Perception of limitations on communicative activities, temporal resolution and figure-to-ground in unilateral hearing loss

Percepção de limitações de atividades comunicativas, resolução temporal e figura-fundo em perda auditiva unilateral

Márcia Ribeiro Vieira[1], Regiane Nishihata[1], Brasília Maria Chiari[2], Liliane Desgualdo Pereira[2]

ABSTRACT

Purpose: To evaluate the hearing behavior of figure-to-ground and temporal resolution, and the self-perception of limitations on communicative activities of children and adolescents with unilateral hearing loss. **Methods:** Participants were 38 individuals, with ages between 8 and 19 years, divided into: experimental group (with unilateral hearing loss) and control group (normal-hearing individuals), each comprising 19 individuals, matched according to gender, age and educational level. All subjects carried out anamnesis, audiological evaluation, and the procedures of study: a self-report questionnaire of limitations on communicative activities, and the auditory processing tests Gaps-in-Noise and Pediatric Speech Intelligibility Test. Statistical analysis was conducted using non-parametric tests. **Results:** In the experimental group the unilateral hearing loss was profound in most participants, having started during the pre-school stage, with unknown or identified etiologies (e.g. meningitis, traumas, mumps and measles). Most subjects presented learning difficulties complaints, and showed predominantly moderate limitations on communicative activities, mainly in noisy situations. The worst results were observed in the experimental group, both for the thresholds of gap detection and the Pediatric Speech Intelligibility Test carried out in the normal ear. There was no significant correlation between the thresholds of gap detection on the normal ear and the side of the ear with hearing loss. **Conclusion:** Individuals with unilateral hearing loss present limitations on communicative activities, especially in noisy environments, associated with worse auditory processing abilities of temporal resolution and figure-to-ground.

Keywords: Unilateral Hearing loss, unilateral; Hearing; Hearing tests; Auditory perception; Hearing disorders.

INTRODUCTION

Until the mid 70's, most of Otorhinolaryngology and Audiology professionals believed that unilateral hearing loss (HL) in children could not affect significantly the development of oral and written language. However, as from the 80's, studies began to suggest that this kind of HL could bring serious damage to the academic development of these subjects[1]. Since then, the interest in investigating the possible risks that unilateral HL causes for both children and adolescents increased.

Auditory Processing refers to the efficiency and effectiveness which the central nervous system uses the auditory information, it included the auditory mechanisms that follow the following skills: sound localization and lateralization, auditory discrimination, auditory pattern recognition, recognition of temporal aspects of hearing and auditory performance in the presence of competing or damaged acoustic signals[2].

A unilateral HL can lead to deficits in auditory processing and consequently in the development of language and communication, especially if it occurs in children. These deficits may be related to the disadvantages that these children experiment because of the lack of binaural hearing[3]. The binaural hearing provides sound localization, binaural summation, the head's shadow effect and the release from the masking. The interaction of these factors makes the binaural hearing favor the recognition of speech in the noise, through the ability to perform figure-to-ground[4]. Therefore, many research have shown that the unilateral HL may cause difficulties in communication

Study conducted at the Graduate Program (Masters degree) in Human Communication Disorders, Universidade Federal de São Paulo – UNIFESP – São Paulo (SP), Brazil.
(1) Graduate Program (Masters degree) in Human Communication Disorders, Universidade Federal de São Paulo – UNIFESP – São Paulo (SP), Brazil.
(2) Graduate Program in Human Communication Disorders, Universidade Federal de São Paulo – UNIFESP – São Paulo (SP), Brazil.
Correspondence address: Márcia Ribeiro Vieira. R. Desfile, 19, Jardim Novo Horizonte, São Paulo (SP), Brasil, CEP: 04856-310. E-mail: marciatim@yahoo.com.br
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as a whole[5]. Difficulties in auditory skill of figure-to-ground and the temporal resolution could be factors which affects the academic performance of individuals with unilateral HL. This is because the ability to perform figure-to-ground is important to perform activities of daily life such as reading in a noisy environment or learning a new school subject in a classroom with other competitive auditory stimulus[4]. Likewise, the ability of temporal resolution is of extremely importance to understand the human speech, which constitutes a prerequisite for language skills, as well as for reading[7].

