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Findings in behavioral and electrophysiological assessment of auditory processing

Achados da avaliação comportamental e eletrofisiológica do processamento auditivo

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ABSTRACT

Purpose: To perform a descriptive analysis of the performance of patients referred to a public educational institution to take part in the assessment of auditory processing and to correlate the assessment findings to the variables of age and hearing complaints, also to correlate results to behavioral and electrophysiological assessments. **Methods:** The study included 159 individuals that were referred to the public health system to take part in an assessment of auditory processing. All participants underwent pure-tone audiometry, acoustic immittance measures, behavioral tests of auditory processing, and electrophysiological hearing assessment. **Results:** The main complaint was learning disability and the tests that presented higher prevalence of abnormal results were temporal processing and dichotic listening tests. In all electrophysiological tests the number of normal results was higher than the altered ones. The proportion of normal and abnormal individuals in behavioral and electrophysiological tests did not differ in relation to gender. There was weak correlation between auditory closure and right ear middle latency responses; between left ear middle latency responses and total middle latency responses; among temporal ordering and electrode effect and P300; between temporal processing and right ear middle latency responses; between dichotic listening and P300 and also between binaural interaction and right and left ears acoustic reflexes. **Conclusion:** The most frequent complaint among participants of this study was learning disability. Temporal processing and dichotic listening skills showed higher prevalence of alteration in the assessment. Most participants were referred to assessment of auditory processing by the speech-language pathologist. Correlation between behavioral and electrophysiological assessments was weak.

Keywords: Speech, language and hearing sciences; Hearing; Auditory perception; Auditory perceptual disorders; Evoked potentials, Auditory; Hearing tests

RESUMO

Objetivo: Realizar uma análise descritiva do desempenho de pacientes encaminhados a um hospital de uma instituição de ensino público, para avaliação do processamento auditivo, e correlacionar os achados desta avaliação à idade, queixas, resultados e às avaliações auditivas comportamental e eletrofisiológica. **Métodos:** O estudo incluiu 159 indivíduos encaminhados pelo sistema público de saúde para avaliação do processamento auditivo. Todos os participantes realizaram audiometria tonal liminar, medidas de imitância acústica, testes comportamentais do processamento auditivo e avaliação eletrofisiológica da audição. **Resultados:** A principal queixa referida foi a de dificuldade de aprendizagem e os testes que avaliam processamento temporal e escuta dicótica foram os que apresentaram maior prevalência de alteração. Em todos os testes eletrofisiológicos, o número de resultados normais foi superior aos alterados. A proporção de indivíduos normais e alterados, nos testes comportamentais e eletrofisiológicos, não diferiu em relação ao gênero. Houve correlação fraca entre fechamento auditivo e potencial evocado auditivo de média latência da orelha direita; potencial evocado auditivo de média latência da orelha esquerda e potencial evocado auditivo de média latência total; ordenação temporal e efeito eletrodo direito e P300; processamento temporal e potencial evocado auditivo de média latência da orelha direita; escuta dicótica e P300 e entre interação binaural e reflexo acústico das orelhas direita e esquerda. **Conclusão:** A dificuldade de aprendizagem prevaleceu sobre as queixas dos participantes e as habilidades de processamento temporal e escuta dicótica apresentaram maior prevalência de alteração. A maioria dos participantes foi encaminhada para a avaliação do processamento auditivo pelo fonoaudiólogo. Os testes eletrofisiológicos apresentaram correlação fraca com os testes comportamentais.

Descritores: Fonoaudiologia; Audição; Percepção auditiva; Transtornos da percepção auditiva; Potenciais evocados auditivos; Testes auditivos

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INTRODUCTION

The Central Auditory Processing (CAP) involves the way the nervous system deals with auditory information, either verbal or nonverbal[1]. Therefore, the CAP refers to what we do with what we hear[2].

Normal hearing thresholds is not enough evidence to assert that there is auditory comprehension. It is necessary to analyze and interpret the audio signal in order for it to become a message with meaning[3].

