AUDITORY TRAINING IN AUDITORY PROCESSING DISORDERS: A CASE STUDY

Treinamento auditivo nas alterações do processamento auditivo: estudo de caso

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ABSTRACT

The aim of this study is to verify the effectiveness of an Auditory Training program comparing the initial performance in the tests of auditory processing evaluation, with the performance after the auditory training. For this case study, developed at the Speech Therapy clinic in the University of Passo Fundo, a subject was selected that presented language alterations, complaints compatibles with auditory processing disorders, basic hearing evaluation with normal results and altered results in the auditory processing evaluation. For this, the tests Pediatric Speech Intelligibility, Staggered Spondaic Word, Dichotic Digits, Random Gap Detection Test, Masking Level Difference, and Pitch Pattern Sequence were used. Auditory Processing tests reevaluation after 8 sessions of the auditory training showed improvements in the abilities that were previously altered, persisting a mild difficulty in organization. The progression from severe to mild degree of the subject proves the effectiveness of the Auditory Training.

KEYWORDS: Hearing Disorders; Acoustic Stimulation; Auditory Perception; Neuronal Plasticity

INTRODUCTION

The auditory processing (AP) refers to the mechanisms and procedures used by the auditory system, responsible for behavioral phenomena, such as localization and sound discrimination, auditory recognition, hearing temporal aspects, auditory performance with acoustic signals in competition and auditory performance in adverse acoustic situations for verbal stimuli, as well as for non-verbal stimuli[1].

Besides having normal hearing thresholds, it is also necessary that the acoustic signal is analyzed and interpreted in order to turn into a message with meaning[2].

The AP is directly related to auditory discrimination, memory and perception. Such competences are important in the expression and comprehension of spoken word, reading and writing[3,4].

The processing does not follow fixed steps of mechanism, operations and auditory phenomena because the context, or speech, will facilitate or complicate the sound transmission from the ear until the nervous centers, which will give meaning to the signals received.

The AP disorder can be defined as a complex and heterogeneous group of alterations, commonly associated to a series of auditory and learning difficulties, though having a normal peripheral hearing[5].

The AP alterations refer to the difficulty in the perception process of auditory information in the central nervous system, resulting in a weak performance in one or more of the auditory abilities[6].

In order to minimize the altered auditory abilities that can be found in a subject, some procedures are proposed, among them the auditory training (AT)[5].

AT it's a term used to describe a set of auditory exercises, intended to improve the subject's capacity to perceive sounds. Points of views diverge as to what should compose the AT, but in the center of all approaches the main aim is to improve the

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patient's communication[7]. This means that the auditory abilities can me enhanced with training and that the better performance in the hearing function is directly related with central nervous system capacity of modification [1].

Finally, this study was carried out aiming to verify the behavior change in the auditory abilities, after AT, in a subject with auditory processing alterations.

CASE PRESETATION

The present research was approved by Research Ethics Committee with Human Beings from Universidade de Passo Fundo (UPF), registry 454/2011 and carried out in the Audiology Laboratory from the Speech Therapy Clinic in Universidade de Passo Fundo (CAMPUS I – Km 171 – BR 285, Bairro São José, Passo Fundo - RS).

This study was developed as a case study. However, to be possible to select the research's subject, first it was necessary to apply the tests in various children, in order to find one that was appropriate to the pre-established inclusion criteria, such as: 5 years old minimum age and 15 years old maximum (regardless of gender), normal outer acoustic meatus inspection; basic audiological evaluation (pure tone threshold audiometry, logoaudiometry and immittance testing) within normality limits; present the AP evaluation altered.

The Speech Therapy Clinic perform the AP exam and, therefore, patients that needed that evaluation were contacted and called through telephone to participate in the research, performing complete basic audiological evaluation, as well as the AP behavior tests.

After this evaluation, a subject that fits the inclusion criteria was invited to be part of the case study, with the responsible consent through the signature in the Written Informed Consent.

The patient selected to the case study, was a male subject, seven years old at the moment of the evaluation, and right-handed. He was a 1st grader student of Elementary School and resident in the town of Marau – RS.

