A DICHOTIC DIGIT TEST AS A SENSITIVE TOOL TO SCREEN AND ASSESS AUDITORY PROCESSING DISORDER IN CANADIAN FRENCH-SPEAKING CHILDREN: RESULTS FROM A PILOT STUDY

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The aim of the present pilot study was to develop a test to screen children with suspected auditory processing disorder (APD). Twenty-one school-aged children with listening or learning difficulties participated in the study. They performed three screening psychoacoustic tests and one memory span test before being assessed with a full auditory processing test battery used to diagnose APD. Results showed that three children had an APD diagnosis. Based on these findings, sensitivity and specificity of the screening tool were calculated. Results revealed that the best percentage of these two psychometric parameters was reached when children failed two out of the three psychoacoustic tests.

Keywords: auditory processing disorder, children, auditory perception
1. Introduction

Children with auditory processing disorder (APD) experience more difficulties in processing auditory information than typical developing children, especially in noisy environments (Jutras et al., 2007; Lagacé et al., 2010). No screening test in French is available to identify children at risk of APD. In English, questionnaires exist to screen APD among children having listening difficulties (Emanuel, 2002; et al. 2011), such as Children’s Auditory Performance Scale (CHAPS, Smoski, Brunt, & Tannahill, 1998), Screening Instrument for Targeting Educational Risk (SIFTER; Anderson, 1989) and Fisher’s Auditory Problems Checklist (FAPC; Fisher, 1985). However, according to Yathiraj et al. (2014)’s results, the combination of a questionnaire with psychoacoustic tests increased the sensitivity and the specificity of the screening test.

This pilot study was the first step to create a tool with good sensitivity and specificity to screen children who might have APD. Thus, this tool may be helpful to identify children who need a complete audiological evaluation to either rule out or confirm a diagnosis of APD.

2. Methods

Twenty-one 7-13 year-old children participated in the pilot study. They had normal hearing thresholds (250-8000 Hz) in both ears and no known neurological disorder or intellectual disabilities, as reported by the parents. Those with an attention deficit, controlled with medications, were included in the study.

The screening test battery was composed of a questionnaire and four psychoacoustic tests: (1) Dichotic Digit Test (DDT) with 10 pairs of double pairs of digits (Jutras et al., 2012). The participants were asked to repeat all the digits heard. (2) Words in Noise Test (WNT) (Lagacé et al., 2013) with 10 monosyllables presented monaurally in a babble noise and the children were asked to identify each of them. (3) Pitch Pattern Sequencing Test (PPST) (Musiek et al., 1987) with 15 sequences of three pure tones (one has a different frequency than the other two) presented in one ear at the time and the task was humming the sequence of the tones. (4) Digit memory span test where the participants repeated the series of digits in forward or reverse order.

The evaluation test battery comprised the same three first tests, but with more items: 20 items for the DDT, 35 items for the WNT and up to 30 items for the PPST. The participants repeated what was heard. Two more tests were added: (1) Duration Pattern Test (Musiek et al., 1990) where up to 30 sequences of three tones were presented monaurally, two tones had the same duration and the participants repeated the sequences of the tones. (2) Random Gap Detection Test (RGDT) (Keith, 2000) composed of series of two tones presented binaurally where the gap in between the two sounds varied randomly between 2, 5, 10, 15, 20, 25, 30 and 40 ms. Sometimes, only one sound was presented. The task was to say if one or two sounds were heard. The children were assessed first with the screening test battery and then with a clinical auditory processing test battery.

3. Results

Three out of the 21 participants failed the clinical APD test battery (APD group). Six failed the screening dichotic listening test (see Table 1) and three of them were in the APD group; one failed the screening frequency sequencing test (see Table 1) with no participant in the APD group and one failed the screening words in noise test (see Table 1) and this child was in the APD group. Among the auditory tests used in the screening protocol, the dichotic digit test was the only one that identified all the participants diagnosed with APD.
Table 1: Number of participants out of 21 failing the auditory processing screening and/or evaluation tests

<table>
<thead>
<tr>
<th>Tests</th>
<th>Screening</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dichotic Digit Test</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Pitch Pattern Sequencing Test</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Duration Pattern Test</td>
<td>---</td>
<td>2</td>
</tr>
<tr>
<td>Random Gap Detection Test</td>
<td>---</td>
<td>0</td>
</tr>
<tr>
<td>Words in Noise Test</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Digit Span Test</td>
<td>7*, 17**</td>
<td>---</td>
</tr>
</tbody>
</table>

* Forward, ** Reverse

Based on the preliminary results, sensitivity (test being able to identify the participants with APD) and specificity (test being able to identify the participants without APD) of the auditory processing screening test battery was calculated with three scenario – when a participant failed one, two or three tests (see Table 2). Results showed that the sensitivity and the specificity got the higher percentage when participants failed two tests in the screening battery.

Table 2: Examples of the sensitivity and the specificity of the auditory processing screening test

<table>
<thead>
<tr>
<th>Results</th>
<th>One test failed</th>
<th>Two tests failed</th>
<th>Three tests failed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>APD</td>
<td>No APD</td>
<td>APD</td>
</tr>
<tr>
<td>Abnormal</td>
<td>3 (TP)</td>
<td>3 (FN)</td>
<td>3 (TP)</td>
</tr>
<tr>
<td>Normal</td>
<td>0 (FN)</td>
<td>15 (TN)</td>
<td>0 (FN)</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>100%</td>
<td>100%</td>
<td>33%</td>
</tr>
<tr>
<td>Specificity</td>
<td>83%</td>
<td>94%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Sensitivity = TP / (TP + FN) x 100  
Specificity = TN / (TN + FP) x 100  
TP - True Positive; FN - False Positive; TN - True Negative; FN - False Negative

4. Conclusion

The aim of the present pilot study was to develop a test battery with good sensitivity and specificity to screen children with APD. Out of 21 school-aged participants, three had APD. When examples of sensitivity and specificity calculations were performed with one, two or three failed tests in the screening battery, the best percentage of these two psychometric parameters was reached when two tests were failed. Furthermore, the dichotic digit test seems the most sensitive screening test to refer children for a full APD clinical assessment.

REFERENCES


6 Anderson, K. *SIFTER: Screening instrument for targeting educational risk in children identified by hearing screening or who have known hearing loss*. Tampa, FL: The Educational Audiology Association, (1989).


