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Speech recognition by the elderly: test proposal concerning word predictability

Reconhecimento de fala em idosos: proposta de um teste considerando a previsibilidade da palavra

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ABSTRACT

Purpose: evaluation of the speech recognition concerning the word predictability based on a developed test. **Methods:** It was perfomed a clinical history, cognitive impairment and depression screening tests and conventional audiological conventional evaluation. A Speech Recognition Test using high- and low-predictability sentences has been developed and applied to 36 elderly (G1 and G3 - groups with normal hearing thresholds of up to 4 kHz, and G2 and G4 - groups with mild--to-moderate sensorineural hearing loss). Two groups underwent the tests in the silence and in the noise (signal/noise ratio of +5 dB) and the other two groups only in the noise (ratio ranging from +5 dB to 0 dB). **Results:** In general, Speech recognition test showed a higher score in the high predictability sentences and better performance for groups without hearing loss. In the silence, elderly with and without hearing loss have also obtained high scores and the lowest scores were achieved in situations with most intense noise. The benefit of predictability was positive for groups 1, 2 and 3. Group 4 showed a different behavior towards the use of predictability (sometimes positive or negative). **Conclusion:** For the elderly evaluated and the differences observed in one of the groups, it was not possible to precisely determine how the elderly benefit from predictability. The hearing loss and the noise have negatively influenced the test performance. Further researches in the area are necessary to confirm the validity of the material produced.

Keywords: Speech perception; Speech discrimination tests; Aging; Presbycusis; Cognition

RESUMO

Objetivo: Avaliar o reconhecimento de fala, considerando a previsibilidade da palavra a partir de um teste elaborado. **Métodos:** Foi realizada anamnese, testes de rastreio de comprometimento cognitivo e depressão e avaliação audiológica convencional. Foi desenvolvido um Teste de Reconhecimento de Fala utilizando Frases de Previsibilidade Alta e Baixa e aplicado a 36 idosos (G1 e G3 - grupos sem perda auditiva até 4 kHz e G2 e G4 - grupos com perda auditiva neurossensorial de grau leve a moderado). Dois grupos realizaram o teste no silêncio e com ruído (relação sinal/ruído +5 dB) e os outros dois grupos somente com ruído (relações +5 dB e 0 dB). **Resultados:** O teste de reconhecimento de fala revelou, de modo geral, maior pontuação nas frases de previsibilidade alta e melhores desempenhos para os grupos sem perda auditiva. No silêncio, os idosos sem e com perda auditiva obtiveram pontuação máxima igual e as menores pontuações ocorreram na condição de ruído mais intenso. O benefício da previsibilidade foi positivo para os grupos 1, 2 e 3. O grupo 4 apresentou comportamento variado quanto ao uso da previsibilidade (ora positivo, ora negativo). **Conclusão:** Com a população de idosos avaliados e as diferenças observadas em um dos grupos considerados, não foi possível compreender, com exatidão, como os idosos se beneficiam do apoio da previsibilidade. A perda auditiva e a presença do ruído influenciaram negativamente o desempenho no teste. Faz-se necessária a continuidade desta linha de pesquisa para determinar a validade do material elaborado.

Descritores: Percepção de fala; Testes de discriminação da fala; Envelhecimento; Presbiacusia; Cognição

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INTRODUCTION

The aging process naturally deteriorate several body functions like motor skills, visual and auditory acuity, and cognition itself. The functions usually deteriorate at the same time, affecting the individuals' quality of life[1].

Although many adults continue to have good hearing at older ages, some level of hearing loss related to aging is common. In addition to peripheral hearing loss, aging can also affect the central auditory process, reducing the efficiency of auditory temporal and spectral resolution, as the sounds are processed. Even a mild peripheral or central hearing loss can affect the success of understanding and of information storage[2].

Regarding the cognition, aging usually deteriorates it and the slower processing of information may cause a lack of understanding of the message spoken in high speed, or in a not clear manner[3].

Studies focused on the cognitive or on the hearing aspect are vast in the literature but those considering both aspects together are limited. To research the dynamics of this interaction, it is a good option to better understand the aging process and its impact on communication[2].

In 1977, a group of researchers[4] pioneered, when they investigated hearing and cognition together. They developed a test called Speech Perception in Noise (SPIN), which required the individual to have access to both acoustic phonemic components, and situational language. The test used a sentence material with controled word predictability (final), presented under different levels of background noise. In high-predictability sentences, the keyword can be somehow predicted by the context, because there are words semantically connected to the keyword in the sentence. In contrast, in low-predictability sentences, the keyword cannot be predicted by the context, because no other word in the sentence is connected to the keyword by meaning.