The seven years old subject, participated in a complete evaluation, composed of anamneses with parents; outer acoustic meatus inspection; pure tone airway audiometry in the frequency of 250 to 8000 Hz; vocal audiometry – SRT and SRPI; immittance (tympanometry and research of ipsilateral and contralateral acoustics reflexes, in the frequency of 500, 1000, 2000 and 4000 Hz) and the application of AP tests: AP screening, Pediatric Speech Intelligibility (PSI), Staggered Spondaic Word (SSW), Dichotic Digit Test (DD), Random Gap Detection Test (RGDT), Masking Level Difference (MLD) and Pitch Pattern Sequence (PPS).

In the anamneses carried out with the parents, it was reported that the patient's speech acquisition occurred in a correct way and his motor development was normal. He hadn't a significant medical history, besides of recurrent otitis media since he was 3 years old, treating these infections for a long period. Hadn't a history that involved the central nervous system, as well as histories of mental disability, auditory disability, or other alteration.

During a 2 years period, he completed private speech therapy in his hometown, because he presented alteration both in written language as in oral language. According to information provided by the family, his progress was slow throughout the therapies.

In relation to learning, the development was found altered. At school, there were complaints about talking a lot in classroom, was behind in relation to the class in questions connected to reading and writing, and in activities such as dictation, a few words were correct. The patient, often, it take some time for him to understand jokes or sentences with dual meaning, presented difficulties related to Math, and in Portuguese he had alterations in writing complex syllables, as reported by the child's mother and teacher. The family also mentioned that the child was quite distracted and was in a hurry to finish school activities, being a little agitated. He had no difficulty following oral instructions.

At first, he was referred to a basic audiological evaluation (pure tone threshold audiometry and acoustic immittance measurements). The subject had no alteration in the outer acoustic meatus inspection, and then he can performs the other exams.

In the pure tone audiometry test it was found the presence of a symmetric audiometric curve, horizontal type with normal hearing[8] in all tested frequencies. In the vocal audiometry, or logoaudiometry, obtained normal results (SRT of 10 dBs in both ears and SRPI with 100% correct in RE and 96% correct in LE), not having then difficulty to comprehend the speech sounds bilaterally.

In the immittance testing, regarding the measures of acoustic immittance it was found normal mobility of the eardrum-ossicular system, curve type A in both ears. The ipsilateral and contralateral middle-ear reflexes were present bilaterally in all tested frequencies.

Afterwards, it was performed a AP screening, a procedure constituted by simple tests that aim to evaluate in a general way the subject's performance regarding his sequential memory for verbal sounds, non-verbal, and sound localization. The screening

was performed in a room in the Speech Therapy Clinic in UPF, for that, it was used musical instruments, such as bells, key, agogo and rattle, besides verbal instructions.

The subject didn't get to achieve the three sound sequences presented with musical instruments stimuli. For verbal sounds, the patient managed to perform properly isolated articulatory production for PA, TA, CA syllables. However, from the three requested sequences involving the syllables mentioned, there was only one correct. In the sound localization test, using the rattle, the subject needed to identify in which direction the examiner presented the sound (right, left, behind, in front of and above his head) and he got all of them correctly.

Finally, the specific tests from AP were applied (PSI, MLD, PPS, RGDT, DD e SSW). They were carried out inside the audiometric booth, from a compact disc player attached to a two-channel audiometer Interacoustic AC 33 and extra-ear headphones TDH-39P, by which the subject listened to the instructions.

After the analysis, it was found that the subject presented alterations in the Decoding, Encoding and Organization processes, with difficulty in the following hearing abilities: figure-background, selective attention, auditory closure, binaural integration and separation, frequency pattern recognition, temporal ordering and nomination, in line with an AP alteration of severe degree[2].

Thus, the subject was selected to participate in the present research and carry out the AT proposed, aiming to improve the performance of the altered auditory abilities.

In the PSI test, applied in a 40 dBHL intensity over SRT, the patient was requested to pay attention to sentences that were together with a competitive message and to point to figures pasted in a poster, according to the order he hears. The PSI aims to evaluate the recognition of sentences through identification of figures in the presence of a competitive message ipsi and contralateral.

To SSW test, carried out in a 50 dBHL intensity over SRT (considering hearing comfort), the patient listened in one ear (through the earphone) one word without competition, then two words simultaneously and, finally, another word in the contrary ear without competition, and he should repeat the four dissyllables words he listened in the order that they were presented. This testing involved the evaluation of binaural integrity, sequential organization, figure-background and memory.

The Dichotic Digit Test, applied in a 60 dBHL intensity, uses verbal numeric stimuli and evaluate binaural integrity, figure-background ability and binaural separation (listening directed to each ear separately). The patient listened to two digits in each ear simultaneously and he was supposed to repeat it the way he heard.