Activity limitations are difficulties that a person may have in executing activities. A limitation of activity can vary from a mild to a serious deviation in terms of quantity or quality in performing the activity compared to the manner or the extension expected in people without this health condition[8]. A person with unilateral HL, for example, has a hearing impairment that can cause difficulties in the act of communication, which here is called Limitation of Communicative Activities (LCA)[9]. The extent of limitation of activities is very individual and cannot be measured by objectives tests, it is usually measured by the use of surveys which measure the self-perception of individual with hearing loss.

Most of the subjects with unilateral HL present difficulties in speech and sound localization; in addition, they use compensatory strategies of communication, such as: change of place, request repetition of the speech to the speaker, the use of visual cues and gestures and show negative feelings towards the difficult situations of hearing they passed through[10]. These communication strategies may reflect the intention of these people to minimize their LCA. Moreover, negative feelings might point the consequence of the limitations caused by the HL.

The unilateral HL can be an indicator of risk for modifications in the auditory processing as a whole, especially in their hearing skills of sound localization, figure-to-ground and temporal resolution. These changes can cause LCA to in varying degrees. So, it is very important to know the auditory behavior of figure-to-ground and temporal resolution and how the hearing disorders may contribute to the LCA of individuals with unilateral HL.

The purpose of this study was to evaluate the behavior of auditory of figure-to-ground and temporal resolution as well as the perception of LCA in children and adolescents with unilateral sensorineural hearing loss classified as severe to profound and compare them to individuals with normal bilateral hearing.

METHODS

The study was approved by the Ethics Research Committee of the Universidade Federal de São Paulo (UNIFESP) filed under number 08/1233.

Participants were 38 subjects aged between 8 and 19 years, where 18 with unilateral HL constituted the experimental group (EG) and 19 without any hearing disorders constituted the control group (CG). Each group had 12 male subjects and 7 female subjects, who were paired according to gender, age and education.

The inclusion criteria to participate in the EG were: present severe to profound sensorineural HL unilaterally, resulted in the basic audiological results within the normal range on the opposite side of the HL, absence of evidence of neurological or psychiatric disease observed through interviews. Individuals of the CG had to present results in basic audiological assessment within the normal range in both ears, and the of any speech therapy and/or learning complaints, obvious neurological or psychiatric diseases, observed through an interview. The participants with unilateral HL were selected from the Hearing Disorder Ambulatory of the Department of the Speech-Language Pathology, and the Pediatric Otorhinolaryngology Ambulatory of the Department of Otorhinolaryngology and Head and Neck Surgery of UNIFESP (*Disciplinas dos Distúrbios da Audição do Departamento de Fonoaudiologia e de Otorrinolaringologia Pediátrica do Departamento de Otorrinolaringologia e Cirurgia de Cabeça e Pescoço da UNIFESP*). The subjects of the CG had no link with the institution and were randomly selected. All were invited to participate in this study without affecting their health care, moreover, the caregivers signed a Term of a Free and Informed Consent, consenting to the realization and publication of this research according to the 196/96 Resolution.

The procedures used for selecting the subjects were: anamnesis, otoscopy, pure tone audiometry, speech audiometry, tympanometry and contralateral acoustic reflexes. After the selection of the individuals, all participants were subjected to some evaluations described below.

Evaluation of the perception of LCAs

A self-evaluation questionnaire adapted/modified from a previous questionnaire designed to compare LCA with and without the hearing aid in patients with unilateral HL was applied[11]. It comprises questions about the limitations that a HL causes in daily activities, in different environments such as home, school and the street. As the original questionnaire proposed is intended for adults, some questions were adapted and other were added, those which are related to the lives of children and adolescents, objects of this study. In addition, there was a change also in the answers' form, since the purpose of this research was to evaluate only the limitation of activities of the individuals and not as the hearing aid can reduce them, as proposed by the original questionnaire.

This way, the questionnaire contains 13 questions and was divided into three scales, considering the different environments in which the individual may suffer any kind of limitation, namely: house (with five questions) school (with four questions) and street (with four questions). Furthermore, the questions were also subdivided according to the type of situation: noisy (seven questions), quiet (four questions) and sound localization (two questions).

