EFFECTIVENESS OF TRAINING AUDITORY IN PLASTICITY OF CENTRAL AUDITORY SYSTEM: CASE REPORT

Efetividade do treinamento auditivo na plasticidade do sistema auditivo central: relato de caso

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ABSTRACT

The objective of the study was to describe, by a case report, the effectiveness of auditory training in the modification of the central auditory system of a child with complaints of change of speech and language. It is a retrospective study, through case report, of a child of the male gender of 02 years and 06 months with complaints of change of speech and / or language. In the evaluation of auditory evoked potential of encephalic stem observed presence of electrophysiological waves I, III and V with absolute latency and interpeak intervals within normal in the right ear and presence of waves I, III and V with absolute latency of the wave V high and interpeak intervals III-V and I-V high in the left ear. The electrophysiological threshold was of 70dBNA to the right and 40dBNA to the left. After evaluation the child was referred for speech therapy based on informal auditory training. To monitor auditory function, after 06 months of speech therapy, the child was referred for reassessment hearing. In the reassessment hearing the results were presence of electrophysiological waves I, III and V with absolute latency and interpeak intervals within normal in both ears with electrophysiological thresholds of 20dBNA bilateral. The auditory training program was effective in rehabilitating of the auditory skills.

KEYWORDS: Hearing; Auditory Perception; Central Nervous System; Auditory Perceptual Disorders; Auditory Pathways

INTRODUCTION

The process of neurological maturity of the auditory pathway up to the brainstem is divided into two phases. In the first phase, usually around the sixth month of intrauterine life, occurs maturation of the peripheral part of the auditory pathways. In the second phase, which starts after birth and is complete at around 18 months of postnatal life, the auditory pathways become myelinated [1-3]. The neural maturation is a fundamental process to organization and complete functionality of the nervous system [4]. Most of the nerve connections appears to be precise When the system becomes operational. The early of the development of hearing involves stabilization of the cellular size and continued maturation of axons and dendrites and the acoustic stimulus may be needed for these elements normally complete the development [5].

Recent studies showed that techniques specific of auditory training can positively influence in the processing of sound information of individuals that present language impairment and the learning. This means that the skills can be enhanced with training and that this better performance in auditory function is directly related with the ability to modification the central nervous system [6]. The behavioral change caused by modification of nerve cells as of environmental influences is known as auditory plasticity. Several animal studies and in humans observed the evidence of an auditory cortical plasticity by of an

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Conflict of interest: non-existent

functional reorganization and that these changes are the result of neural responses to auditory stimuli [7].

Therefore, the auditory training and the brain plasticity are directly linked, because the benefit of process the sound information is linked to neural plasticity, which is observed when the audio system is trained and improved in their performance [8].

The auditory processing refers to the efficiency and effectiveness by which the central nervous system uses auditory information. The auditory processing is the specific skill set of which the individual depends to analyze and interpret the sound events [9,10]. Most humans born hearing and develops auditory skills as the location of the sound source, discrimination, memory and recognition. However, the child's relationship with the environment is determinant to the quality of the development of these skills [10,11].

The auditory processing disorder occurs when there an flaw in this neural mechanism. However, this disorder may carry or be associated the language difficulties, learning and communicative functions [7,12]. When auditory processing disorders are diagnosed, due the impact of these changes in hearing and communication, is required rapid intervention, by of programs based in the auditory training and in the improves of the acoustic signal, besides the use of language strategies, cognitive and metacognitive, the which will promote plasticity and cortical reorganization [7,12].

The plasticity can be observed by of behavioral changes and electrophysiological. Many studies observed changes in morphology and auditory performance after auditory training or rigorous sound stimulation. Younger brains have more plasticity and may change rapidly, observing effective improvements in the skills of individuals submitted to auditory training [13,14].

