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Speech-evoked brainstem response in normal adolescent and children speakers of Brazilian Portuguese

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ABSTRACT

This study aimed to analyze the coding responses of speech sounds (syllable/da/) in children and adolescent speakers of Brazilian Portuguese with typical development and normal hearing, aged between 8 and 16 years, in order to establish normative data of speech ABR response. This normative data can be used as a reference for speech ABR responses and also to enable the diagnosis in individuals with different pathologies. The analyze for absolute latency of speech sounds, more specifically the syllable/da/, for speech-ABR in children and adolescent speakers of Brazilian Portuguese with typical development were: right ear - wave V (6,43–6,57), wave A (7,35–7,57), wave C (18,19–18,46), wave D (21,99–22,42), wave E (30,73–31,05), wave F (39,19–39,55) and wave O (47,75–48,24) and left ear - wave V (6,44–6,57), wave A (7,36–7,59), wave C (18,26–18,55), wave D (22,22 -22,50), wave E (30,58–30,97), wave F (39,05–39,35) and wave O (47,78–48,13). For the amplitude values (μv), the responses were within the following ranges: right ear - wave V (0,10–0,14), wave A (0,19–0,25), wave C (0,08–0,13), wave D (0,11–0,17), wave E (0,17–0,42), wave F (0,14–0,33) and wave O (0,11–0,31) and left ear - wave V (0,09–0,13), wave A (0,08–0,23), wave C (0,08–0,14), wave D (0,10–0,15), wave E (0,20–0,26), wave F (0,16–0,22) and wave O (0,12–0,20). For the values of complex VA (slope: μv/ms and area μv x ms) the follow values obtained were: right ear – slope (0,32–0,42) and area (0,29–0,38) and left ear – slope (0,30–0,39) and area (0,27–0,35).

1. Introduction

The Speech ABR has recently emerged as a neurophysiological procedure to evaluate complex sound stimuli [1–3]. Previously, the evaluations of ABR were carried out only with non-verbal stimuli to analyze the integrity of auditory pathways and to establishment electrophysiological thresholds, enabling ascertain basic neural abnormalities and assisting the evaluation when the patients not provide reliable answers in behavioral audiological evaluations [4]. Technological advances have permitted the inclusion of this new stimulation mode in the ABR equipment.

Studies have shown that the results obtained of speech ABR allows to confirm the biological processes involved in analysis of the brainstem verbal sounds in normal individuals and/or in different clinical populations [3,5,6] This analysis become important, once the speech perception of speech sounds, which begins in the brainstem, are related of reading process and phonological acquisition [7–9]. Speech ABR evaluation is an effective and objective way to investigate this process which allows the identification of fine-grained auditory processing deficits associated with real-world communication skills. One of the great advantage of this assessment it potentially can be used for early identification of auditory processing impairments in very young children [10]. Specially, the speech ABR might be used as an objective measure of hearing function. Another great advantage is that this method is not influenced by environmental issues, which can disrupt the behavioral assessments, once the behavioral tests can be affected by some factors such as attention, motivation, fatigue and co-occurring disorders such as language impairments, learning impairments or attention deficits [11].

The majority of studies with speech ABR were performed with

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native English [3,12]. However, researchers have been able to evaluate native speakers of different nationalities due to the wide dissemination of findings in international publications [12].

There is an important difference between cultural and social reality of Brazilian children compared to English children. Thus, this research could be used as a reference for studies with individual speakers of Brazilian Portuguese. Learning difficulties have been the most common pathology in Brazilian children and speech ABR has proven an effective tool to monitor them. However, before develop studies of speech ABR in children with different pathologies is required know the standard of normality in children with typical development.

The Brazil is the largest country in both South America and the Latin America region and the largest Portuguese-speaking in the world. It is the world's fifth-largest country, both by area and population, around 205 million [13,14]. The Portuguese language is the only language used in schools, newspaper, radio and TV [15,16]. Some researchers have published studies of speech ABR in Brazil with native speakers of Brazilian Portuguese, however, among the developed studies, only one of them aimed to characterize the findings of Speech ABR in adults with typical development [17]. Other studies presented control groups with typical development that was used as comparative data to the findings of the experimental groups composed of different clinical populations, such as auditory processing disorder, specific language impairment, phonological disorders [18–20] or case studies involving a specific population as scholastic difficulties [21].

