain MRI)

- Additional Electrophysiology
Additional assessments

- Other dichotic tests
- Environmental sound CD
- Montreal Battery of Evaluation of Amusia Peretz et al., 2003 (adults)
- Gordon’s Musical Aptitude profile (children)
- Newcastle Auditory Test battery (Griffiths et al., 2001)
Masking Level Difference

- Presentation of pulsed tone (500 Hz) or spondee word to both ears simultaneously with binaurally presented masking noise.
- Signal Threshold for homophasic (S and N in-phase) and antiphasic (S and N out of phase) condition.
- Difference of the two = MLD
Monaural low redundancy speech tests

• Filtered speech: low pass filtered speech, monaurally presented.
• Speech in Noise/babble (White noise/speech noise/multitalker babble)

• Little difference in performance between the two ears
• Language factors
• Moderately sensitive
Dichotic tests

• Binaural integration or separation tasks

• Binaural integration:
  – Dichotic Digits, CVs
  – Staggered Spondaic Words

• Binaural separation:
  – Competing Sentences
  – Synthetic Sentence Identification with Contralateral Competing Message
Dichotic Digits

- Sensitivity > 70%, specificity > 90%
- Low linguistic load
- Relatively resistant to cochlear SNHL
- R ear advantage in younger children which decreases with age - minimal by age 12

Affected by attention & memory – what does the test measure?
Temporal tasks

- Duration Pattern Tests
- Frequency Pattern Tests
- Gap Detection
Frequency / Duration Patterns

- Three tone burst sequences of
  - High (1122 Hz) and Low (880 Hz) frequency tone
  - Long (500ms) and Short (250ms) 1000 Hz tone
Frequency /Duration Patterns

• Subject requested to label the sequence (high-high-low, or long-short-long)
• Pattern recognition on R hemisphere, labelling on L hemisphere

• Not affected by SNHL
• >80% sensitivity, >90% specificity
Gaps in Noise test

- Monaural presentation of a 6 s white noise burst, in which 0 - 3 gaps of varying duration (2ms to 20ms) are embedded.
- Patient has to identify number of gaps in each noise burst.
Screening procedures: SCAN and SCAN-A

Filtered words: reflects ability to understand distorted speech in a poor acoustic environment (auditory closure)

Auditory Figure ground: reflects ability to understand speech in background competing noise

Competing Words/Sentences: indicates auditory maturation
SCAN and SCAN-A

- Easy to administer, quick
- From 3 years onwards

But:
- Test-retest reliability
- Validity (not validated on CANS lesions)
- Small normative data sample
- Screening, not diagnostic procedure
Minimal APD Test Battery

• Behavioural
  – PTA
  – Performance – intensity functions for word recognition
  – Dichotic tests
  – Duration pattern sequence test
  – Temporal gap detection

• Electrophysiological
  – Immitance audiometry
  – OAEs
  – ABR and MLR

• Consider testing other modalities, eg vision

Consensus Conference on APD in Children, 2000
CAPE testing battery (IHR, UK)

14 measures of auditory processing

Normative study incl:
- peripheral hearing tests
- speech in noise and in quiet
- performance IQ, language
- memory, attention

Simple and composite measures of auditory processing abilities
Dissociations with other related skills

Moore, Aud Medicine 2006
3. How can it be managed?

- **Management strategies**
  - Signal enhancement strategies
  - Auditory Training
    - Formal
    - Informal
  - Linguistic, cognitive, metacognitive and educational strategies

Bamiou, Campbell, Sirimanna Audiological Medicine 2006;4:46-56.
Auditory Training: Formal

- AT as indicated from auditory test battery in clinic

- Earobics (Cognitive Concepts, Inc 1997)  

- FastForWord (Scientific Learning Corporation, 1997)  

- Phonomena (Mindweavers, 2005)  
  [http://www.mindweavers.co.uk/main.asp](http://www.mindweavers.co.uk/main.asp)
AT for older adults

- Brain Fitness Program (Posit Science)
- 6 adaptive exercises
- 5-day weekly, hour-long training sessions for 8 weeks
- specifically designed for older adults.
- A randomized controlled study in 182 adults aged > 60 showed that the group who performed this programme over 8 weeks attained significant improvements in the trained tasks as well as in a standardized neuropsychological measure of memory function (vs. no improvement of the control groups) (Mahncke et al., 2006).
- this improvement was maintained 3 months after the end of training (Mahncke et al., Ann N Y Acad Sci 2006).
4. Clinic structure

• Tertiary environment
• Ideal team should include
  – Medic (audiological physician/neurologist/paediatrician/ENT)
  – Scientist
  – SLT
  – Ed Psychologist/Clinical psychologist
  – ToD
  – Hearing Therapist
  – Occupational therapist
  – etc
Children's National Service Framework (NSF)

• The Children's NSF aims to ensure that children and young people who are disabled or who have complex health needs, receive co-ordinated, high-quality child and family-centred services which are based on assessed needs, which promote social inclusion and, where possible, enable them and their families to live ordinary lives.

• The three priority areas to improve outcomes for disabled children are:
  • access and empowerment
  • responsive services and timely support
  • improving quality and capacity
Final Comments

- Ignorance amongst professionals – is APD a “hearing” disorder? Is it a sensory impairment? Need to educate them re referrals
- Increasing awareness in public
- However, patients who seek you out may not be APD
- Conversely, APD patients do not necessarily perceive their problems analysing sound as “hearing” problems
Final Comments

- Addressing the need of the child/adult with APD can be costly – who foots the bill?
- Patients and their families may need to fight with educational/other authorities to persuade them to meet their needs
- Frustration and different coping mechanisms
- Evidence-based approach needed, but info lacking
- Guidelines & legislation
THANK YOU FOR YOUR ATTENTION!

Any questions?