The answer choices were given by the visual analogue scale (VAS)[12]. The scale consisted in a horizontal life of ten centimeters wide, where they placed only the minimum (zero) and the maximum (ten), where zero means "no limitation" and ten "extreme limitation". The individual should have marked a point in the area which he believed to be closer to

his degree of limitation. Each question was measured with a ruler, to set the limitation's value. After identifying the value of the answer, this was converted into a percentage for all the questions. Next, a full analysis of each type of environment and situation was held. The questionnaire and the answer sheet are presented in Appendix 1.

The classification of the limitations used was proposed by the International Classification of Functioning (ICF)[8] (Chart 1).

Chart 1. Classification of the limitation of communicative activities

Answers (%)	Classification
0 – 4	No limitation
5 – 24	Slight limitation
25 – 49	Moderate limitation
50 – 95	Severe limitation
96 – 100	Complete limitation

Adapted from: CIF (2002)

The Gaps-in-noise test – GIN

The GIN test evaluates the ability of auditory temporal resolution[13] and was conducted in a sound proof booth using a Compact Disc (CD) recording, which is composed of one training-track and four test-tracks. There are six seconds of white noise segments interspersed with random gaps. The duration of the gaps is varied (2, 3, 4, 5, 6, 8, 10, 12, 15 till 20 milliseconds). Each gap appears six times in the total of items of each test-track, a total of 60 gaps per test-track. It was presented till three breaks of silence per noise segment and some segments did not present any. It was presented for 50 dBLS and the stimulus presentation was made monaurally for both groups, since the tested ears were those with normal EG.

The GIN test performance was based on the threshold approximate from a gap. This threshold was defined as the shortest noise break inserted in the noise where at least four of the six possible events were correctly identified and with a correct identification of the major breakaway that followed.

A comparison was made between the individuals of the EG according to the HL side. As previous researches suggest that there is an improvement in the answers on the GIN test with the increase of age[13], it was decided then that in this research to divide the groups into two age groups: 8 to 10 years and 11 to 19 years. According to this division, the answers of the gap threshold were compared between the EG and the CG. Furthermore, a comparison was made between the individuals of the EG according to the HL side. The results were statistically analyzed and a comparison was made to verify possible differences between EG and CG.

Pediatric Speech Intelligibility Test – PSI Test

The PSI test was applied to evaluate the auditory ability of figure-to-ground for verbal sounds. It consists in identifying sentences with contra and ipsilateral competitive message (IMC and CCM respectively), in a soundproof booth. Its goal is to evaluate the recognition of phrases (message) in the presence of a story (competing message)[14]. The test is performed with a banner in which the individual points to the figure heard in the spoken phrase. Participants were oriented to pay attention and point to the figures matching to the sentence heard, dismissing the competitive message (story).

The presentation intensity of the speech signal was 40 dBLS. As the EG individuals have unilateral HL just the IMC step was evaluated. Ten sentences were then presented to the signal-to-noise 0, -10 and -15 in the normal ear. For the CG, the evaluated ear was the same ear where the stimuli were presented to their pair of the EG.

The normal expected results vary according to the condition of the competition. It is hoped in the PSI – IMC (0) values of 80% correct or greater. In the PSI – IMC (-10) values equal to greater than 70% and for PSI – IMC (-15), 60% or more correct answer[14]. The answers were recorded in a specific protocol and shown in percentage of correct answers.

RESULTS

Characteristics of the sample

The average of the sample was 12.32 (8-19 years). There was predominance of males (63.2 % of the sample), while females constituted 36.8% of the participants. No difference were observed between the of the HL in this sample, as 47.6% had HL on the right side and 52.6% on the left.

The loss (HL) happened before the speech acquisition (pre-lingual hearing loss) in 42.1% of cases and 84.2% of children unilateral HL occurred before the onset of literacy (preschool).

The interview with the responsible revealed that 57.9% of the children with unilateral HL had some type of complaint in learning. Moreover, 36.8% of them were in process of speech therapy.

Questionnaire of perception of LCA

It was observed that the perception of the LCA in the EG group was predominantly moderate in the environments studied (Figure 1).