There are several programs auditory training targeted to individuals with auditory processing disorders, of oral or written language, as well as of learning. Basically, there are two types of auditory training: the formal and the informal. The formal auditory training uses electroacoustics equipment and/or computer programs and the informal auditory training is performed at home with parents or in the school with teachers, without the need for sophisticated equipments [15]. The auditory training promotes an neural reorganization of the auditory system and of the connections with other sensory systems to he related and, consequently, there is an improvement of skills that were previously changed. These changes are measured by of hearing tests, behavioral and electrophysiological, that which show the maturity of the auditory system and which the level of neuroplasticity that occurred during the auditory training [7,12].

The objective of this study was to describe, by of case report, the effectiveness of auditory training in the process of plasticity of the central auditory system. Thus, this research was justified by importance of auditory training in the auditory processing disorders and by need for rapid intervention, as way to minimize the losses communicative, school and social that may appear as result of these disorders.

CASE REPORT

The procedures in this study were approved by the Research Ethics Committee of Pontifícia Universidade Católica de Minas Gerais (PUC Minas), under protocol number 0399.0.213.000-11 (Resolution 196/96 National Health Council – CONEP).

This was a retrospective study, by of case report, of an male child of 02 years and 06 months in speech therapy weekly, in an social project (Obra Prima Project) nonprofit located in the municipality of Belo Horizonte. The audiological evaluation of the child was performed in the Clinical Center for Speech – Language Pathology and Audiology of PUC Minas.

The responsible for the child was communicated personally about the objectives of the research, the absence of damage to health of the child, the guarantee of confidentiality of the identity of the child or any other characteristics which could identify them, and on the roadmap of the research. Being properly informed, the responsible by the research subject signed the Consent Term.

In February of 2011, the child, with 01 year and 09 months, attended the Obra Prima Project, accompanied by their parents, that presented complaints of change of speech and language. The child, then, was underwent to speech evaluation. In the language evaluation observed that the child not manipulated objects and showed no interest by the same, observed absence of symbolic behavior, absence of imitation of sounds and body movements and absence of interactive behaviors intentional.

The child, then, was referred to audiological evaluation in the Clinical Center for Speech – Language Pathology and Audiology of PUC Minas. This evaluation consisted of: anamnesis, otoscopy, tympanometry and search of the acoustic reflexes, observation of the auditory behavior, evoked otoacoustic emissions by transient stimulus, evoked otoacoustic emissions distortion product and auditory brainstem response (PEATE).

In the anamnesis was obtained information as personal data, audiological history and aspects

related to health. The anamnesis was performed with the same protocol utilized in the Clinical Center for Speech – Language Pathology and Audiology of PUC Minas.

During the anamnesis the following information was collected: the child was born at term, without complications. The pregnancy was unwanted and child's mother performed prenatal from the beginning of pregnancy. The child not breastfed in the maternal breast, because not get performing the movement of suction. In relation to motor development and language, the following data were informed: not yet crawled, did not sit without support, not walked and not babbled.

To perform the visual inspection of the external auditory canal (otoscopy) was used otoscope, of the brand TK®, model 22. In the otoscopy no changes were observed.

The tympanometry and the research of acoustic reflexes were performed through the middle ear analyzer, model AZ7, of the brand Interacoustics®. The acoustic impedance measurements were: tympanometric curve type A and absence of ipsilateral acoustic reflexes and contralateral in both ears.

In observation of the auditory behavior the child presented answers below the expected for the chronological age. The results this evaluation were: absence of cochleo-eyelid reflex and attention only to sound uncalibrated of 70 to 80dBNPS (bell and coconut).

The transient otoacoustic emissions were performed with non-linear stimulus, type click, with intensities from 80 and 85 dBNPS. The distortion product otoacoustic emissions were performed with stimuli f1/f2 to 65/55dB respectively and relation 2F1-F2=1,22. To perform these procedures was observed the otoacoustic emission analyzer model ILO 292, with program version 6, of the brand Otodynamics®. In the otoacoustic emissions was observed: presence of transient otoacoustic emissions and of distortion product otoacoustic emissions in the frequencies of 1,4; 2; 2,8; 4 e 6 kHz in both ears.