The RGDT, applied in a 60 dB intensity, evaluate the binaural relation and perception of the temporal gap in different frequencies (500, 1000, 2000 and 4000 Hz). The subject heard one or two whistles in a determined space of time, and should tell the examiner when he hears to only one or when he hears two. The result of RGDT was obtained through the average of the lowest gap by milliseconds in the frequencies of 500, 1000, 2000 e 4000 Hz.

In the MLD test, applied in a 50 dB intensity, which evaluates the binaural integrity, a noise was introduced to both ears while a 500 or 1000 Hz pulsatile tone was presented in homophasic and antiphasic conditions. The patient was instructed to verbally respond to the examiner when he heard a tone (whistle); the value obtained in the MLD test was calculated from the last threshold scored on the tone out of phase, reducing from the last threshold scored in phase tone and their respective signal/noise relations.

The PPS, applied in a 50 dB intensity over subject's SRT, is a test that evaluates the temporal recognition of frequencies. It's composed of 60 sequences of three pure tones each, that differentiate itself in relation to the stimuli frequencies: high and low*. From the 60 sequences presented in binaural way, 30 should be responded under the form of murmur (imitation) and 30 by nomination. However, in this study it was used only a part of the test that requires answers by nomination, once the patient presented difficulties in performing the test when the answer by murmur was used.

The references criteria used were the ones for normality of the auditory abilities evaluated in the used tests for a 7 year old child[9].

Subsequently to this evaluations, the subject selected was submitted to an AT program. This training was based on the same models of other studies[5,10,11], that is, eight sessions, lasting an average of 45 minutes each, that were performed in the Speech Therapy clinic of UPF.

The therapy was based in formal and informal AT technics, prioritizing the development and training of the altered auditory abilities found in the AP evaluations. The strategies, as well as the activities used for the AT were organized according to the proposed by the authors[12-15].

Among the various activities used, it can be mentioned:

for work involving memory, sound sequence and selective attention cards with figures of animals were used, various sequences were presented to the child, who should memorize and subsequently

repeat the order of stimuli presentation. The same was performed using musical instruments, syllables and minimum pairs

for work with the discrimination and recognition it was used minimum pairs and activities done inside the audiometric booth, using tones in different frequencies and intensities, which should be noticed and expressed verbally by the patient as a sound "higher" or "lower" (frequency), "higher" or "lower" (intensity), "longer" or "shorter".

for work with binaural synthesis, auditory and visual stimuli integration and selective attention were proposed for the story telling, while over the table there was the figures contained in the text. Each time the patient heard the target words he should look for the corresponded picture. Throughout the scores, it was placed competitive stimuli in order to make it a harder task. It was also used a bingo with sound and logic sequence's stories.

It should be noted that, the attention (focused and selective), as well as the memory, permeate all the other abilities and, therefore, were constantly worked, in parallel with the other auditory abilities. Also, it was worked, in most sessions, verbal and non-verbal sounds aiming to stimulate both the right cortical hemisphere as the left cortical hemisphere, as well as stimulate the inter-hemispheric transfer, essential for various AP capabilities.

Within each step the task complexities have been respected, starting with simple activities and as the scores were becoming more consistent, the activities were becoming harder and these included more stimuli. In several sessions the complexity of the tasks were manipulated with introduction of competitive sounds (music, noise, hiss, speech) so that, in this way the proposal of therapy becomes more effective.

The stimuli varied according to the tasks. It was used verbal and non-verbal stimuli produced by musical instruments, by the therapist, by different sound sources (such as the radio).

Using a material prepared by other authors[16] activities were carried out inside the audiometric booth, with the use of extra-auricular earphones, using pure tones produced by the audiometer (in different frequencies and intensities), and a CD player to produce verbal and non-verbal sounds. The CD (accompanied by the engravings, manual and protocol sheets) it has 30 soundtracks that were prepared to stimulate various auditory abilities (figure-background, memory, selective attention, binaural integration and separation, discrimination). According to the authors, this material was inspired in the model of AP Tests, proposed by the AP Evaluation Manual[9].

For a daily training in addition to the work done in session, the patient and his responsible received in all sessions an orientation and a specific material to perform this tasks at home. These should last an average of 15 minutes, and must be performed three to four times a week.

