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ARTICLES

Influence factors in speech perception in elderly users of hearing aids

Fatores de influência na percepção de fala em idosos usuários de próteses auditivas

Factores de influencia en la percepción del habla de adultos mayores usuarios de prótesis auditivas

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Abstract

Purpose: To verify the performance of the elderly in speech tests considering the aspects: adjustments of hearing aids and / or degree and configuration of hearing loss, performance on cognitive screening and hearing skills. **Methods**: Participated 36 elderly aged 60 to 87 years , with sensorineural hearing loss of mild to moderately severe. Obtained the Sentence Recognition Indexes in Noise (SRIN) through Brazilian Portuguese Sentence List, with hearing aids, using the following settings: omnidirectional microphone; noise reduction and omnidirectional microphone; directional microphone; the noise reduction and directional microphone. Considered: tritonal average 500,1000, 2000 Hz and 3000, 4000 and 6000 Hz; Mini mental state examination results, dichotic digits test and standard duration. **Results**: When speech and noise came from the same direction (0/0° azimuth), there was no predominance of the settings in the best performance in SRIN. In the condition that the noise focused behind the subject (0/180° azimuth), the directional microphone associated noise reduction were essential for the best performance. There was a correlation between the SRPRN 0/0° and the dichotic digits test. **Conclusion**: The ability of figure-ground for verbal sounds showed influence in the communicative performance of the elderly user of hearing aids, when speech and noise came from the same direction. But when speech

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Authors' contributions:
GCF performed the interpretation of results and developed the discussion;
SNS designed the study and was responsible for data collection, analysis and interpretation;
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and noise are spatially separated, the directional microphone and the associated noise reduction helped the individual to respond more efficiently to the stimuli presented.

Keywords: Hearing aids; Speech discrimination; Hearing loss; Auditory perceptual disorders; Aged.

Resumo

Objetivo: Verificar o desempenho dos idosos nos testes de fala considerando os aspectos: ajustes das próteses auditivas e/ou grau e configuração da perda auditiva, desempenho na triagem cognitiva e habilidades auditivas. **Métodos**: Participaram 36 idosos, com idade entre 60 e 87 anos, com perda auditiva neurossensorial de grau leve a moderadamente severo. Obtidos os Índices Percentuais de Reconhecimento de Sentenças no Ruído (IPRSR), através das Listas de Sentenças em Português Brasileiro, com as próteses auditivas, utilizando os seguintes ajustes: microfone omnidirecional; redutor de ruído e microfone omnidirecional; microfone direcional; redutor de ruído e microfone direcional. Consideradas: médias tritonais de 500, 1000, 2000 Hz e 3000, 4000 e 6000 Hz; resultados do Mini Exame de Estado Mental, teste dicótico de dígitos e padrão de duração. **Resultados**: Quando fala e ruído vieram da mesma direção (0/0º azimute), não houve predominância dos ajustes no melhor desempenho no IPRSR. Já na condição em que o ruído incidiu atrás do sujeito (0/180° azimute), o microfone direcional associado ao redutor de ruído foram imprescindíveis para o melhor desempenho. Houve correlação entre o IPRSR a 0/0º e o teste dicótico de dígitos. **Conclusão**: A habilidade de figura-fundo para sons verbais mostrou influenciar o desempenho comunicativo do idoso usuário de próteses auditivas, quando fala e ruído vieram da mesma direção. Já quando fala e ruído estão separados espacialmente, o microfone direcional, e este associado ao redutor de ruído, auxiliaram o indivíduo a responder aos estímulos apresentados de maneira mais eficiente.

Palavras-chave: Auxiliares de audição; Discriminação de fala; Perda auditiva; Transtornos da percepção auditiva; Idoso.