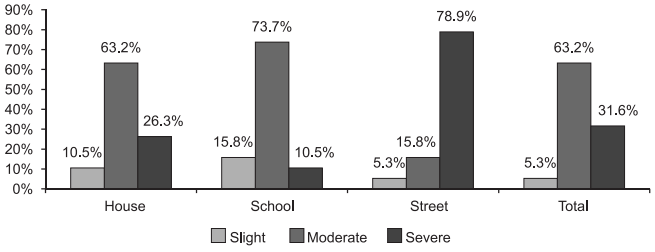

Figure 1. Perception of the experimental group of the limitations of communicative activities in different environments

Concerning the type of situation, the individuals of the EG had higher LAC in noisy situations and sound localization (Figure 2).

There were no correlations between the degree of perception of the LCA and the age, the gender, side of the HL, learning difficulties or time of onset of the HL for any of the studied environments.

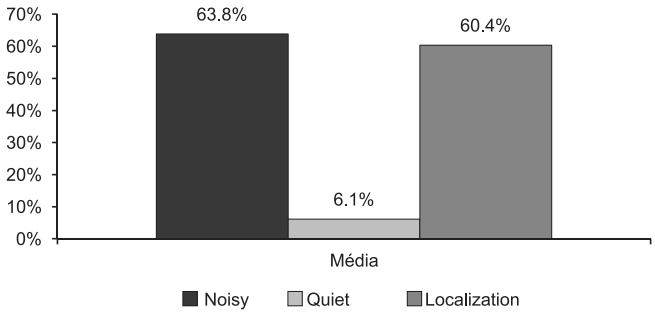

Figure 2. Perception of the experimental group of the limitations of communicative activities in different situations

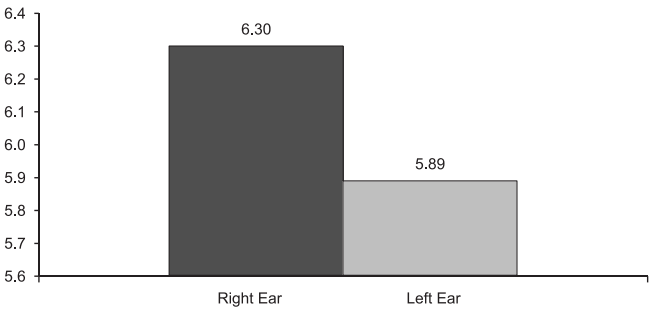

Figure 3. Comparison of the average gap detection thresholds in right and left ears

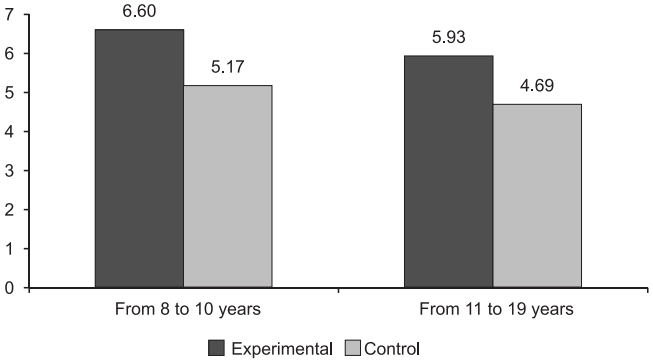

Figure 4. Comparison of the average gap detection thresholds between the groups

Concerning the HL level, it was observed that individuals with profound unilateral HL presented sense limitation from moderate (71.4%) to sever (40%), as those with severe HL, there was higher occurrence of slight degree of limitation (20%) to moderate (40%) and the difference tended towards significance (p=0.086)

The comparison between the groups showed that the EG had higher LCA than CG for all types of environments and situations (Table 1).

GIN test

The group with HL in the right side presented higher gap detection thresholds than those with HL in the left side (Figure 3).

The GE presented higher gap detection thresholds than the CG in both age groups studied (Figure 4).

Pediatric Speech Intelligibility Test – PSI Test

The EG had worst results than the CG in the relations 0 and -10. There were no differences between the performance of the group with HL in relation to the influence of the HL side in the PSI test (Table 2).