Auditory skills evaluated through behavioral tests include: detection, audio source localization, auditory discrimination, selective attention, auditory figure-ground, auditory closure, binaural separation and integration and auditory sequential memory, considering that CAP evaluation classifies the individual as normal or altered[4].

Alterations in one or more of the auditory skills might be diagnosed as a disorder in the auditory processing[5], that is, an obstacle in the ability of analyzing and/or interpreting audio patterns, that might be associated to difficulties in hearing or understanding speech, to language development and to the learning process[4,6].

There is an indication of auditory processing disorder (APD) when an individual presents hearing difficulties without clear evidences. The main characteristic is the difficulty of hearing when there is background noise, even when the individual presents a normal audiogram[7]. In addition, children with auditory processing disorder often present difficulties in reading, such as comprehension, difficulties with phonemes, with writing, such as spelling mistakes, difficulties of expressive and receptive language[4,8].

Children with APD show alteration in directed attention, getting easily distracted; fatigue in more complex and long tasks; difficulties to follow verbal commands, increasing the need of repeating the commands; slow learning process; difficulty in speech comprehension in a noisy environment and poor academic performance[8].

Hence, it is recommended in the auditory processing assessment the use of verbal and nonverbal stimuli with the use of behavioral tests in order to assess the auditory function or the auditory skills and/or the use of electrophysiological tests, which verify the integrity of auditory canals[9,10].

The assessment of central hearing through electrophysiological tests is also very useful in the assessment of auditory processing, since it provides more data in differential diagnosis to professionals. Also, it is useful in intervention on language difficulty and learning disorders, as it is an objective method of assessment[8].

CAP's behavioral assessment is conducted with standardized tests within acoustic booths. These instruments can be divided into four categories[11]: monaural low-redundancy test (when there is reduction in the extrinsic redundancy of the speech signal and evaluation of the auditory closure skill of a listener, that is, the ability to understand an entire sentence when parts of it are omitted), dichotic test (different stimuli that are simultaneously presented to both ears and primarily evaluate the auditory figure-ground skill and auditory synthesis in binaural integration and separation tasks), temporal processing test (the way the central auditory nervous system – CANS – analyzes temporal aspects of acoustic signals, that is, how sounds are distinguished and perceived in time) and binaural interaction and localization test (CANS's ability of receiving different pieces of information, though complementary, and unifying them in a perceptual event)[12].

The electrophysiological assessment is composed by evoked potentials of short, middle, and long latency. Short latency potentials analyze the electrophysiological activity of the auditory system from the inner ear to the upper brainstem; the middle latency potentials analyze the potentials originated in the primary auditory cortex area, through thalamocortical and reticular formation, and the long latency potentials assess the electrophysiological activity from the thalamus to the auditory cortex and association areas. The electrophysiological study of hearing includes: brainstem auditory evoked potentials (BAEP), middle latency auditory evoked potentials (MLAEP) and the P300, respectively[12-14].

Thus, the auditory processing assessment is relevant to determine and qualify auditory disorders that might influence, in a negative way, aspects of communication such as language, speech, reading and writing, besides other mental functions such as attention, memory and cognition.

The aim of this study was to do a descriptive analysis of the performance of patients that were referred to a public hospital of an educational institution to take part of an auditory processing assessment, and to correlate the findings of this assessment to age, gender, complaints, results and to behavioral and electrophysiological auditory assessments.

METHODS

This transversal descriptive study was analyzed and approved by the Research Ethics Committee of *Universidade Federal de Minas Gerais* (UFMG), under protocol 668.376.

The study sample was composed by a cohort of patients that were referred from the public health system to the Hospital das Clínicas of UFMG for auditory processing assessment.

This study included individuals that took part in the auditory processing assessment, from August 2013 to August 2014, who gave their consent or that had their parents and/or their tutor's permission to take part in the research, through signing the Free and Clarified Consent Term. Incidents of evident alterations in cognitive and/or psychological aspects and peripheral hearing problems were excluded.