The auditory brainstem response was performed by of equipment of the brand Amplaid®, model MK22. In the evaluation of PEATE, research of site of injury, was observed presence of electrophysiological waves I, III and V with absolute latency and interpeak intervals within normal in the right ear and presence of waves I, III and V with absolute latency of the waves V elevated and interpeak intervals III-V and I-V elevated in left ear (Figure 1). The electrophysiological thresholds were obtained of 100dBpeNPS corresponding to 70dBNA at the right and of 70dBpeNPS corresponding to 40dBNA at the left (Figure 2).

In due of the results suggestive of change in the maturation of central auditory nervous system, the child was, then, referred for speech therapy, which occurred in the order of one weekly session with duration of forty minutes.

The main objective of the speech therapy intervention in the this case was develop the central auditory skills: detection (attention to the sounds and location of the sound source), discrimination, recognition / identification and understanding. The therapy relied on informal auditory training techniques that prioritize development and the central auditory skills training.

For the detection ability were used onomatopoeic sounds and environmental sounds. Initially, the child only realized the sounds presented in greater loudness. The responses from the child front of the sound stimuli were quieted and smile. Posteriorly, the volume of sounds presented was decreasing and the child continued to show reactions to sound stimuli, such as: look for the sound source (turn heads in direction at the sound presented), cease the activity that was performing and vocalize.

From then on, was used music and children's stories (presented herein in female voice, herein in male voice) as verbal stimuli. So, by prosody, of the auditory perception, of the auditory closure, of the selective attention, of the body expression associated with music, of the rhythmic games and of the sound symbol association was possible to stimulate the discrimination skills, recognition / identification and understanding.

In relation to language, strategies were used to stimulate activity of sensory motor exploration, as, object manipulation in order to know its physical properties (touch, pull, beat, placed in the mouth) and establish relationships between them (hitting an object in the other). Also strategies were used to develop imitative behaviors as visible movements in the body, movements are not visible in the body, vocalizations and different actions on objects.