Resumen

Objetivo: Identificar el desempeño de adultos mayores en pruebas de habla llevando a cabo los aspectos: ajustes de las prótesis auditivas y/o grado y configuración de la pérdida de audición, desempeño en la tría cognitiva y habilidades auditivas. **Métodos:** Participaron 36 adultos mayores, con edades entre los 60 y 87 años, con pérdida auditiva neurosensorial de grado leve a moderadamente severo. Obtenidos los Índices de Porcentajes de Reconocimento de Frases con Ruido (IPRSR), por las Listas de Frases en Portugués Brasileño, con prótesis auditivas, utilizando los siguientes ajustes: micrófono omnidireccional; reductor de ruido y micrófono omnidireccional; micrófono direccional; reductor de ruido y microfone direcional. Consideradas: medias tritonales de 500, 1000, 2000 Hz y 3000, 4000 y 6000 Hz; resultados del Mini Examen de Estado Mental, test dicótico de dígitos y padrón de duración. **Resultados:** Cuando habla y ruido vinieron en misma dirección (0/0º acimut), no hubo predominancia de los ajustes en el mejor desempeño en el IPRSR. En la condición que el ruido incidió atrás del sujeto (0/180° acimut), el micrófono direccional asociado al reductor de ruido fue imprescindible para el mejor desempeño. Hubo correlación entre IPRSR a 0/0º y el test dicótico de dígitos. **Conclusión:** La habilidad de figura-fundo para sonidos verbales mostró influenciar el desempeño comunicativo de adultos mayores, usuarios de prótesis auditivas, cuando habla y ruido vinieron en misma dirección. Cuando habla y ruido están separados espacialmente, el micrófono direccional asociado al reductor de ruído auxiliaron el individuo a responder a los estímulos presentados de manera eficiente.

Palabras clave: Auxiliares de audición; Discriminación del habla; Pérdida auditiva; Transtornos de la percepción auditiva; Adulto mayor.

Introduction

Difficulty in hearing, especially in environments with competitive noise, is one of the disorders that primarily affects elderly individuals and influences the ability to relate to others, drastically decreasing quality of life[1].

Understanding speech in difficult listening environments is a complex task for this population. This barrier cannot be solely estimated by the type and degree of hearing loss, since elderly people with little difficulty in detecting low-intensity sounds may report that they have trouble understanding in environments with competitive noise[2,3].

Therefore, this complaint may be justified by other reasons, such as cognitive processing deficits that occur with advancing age[4], and that reduce neural synchrony and temporal processing of sounds[5]. Such factors directly affect the way information is organized, causing the individual to interpret the sounds in a slow manner. Consequently, the more complex the information received, the bigger the occurrence of hearing complaint.

When the hearing difficulty cannot be reversed by any type of treatment, the use of hearing aids is the indicated intervention. However, complaints related to speech intelligibility in noisy environments may persist, requiring a careful selection of adjustments according to individual characteristics, in order to achieve better results.

With a proper regulation, it is expected that the hearing aid can significantly improve speech recognition. For this purpose, the most effective way is to minimize the interference of environmental noise in communication through the use of directional microphones and noise reduction algorithms[6,7], found in this device. However, these adjustments are not always sufficient to reduce these patients' complaints.

With the purpose of investigating the possible influences on speech intelligibility in elderly users of hearing aids, this study aimed at identifying the best individual performance in speech tests, as well as analyzing which aspects influenced the results: adjustments of the hearing aids and/or degree and configuration of hearing loss, cognitive screening performance, and figure-background auditory skills for verbal sounds and auditory temporal ordering.

Methods

This prospective longitudinal quantitative study originated from a larger study[8], in which some objectives have already been published[9], was approved by the Research Ethics Committee of the Federal University of Rio Grande do Sul, under the protocol number 127.520, developed in the Auditory Prostheses Laboratory of the Speech and Hearing Service at the same institution. Participants received instructions on the objectives of the research and procedures that would be performed and, after agreeing to voluntarily participate, signed the informed consent form.

At first, a survey was carried out based on the analysis of medical records of patients aged 60 years and over, who were in the phase of hearing aid adaptation, through the Hearing Aid Assistance Program of the Ministry of Health, during the period from October 2012 to September 2013.

After this survey, the following were the study eligibility criteria: audiological diagnosis of mild to moderately severe neurosensorial bilateral hearing loss; speech recognition threshold of at least 65 decibels (dB) in the ear with the best hearing skills; never used hearing aids before; to be in the phase of binaural BTE type B hearing aid adaptation, with the possibility of adjusting the noise reduction control and the directional microphone; absence of neurological changes (memory problems, stroke, dementias, among others); and/or verbal fluency that could interfere with the tests.

Thus, the study group consisted of 36 elderly patients, new hearing aids users, aged between 60 and 87 years. Of these, 12 were female and 24 were male.

To obtain the results of the variables analyzed in this study, the patients attended five consultations, with a minimum interval of 14 and a maximum of 24 days between them.

