

Caroline Nunes Rocha-Muniz<sup>1</sup>  
 Renata Filippini<sup>1</sup>  
 Ivone Ferreira Neves-Lobo<sup>2</sup>  
 Camila Maia Rabelo<sup>2</sup>  
 Aline Albuquerque Morais<sup>1</sup>  
 Cristina Ferraz Borges Murphy<sup>1</sup>  
 Karenina Santos Calarga<sup>1</sup>  
 Líbia Camargo Ribeiro Leite<sup>1</sup>  
 Mayra Monteiro Pires<sup>1</sup>  
 Taise Argolo Sena-Yoshinaga<sup>1</sup>  
 Eliane Schochat<sup>2</sup>

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### Correspondence address:

Caroline Nunes Rocha-Muniz  
 Rua Cipotânea, 51, Cidade Universitária,  
 São Paulo (SP), Brasil, CEP: 05360-000.  
 E-mail: carolrocha@usp.br

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# Can speech-evoked Auditory Brainstem Response become a useful tool in clinical practice?

## *O Potencial Evocado Auditivo com estímulo de fala pode ser uma ferramenta útil na prática clínica?*

### ABSTRACT

**Purpose:** To discuss the clinical applicability of the speech-evoked Auditory Brainstem Response (speech-evoked ABR) to help identifying auditory processing disorders. **Methods:** We analyzed the records of 27 children and adolescents, aged between seven and 15, who presented abnormal speech-evoked ABR. Then, the data from the behavioral auditory processing evaluation of these individuals were surveyed. **Results:** It was observed that, among the 27 children with abnormal speech-evoked ABR, 23 also had auditory processing disorders. Therefore, from this sample, an 85.15% probability of observing abnormal behavioral assessment of auditory processing in a child who presented abnormal speech-evoked ABR was obtained. **Conclusion:** It is argued that the speech-evoked ABR can be used in clinical practice as an important aid tool in the diagnosis of auditory processing disorder, because, in this study, an abnormal speech-evoked ABR usually represented a deficit in the results of behavioral assessment of auditory processing. Thus, it can be used to obtain information about the perception of speech sounds in children under seven years or with challenging behavioral assessment.

### RESUMO

**Objetivo:** Discutir a aplicabilidade clínica do Potencial Evocado Auditivo com Estímulo de Fala (PEATEf) no auxílio à identificação dos transtornos do processamento auditivo. **Métodos:** Foram selecionados os prontuários de 27 crianças e adolescentes, com idade entre sete e 15 anos, que apresentaram alteração no PEATEf. Foram levantados os dados referentes à avaliação comportamental do processamento auditivo desses indivíduos. **Resultados:** Observou-se que das 27 crianças com PEATEf alterado, 23 também apresentaram alteração de processamento auditivo. A partir dessa amostra, foi possível apontar probabilidade de 85,15% em observar avaliação comportamental do processamento auditivo alterada em uma criança que apresentou PEATEf também alterado. **Conclusão:** Sugere-se que o PEATEf pode ser utilizado na prática clínica como uma ferramenta importante no diagnóstico do Transtorno do Processamento Auditivo, uma vez que neste estudo uma alteração do PEATEf quase sempre representou, também, uma alteração nos resultados da avaliação comportamental do processamento auditivo, portanto pode ser utilizado para obter informações acerca da percepção dos sons da fala em crianças menores de sete anos ou de difícil avaliação comportamental.

Study carried out at the Department of Physical Therapy, Speech-Language Pathology and Audiology and Occupational Therapy at the School of Medicine, Universidade de São Paulo – USP – São Paulo (SP), Brazil.

(1) Graduate Program in Rehabilitating Sciences at the Department of Physical Therapy, Speech Language Pathology and Audiology and Occupational Therapy at the School of Medicine, Universidade de São Paulo – USP – São Paulo (SP), Brazil.

(2) Speech Language Pathology and Audiology Course at Department of Physical Therapy, Speech Language Pathology and Audiology and Occupational Therapy at the School of Medicine, Universidade de São Paulo – USP – São Paulo (SP), Brazil.

**Conflict of interests:** nothing to declare.

## INTRODUCTION

Approximately 35 years ago, Greenberg<sup>(1)</sup> presented the first study using speech as a stimulus in Auditory Brainstem Response (speech-evoked ABR) to the scientific community, and demonstrated that specific acoustic information of speech sounds is codified by ABR with great accuracy. In Brazil, speech-evoked ABR has been studied for approximately 10 years, and has only a few publications<sup>(2-6)</sup>.

Researchers have been trying to establish reliable normative criteria for speech-evoked ABR response parameters<sup>(7-10)</sup>, once this potential is capable of representing the acoustic properties of the stimulus (i.e., speech formants are totally preserved in the brain stem response<sup>(8)</sup>) changes in this response may represent changes in the perception of speech characteristics.

Many studies agree as to the association between abnormal responses in speech-evoked ABR and difficulties in speech auditory processing (AP)<sup>(5-9)</sup>; however, one of the main issues related to this potential refers to its clinical use.

