AUDITORY PROCESSING DISORDER IN CHILDREN: INTEREST OF A MULTI-DISCIPLINARY ASSESSMENT

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Abstract

Auditory Processing Disorder (APD) affects 0.5-7% of the pediatric population. This disorder is responsible for a child’s low hearing ability. The diagnosis of APD is difficult because of polymorphic symptoms possibly entangled with other difficulties (learning, communication, attention ...). We opened a multi-disciplinary consultation for the children suspected of APD. The purpose of this study is to analyze this multi-disciplinary assessment.

32 children benefited from a multidisciplinary consultation with:
- targeted behavioral assessment APD: speech-in-noise perception, dichotic listening test, temporal processing tests.
- psychometric assessment: assessment of visual / auditory working memory, visual / auditory attention, study of cognitive functions.
- ENT examination with otoscopy, tonal and vocal audiometry and ABR recording.

The main reason for consultation was linked to difficulties to understand in the noise for 52% of patients. A diagnosis of APD was reached for 9 children (39% of cases), this diagnosis was ruled out for 11 children and remained doubtful in 3 cases. The average age was 10 years old. 9 patients were excluded from the study. Associated disabilities were found in 2/3 of the children.

Auditory Processing Disorder is a common pathological condition that remains difficult to diagnose. Today, this diagnosis is based on several arguments, facilitated by a multi-disciplinary approach, allowing to propose an adequate remediation.

Key words: Auditory Processing disorder (APD), attention, children
1. Introduction

Children with Auditory Processing Disorders (APD) have poor hearing abilities with sometimes significant difficulty hearing in noise, while their peripheral hearing is normal [1-4]. This disorder could affect 0.5 to 7% of an age group [1-2].

The diagnosis of APD remains difficult because this clinical entity is poorly identified. Some symptoms may be part of other specific disorders, and some children may present several difficulties (attention deficit and hyperactivity disorder, overall learning difficulties, specific language disorder, etc.) [1,5-7].

The international recommendations for the diagnosis of APD are to conduct an assessment combining an audiological assessment and a targeted speech evaluation [1,3-4,8].

Children with suspected APD were assessed in a multi-disciplinary approach in order to improve methods of diagnosis. The purpose of this study was to analyze this evaluation protocol.

2. Materials and Methods

32 children were seen in a multi-disciplinary consultation for Auditory Processing Disorders in Necker Hospital - Department of Audiology, between October 2015 and March 2018.

The evaluation included:
- An ENT consultation with clinical examination, otoscopy under microscope.
- Tonal and vocal audiometry in silence in separate ears.
- A recording of auditory brainstem responses (ABR) in order to eliminate an auditory neuropathy.
- A targeted Auditory Processing (AP) speech assessment:
  - Speech perception in noise test: a list of words (Boorsma before 8 years old, Fournier from 8 years old) and sentences (Hint) in noise; with a signal to noise ratio (SNR) of 0dB and +5dB.
  - The results were considered pathological when the child recognized less than 50% of words with a signal to noise ratio at 0 dB, and less than 80% with a signal to noise ratio at +5dB, whether for word lists or sentence lists.
  - Dichotic listening test: number of digits, words and syllables repeated in a directed (or forced) report, as well as in free report. Results were analyzed using standard deviation, in comparison to normalized scores (according to the age of the child) [9].
• Frequency and duration patterns test. Scores were analyzed in standard deviation from normalized scores (according to the age of the child) [9]. This test was carried out from September 2017.
Stimuli were delivered in a helmet at 60dB.

Children were identified as having APD when at least two of the AP test scores were 2 Standard Deviations (SDs) below the mean or when only one test was 3 SDs below the mean [3-4,6].

- A psychometric assessment (carried out from September 2017):
  2 different tests were carried out according to the age of the patient, TEA-CH from 6 to 12 years and 11 months old, WISC-IV from 13 to 16 years and 11 months:
  - Assessment of auditory and visual memory.
  - Assessment of auditory and visual attention.
  Difficulties were identified when the tests scored were below 2 SDs.

  A diagnosis of APD was made if the targeted APD speech assessment was pathological according to the described criteria, in agreement with the recommendations of the literature [3-4,10].
  A diagnosis of APD was ruled out in case of peripheral hearing loss, auditory neuropathy, visual attention disorder, untreated attention disorder, important cognitive failure (IQ below 80).

3. Statistical Analyses

  Percentage comparisons between disordered and normal groups were made using the Pearson Chi-2 test (and Yates if less than 5).

4. Results

  32 children were tested for APD following this diagnostic approach detailed above. 9 children were excluded from the study (children with hearing loss, children that were too young or children with other difficulties making the assessment impossible).

  The 23 children included in the study all had normal peripheral hearing, and no auditory neuropathy. 6 children presented to the hospital with complaints of hearing impairment, 12 consulted for significant difficulties hearing in noise, 3 had significant difficulties and delays in their speech ability, 1 presented with memory difficulties and 1 child had a significant slow performance associated with hearing difficulties.