Anamnesis was carried out during the first consultation, with the purpose of obtaining information regarding personal data, history and auditory complaints, as well as daily routine habits. After the interview, the cognitive function was screened, and auditory abilities and speech intelligibility in the noise were assessed.

Finally, hearing aids adaptation was performed, and participants received device care and handling guidelines.

In the other four consultations, the speech intelligibility in noise was re-evaluated and adjustments of the hearing aids were performed, with settings different from the last session, as well as the maintenance of the hearing aids, through listening and checking the battery level.

Procedures

Cognitive function screening test

The instrument applied was the Mini-Mental State Examination (MMSE) developed by Folstein, Folstein and McHugh (1975). This is a screening test that has been used in clinical practice to investigate the cognitive status of geriatric patients.

The MMSE evaluates the cognitive function through tasks that include temporal and spatial orientation, memory, attention, calculation, language and visual constructive capacity, with a specific scoring for each item and a maximum score of 30 points.

The application took around 10 minutes and the cut-off point referred to the years of study[11] reported by the patient during the anamnesis. Therefore, the following classification was used, according to the final score: illiterate – at least 20 points; from 1 to 4 years of study – 25 points; from 5 to 8 years of study – 26.5 points; from 9 to 11 years of study – 28 points; and over 12 years of study – 29 points.

Assessment of auditory skills

Due to the fact that this study was longitudinal, involving several consultations and procedures, and that not all participants live in the city where the research was carried out, a complete evaluation of auditory processing skills was not performed. Thus, the Dichotic Digit Test and the Duration Pattern Test were selected.

Hence, Dichotic Digit Test [2] (DDT) and the Duration Pattern Test[13] (DPT) were used to evaluate the figure-background auditory skills for verbal sounds, through the ability to recognize two or more sounds simultaneously emitted by the binaural integration and separation task, and, to assess the auditory temporal ordering perception, which refers to the processing of two or more acoustic stimuli in their order of occurrence over time, allowing the recognition, identification and proper sequencing of auditory patterns. These tests, recorded on Compact Disc (CD), were shown via CD Player Toshiba Cd 4149, coupled to a Fonix FA-12 two-channel digital audiometer.

In the Dichotic Digit Test (DDT) two digits are presented to each ear, simultaneously. The digits used represent the disyllabic digits of the Portuguese language, on a scale ranging from one to ten (4, 5, 7, 8 and 9). In the present study, 20 sequences of four digits each were presented, two to one ear and two to the opposite ear, simultaneously. In the following step, the stimuli must be reproduced, independently of their order of presentation. Binaural integration and separation tasks were requested.

The DPT consists of presenting three-tone 1000 Hz sequences, which are different at two dissimilar durations: 500 milliseconds (long-L), and 250 milliseconds (short-C). Thirty binaural stimuli were presented, which should be answered in a murmur (humming). The possible answers were LLC; LCL; LCC; CLL; CLC and CCL, three tones properly answered were considered correct.

During tests performance, participants reported the highest level of comfort, between 30 and 40 dB NS above the tritonal average, close to the presentation level in which the Speech Recognition Percentage Index was performed[14].

Adaptation of hearing aids

In relation to hearing aids, the present research selected two models of type B digital technology (SUS classification) from different brands, but with the same type of directional microphone, i.e. hypercardioid, and the same kind of noise reduction through multiband modulation.

For the initial setting of the hearing aids, the NAL-NL1 prescription procedure, present in the programming software, was applied, activating randomly, in each session, one of the programming possibilities: omnidirectional microphone, omnidirectional microphone and noise reduction; directional microphone; directional microphone and noise reduction.

Evaluation of speech intelligibility in noise

To evaluate speech recognition in noise, the patients were submitted to the Sentence List for Brazilian Portuguese (SL-BR), consisting of lists of sentences in Brazilian Portuguese and a speech-spectrum noise[15].

A Fonix FA-12 two-channel digital audiometer was used, in addition to a TA 1010 amplification system for sound field audiometry. Sentences were presented using a CD Player, coupled to the audiometer.

During the five consultations, the Sentence Recognition Thresholds in Noise (SRTN) and the Sentence Recognition Percentage Index in Noise (SRPIN) were investigated in the sound field. Patients were positioned one meter from the speakers, which were set at 0º/0º and 0º/180º azimuth. The speech remained fixed in the front speaker (0º/0º azimuth) while the noise was first presented in the front speaker (0º/0º azimuth) and later in the back speaker (0º/180º azimuth). The noise level remained constant at 65 dB NPS (A) in all measurements obtained.