The majority research of speech ABR demonstrated in literature review have involved young/adults and/or older adults [12]. The main reason for this age-selection was probably the consistency of the responses of speech-ABR in adults due to the maturational process. Besides that, data collection is also easier in these cases, once adults understand better the clinical requirements. In contrast, publications using data with children and teenagers are scarcer. It is importance to know the functioning of subcortical encoding responses in children and adolescent, since altered responses in speech ABR may be associated with difficult to understand speech perception in noise. These changes might have a negative impact on communication and have serious consequences for academic success [10]. The speech ABR will be mature around the five year of life [22], this way, this procedure can be used in young and school age children helping the differential diagnosis of pathologies with similar symptoms [21]. The major application of speech ABR might be in diagnosing and categorizing children with learning disability in different subgroups, assessing the effects of aging on central auditory processing of speech and the effects of central auditory deficits in hearing aid and cochlear implant users [21,23]. So far there are no data in the previous literature that has analyzed the standard of normality of speech ABR in children and adolescent.

The purpose of this study was to analyze the coding responses of speech sounds (syllable/da/) in children and adolescent speakers of Brazilian Portuguese with typical development using speech-evoked brainstem response. It is worth mentioning that our study differs from the first study developed of speech ABR with normal individual in Brazil [17], by the following points: (i) it is a survey of the population of children and adolescents, (ii) analysis of responses was more fully contemplating the seven waves (V, a, C, D, E, F and O) and the complex VA (area and slope), (iii) the assessment was performed with the monaural stimulus presentation on the right and the left ears and (iv) finally, the present study shows normative values with 95% confidence interval for all components of the speech ABR.

2. Methods

2.1. Ethics statement

This study was approved by State University of Campinas (UNICAMP), Ethics in Research Committee, Campinas, São Paulo, Brazil, under number 889074. Data collection was conducted at the Audiology Laboratory of the Center for Studies and Research in Rehabilitation Professor Dr. Gabriel Porto, Faculty of Medical Sciences - State University of Campinas (CEPRE-FCM/UNICAMP) from October 2013 to January 2016.

Informed consent was obtained from all participants after explanation of nature, purpose and expected outcomes of the study.

2.2. Participants

The sample size was calculated for the sample mean estimator, with an error of ± 0.3 in average, a significance level of 5% and considering the standard deviation of a previous study related to the same measure in this study. The result was 25 individuals.

A total of forty children and adolescents aged from 8 to 16 years old, 25 female and 15 male, were included in the study in two groups: 8–10 years and 11–16 years. All participants were Brazilian-Portuguese native speakers, right handed, typically developing with documented normal hearing.

Inclusion criteria were defined as: Pure tone audiometry were determined to be within normal limit (below 20 dBHL) at 250–8000 Hz; immittance values were determined to be with normal middle ear function at the type A tympanograms and with presence of ipsi and contralateral acoustic reflexes in both ears [24,25]; normal responses in the central auditory processing test battery, including the dichotic digits test [26], frequency pattern sequence test [27], gaps-in-noise test – GIN [28] and Synthetic Sentence Identification - SSI [29]; click Auditory Brainstem Response (ABR) with the waves I, III and V present and with an inter-peak interval I–III, III–V e I-V within normal standards (Biologic Navigator Pro ®); no history of neurological disorders; and no language or learning complaints as informed by children's parents and teachers. Those children who presented alterations in one or more of the above auditory assessment procedures were not included in the study.

2.3. Procedures

Electrophysiological evaluation was conducted using speech stimulus and the equipment used was an electroneuromyograph (Biologic Navigator Pro). Electrophysiological responses were recorded while the children were sitting passively on a reclining chair, in a comfortable position and in a sound-attenuating electrically shielded room.

Neurophysiological response was recorded with the active electrode positioned on the vertex (Cz), the reference electrodes on the ipsilateral mastoid and the ground on the contralateral mastoid, using one channel with surface electrodes fixed, according to the 10–20 positioning system [30]. Automatic switching function of reference signals and the amplifier ground based on the stimulated ear was activated on the equipment. The electrode on the left ear was connected to input 2/channel 1 and the electrode on the right ear was connected to ground connection cable. During the recording session, impedance was maintained at below 5 k Ω and inter-electrode impedance below 3 k Ω.

Participants were asked to keep their eyes closed in order to