Finally, the patient went through another AP evaluation, including the same test initially done. Therefore, the analysis of the data was performed by means of a pre and post AT tests comparison, using a descriptive statistical analysis.

RESULTS

During the eight session of AT the altered abilities in the AP evaluation were worked, with several formal and informal activities.

In all of them the patient, 7 year old, showed himself willing and always very collaborative. He was interested in the activities proposed in session, although many times he felt agitated and anxious to know which activities were next. It was also necessary to work this aspect, so he would be more concentrated on the task performed.

In all sessions, the training was initiated with simpler proposals of verbal and non-verbal sounds, so that the patient could become familiar with what was being requested. As the scores became more consistent the level of difficulty was raised. It was necessary a continuous training with the abilities of auditory memory, figure-background, selective attention, sound sequence, auditory closing, binaural integration and separation and frequency pattern recognition.

Throughout the sessions, the patient started to present progressions in several aspects: he reflected about the activity that was being performed making relevant comments about what was worked, he concentrate, gradually improved memory and selective attention, he could differentiate low pitch from high pitch sounds.

Working the other abilities it was also noted improvement throughout the sessions. He obtained success in the activities that involved verbal and non-verbal sound sequence, words discrimination with minimum pairs, rhymes and monosyllables. The patient developed the capacity to stay attentive in certain activities even with competitive stimuli, integrate information that was presented in different ears, and notice difference in the temporal gap. He improved on prosody training in simple sentences, in the task involving production and identification of monosyllables and dissyllables, as well as in the activities of dichotic listening.

The patient strove to the maximum in each task. It is known that the motivational factor is extremely

important to contribute to success in any AT program that's why he was always given encouraged, praised and motivated to improve. It is worth it to notice that he would come from another town to the place where the sessions occurred and his family was of great participation in the tasks done at home.

For the sound sequencing, verbal and non-verbal, it was observed that the patient presented a lot of difficulty before the AT and that this aspects became appropriate after the AT sessions. Concerning sound localization test there was no alterations found (Table 1).

Table 1 – Auditory processing screening

Test	Pre AT	Post AT
	N scores	N scores
Sequence of non-verbal sounds test (3 presented sequences)	0	3
Sequence of non-verbal sounds test (3 presented sequences)	1	3
Sound localization test (5 directions presented)	5	5

AT – Auditory Training; N – Numbers.
Results obtained in the test performed during the Auditory Processing Screening pre and post Auditory Training.

In the PSI test the patient presented, in the first evaluation, altered performance in the ipsilateral competitive messages to signal/noise ratio -15 dB in both ears. Also presented alteration in the condition of ipsilateral competitive message in the left ear in to signal/noise ratio -10 dB. After the AT there was an improvement in the to signal/noise ratio, previously altered, being possible to reach the reference value for the age. Although in the condition of contralateral competitive message and their respective to signal/noise ratio the values were found in the limits of normality in the pre therapy evaluation, as in the post therapy evaluation (Table 2).

Table 2 – Pediatric Speech Intelligibility Test – PSI, in the condition of ipsilateral competitive message (ICM) and contralateral competitive message (CCM)

	PSI Pre AT (% scores)		PSI Post AT (% scores)		Reference Value
Condition	**RE**	**LE**	**RE**	**LE**	
ICM (S/N)					
0 dB	100%	100%	100%	100%	80%
-10 dB	80%	50%	80%	80%	70%
-15 dB	50%	40%	60%	70%	60%
Condition	**RE**	**LE**	**RE**	**LE**	
CCM (S/N)					
0 dB	100%	90%	100%	100%	100%
-40 dB	100%	100%	100%	100%	90%

RE – Right Ear; LE – Left Ear; ICM – Ipsilateral Competitive Message; CCM – Contralateral Competitive Message; AT – Auditory Training; S/N – Signal/noise relation.
Results obtained in the PSI test, performed in both ears, pre and post Auditory Training.

In the competitive condition and the order effect, in the first moment of the evaluation it could be observed significant alterations. They trained the abilities of binaural separation and integration, memory and sequence organization, which are related with the results obtained in SSW. Thus, in the post AT evaluation, it was possible to observe changes in the competitive condition in both ears reaching the reference value expected for the age group (Table 3).

In the Dichotic Digit Test alterations in both ears before the AT can be observed. After the sessions, an improvement both in the right ear as in the left ear can be noticed, due to the training carried out working the abilities related to this test, such as binaural integration and binaural separation (Table 4).