SRTN and SRPIN were obtained in the first consultation without the hearing aids, before their adaptation; in the following consultations, the evaluations were performed with the hearing aids, according to the schedule established in the previous consultation, after a period between 14 and 24 days of use.

To carry out a research on the SRTN, the initial speech stimulus was presented in an S/R ratio obtained according to previous training for the test, performed with each individual. When the participant recognized the speech stimulus correctly, the level of the stimulus was decreased, otherwise increased. This procedure was repeated until the end of the sentences list, initially using 5 dB intervals, and after the first change in the response pattern of the patient, 2.5 dB intervals were used.

In the SRPIN research, the presentation level of sentences remained the same for the S/R ratio obtained according to the SRTN found in each individual[16]. The SRPINs were scored considering errors only the word(s) that were omitted or repeated incorrectly[17]. After obtaining these measurements, the best performance of each subject in each test condition (SRPIN at 0º/0º and 0º/180º azimuth) was selected and analyzed in this study.

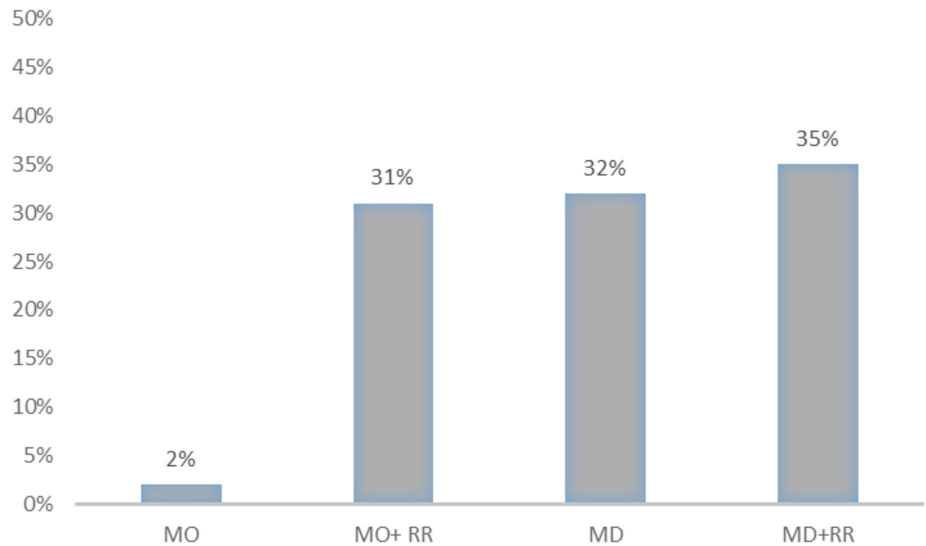
Data analysis

After data collection, the statistical test Lilliefors was applied, in order to identify non-normal (skewed) distribution in the results found. These were analyzed in a descriptive way, using the means and medians, as well as statistically, using the Spearman correlation test, correlating the variables surveyed with the results of the SL test. Results were considered statistically significant at $p < 0.05$.

Results

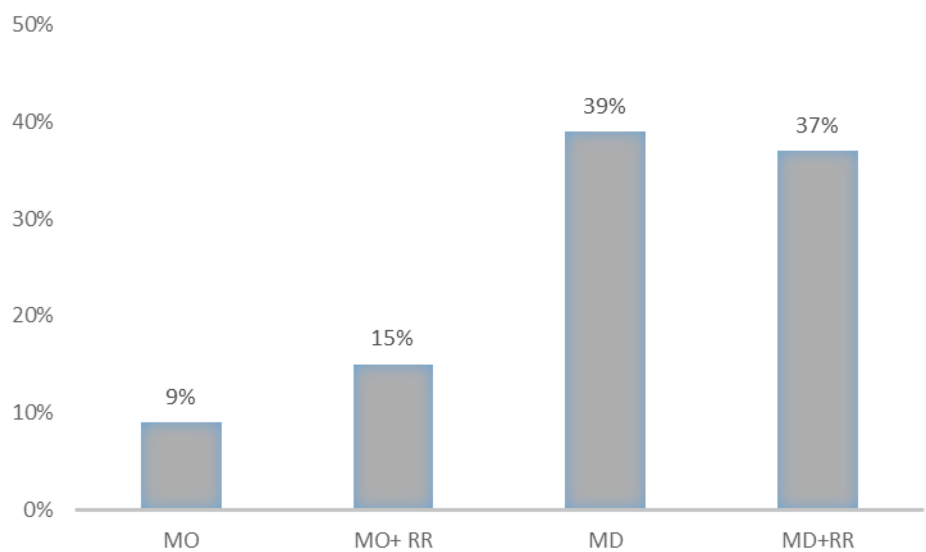
Figures 1 and 2 show the best individual performances according to the different adjustment possibilities, with incident noise at 0º/0º azimuth and 0º/180º azimuth, respectively.