DISCUSSION

Characteristics of the sample

Most studies on unilateral HL showed that the incidence

Table 1. Descriptive measures of the perception of LCA compared between experimental and control group in different environments and types of situation

Environment/ situation	Group	Mean (%)	Median (%)	SD %	1st quartile (%)	3rd quartile (%)	n	CI (%)	p-value
House	Experimental	42.1	41.2	10.6	36.4	49.5	19	4.8	<0.001*
	Control	13.8	14.2	4.7	10.8	16.9	19	2.1	
School	Experimental	35.4	33.8	10.2	28.8	43.5	19	4.6	<0.001*
	Control	16.3	15.8	6.1	12.0	19.6	19	2.8	
Street	Experimental	60.0	58.0	17.6	51.4	71.6	19	7.9	<0.001*
	Control	19.8	20.3	5.9	16.0	22.9	19	2.6	
Total	Experimental	45.5	45.6	9.6	42.2	51.3	19	4.3	<0.001*
	Control	16.4	16.0	3.4	14.1	18.2	19	1.5	
Noisy	Experimental	63.8	64.3	14.7	52.4	72.3	19	6.6	<0.001*
	Control	24.7	24.9	6.4	18.2	28.9	19	2.9	
Quiet	Experimental	6.1	5.8	4.3	3.0	8.0	19	2.0	0.136
	Control	4.7	2.8	5.2	1.9	5.3	19	2.3	
Localization	Experimental	60.4	59.0	20.7	47.5	71.8	19	9.3	<0.001*
	Control	10.8	9.5	8.4	2.8	19.3	19	3.8	

* Significant values (p≤0.05) – Mann-Whitney test

Note: SD = standard deviation; CI = confidence interval

Table 2. Descriptive measures of the comparisons between the groups for the PSI in the 0, -10 and -15 relations

PSI	PSI (0)		PSI (-10)		PSI (-15)	
	Experimental	Control	Experimental	Control	Experimental	Control
Mean	94.21	100.00	90.53	98.42	83.16	94.74
Median	100.0	100.0	100.0	100.0	90.0	100.0
SD	9.02	0.00	13.53	5.01	17.97	6.97
1st quartile	90.0	100.0	85.0	100.0	65.0	90.0
3rd quartile	100.0	100.0	100.0	100.0	100.0	100.0
n	19	19	19	19	19	19
CI	4.05	- x -	6.08	2.25	8.08	3.13
p-value	0.004*		0.024*		0.061#	

* Significant values (p≤0.05) – Mann-Whitney test

\# values with a tendency towards statistical significance

Note: DP = standard deviation; IC = confidence interval

if this type of HL is higher in males[1,10,15,16]. The same was shown in our sample.

In relation to the etiology of unilateral HL, it can be congenital (genetic, or acquired during gestation), perinatal or acquired throughout life due to a disease or trauma. Most research indicated that approximately 35% of the reason of the cause of the unilateral HL is unknown[17]. In our study, the etiology of unilateral HL was unknown in 36% of the cases, in agreement with literature data. The rest were acquired throughout life, in addition we also found similar causes to literature such as mumps, meningitis, measles and trauma.

Previous research about the academic performance of children and adolescents with unilateral HL, mostly severe to profound, indicated that a significant percentage of them had learning difficulties and higher rates of school failure than individuals with normal hearing. Also, most of them attended school support programs and needed speech-language pathology intervention[16,18,19]. Other studies have indicated, however, that the unilateral HL did not significantly affect school learning[20]. Thus, not all children with unilateral HL have educational problems and learning disabilities, and other features, in addition to the HL, can influence the learning aspects of these individuals[3]. As in the studies listed, the relation between the HL and learning difficulties in our sample is not clear, in that there was no significant difference between the number of subjects whose parents had this complaint and the group without complaints. The difficulty of establishing a clear relationship between the unilateral HL and learning difficulties can be explained by the fact that the assessment in our study was done only by means of an interview with the parents, who often had inaccurate answers or did not participate in a actively development of school children.