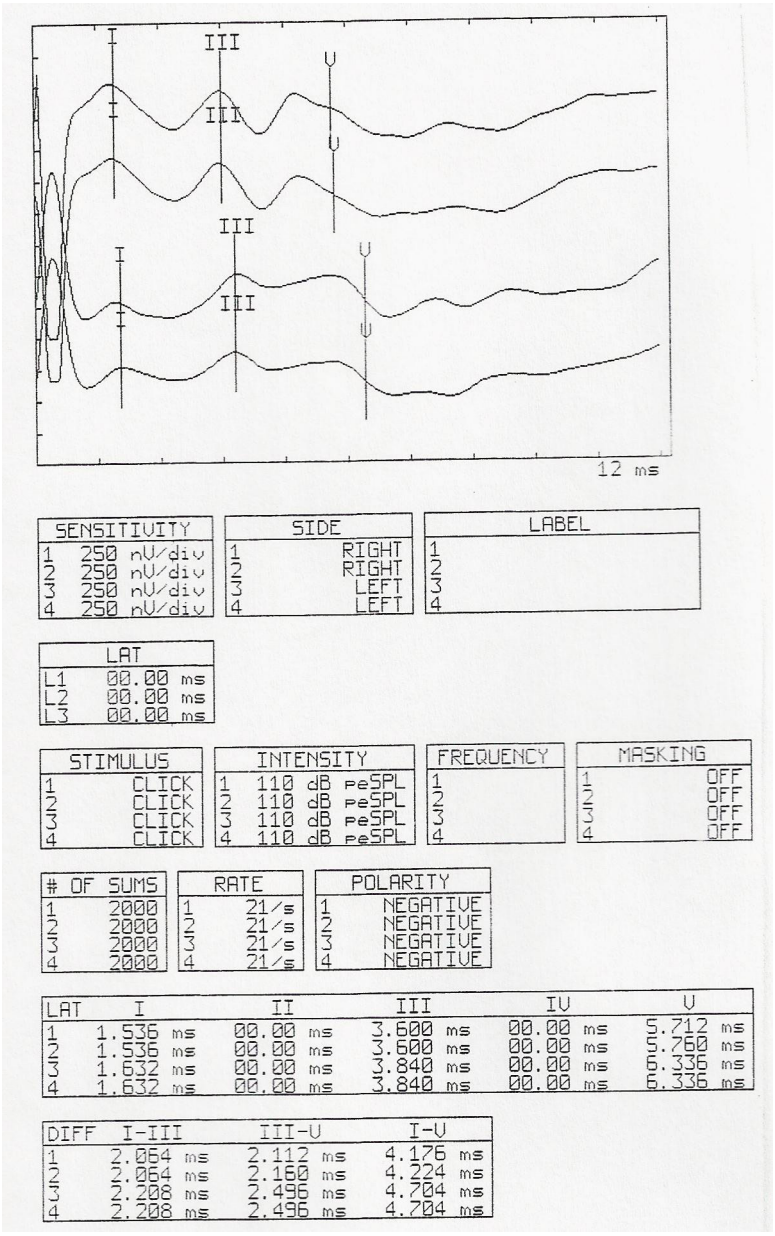

Figure 1 – Results PEATE (research of site of injury) in the pre-test

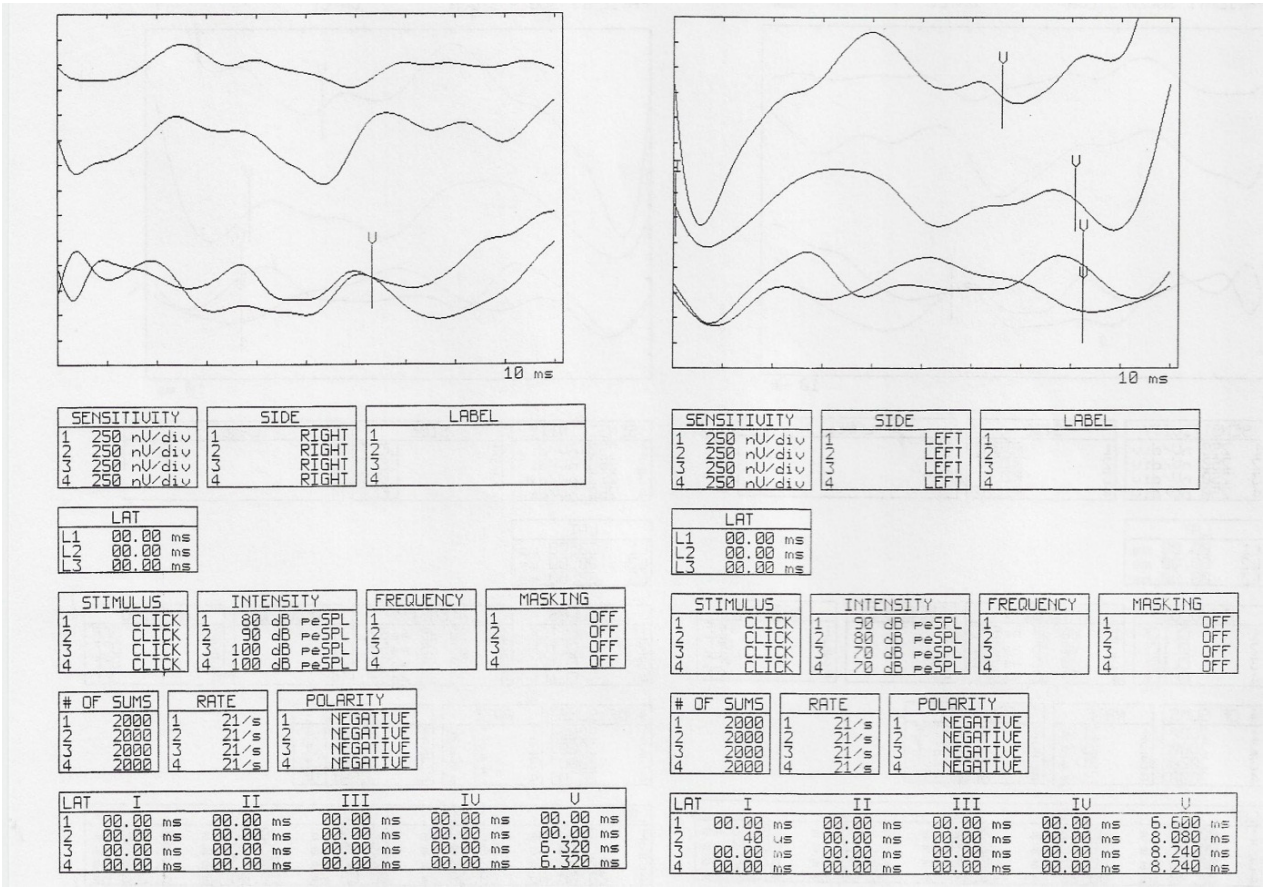

Figure 2 – Results PEATE (threshold research) in the pre-test

RESULTS

After 6 months of intervention, with the objective of monitor the work realized, the child was referred for reassessment auditory. The same procedures performed in the evaluation were also conducted on revaluation.

The results of the otoscopy, of the tympanometry, of the research of acoustic reflexes and the otoacoustic emissions remained unchanged. Therefore, there was no difference between the results of the assessment and reassessment auditory for these procedures.

The assessment of the auditory behavioral was not performed in the reassessment, because the child's age was already more than 02 years. So, only the research cochleo-eyelid reflex was, again, performed. The result was found presence of cochleo-eyelid reflex.

In the assessment PEATE, research of site of injury, observed presence of electrophysiological waves I, III and V with absolute latency and interpeak intervals within normal in both ears (Figure 3). In the threshold research the last wave V found was in 50dBpeNPS corresponding to 20dBNA in both ears (Figure 4).