The initial sample included the assessment of 167 individuals, 73 (43.7%) of them were female and 94 (56.3%) of them were male. However, eight individuals were not included in the

research for having peripheral hearing problems. Therefore, in the final sample 159 individuals were assessed, 69 (43.4%) of them were female and 90 (56.6%) of them were male, between the ages of 4 and 72.

After the anamnesis and otoscopy, acoustic immittance measures with the study of the acoustic impedance curve and contralateral acoustic reflexes were performed. In this exam it was used the AT235h, an Interacoustics® equipment (Assens, Denmark). All of the participants also took part in the Pure-Tone Threshold Audiometry with the study of auditory thresholds at frequencies of 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz and Speech Audiometry, with the study of Speech Reception Threshold (SRT) and Percentage Index of Speech Recognition (PISR), with recorded list[15].

For behavioral assessment of auditory processing were selected tests according to the patients' age and range of answers. There was an intention of including in the assessment at least one monaural low redundancy speech test (auditory closure), one verbal dichotic test (auditory figure-ground to linguistic sounds), one temporal processing test (ordering and temporal resolution) and one binaural interaction test. However, some individuals showed difficulty in understanding the directions of some tests, which made their performance unfeasible.

The audiometric assessment and the behavioral tests of auditory processing were performed with the Interacoustics® AC33 audiometer attached to a portable CD player. The materials used in the behavioral assessment were the Manual de Avaliação do Processamento Auditivo Central (Central Auditory Processing Evaluation Manual) – Pró-Fono[15] to conduct the dichotic and monaural low redundancy speech tests, and also the PISR and the Pitch Pattern Sequence (PPS) (Musiek), Masking Level Difference (MLD) and Gaps in Noise (GIN) tests recorded in an Auditec® St Louis CD.

The electrophysiological assessment included the study of brainstem auditory evoked potentials (BAEP), middle latency auditory evoked potentials (MLAEP) for patients who were 7 years old and beyond and the P300 cognitive potential, for patients who were 8 years old and beyond (Chart 1). In the electrophysiological study it was used Navigator Pro equipment, Biologic®, software EP 317.

In the clinic where the study was conducted, all patients were invited to take part in the electrophysiological assessment of hearing, however, due to the fact of not being mandatory and to locomotion problems related to the need of attending to all sessions, not all individuals with behavioral assessment also took part in the electrophysiological study.

The categorical variables in this study were: Auditory closure, Temporal ordering, Temporal resolution, Dichotic listening, Binaural interaction, BAEP's result, MLAEP's result and P300's result, contralateral acoustic reflexes' result. The continuous variables were: age, P300 latency, P300 amplitude.

The Chi-square test or the Fisher exact test were used in the statistical analysis, followed by Kappa coefficient to assess the level of association of categorical variables. In the assessment of the correlations of continuous variables it was used the t--test in normal variables (P300 amplitude and latency) and the Mann-Whitney test in the variable without normal distribution (age). The assessment of distribution of variables was conducted using the Kolmogorov-Smirnov test. The significance level adopted was of 5%.

The Kappa coefficient was the measure of association used to describe and test the degree of agreement in classification. In order to do this, the following scale[16] was used: 0 – 0.2: very weak correlation; 0.21 – 0.4: weak correlation; 0.41 – 0.6: moderate correlation; 0.61 – 0.8: good correlation; 0.8 – 1.0: very good correlation.

RESULTS

Among the 159 individuals that were included in the sample, 154 of them specified their main complaint, considering that the prevalent complaint was learning disabilities. In the studied