Questionnaire of perception of LCA

The analyses of the answers of the questionnaire showed that all subjects of the EG had some degree of perception of the LCA. When seen in total, the degree of perception of limitation that occurred the most was the moderate. Individuals with unilateral HL have difficulties in speech recognition in noise and sound localization and perform compensatory strategies of communication[20]. These compensatory strategies observed suggest that these individuals have a clear understanding of their limitations, as notes in this study.

In our sample there were no significant correlations of age or gender with the degree of perception of the LCA. Likewise, studies on the subject did not show this correlation[10,11]. Although age has been widely studied, the younger group (8 to 11 years) was as happy as the older group (12 to 19 years) to answer the questions. This may be due to the fact that the questionnaire was adapted from the original (designed for adults) with much simpler questions which made it easier to understanding of the two age groups. Also, the form of answer was given by the VAS scale, which is deal for children and adolescents; it has the advantage of being easy to apply and does not require too much time reading possible alternatives[12]. In this way, this questionnaire may be useful in investigating the perception of LCA in children and adolescents especially if the VAS scale is used.

The statistical analysis of this survey indicated that the side of the HL did not influence the degree of perception of the LCA. Instead, another study found that the relation between the degree of the unilateral HL and the restrictions on academic performance since it was observed that children with HL on the right side had more school failure than those with HL on the left side[15].

There was an influence of the degree of unilateral HL and the perception of the LCA, this perception is greater in individuals with profound HL. Although there are no studies that indicate these correlations, those who evaluated the academic performance, of these individuals also showed that the higher the degree of unilateral HL, the greater the learning difficulties[3,4,15].

In our sample we find no correlation between the degree of perception of the LCA and the presence of complaints of learning disability for any environment or situation. Likewise, there was no association between time of onset of the HL and the degree of limitation. That is, for individuals in our study, regardless of time of onset of HL, it interferes in the same way in the LCA.

Comparing the types of situation it was found that the occurrence of the perception of LCA in quiet situation was

lower than the occurrence in situation of noise and sound localization. That means that, the unilateral HL influence speech understanding especially in noisy environments and sound location and there was little influence in quiet situations. These findings agree with most of the studies on the subject. The difficulties that unilateral HL bring to children may be related to speech understanding in the noise, since the binaural hearing and binaural summation contribute to the detection and speech recognition in the noise[3]. In addition, some studies were performed in order to assess the hearing abilities of sound localization and auditory closure of children and adolescents with unilateral HL by testing specific auditory processing. The majority observed changes in the ability to locate sound[1,4,21]. Similarly, tests that evaluated the ability of auditory closure indicated that individuals with unilateral HL have a worse performance than normal subjects, even when the stimulus is presented in the normal ear[15,22].

Comparing the perception of the LCA between the EG and the CG, it showed that there was there was differences for all types of environments and situations, except the silent situation, in which despite the fact that EG have major limitations, this difference was not significant. This fact suggests that the unilateral HL does not influence significantly the understanding of speech in ideal acoustic environments. This can be explained by the fact that an individual with disabilities in the auditory close skill shows failure in redundancy intrinsic of the central nervous system, reducing or eliminating the repeated representation of the signal reaching the auditory pathways. Therefore, any complications that reduce the auditory signal redundancy extrinsic can interfere with the individual's ability to identify a message through the auditory closure. In its most basic level, a deficiency of auditory closure may interfere with the ability of decoding phonetic aspects of a speech signal. Conversely, the listener with a deficiency in the auditory closure skill, may not have difficulty in speech understanding in an ideal acoustic environment, however, may have greater difficulty with background noise or unknown speakers[23].

The few studies that involve self-assessment questionnaire on unilateral HL showed that most individuals present the LCA perception mainly in noisy situations and sound localization[24,25].

GIN test

It was observed that individuals with the HL on the right had gap detection threshold worse than those with the loss on the left. However, these differences were not significant. This finding agrees with literature data, where it was observed that when the HL was in the left, the responses in the normal ear (right) were better than when the HL was on the right. So, the input of audio signal from the right or from the left ear produces different patterns of auditory information, like this, the pattern encoded was more efficient by the left ear afferent. A likely hypothesis would be that the stimulus reaches directly the right hemisphere in which it would be processed more efficiently. The worst responses seen in patients with the HL on the right side may be related to the fact that the left auditory cortex (answers coming from the right ear) is specialized in the processing of acoustic stimuli with the complex temporal structure, as speech, and the right hemisphere (lest ear responses) favors tonal stimuli and music[26]. The ability to encode and analyze temporal aspects of acoustic information can be related to the contribution of the left hemisphere for language functions[27]. That is, the temporal resolution may be more related to the left hemisphere and therefore the HL on the right causes a greater disadvantage in the hearing ability.