Table 3 – Staggered Spondaic Words Test – SSW

Condition	SSW Pre AT (% scores)	SSW Post AT (% scores)	Reference Value
CR	47,5%	90%	75%
CL	35%	72,5%	65%
Inversions	4	2	5
Type A Pattern	5	6	6
Auditory Effect	-7	6	-8 a +6
Order Effect	13	8	-4 a +10

CR – Competitive Right; CL – Competitive Left; AT – Auditory Training.
Results obtained in the SSW test, in both ears, pre and post Auditory Training.

Table 4 - Dichotic Digits Test

	DD Pre AT	DD Post AT	Reference Value
RE	77,5%	90%	85%
LE	72.5%	87,5%	82%

RE – Right Ear; LE – Left Ear; DD – Dichotic Digits; AT – Auditory Training.
Results obtained in the Dichotic Digits test, in both ears, pre and post Auditory Training.

In the RGDT test, a result very close to the limit of normality for the patient age group was found. After worked with aspects such as temporal gap perception, BINAURALIDADE, sound intensity and frequency a reduction was noted, in other words, an improvement of the average in the gap perception, that moved from 9,7 ms to 2,75 ms (Table 5).

In the MLD test the result was found appropriate for the age, pre and post AT. Even though it was obtained a smaller value in the revaluation, the same was still in the normality patterns. Although, in the PPS test, in the sequences that were responded by nominating the result obtained presented alteration. The frequency recognition training it could be reached a progress from 3% to 30%, however, this was the only test where it was not possible to reach the reference value for the patient age group (Table 5).

Table 5 - Random GAP Detection Test – RGDT, Masking Level Difference Test – MLD, Pitch Pattern Sequence Test – PPS

	RGDT Pre AT	RGDT Post AT	Reference Value
Mean	9,7 ms	2,75 ms	Equal or < 10 ms
	MLD Pre AT	**MLD Post AT**	**Reference Value**
Mean	14 dB	10dB	> 9 dB S/N
	PPS Pre AT (% scores)	**PPS Post AT (% scores)**	**Reference Value**
Nomination	3%	30%	40%

AT – Auditory Training; dB – decibels; ms – milliseconds.
Results obtained in the RGDT, MLD and PPS tests, pre and post Auditory Training.

Through the AP specific behavioral tests performance and analysis, it can be affirmed that the patient in this case study presented a severe degree alteration with deficits in the process of decoding, encoding and organization. After the AT session that aim to adequate the impaired abilities, it was noted that the alteration reduced, getting to a lighter degree, still remaining with some difficulties related to the organization in the ability to recognize frequency patters, since in the last test described (PPS) the patterns of reference weren't reached.

Although the hearing tests have been administered before and after the AT program, it was important to give an informal feedback about the patient's general state, especially in relation to communication and school performance. Some days after the sessions were over the patient's mother were contacted and she reported some significant data, saying that the auditory behavior developed, he was more attentive, the comprehension with background noise and his communication also improved. She even mentioned that in school, the teacher referred that the written language and his reading were improving.

DISCUSSION

The Auditory Training is capable of promoting a neural reorganization of the hearing system and the connections with others sensory systems related to it, generating an improvement of the abilities that were altered[17].

The present study aimed to demonstrate exactly this, in other words, that there may be a behavioral change promoted by an AT for alterations that affect the AP abilities.

The case presented in this study is of a 7 year old subject, which the history and the results of the central auditory testing were consistent with an Auditory Processing Disorder (APD). Then, he was submitted to speech therapy sessions and presented better performances in the AP testes after the AT. The improvement in the answers can be observed in most of the tests carried out.

In the results comparative analysis in this case study with other similar researches, it can be observed that the results obtained in the tests, post AT sessions, are in accordance with other studies, that demonstrate the abilities of AP can be trained and, therefore learned[1,2,5,10,14,17].

In this study, it was found a severe degree alteration[2], with alterations in the processes of decoding, encoding and organization, related to the abilities of figure-background, selective attention, auditory closure, binaural integration and separation, frequency pattern recognition, temporal ordering and nominating, in the subject evaluated. Other researchers[1] observed similar results in their case study, where the patient also presented a severe degree alteration, characterized by alterations in the processes of coding, organization and memory, such as significantly difficulty for attention and auditory closure. After the AT sessions the subject of this study presented improvements in most of these abilities, progressing from a severe to a mild degree remaining only with a deficit in the organization process, related to the ability to recognize frequency patterns and temporal ordering. In the same way, the authors of the study mentioned before observed that after the AT, there was still a significant loss in the process of organization, however the alteration became a moderate degree and did not presented anymore difficulty for auditory closure.