Chart 1. Adopted protocol in the electrophysiological assessment of hearing

	BAEP	MLAEP	P300
Gain	50.000	100.000	24.000
Filters	100 Hz – 3000 Hz	3 Hz – 100 Hz	1 Hz – 100 Hz
Transducer	Supra-aural phone	Supra-aural phone	Supra-aural phone
Stimulus	Rarefaction click	Alternating click	Rare tone burst 1000 Hz Alternating tone burst 2000 Hz
Number of stimulus	1024 (2 registers)	1000	500
Stimulus rate	21.1/s	7.7/s	1.1/s
Stimulus' intensity	80 dB HL	70 dB HL	75 dB HL
Electrodes (derivation)	A1, A2, Fz, Cz	C3, C4, A1, A2, Fz	Cz, A1, A2, Fz
Task/state of alertness	No task, dorsal decubitus positioning with comfortable angle of inclination, relaxed in natural sleep	No task, dorsal decubitus positioning with comfortable angle of inclination, relaxed and awake	Dorsal decubitus positioning with comfortable angle of inclination, relaxed, mentally counting rare stimuli

Note: BAEP = Brainstem auditory evoked potential; MLAEP = Middle latency auditory evoked potential

sample, 22 (14.3%) subjects presented hearing problems as their main complaint; 38 (24.6%) mentioned language and/or speech difficulties; 68 (44.2%) reported learning disability; 20 (13%) mentioned attention deficit and 6 (3,9%) of them mentioned other complaints, different from the ones mentioned above.

The majority of the participants of this study was referred by a speech-language pathologist (n=85 – 58.62%). Others were referred by a neurologist (n=34 – 23.45%), an otorhinolaryngologist (n=23 – 15.86%) and other professionals (n=3 – 2.07%). It was not possible to determine by which professional 14 of the participants were referred to.

In relation to the contralateral acoustic reflex, 115 (85.8%) individuals presented acoustic reflex in the right ear and 113 (84.3%) of them presented acoustic reflex in the left ear; 11 (8.2%) of them presented absent acoustic reflex in the right ear and 14 (10.4%) of them presented absent acoustic reflex in the left ear; and 8 (6%) of them presented elevated acoustic reflex in the right ear and two (5.2%) of them presented elevated acoustic reflex in the left ear.

In relation to the behavioral assessment of auditory processing, among the 140 individuals that took part in monaural low-redundancy tests, 96 (68.6%) of them presented a normal result and 44 (31.4%) of them presented an alteration in the result; among the 125 individuals that took part in temporal processing tests, 50 (31.4%) presented a normal result and 75 (47.2%) presented an alteration in the result; among the 152 individuals that took part in dichotic listening tests, 29 (19.1%) presented a normal result and 123 (80.9%) presented an alteration in the result; and among the 126 individuals that took part in binaural interaction tests, 78 (61.9%) presented a normal result and 48 (38.1%) presented an alteration in the result. Temporal processing and dichotic listening tests were the ones that demonstrated higher prevalence of alterations (Figure 1).

Not all of the individuals that took part in the behavioral assessment took part in the electrophysiological one. Among the 159 individuals of the sample, only 59 took part in the electrophysiological study. Among these, 51 took part in behavioral and electrophysiological assessments.

As to the electrophysiological assessment of auditory processing, in relation to BAEP, among the 55 participants,

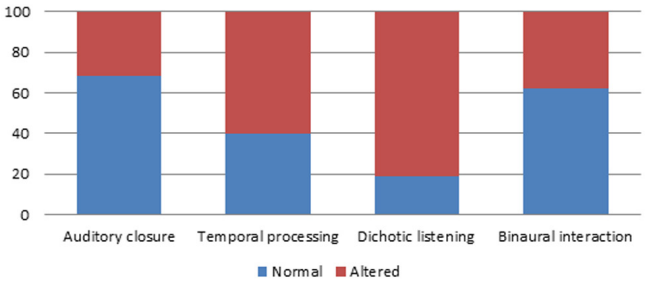

Figure 1. Distribution of normal and altered results in behavioral tests in the assessment of auditory processing

49 (89.1%) of them obtained normal results and 6 (10.9%) had alterations in the results; among the 50 individuals that took part in MLAEP, 27 (54%) obtained normal results and 23 (43%) had alterations in the results; and among the 39 individuals that took part in P300 test, 23 (59%) of them obtained normal results and 16 (41%) had alterations in the results. In all electrophysiological tests, the amount of normal results was higher than the amount of results with alterations.