The gap detection thresholds of the EG were worse than the GC in both age group studied. These data agree with a previous study[26], which it was also found worse results in individuals with unilateral HL in the GIN test when compared to subjects with normal hearing bilaterally. Similarly, individuals with unilateral HL have worse results than the normal-hearing when the hearing ability of temporal resolution is evaluated by Random Gap Detection Test (RGDT)[22].

We note that in our sample the gap detection thresholds of the two age groups of the CG approached the majority of studies, in which the averages range from 4.6 ms to 4.9 ms[13,28]. However, the EG had higher values of thresholds gap detection in both age groups. Thus, the results suggest that the temporal resolution ability of individuals with unilateral HL can be affected if compared to those with normal hearing bilaterally. This damage may be due to the fact that the temporal resolution depends of two processes: analysis of the temporal pattern that occurs in each frequency channel (intra-channel temporal analysis) and the comparison of temporal patterns of the various audio channels activated at each moment (inter-channels temporal analysis). Such channels refer to the filtering characteristics of the peripheral auditory system. The cochlea behaves like a set of filters, which divides the components of a complex signal into "channels", tuned to different center frequencies. That means that the lack of response of the cochlea in one ear may influence the temporal analyses of the sound.

The auditory ability of temporal resolution is essential for speech understanding, being a prerequisite for language skills, as well as for reading[7]. Thus, the loss in temporal resolution observed in individuals with unilateral HL may explain the difficulties of learning a significant part of this sample.

Pediatric Speech Intelligibility Test – PSI Test

The PSI was developed to evaluate the ability of auditory figure-to-ground for children under 7 years old, or little knowledge of graphical code[14]. It was applied to the individuals in our sample, since it does not involve the dominance of graphical code and most participants of the EG had difficulty in reading and writing. In order for the comparison between groups would be effective, the PSI was also applied in the CG, although there was no complaints for reading and writing in this group. It is worth noting that the majority of individuals of the EG studied in public schools in Sao Paulo, in which, according to the parents of the children, there is the method of automatic promotion. This method consists in the promotion of all children for the next grade even if they have not learned the school's curriculum proposed for the grade in which they are. The flunk occurs only in sporadic cases in the last year of

each cycle (4th and 8th grades of elementary school and in the third year of high school). This way, the matching by age and education was possible although children of the EG present difficulties in reading and writing, since they had not repeated any grade, as well as individual in the CG, moreover, had no complaints of reading and writing. In our studies, it was not observed differences concerning the side of the HL in the PSI – IMC. Likewise, previous studies do not describe the right ear advantage in this test[14].

In our sample, it was verified that the EG had lower percentage of correct answers that the CG for all competitive relations in the PSI – IMC. These differences between the groups were significant in the 0 and -10 relation. These findings agree with previous studies that found that children with unilateral HL present unilateral speech recognition performance significantly worse even in direct monaural conditions (in the better ear) when compared to CG, especially in most difficult relations of PSI test[5,30].

The differences between the groups regarding the ability of figure-to-ground auditory happen possibly because the binaural interaction depends on the simultaneous use of both ears, the neural interaction that occurs with signals perceived by both of them, and how auditory information is processed. These interactions help locating the individual sound sources in the space and perform figure-to-ground[21].

The PSI test has been a useful tool in evaluating children with learning difficulties. Individuals with learning disorder had significantly worse results, especially in the stage of monotic with signal/noise -10 ratio[6]. In a way, the results of our studies agree with these finding, since that in the PSI the EG (group in which 57.9% had learning difficulties) had results below the GC, which did not have any type of learning disability. This relation between impairment in figure-to-ground ability and learning difficulties is the fact that this ability is important in carrying out activities of daily living, such as reading in a noisy environment or learning a new school subject in a classroom with other competitive auditory stimuli[6].