Similar to the findings in this study, other authors[10], when evaluating two subjects of nine years old, found deficits related to decoding, encoding and organization. The patients were submitted to speech therapy using the software and, afterwards, a revaluation of the AP was carried out. It was verified that, after the informal AT, there was an improvement related to the questions of organization and encoding. The decoding deficit

presented an expressive improvement, although both subjects remained with a mild alteration in this process. In the present research it was also carried out, in some sessions, activities using the computer. The improvements obtained in both studies, proves that the computer can be used as a therapeutic instrument, being an important resource to the development of auditory abilities.

The results showed that there was a positive difference in the evaluation pre and post auditory therapy in five of the six tests performed in this studies (Table 2, 3, 4, 5). Once more, these findings agree with a research[17] carried out with 10 subjects. After ten sessions of informal AT, where it was trained directly with auditory abilities altered, it can be found average percentage scores in the pre and post AT situation with differences statistically significant in all the tests carried out. Not all participants were able to reach the performance expected for their age, but all of them had improvement, what indicated the effectiveness of the AT.

As it can be observed, in the PSI better percentages were obtained in both ears after the AT in signal/noise ratio that were found altered, as well as the SSW in the conditions of competitive right and left (Tables 2 and 3). These tests evaluate respectively the abilities of figure-background and binaural integration. This improvement is confirmed by a previous study[5], where the authors carried out an AT in the same way done in this study. The results of the evaluation post AT verified an improvement in the behavioral tests with a statistically significant increase in all the used tests (PSI, Speech with noise, DNV and SSW).

Another study[18] shows that in two evaluated patients, one had the SSW test altered. The biggest mistakes happened in the competitive situations, especially in F column. After the AT sessions, although with percentages still altered, there was a significant improvement. These data are in agreement with the present study, because the patient evaluated presented big alterations in the competitive conditions, a column with higher number of mistakes it was also F, and after the AT, the subject reached the reference value for his age in the test in question.

There is still another research[17] similar to this one, that also refers to progresses in the SSW test in the group of patients evaluated, since it was determined statistically significant differences between the performance pre and post test, indicating an improvement of the auditory abilities altered and effectiveness of AT.

In the Dichotic Digits test it was found bilateral alterations, that were modified and improved after the sessions carried out (Table 4). In another case study[14], there was also found alterations in the Dichotic Digits test pre AT, being that this reached higher scores after the training. The same was reports in other studies[10,17] where the participants in the research got better results in the DD test after the therapy sessions. The Corpus Callosum maturation has been pointed as an influence factor in the dichotic test[19].

In the RGDT test, it was obtained a value that fit in the normality patterns, however it was too close to the expected limit for the group age. In the pre AT it was found an average of 9,75, it is worth noting that, in the frequency of 2000 Hz there was the biggest gap (25 ms) (Table 5). A similar fact happened to two participants of a research[10], which presented alterations in the AP tests, including in the RGDT test, and the biggest gap found also in the frequency of 2000 Hz before training. In the present study after the AT sessions the gap was reduced to 5 ms and consequently the total average became 2,75 ms. The same happened in the research mentioned, where one of the participants was able to reach normality and the other, although it has not achieved the same, had an expressive improvement in the general average as in the gap of 2000 Hz.

The children from the control group presented an average of detection of time interval similar to the experimental group in the frequencies of 500, 1000 and 4000 Hz. In the frequency of 2000 Hz and in the average results presented statistically significant differences, indicating that the group with reading difficulty presented an average of detection of interval significant higher than the group without alteration.

The temporal processing is one of the auditory behaviors that have been commonly associated to the speech perception in listener children. It is known that alterations in the temporal processing relate to the difficulty of noticing stimuli that rapidly modify, and associate mainly to a deficit in the phonologic processing, auditory discrimination and language[20].

In the present study alterations in the MLD test were not found, although different values was obtained pre and post therapy, both results kept in the pattern expected for normality (Table 5). No studies similar to this one were found that used this test in the battery of AP evaluation, however it is known that the MLD is also closely connected with the capacity of sound localization and it's the most sensitive behavioral test to evaluate the integrity of brainstem[21].