Despite being well established both clinically and scientifically as the main tool used to diagnose Auditory Processing (AP) deficits, the evaluation of AP is influenced by top-down factors (cognition and language), motivation, and fatigue<sup>(11)</sup>, besides the possibility that other associated disorders may compromise the necessary conditions for the reliability of behavioral responses. Therefore, it is recommended that the auditory processing disorder (APD) be diagnosed carefully on the basis of the analysis of a set of tests and on the support of electrophysiological evaluations<sup>(12)</sup>.

Thus, considering the variables involved in the establishment of an accurate APD diagnosis and the contributions of speech-evoked ABR to evaluate the elements that underlie the auditory processing of speech, the objective of this study is to discuss the clinical applicability of speech-evoked ABR as an aid to identify APD through the analysis of behavioral evaluation of children with abnormal speech-evoked ABR.

## METHODS

This retrospective study used a data survey in an Auditory Processing Diagnostic Center from a public institution. This study was approved by the Ethics Committee (protocol no. 1049/07).

Medical records from 27 individuals, aged between 7 and 15 years old (mean: 10 years), were selected. They presented abnormal speech-evoked ABR and complaints regarding AP, without evidence of neurological or psychiatric changes, and had normal hearing evaluation. The data were surveyed from anamnesis and the behavioral evaluation of the AP.

An speech-evoked ABR was conducted with the *Navigator Pro-Bio-Logic*, equipped with BioMAP (current BioMARK). The parameters used to obtain speech-evoked ABR were in accordance with criteria previously established in the literature<sup>(11)</sup> as follows: the stimulus used consisted of the five first formants of the syllable [da] (40 ms), presented monaurally

(right ear), in alternate polarities at 80 dB SPL and presentation rate of 10.9 stimuli/second. The recording window was of 74.67 ms, with a 100 Hz high-pass and 2,000 Hz low-pass filters.

Two sweeps of 3,000 stimuli were carried out. After the replication of the waveforms, a grand average was performed, and in the resulting waveforms the waves V and A were marked (Figure 1). Abnormal speech-evoked ABR was determined by the score generated by the algorithm contained in BioMAP, which is based on the values of five response parameters: wave V latency, wave A latency, slope, frequency of the first formant, and high frequencies. speech-evoked ABR was considered abnormal when the score ranged between 7 and 22<sup>(13)</sup>.

All individuals had been evaluated by at least five of the following behavioral tests: Sound Localization, Sequential Memory for Non-Verbal Sounds, Sequential Memory for Verbal Sounds, Speech perception in Noise or Identification of Figures with Noise, *Staggered Spondaic Word Test*, Frequency and Duration Pattern tests, and *Gaps in Noise*. The normality criteria of the behavioral tests were those previously established<sup>(14)</sup>. The individual was considered with APD when presenting deficit on at least one test<sup>(15)</sup>.

Data analysis was descriptive and qualitative, and the probability of obtaining abnormal AP in relation to abnormal speech-evoked ABR was observed.