Table 1 shows the minimum, maximum, mean and median values of the percentage of sentence recognition in noise at 0º/0º azimuth, age, tritonal means, duration pattern, dichotic digit test and correlation between variables. Table 2 shows the same variables, in addition to the percentage of sentence recognition in noise at 0º/180º azimuth.



Caption: MO: Omnidirectional Microphone; MO+RR: Omnidirectional Microphone and Noise Reduction; MD: Directional Microphone; MD+RR: Directional Microphone and Noise Reduction (in percent).

Figure 1. Best individual performances according to the different adjustment possibilities, with incident noise at 0º/0º azimuth.



Caption: OM: Omnidirectional Microphone; OM+NR: Omnidirectional Microphone and Noise Reduction; DM: Directional Microphone; DM+NR: Directional Microphone and Noise Reduction.

Figure 2. Best individual performances according to the different adjustment possibilities, with incident noise at 0º/180º azimuth.

Table 1. Minimum values, maximum values, averages and medians of the Sentences Recognition Percentage Index with noise at 0/0º azimuth (%), of age range, tritonal averages, Mini-Mental State Examination, Duration Pattern Test, Dichotic Digit Test and the correlation between variables.

Variables	Minimum	Maximum	Average	Median	p value
SRPIN	71,92	100	91,09	92,79	0,755743
Age	60	87	73,47	73,00	
SRPIN	71,92	100	91,09	92,79	0,986450
TAF1	38,33	76,67	50,46	50	
SRPIN	71,92	100	91,09	92,79	0,456329
TAF2	46,67	106,67	69,67	66,67	
SRPIN	71,92	100	91,09	92,79	0,538520
MMSE	20	30	25,39	26	
SRPIN	71,92	100	91,09	92,79	0,813639
DPT M	6,66	59,94	26,64	23,31	
SRPIN	71,92	100	91,09	92,79	0,046786* r=0,333584
DDT BI RE	35	86,26	55,15	48,75	
SRPIN	71,92	100	91,09	92,79	0,040867* r=0,343874
DDT BI LE	18,75	85	53,44	48,75	
SRPIN	71,92	100	91,09	92,79	0,097654
DDT AD OD	15	97,50	63,36	73,25	
IPRSR	71,92	100	91,09	92,79	0,087243
DDT AD RE	12,50	95	71,08	80	

* statistical signficance p ≤ 0,05. Spearman's Correlation Coefficient.
Caption: SRPIN: Sentences Recognition in Noise Percentage Index; TAF1: Tritonal average for 500, 1000 and 2000 Hz frequencies; TAF2: Tritonal average of 3000, 4000 and 6000 Hz frequencies; MMSE: Score in the Mini-Mental State Examination; DPT M: Murmuring for the Duration Pattern Test; DDT BI RE: Dichotic Digit Test binaural integration right ear; DDT BI LE: Dichotic Digit Test binaural integration left ear; DDT AD RE: Dichotic Digit Test attention directed right ear; TDD AD LE: Dichotic Digit Test attention directed left ear; r: Correlation coefficient.

Table 2. Minimum values, maximum values, averages and medians of the Sentences Recognition Percentage Index with noise at 0/180º azimuth (%), of age range, tritonal averages, Mini-Mental State Examination, Duration Pattern Test, Dichotic Digit Test and the correlation between variables.