  All children spoke French, 3 were bilingual. They were aged between 6 and 17 years old. The average age was 10 years.
A diagnosis of APD was made for 9 patients (39%). It was not retained in 11 of them. The diagnosis remained uncertain for 3 patients.

The results are reported in Table 1 according to the selected diagnosis.

<table>
<thead>
<tr>
<th>Table 1- Comparison of tests scores between normal and disordered groups</th>
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<tbody>
<tr>
<td><strong>Children with APD</strong></td>
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<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Words list, S/B O dB</td>
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<tr>
<td>Words list, S/B + 5dB</td>
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<td>S/B sentences lists +5dB % of words</td>
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<td>Dichotic Test</td>
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<td>Pattern: duration</td>
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<td>Pattern: frequency</td>
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<td>Auditory attention</td>
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<td>Visual attention</td>
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* The difference is statistically significant.

5. Discussion

APD can be responsible of many difficulties: difficulty understanding speech in complex listening situations; message; difficulty localizing the source of an auditory signal; misunderstanding messages; frequently requesting repetitions; difficulty with similar sounding words; difficulty following complex auditory directions/commands; difficulty learning songs; difficulty learning foreign language… [1, 3-4, 11]. These abnormalities on auditory signal processing can have consequences, or even coexist with acquisition difficulties, and thus have repercussions on academic performance.

Academic difficulties related to this low audibility (increased in difficult listening conditions) are an increasingly frequent reason for consultation.

There is currently no gold standard for diagnosing APD. The international recommendations include: audiological assessment, targeted speech evaluation, and brain imaging [1, 3-4, 8]. This prompted us to open a multi-disciplinary consultation to improve the diagnosis and therefore the care of these children.
Our protocol was modified from September 2017 till now with the addition of a psychometric assessment of attention, visual and auditory working memory (TEA-CH from 6 to 12 years and 11 months old, WISC-IV from 13 to 16 years and 11 months), and pattern analysis (duration and frequency).

Several studies have linked APD and Attention Deficit Disorder (ADHD), either directly as a consequence of audibility difficulties, or as a cause of APD or as two separate entities that can co-exist [2,8,12]. Attention and cognitive skills should be systematically evaluated if an APD is suspected [1-2, 6, 8, 11-12].

The primary cause of consultation was difficulties understanding speech in complex listening situations with background noise (52%), which was found in 33% of the APD group.

The analysis of perception in noise in French is difficult because of the absence of standardized tests according to the age of the child. The results were considered pathological when the child recognized less than 50% of the words with a signal to noise ratio at 0 dB, and less than 80% with a signal to noise ratio at +5dB, whether for word lists or sentence lists.

The dichotic test (number of digits, words and syllables) repeated in a directed report, as well as in free report was pathological in 7 out of 9 children with APD (78%) and never pathological in children without APD (0/11). Ear prevalence was always on the right side in the APD group.

The study of the temporal processing of the acoustic signal consisted of two tests, the duration and the frequency pattern test. The duration pattern has never been pathological regardless of the child group (APD or no). The frequency pattern was pathological in 2 out of 3 children in the APD group (67%) and normal for all in the group without APD (0/6).

4 children in the APD group had an attention assessment: in 3 cases, this assessment was pathological concerning auditory attention (75%) and in one case, it was pathological for auditory and visual attention (25%). A cognitive assessment was carried out in 5 cases within the group of children diagnosed with APD. The test was normal for 2 children, it was of average low level for 2 children and in favor of a high potential for a child. In the group without APD, among 5 children tested, 3 had a low average level.

15 out of 23 patients had associated disorders (65%). Among patients diagnosed with APD, 6 had associated difficulties (66.7%).

Among the APD group, 6 children had academic difficulties (66.7%), and none of them had grade repetition.

In the non-APD group no child had failed the dichotic test and the auditory attention test (specificity at 1). Among the group of children diagnosed with APD, the tests that have the best sensitivity are: the dichotic test (0.77), the frequency pattern, the assessment of auditory attention and the study of perception in noise background (sentences with a signal / noise ratio of +5dB). These results are in agreement with the data from the literature [8,10,12-13].

The low number of children for patterns test and auditory attention should lead us to be cautious in interpreting the results of the statistical analysis performed.

6. Conclusion
The diagnosis of APD remains a challenge. The multi-disciplinary approach has taken into account the attention difficulties as well as the cognitive deficits that can be associated or coexist with this pathology. In addition, the assessment of speech perception in French in noise must use standardized tests according to the age of the child. According to data from the scientific literature, the most effective tests to make a diagnosis of APD are: the dichotic test, the frequency pattern, the assessment of auditory attention. The interest of these tests is that they combine verbal and nonverbal tests, evaluate attention and identify possible cognitive problems associated to the APD. It is important to pursue the study in order to evaluate this protocol on a larger number of patients to confirm these initial results.

REFERENCES