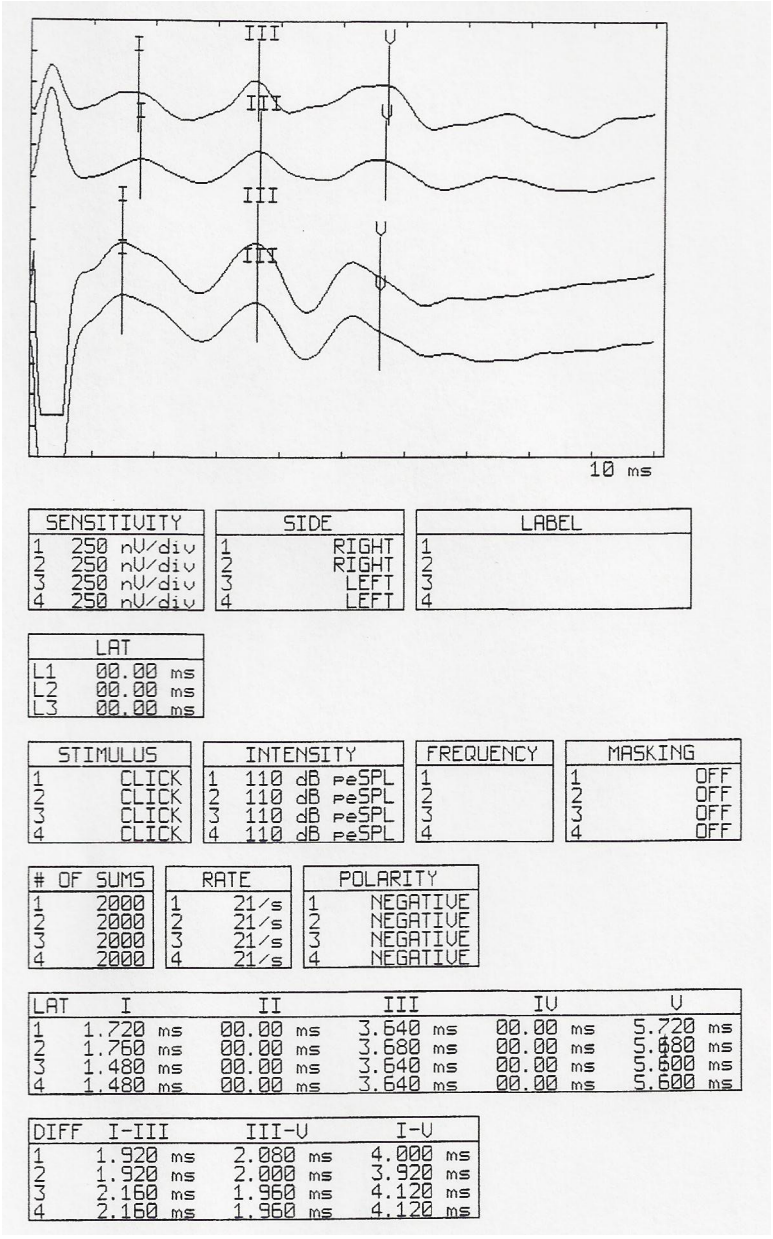

Figure 3 – Results PEATE (research of site of injury) in the post-test

From the results of the reassessment auditory, it was decided to send the child for conditioned audiometry. This was performed in acoustically cabin treated and with two-channel audiometer, model Midimate 622, of the brand Madsen Electronics®, using free field of the brand Widex.

The results found in the conditioned audiometry in free field were: in 125 Hz threshold in 40dBNA, in 250 Hz threshold in 30dBNA, in 500, 1000 e 2000 Hz threshold in 35dBNA, inem 3000 Hz threshold in 25dBNA and in 4000, 6000 e 8000 Hz threshold in 30dBNA.

In the revaluation of language observed that the child manipulating objects and showed interest in them, observed presence of symbolic behaviors, imitation of sounds and body movements and presence of interactive behaviors intentional.

It is noteworthy that the child's family received orientation to tailor the acoustic environment and to create strategies to improve communication with the child. Thus, an auditory training diary add up with the intervention speech therapy weekly was fundamental to the success of rehabilitation auditory.