CONCLUSION

All subjects of the EG had some degree of perception of limited communicative activities for all the tested environments (home, school and street). The perception of the LCA ranged from light to severe degree and is predominantly moderate. There was greater awareness of the limitation in noisy situation and the ability to locate sounds. On the other hand, there was no correlation between the perception of the LCA with the age, the gender, the type of the HL or learning difficulties. Apparently the HL side did not influence significantly the results of the GIN test. Finally, the group with unilateral HL showed worse thresholds and smaller percentage of hits in the GIN test and greater difficulties in the ability of auditory figure-to-ground, as evidenced by PSI test, than normal-hearing individuals.

Therefore, we conclude that individuals with unilateral hearing loss have limitations in communicative activities, especially in noisy environments related to the worse hearing abilities of temporal resolution and of figure-to-ground.

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RESUMO

Objetivo: Avaliar os comportamentos auditivos de figura-fundo e resolução temporal, e a auto-percepção das limitações de atividades comunicativas de crianças e adolescentes portadores de perda auditiva unilateral. **Métodos:** Participaram do estudo 38 indivíduos, com idades entre 8 e 19 anos, divididos em: grupo estudo (portadores de perda auditiva unilateral) e grupo controle (ouvintes normais), cada um formado por 19 indivíduos, pareados conforme gênero, idade e escolaridade. Todos foram submetidos à anamnese, avaliação audiológica e aos procedimentos do estudo: questionário de auto-avaliação das limitações de atividades comunicativas, testes de processamento auditivo *Gaps-in-Noise* e *Pediatric Speech Intelligibility Test*. A análise estatística foi realizada por meio de testes não paramétricos. **Resultados:** No grupo estudo, a perda auditiva unilateral na maioria dos participantes foi de grau profundo, com início na fase pré-escolar, com etiologias desconhecidas ou identificadas como meningite, traumas, caxumba e sarampo. A maioria dos indivíduos apresentou queixa de dificuldades de aprendizagem e mostrou limitações de atividades comunicativas de grau moderado predominantemente, e principalmente em situações ruidosas. No grupo estudo foram observadas as piores respostas tanto para os limiares de detecção de *gap* como no teste *Pediatric Speech Intelligibility Test* obtidas na orelha normal. Não houve correlação significativa entre os limiares de detecção de *gap* na orelha normal e o lado da orelha com perda auditiva. **Conclusão:** Indivíduos com perda auditiva unilateral apresentam limitações de atividades comunicativas, principalmente em ambientes ruidosos associadas a piores habilidades auditivas de resolução temporal e de figura-fundo.

Descritores: Perda auditiva unilateral; Audição; Testes auditivos; Percepção auditiva; Transtornos da audição.

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Appendix 1. Questionnaire of the Perception of Activity Limitations (based on Radin, 1994)[11]*
* Modified on how to respond and reducing the number of original questions

Name: _____ Date: ___/___/_____

What is the restriction – how your hearing loss disturb you in the following activities:
zero: there is no limits/does not disturb
ten: extreme limitation/disturbs a lot

At home, when:
1. You are on the telephone and other people are talking at the same time in the same room.
2. You are on the telephone and the is not noise around.
3. You are having dinner with the family on the table and the person sitting in the side that your hear better talk to you.
4. You are having dinner with the family on the table and the person sitting in the side that your hear the worst talk to you.
5. You are talking with someone of your family who is in another room.

In school, when you need:
6. To understand what the teacher says when the classroom is quiet.
7. To understand what the teacher says when your classmates are talking.
8. To understand what your classmates say when there is more than one talking
9. To understand what your classmates say when they talk each one at a time.

Various situations – when:
10. You are talking to someone on a very busy street.
11. You are talking to someone in a noisy party.
12. When you are in the car, with the radio on and you are talking to someone.
13. You are talking to someone on the street and it is raining a lot.

Answer sheet for the questionnaire

	zero	ten
1.	_____	
2.	_____	
3.	_____	
4.	_____	
5.	_____	
6.	_____	
7.	_____	
8.	_____	
9.	_____	
10.	_____	
11.	_____	
12.	_____	
13.	_____	