There was no difference between normal and altered behavioral test and the mean age (p>0.05), that is, individuals that presented an alteration in the behavioral test had, nearly, the same median age of the individuals that presented a normal result in the behavioral test.

There was no statistical difference in the comparison between gender and result of the behavioral and electrophysiological assessments, that is, in the group of individuals that participated in this study, the proportion of individuals with normal and altered results in behavioral and electrophysiological tests did not differ in relation to gender (p>0.05).

Considering the relation between complaints and behavioral assessment, the amount of individuals that presented an alteration in the dichotic listening task was higher than all of the analyzed complaints (Table 1).

The correlation among behavioral tests, electrophysiological categorical variables and contralateral acoustic reflex is described in Table 2.

The results show correlation among auditory closure and right ear MLAEP and left ear MLAEP and TOTAL MLAEP; among temporal ordering and right electrode effect and P300;

Table 1. Analysis of frequency of complaints according to the results of behavioral tests

Complaints	Altered auditory closure		Altered ordering		Altered resolution		Altered temporal processing		Altered hearing		Altered interaction		General alteration	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Hearing	5	11.4	7	10.1	2	13.3	8	10.7	18	15.1	9	19.1	20	14.1
Language/speech	11	25	16	23.1	3	20	16	21.3	27	22.7	9	19.1	33	23.2
Learning	22	50	39	56.5	9	60	43	57.3	54	45.4	18	38.3	65	45.8
Attention	3	6.8	6	8.7	1	6.7	7	9.3	17	14.3	9	19.1	19	13.4
Others	3	6.8	1	1.4	0	0	1	1.3	3	2.5	2	4.3	5	3.5
Total	44	100	69	100	15	100	75	100	119	100	47	100	142	100

Table 2. Correlation among behavioral tests, electrophysiological categorical variables and acoustic reflex

Variables	RE Reflex	LE Reflex	BAEP	RE MLAEP	LE MLAEP	L ear effect	R ear effect	L electrode effect	R electrode effect	Total MLAEP	P300
Closure	0.515	0.555	0.154	0.019* Kappa: 0.331	0.036* Kappa: 0.309	_	_	_	_	0.003* Kappa: 0.374	0.64
Ordering	0.154	0.414	0.204	0.183	0.51	0.063	0.201	0.563	0.025* Kappa: 0.485	0.155	0.016* Kappa: 0.412
Resolution	0.64	0.605	0.591	0.573	0.668	0.434	0.182	0.427	0.593	0.464	0.508
Dichotic listening	0.666	0.904	0.229	0.571	0.327	0.137	0.632	0.707	0.098	0.403	0.016* Kappa: 0.264
Binaural interaction	0.019* Kappa: 0.211	0.013* Kappa: 0.224	0.524	0.45	0.325	0.535	0.064	0.342	0.465	0.438	0.22
Temporal processing	0.453	0.723	0.332	0.049	0.616	0.594	0.5	0.5	0.083	0.145	0.134
General	0.538	0.501	0.788	0.422	0.994	0.609	0.522	0.478	0.609	0.724	0.226

*Significant values (p<0.05) – Fisher exact test or Chi-square test

Note: - = it was not possible to calculate the p value because the number of people included in this analysis was small; RE = right ear; LE = left ear; BAEP = Brainstem Auditory Evoked Potential; MLAEP = Middle Latency Auditory Evoked Potential; P300 = Auditory Evoked Potential

between temporal processing and right ear MLAEP; between dichotic listening and P300 and between binaural interaction and acoustic reflex of right and left ears.

The existing correlation between the auditory skills evaluated through the behavioral assessment of auditory processing and electrophysiological tests is considered weak, according to Kappa coefficient.

DISCUSSION

In this study it was observed that the main complaint mentioned by participants was the learning disability, which is consistent with the literature, since the main complaint reported in the CAP´s anamnesis matches study and learning disabilities[17]. One of literature's studies points out that individuals with learning disabilities may present maturational delay of cortical structures which affect the performance of auditory skills and may influence the results of auditory processing tests[4].