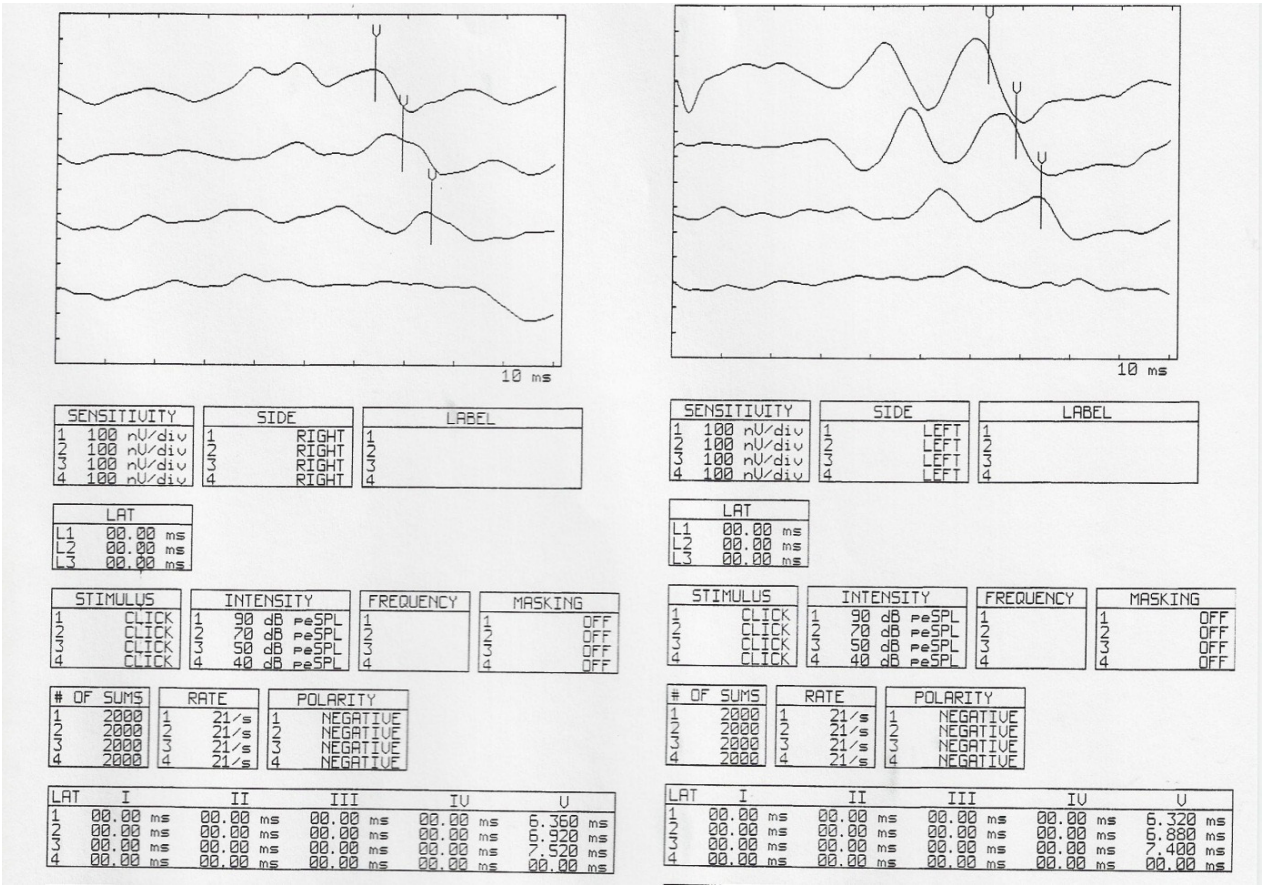

Figure 4 – Results PEATE (threshold research) in the post-test

DISCUSSION

In previous studies, some researchers highlighted that the major causes of the auditory processing disorders could be related to changes of the neurological conditions, delay of maturation of the central nervous system and coexistence with other disorders of the development [2].

In this study, was possible establish an relationship between the behavior and the neural development, in other words, between the development of the hearing ability and the neural maturation [8]. So, it can be stated that the improves due to auditory training it is of agreement with several research, that demonstrated that the hearing ability are liable of training and, therefore, of learning [7].

The auditory training already was utilized in individuals that presented hearing deficiency of degree profound, for the purpose of improve the use of its residual hearing. With the advancement of research, the auditory training passed to be utilized in individuals with hearing loss smaller to auxiliary in the adaptation of the apparatus of sound amplification of individual use (AASI), with the intention of maximize the use of the residual hearing. The auditory training does not improve the hearing threshold, but enhances the perception of acoustic signals more complexes as the speech [9,11].

The general characteristics of a program of auditory training efficacious were cited by several authors. Despite some differences, all agreed that the auditory training must be intensive, contain challenging activities to auditory system and be sufficiently interesting of mode to maintain motivation of the patient, avoiding its frustration [8,11,15].

It is essential that the auditory training be monitored by of pre and post-tests, are they behavioral and electrophysiological, the that directs the performance of professional, as well as may serve as motivational strategy to the own patient and/or family [12,15].

In the present study, was possible demonstrate efficacy of the auditory training, once there was significant difference between the pre and post-test, showing that the child study participant presented significant improvement of the auditory skills stimulated. Thus, this study agrees with other that also

found improvement of listening skills after auditory training [7,9,12,13].

The behavior related to neural plasticity may be predictable, as the plasticity is defined as an changes in nerve cells that occur of according with the environmental influences, that can be controlled and modeled of the desired way [2,14].

For some authors there are three types of plasticity in the auditory system: developmental plasticity, compensatory plasticity (resultant of an injury occurred in the auditory system), and the plasticity related to learning. Therefore, in this study, observed that the plasticity occurred was to related with the learning, once the child was undergo to a program of training of the listening skills that were changed [7,9,13,14].

The purpose of auditory training is improve the functioning of the auditory system in relationship to treatment of acoustic signals. So, by of a program of auditory training evidence emerged that suggest that the central auditory system may change with the aid of the auditory training revealing the plasticity of the central auditory nervous system. However, is not only the auditory training isolated that will bring only benefits, but an global approach that involving all necessary areas, as the language and the learning [11,14].

CONCLUSION

The evaluation and monitoring of auditory function was possible diagnose the change of the central auditory processing, target the goals of the therapeutic intervention and map the evolution of treatment. Therefore, the case report described illustrates the effectiveness of an program of auditory training in rehabilitation of the listening skills and the plasticity of the central auditory nervous system.