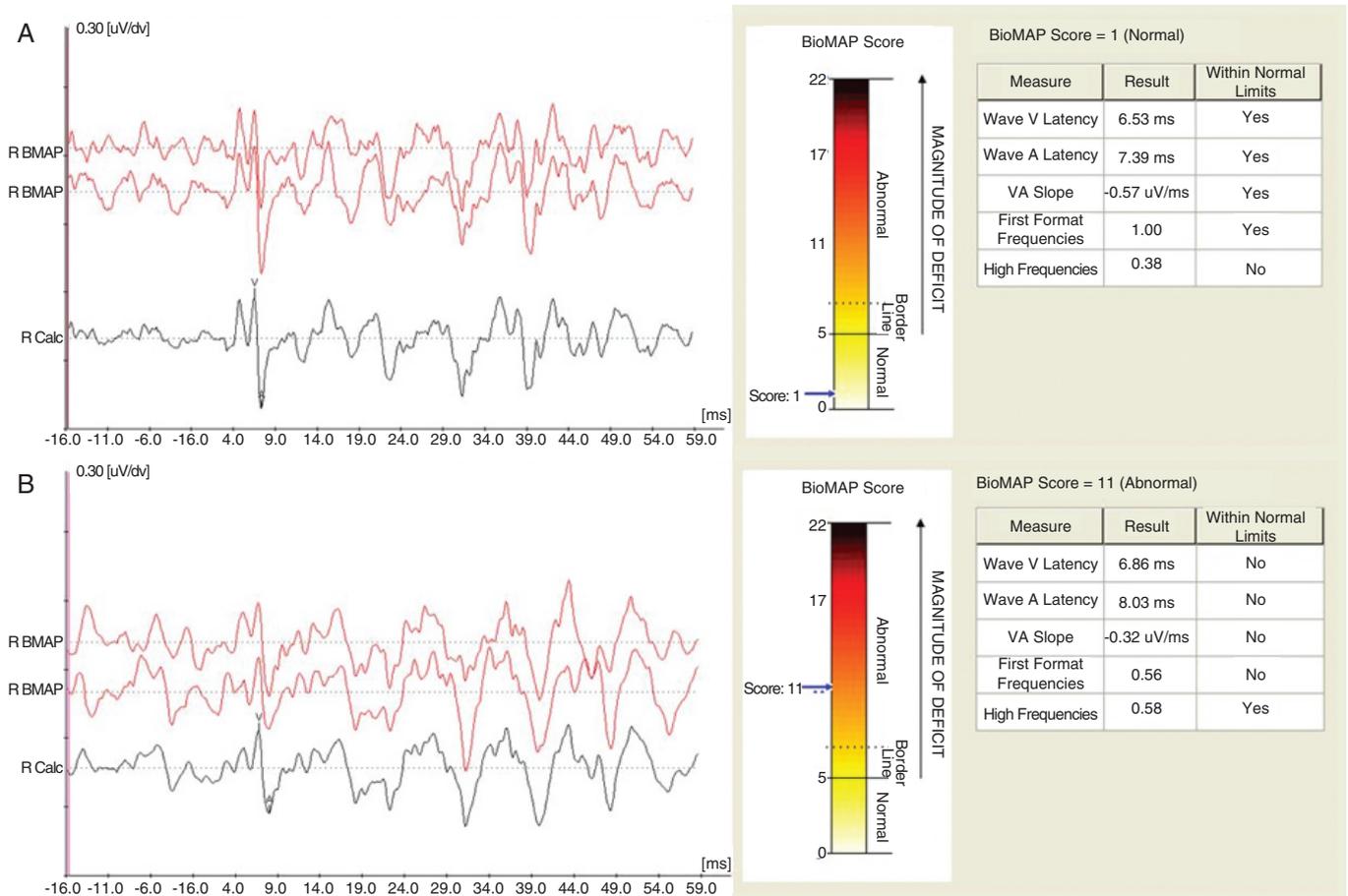
## RESULTS

It was observed that among the 27 children with abnormal speech-evoked ABR, whose medical records were analyzed, 23 presented AP deficits (Table 1). Based on this sample, we observed an 85.15% probability of obtaining deficits on behavioral evaluation of the AP in a child with abnormal speech-evoked ABR.

## DISCUSSION

The analysis allows inferring that abnormal speech-evoked ABR has a high level of accuracy in the positive diagnosis of APD. In other words, an abnormal speech-evoked ABR means there are great chances (85.15%) that the individual demonstrate deficits in the AP behavioral evaluation. Similar results were also observed in a previous study<sup>(7)</sup>, which observed the responses of children with APD, and demonstrated that 80% of them had abnormal speech-evoked ABR. These data are in accordance with studies that showed a major relationship between deficits in speech-evoked ABR and in auditory perception<sup>(6-8)</sup>, and that demonstrated improved speech-evoked ABR response after auditory stimulation<sup>(5,9,11)</sup>.

Based on the observations of the present study, and on the current knowledge about speech-evoked ABR, it is possible to discuss some clinical applications of this potential. Its main application lies on the differential diagnosis of APD and on monitoring the benefits of auditory stimulation in those cases. Among the auditory evoked-potentials that have been related to AP deficits, speech-evoked ABR



In red, waves with 3,000 stimuli each; in black, the grand average of these waves. Panel A: individual with normal ABR, according to the score provided by BioMAP. Panel B: individual with abnormal ABR, according to the score provided by BioMAP.

**Caption:** ABR = Auditory Brainstem Response.

**Figure 1.** Example of ABR waveforms

**Table 1.** Distribution per age group and gender of individuals with abnormal speech-evoked potential, according to the performance in auditory processing behavioral tests

AP	7 to 8 years old				9 to 10 years old				11 to 16 years old			
	Normal		Abnormal		Normal		Abnormal		Normal		Abnormal	
	n	%	n	%	n	%	n	%	n	%	n	%
Male	0	0	8	80	1	11	4	44	1	12.5	4	50
Female	1	10	1	10	1	11	3	33	0	0	3	37.5
Total	1	10	9	90	2	22	7	78	1	12.5	7	87.5

**Caption:** AP = Auditory processing.

is the one that seems to be more reliable, with lower intra- and inter-subject variability and has well-established normative criteria.

In addition, speech-evoked ABR can be used to assess younger children, for whom behavioral tests are not standardized, because after the age of five the response of children to speech-evoked ABR is expected to be similar to that of adults<sup>(13)</sup>. Therefore, speech-evoked ABR deficits in these children may represent a disorder in the auditory system, which would allow early intervention, even without the results of a behavioral evaluation. The same can be said for children with non-auditory deficits, which can make it difficult to perform an AP behavioral evaluation<sup>(11)</sup>.

**CONCLUSION**

In this study, it was observed that speech-evoked ABR deficits usually represent AP deficits, which allows the suggestion of speech-evoked ABR in clinical practice as an aid tool to evaluate AP. It can also provide information regarding the speech sound perception among children with difficult behavioral evaluation.

\*CNRM, RF, FNL, and CMR proposed the original idea, collected and analyzed data, and wrote and revised the manuscript; AAM, CFBM, KSC, LCRL, MMP, and TASY collected and analyzed data, reviewed the literature, and wrote the manuscript; ES proposed the original idea, coordinated the study, and revised the manuscript.

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