As to the professional who made the referral, most individuals were referred for CAP´s evaluation by speech-language pathologists, which can be explained by the fact that these professionals have a greater knowledge of the subject. This finding indicates that other professionals are in need of updates on what CAP is and when making referrals. Furthermore, such knowledge provides indications on the individual's ability to follow a conversation in noisy environments (such as in a classroom) and assists in defining therapeutic strategies aimed at each patient's problem, especially those with learning disabilities, in the verification of presence or absence of APD and carrying out differential diagnosis with other comorbidities, and also to determine whether there is a need for formal auditory training.

In this study, the number of individuals with altered contralateral acoustic reflex was much lower compared with individuals with normal acoustic reflex and there was statistical difference between the altered acoustic reflex in both ears and the binaural interaction task. In another study the auditory skills of figure ground and sequential memory were the ones who showed the greatest relevance in relation to the change of the acoustic reflex[18].

According to the literature, the action of the superior olivary complex regulates the contraction of intratympanic muscles and the skills involved in CAP. Thus, it is possible that changes in the acoustic reflex results stimulate the occurrence of alterations in auditory processing skills[19]. Besides the inner ear protection, the stapedial reflex arc is also related to the ability of sound location, speech detection, improved listening ability, improved speech intelligibility and noise attenuation in speech understanding[19]. It should be emphasized that the history of recurrent otitis, so prevalent in individuals with altered auditory skills[20], may justify the alterations of contralateral acoustic reflex. In this research, individuals with a history of hearing alterations were included in the group of hearing complaints, however, in the time lapse studied there were no individuals undergoing otologic surgical procedure.

In behavioral assessment, tests that demonstrated higher number of abnormal results were those that evaluate the temporal processing and dichotic listening. The alteration in temporal processing may be attributed to the fact that phonemes in

Portuguese are easier to be distinguish than phonemes of other foreign languages such as English, that is, the auditory system needs to make less effort, which generates a discernment less accurate in frequency and length[21]. In relation to the dichotic listening, when there is correct processing of stimuli in the right ear, one can surmise proper functioning of the left hemisphere and, in turn, abnormal results in both ears suggest alterations in the left hemisphere for speech processing[22].

The dichotic listening task was also the most altered and prevailing one in relation to all complaints that were analyzed in the study, mainly in the individuals that reported having learning disability. In one of the literature's studies that conducted two groups, one group with learning disability (G1) and the other one without learning disability (G2), the G1 presented a lower average score in both ears, indicating lower capacity when responding to stimuli, due to alterations in the development of auditory attention skill[23].

Considering the gender, although most of the individuals in this study are male (n=90), a difference in relation to this aspect and CAP's behavioral and electrophysiological assessments was not detected. According to one study, the reason there are more boys with signs of having APD is due to the fact that mothers produce high levels of testosterone during boy pregnancy, which may slow down the development of the left hemisphere of the brain and stimulate the development of the right hemisphere[17].

As it was possible to observe in the results, only 51 individuals participated in the behavioral and electrophysiological assessments. Within that sample, 49 individuals presented altered behavioral test, considering that 31 of them also presented altered electrophysiological test. Therefore, it was possible to verify that an alteration in the behavioral test does not necessarily mean that there is an alteration in the electrophysiological test. Nevertheless, most of the patients that were referred to the Audiology Services present an alteration in the behavioral assessment, indicating a high incidence of these cases, which makes it difficult to find a statistical correlation between them.

The human peripheral auditory system is almost complete at birth, however, the myelination process continues for some years in upper auditory canals[21]. Therefore, in relation to the maturation of the auditory canal, it is possible to observe better results from birth to, approximately, the age of 12. In relation to behavioral tests, there is a quantitative improvement in the results when age increases[10]. In this study the correlation between normal or altered behavioral test and mean age was not observed.