RESUMO

O objetivo do estudo foi descrever, por meio de relato de caso, a efetividade do treinamento auditivo na modificação do sistema auditivo central de uma criança com queixas de alteração de fala e linguagem. Trata-se de um estudo retrospectivo, por meio de relato de caso, de uma criança do gênero masculino de 02 anos e 06 meses com queixas de alteração de fala e/ou linguagem. Na avaliação de potencial evocado auditivo de tronco encefálico observou-se presença de ondas eletrofisiológicas I, III e V com latência absoluta e intervalos interpicos dentro da normalidade na orelha direita e presença de ondas I, III e V com latência absoluta da onda V elevada e intervalos interpicos III-V e I-V elevados na orelha esquerda. O limiar eletrofisiológico foi de 70dBNA à direita e 40dBNA à esquerda. Após a avaliação a criança foi encaminhada para terapia fonoaudiológica baseada no treinamento auditivo informal. Para monitorar a função auditiva, após 06 meses de terapia fonoaudiológica, a criança foi encaminhada para reavaliação auditiva. Na reavaliação auditiva os resultados foram presença de ondas eletrofisiológicas I, III e V com latência absoluta e intervalos interpicos dentro da normalidade em ambas as orelhas com limiares eletrofisiológicos de 20dBNA bilateral. O programa de treinamento auditivo foi eficaz na reabilitação das habilidades auditivas.

DESCRITORES: Audição; Percepção Auditiva; Sistema Nervoso Central; Transtornos da Percepção Auditiva; Vias Auditivas

REFERENCES

1. Baran JA, Musiek FE. Avaliação comportamental do sistema nervoso auditivo central. In: Musiek FE, Rintelmann WF. Perspectivas atuais em avaliação auditiva. Barueri: Manole; 2001. P. 371-409.

2. Bamiou DE, Musiek FE, Luxon LM. A etiology and clinical presentations of auditory processing disorders: a review. Arch Dis Child. 2001;85:361-5.

3. Schochat E. Avaliação eletrofisiológica da audição. In: Ferreira LP. Tratado de fonoaudiologia. Saõ Paulo: Roca; 2004. P.656-68.

4. Kolb B, Whishaw IQ. Neurociências e comportamento. Baureri: Manole; 2002.

5. Cant NB. Structural development of the mammalian auditory pathways. In: Rubel W, Popper AN, Fay RR. Development of the auditory system. New York: Springer; 1998.

6. Musiek F. Habilitation and management of auditory processing disorders: overview of selected procedures. JAAA. 1999;10:329-42.

7. Musiek F, Shinn J, Hare C. Plasticity, auditory training, and auditory processing disorders. Seminars in Hearing. 2002;23(4):263-75.

8. Chermak GD, Musiek FE. Auditory training principles and approaches for remediation and managing auditory processing disorders. Seminars in Hearing. 2002;23:297-308.

9. Samelli AG, Meca FFDN. Treinamento auditivo para transtorno do processamento auditivo. Rev CEFAC. 2010;12(2):235-41.

10. Ribas A. A influência do meio social sobre o desenvolvimento da percepção auditiva em crianças. J Soc Bras Fonoaudiol. 2001;2(8):224-8.

11. Zalcman TE, Schochat E. A eficácia do treinamento auditivo formal em indivíduos com transtorno de processamento auditivo. Rev Soc Bras Fonoaudiol. 2007;12(4):310-4.

12. Chermak GD. Neurobiological connections are kery to APD. Hear J. 2004;57(4):58-9.

13. Schochat E, Carvalho LZ, Megale R. Treinamento auditivo: avaliação da manutenção das habilidades. Pró-Fono R. Atual. Cient. 2002;14(1):93-9.

14. Kozlowskil L, Wiemes GMR, Magni C, Silva ALG. A efetividade do treinamento auditivo na desordem do processamento auditivo central: estudo de caso. Braz J Otorhinolaryngol. 2004;70(3):427-32.

15. Schochat E. Insights for management of processing disorders. Hear J. 2004;57(10):58.

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