Variables	Minimum	Maximum	Average	Median	p value
SRPIN	74,01	100	93,81	96,61	0,657890
Age	60	87	73,47	73,00	
SRPIN	74,01	100	93,81	96,61	0,493820
TAF1	38,33	76,67	50,46	50	
SRPIN	74,01	100	93,81	96,61	0,466116
TAF2	46,67	106,67	69,67	66,67	
SRPIN	74,01	100	93,81	96,61	0,454931
MMSE	20	30	25,39	26	
SRPIN	74,01	100	93,81	96,61	0,923582
DPT	6,66	59,94	26,64	23,31	
SRPIN	74,01	100	93,81	96,61	0,295231
DDT BI RE	35	86,26	55,15	48,75	
SRPIN	74,01	100	93,81	96,61	0,325791
DDT BI LE	18,75	85	53,44	48,75	
SRPIN	74,01	100	93,81	96,61	0,567489
DDT AD RE	15	97,50	63,36	73,25	
SRPIN	74,01	100	93,81	96,61	0,326479
DDT AD LE	12,50	95	71,08	80	

*statistical signficance p ≤ 0,05. Spearman's Correlation Coefficient.
Caption: SRPIN: Sentences Recognition in Noise Percentage Index; TAF1: Tritonal average for 500, 1000 and 2000 Hz frequencies; TAF2: Tritonal average of 3000, 4000 and 6000 Hz frequencies; MMSE: Score in the Mini-Mental State Examination; DPT M: Murmuring for the Duration Pattern Test; DDT BI RE: Dichotic Digit Test binaural integration right ear; DDT BI LE: Dichotic Digit Test binaural integration left ear; DDT AD RE: Dichotic Digit Test attention directed right ear; TDD AD LE: Dichotic Digit Test attention directed left ear; r: Correlation coefficient.

Discussion

Understanding speech in a noisy environment is a challenging task for elderly individuals, since they need a greater signal-to-noise ratio in relation to adults and youngsters, even in the absence of hearing loss[18]. For this population, interference caused by noise can often make communication impossible[19], as the information processing does not occur efficiently enough to recover the sound amid the distorted signals[20]. Therefore, understanding the factors that may be concomitantly associated with hearing loss is of paramount importance to help decision making regarding the most appropriate course of action to each case.

With this in mind and aiming at checking the factors that may have been determinant for the best performance in the speech tests, the present research initially surveyed the adjustments (omnidirectional microphone, noise-reduction control + omnidirectional microphone, directional microphone, noise-reduction control + directional microphone) that resulted in more effective responses, considering speech and noise data at 0º/0º azimuth and speech at 0º/0º and noise at 0º/180º azimuth, different situations analyzed in this study.

Thus, when speech and noise came from the same direction, at 0º/0º azimuth (Figure 1), none of the settings or their combinations prevailed in the best performance in speech recognition. This data may suggest that, in situations where the speech and noise coming from the front of the listener, other factors may have contributed to and influenced the patient's response, rather than just a certain adjustment in hearing aids.

However, in situations where the sounds came from the back of the subject (Figure 2), the best performances occurred when the directional microphone, connected to the noise reduction control, was activated. Thus, based on these results, it is suggested that these adjustments possibly helped the individual to respond more efficiently to the stimuli presented. These findings agree with those found in the literature, since they report that directional microphones improve speech comprehension in situations where signals and noise are spatially separated [21,22], and this is the best strategy to provide a signal-to-noise ratio[9].

Regarding other factors considered, such as degree and configuration of hearing loss, cognitive screening performance, and figure-background auditory skills for verbal sounds and auditory temporal ordering (Tables 1 and 2), the presence of a correlation between the SRPIN obtained with noise at 0/0º azimuth and the DDT results in the task of binaural integration. These data indicate that when performance in one test increases, the other also tends to increase and vice versa, showing that their results were directly proportional.

Once this result has been found, it can be inferred that the figure-background ability for verbal sounds, assessed through DDT in the divided-attention procedure, may have influenced the performance of the patients to recognize speech in the presence of noise, when both came from the front. Thus, the better the performance on this task, the greater the chances of the elderly patients recognizing two or more sounds emitted simultaneously with the use of the hearing aid in adverse communication situations.

Studies consider that the difficulty of understanding speech in noise is not only associated with peripheral hearing loss, but also with the decline of cognitive functions inherent to the aging process, such as working memory, selective attention and information processing speed[19,22,23]. These changes, associated with the decline in auditory processing abilities due to aging, can significantly influence the patient's performance with the use of the hearing aid[24].

On the other hand, when analyzing the variable degree of hearing loss, no correlation was found between the performance in the SLT test and the tritonal means. Since the degree of hearing loss was similar among the majority of individuals assessed, TAF1 did not show any influence on the performance of the speech test applied. Regarding TAF2, although the tone thresholds of acute frequencies are important for speech intelligibility[25], mainly related to the perception of fricative sounds, they were not decisive in the performance of the sentences list test in noise for the patients surveyed.