There was correlation between the auditory closure skill and the MLAEP in both ears and between temporal processing and the right ear MLAEP. According to the literature, the MLAEP are related to the nucleus and the auditory canals situated in the thalamocortical region and primary auditory cortex. Such potential reflects upon cortical activities involved in primary auditory skills – recognition, discrimination and figure-ground – and upon the ones that are not primary – selective attention, auditory sequencing and audiovisual integration[14]. In this same study, the author found as a result an alteration in the auditory closure and auditory figure-ground skills, which suggests a difficulty in the reception of auditory pieces of information, mainly in the cases when tests happen in cases of degraded speech.

In another study in which there was a correlation between temporal processing and MLAEP, the authors did not find agreement between such auditory skill and the electrophysiological test. According to these authors, the fact that the development and maturation of the structures involved must be taken into account when performing temporal functions leads to the conclusion that an individual can only have a proper response to this test at the age of 9 or 10. Also, according to the literature, the latency peak *Na* can be reliable at birth and the *Pa* wave only becomes similar to an adult one around the age of 8[24].

In this study, it was possible to verify that the temporal ordering and dichotic listening skills presented a correlation with statistical significance with the long latency auditory evoked potential – P300. These skills have a strong relation with auditory attention, which is assessed through this potential. The P300 indicates electrical responses produced by the thalamus, auditory cortex and cortical association areas, which reflect cortical electrophysiological activity involving attention, discrimination, memory, integration and decision making skills[10].

The temporal ordering skill may be simple, when the individual identifies nonverbal sounds in silent environments; and complex, when the individual identifies competitive verbal sounds, keeping a given order[10]. This skill plays an essential role in speech perception, when segmenting speech sounds, in language learning and comprehension, being a prerequisite for reading and writing acquisition[25], and it is directly related to perception and phonemic discrimination. The auditory attention, assessed through P300, is necessary to the acquisition of acoustic and phonetic aspects of language patterns, which are important when learning how to read and write[10].

In another study in which the relation between the auditory skill of dichotic listening and P300 was made, it was possible to notice that individuals that presented an alteration in the P300 result, also presented some kind of alteration in the dichotic listening test[26], what corroborates the findings of this study, since the P300 is related to attention and recent memory[10].

There was correlation between the auditory skill of temporal ordering and the right electrode effect, assessed through the MLAEP. The electrode effect may be found in individuals that present a lesion in one of the hemisphere, with reduced response on that side of the brain[27]. In the case of temporal ordering, the recognition of the pattern outline is detected in the right hemisphere, and through the corpus callosum this information is transferred to the left hemisphere, where language processing[28] occurs. Thus, such correlation my suggest that these individuals present some alteration in the right hemisphere, that might complicate or prevent the auditory recognition of frequency pattern, not allowing its processing, and that might

present lower amplitude values in the Na-Pa relation on this same side of the brain, indicating the presence of electrode effect in the MLAEP.

In this study, the electrophysiological tests demonstrated weak correlation with behavioral tests, which may be explained be the nature of this assessments. Whilst the behavioral assessment provides a measurement of the functional performance of the individual considering the operation of the entire auditory system, the electrophysiological assessment provides a measurement of the neural synchrony, it presents a wider variability among individuals and it is under bigger influence of external factors. Thus, there is not a proportional agreement between the two modalities of assessment. Even so, the electrophysiological assessments may contribute to a conclusion in the diagnosis, endorsing the auditory origin of the disorder. In addition, the electrophysiological study may assist the assessment of the effectiveness of auditory training, since it reveals the integrity of the central auditory nervous system, with the possibility of indicating the level or the place of the disorder.

CONCLUSION

Learning disability predominated in relation to others complaints presented by the participants of this study, and the temporal processing and dichotic listening skills presented higher prevalence of alteration. Most participants were referred to a CAP assessment by a speech-language pathologist.

No difference was detected between the individuals who presented behavioral and electrophysiological tests with and without alteration, in relation to age and gender.

The electrophysiological tests presented weak correlation to the behavioral ones.

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