In the frequency pattern test (PPS), it was observed a performance very lower than expected for normality. After the AT, this result developed the scores from 3% to 30%, however it wasn't reached the reference value expected for the age

(Table 5). Another study[14] also revealed that the patient reached better results in this test after the proposed AT program. Other authors[22] carried out the same test, in 26 children, they had AT using software assist in rehabilitation of auditory alterations and in this group, there was also an increase of the average scores after the intervention, but statistically significant differences were not found. These data may be related to the fact that the verbal answer for this test is more complex, since it requires learning or neuro-maturation of the nervous system involving the secondary hearing areas and/or language area of the left temporal lobe, inter-hemispheric areas and temporal, frontal and subcortical areas related with short-term memory, operating memory, sustained attention and language[22].

A study[23] aiming to examine the plasticity of the central auditory pathways, uses Evoked Potentials of Medium and Long Latency. These tests can be a very useful tool for monitoring changes that happens in the Central Auditory Nervous System (CANS) after the AT. A research[11] carried out with 29 subjects had found, by means of behavioral and electrophysiological tests, APD in all participants. They went through an AT and later the same battery of processing tests, as the P300. When comparing the evaluations carried out before and after the AT, it was noticed that there was a statistically significant difference between the latency values of P300 and between the percentage of scores in the behavioral tests used for the AP evaluation. Therefore, the P300 it proved to be useful in monitoring the changes occurred in the auditory nervous system after the AT.

Weeks after the AT sessions were over with subject of the present study, the family was contacted aiming to verify the improvement or not in the patients behavior, at home and in school; this conduct is suggested by other authors[14]. The patients' mother reported, that he has been presenting better results in relation to communication and school performance. This progress was also verified in the study mentioned[14], where the authors found, using an informal questionnaire, that, besides the school, the mother had also noticed that the communicative abilities of her son had evolved.

The results found in this case study, in other words, the improvement provided by the AT in several auditory abilities trained, are related to the capacity of the central nervous system of changing in front of a environment stimulation. According to studies[13], it can occur three types of plasticity in the auditory system: developmental plasticity; compensatory plasticity, it's the result of a injury occurred in the auditory system and the plasticity related to learning.

Thus, it is supposed that the plasticity occurred in this study is related to the learning, once the AT program used induce beneficial changes in the auditory abilities related to the central nervous system, which can be confirmed by the improvement in the performance of the patient in the used test for the AP behavioral evaluation. Another relevant data, which also was taken under consideration by other authors[3], is related with the patients' motivation and encouragement, critical factors for a well succeed program.

Ultimately it is believed that these results should encourage continuing investigate about the effect of the auditory training programs. It is emphasized that the AT is an important aspect on the improvement of patients with ADP, although there are other strategies, such as the electronic devices and acoustic control of environments, which can help patients with AP alterations[14].

CONCLUSION

The AT program used in this study proved to be effective in this patient with AP disorder, once it determined the difference between the performance pre and post therapy in the PSI, SSW, RGDT, DD and PPS test. In relation to the alteration, the patient progressed from severe to mild degree, this way, proving the effectiveness of the Auditory Training.

RESUMO

O objetivo deste estudo é verificar a eficácia de um programa de Treinamento Auditivo comparando o desempenho inicial, nos testes de avaliação do processamento auditivo, com o desempenho após o treinamento auditivo. Para este estudo de caso, desenvolvido na clínica de Fonoaudiologia da Universidade de Passo Fundo, foi selecionado um indivíduo que apresentava alterações de linguagem, queixas compatíveis com alterações de processamento auditivo, avaliação audiológica básica normal e avaliação do processamento auditivo alterada. Para isso, foram utilizados os testes *Pediatric Speech Intelligibility*, *Staggered Spondaic Word*, Dicótico de Dígitos, *Random Gap Detection Test*, *Masking Level Difference* e *Pitch Pattern Sequence*. Os resultados obtidos na reavaliação com os testes de Processamento Auditivo após oito sessões de treinamento auditivo apontaram melhoras na decodificação e codificação que se encontravam alteradas, persistindo um leve prejuízo na organização. A evolução do indivíduo de grau severo para leve comprova a eficácia do Treinamento Auditivo.

DESCRITORES: Transtornos da Audição; Estimulação Acústica; Percepção Auditiva; Plasticidade Neuronal

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