This result is in consonance with other authors' studies[2,3], since they reported that although the degree of hearing loss strongly influences speech comprehension, elderly people seem to face more obstacles than would be expected only because of their audiometric configurations. Other researchers have also pointed out that these individuals have more difficulty discriminating acoustic cues and extracting temporal information relevant to the identification of speech contrasts[26].

In relation to the analysis performed between the results of the speech test in noise and the scores obtained in cognitive screening, although no correlation was found between these measures, the inherent decline in the cognitive functions due to the aging process is well known, as well as the fact that they are of utmost importance for speech intelligibility. Thus, it may be suggested that MMSE, an instrument used for cognitive screening, may not have been able to identify these difficulties[26].

Another aspect analyzed in this study was the ability to recognize, identify and sequence auditory patterns related to temporal ordering, which allows the investigation of the possible relationship between SRPIN and DPT. However, the analysis did not find a correlation between the performances of individuals in these two tests. Nonetheless, despite this result, the importance of these skills for speech comprehension is widely recognized.

Considering that aging leads to a decline in the temporal processing of sounds, including the auditory temporal ordering, it is extremely important to evaluate these abilities[3]. Since the auditory information is influenced by the way they occur during an interval of time, perceiving small intervals between two sounds is fundamental to identify which sound was preceded by the other, and thus to understand the information received[27,28,29].

Thus, this result may be justified by the fact that DPT is a test that requires the memory of the tones heard, and then evokes them. For that reason, it is possible that elderly people present worse responses, not because they cannot discriminate the different tones, but because they present some memory-related impairment[26].

Therefore, among the aspects considered in this research, it is suggested that the figure-background auditory skills for verbal sounds, through the binaural integration task, may have a greater influence on the communicative performance of the elderly patient, a hearing aid user, in adverse communication situations, when speech and noise came in the same direction, from in front of the individual.

Based on the above, the assessment of auditory skills through the auditory processing tests allows establishing a better understanding of the communicative function of each individual. As a result, besides being a useful tool to quantify auditory deficits caused by functional alterations of the central nervous system, they also help to define the auditory skills of a patient when his auditory sensitivity is corrected by hearing aids.

Hence, the performance of elderly individuals in the DDT, in the task of binaural integration, can help to estimate whether or not the use of hearing aids is successful, since hearing loss is not a determining factor, but a factor that exacerbates speech comprehension difficulties.

Seen in these terms, due to the fact that a communication situation with noise at 0º/0º azimuth is common and sometimes it is not possible to obtain satisfactory communicative performance with hearing aids, auditory training, especially on dichotic listening tasks, may provide better results. Consequently, the elderly patient would be better prepared to face adverse communication situations when exercising skills involving selective attention, auditory closure, analysis, synthesis and organization of sound events.

However, when considering the noise condition at 0º/180º azimuth, the results suggest that the adjustments selected in the adaptation of the hearing aids may more efficiently assist the individual to respond to the stimuli presented in a less complex communication situation in which he speaks and noise is spatially separated[9].

According to the findings of the present research, it is evident that the greater the number of information available on the auditory system, both peripheral and central, the more adequate will be the counseling regarding realistic expectations for the use and care of hearing aids, and whether there is an impending need to perform auditory training therapy. Thus, counseling-based aural rehabilitation will be based on objective information, obtained from specific individualized assessments, giving the individual a better perception of the causes of their problems[30].

It is worth mentioning that due to auditory processing evaluations, cognitive screening and the first evaluation of speech comprehension have been applied in the same session, the results found may have been influenced by fatigue and attentional limitation, a possible bias in the procedures carried out in this study. In addition, the selection of the tests for the assessment of hearing abilities must be taken into account, since others could have been more sensitive to evaluate the issues of concern of the present investigation, but were not available in the institution in the period in which the research was carried out.

Conclusion

Among the aspects analyzed in this study, it is suggested that in adverse communication situations, in which speech and noise come from the same direction, figure-background auditory skills for verbal sounds may influence the communicative performance of elderly hearing aid users. When the speech came from the front and the noise from the back, the directional microphone, which is associated with noise reduction, may have helped the individual to respond better to the stimuli presented.

Regarding the degree and configuration of hearing loss, cognitive screening and the auditory temporal ordering skills, these factors were not crucial for a good performance with the use of hearing aids.

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