The SPIN test has been widely used, and different results have been reported based on the age, the presence or absence of hearing loss, and the effect of the benefit of the context for predicting the keyword predictability[5,6,7,8,9,10,11,12,13,14,15,16].

In the national literature, there are speech recognition tests developed by sentences[17,18], but none of them used the benefit of the context to predict the keyword.

Given the above, this study aimed to evaluate the speech recognition, concerning the word predictability based on a developed test, applied to elder patients with and without peripheral hearing loss.

METHODS

This study[19] has been approved by the Ethics Committee of the *Universidade Federal de São Paulo* (UNIFESP), under the number 0948/09. All participants signed a consent form.

Material production

For developing the Speech Recognition Test, a survey on the words has been conducted, carried out by the project Current Portuguese Sound Analysis (ASPA)[20]. This project selected certain characteristics of words with high occurrence in Portuguese. Among them, noun, disyllabic and paroxetine words have been chosen (more than 50 occurrences per one million). Another option considered was to select specific words, but this was not available to the project. Thus, it was necessary to use a test to determine this characteristic.

A test of concrete words[21] was used and the words included in high-concreteness categories were selected. Then, a semantic association test[19], has been used, in order to identify words semantically connected to all keywords, later used to formulate the sentences.

In order to produce the most homogeneous material as possible, the following criteria for formulating sentences have been established: they were supposed to be declarative, affirmative, structured in a single period, containing the basic elements (subject, verb and predicate) and with controlled extension (11 to 14 syllables). The sentences should also be easy to understand, in a daily/ common language.

Regarding the position of the selected words, they had to be placed at the end of the sentence, being called keywords. High-predictability sentences have been formulated, for having one or two words semantically connected to the keyword in each of them. In low-predictability sentences, there was no other word semantically connected to the keyword.

At the following stage, a test of word predictability was applied to formulate sentences. Based on the Kalikow et al. (1977)[4], it was possible to define the reference range for low-predictability sentences (from 10% to 40% of consistent responses) and for high-predictability sentences (from 60% to 90% of consistent responses). Thus, they have avoided using sentences that were excessively predictable (over 90%), not enough predictable (up to 10% of consistency among the participants) and average predictable (from 40 to 60%), which were not enough different from the high- and low-predictability levels.

For the first version, the predictability test was applied to 30 college volunteers from 18 to 24 years. The number of possible sentences was not enough for compiling the final lists. Thus, new sentences were formulated using only the keywords that have not formed low- and/or high-predictability sentences. Two new versions of the test have been applied to 30 participants for each test. Participants were university students, from 20 to 45 years old. All volunteers were asked to file the last word of each sentence with the first word that came to their mind, and were required to write a single word.

In order to compile the final lists, the keywords were organized according to the consonant sounds and maintaining a phonetic balancing, so that, for each pair of list (1 and 2, 3

and 4), the keywords achieved the best balance of the Brazilian Portuguese sounds as possible, in addition to the place where the phonemic sound occurred.

Finally, four lists (Appendices 1, 2, 3 and 4) were compiled, as List 1 (L1), List 2 (L2), List 3 (L3) and List 4 (L4), with 20 sentences each. They were divided into a group of ten high-predictability sentences (HP) and ten low-predictability (LP), so that the keyword appeared only once in each list. A training list (Appendix 5) was also made, with ten high- and low- predictability sentences.

The Speech Recognition Test was recorded in a professional studio, narrated by a radio host. Each list has been recorded on a separate track, and the whole test lasted 12'26". In addition to the test tracks, a pure tone of 1 kHz (a track lasting 12 seconds) was also recorded to be presented as a calibration tone.

In addition to the lists, a background noise—previously created by another study[22],—was used, extracted from the original CD with test Lists of Portuguese Sentences[23], with the author's permission. The noise was tuned to a different channel from the one of the Speech Recognition Test. Thus, the lists could be presented in the silence and in the noise under a monotic stimuli.

Application of the Speech Recognition test

Casuistry

Men and women over 60, considered elderly for developing countries by the World Health Organization, were participants in the study. The elderly were selected according to the following criteria: to have studied for at least eight years; have normal hearing thresholds of up to 20 dB at 500 Hz to 4 kHz, or have symmetrical sensorineural hearing loss and at the highest moderate level[24]; tympanograms not indicating middle ear disorders; no apparent neurological disorder; no history of head injury; no cognitive impairment and no severe depression or dysthymia.

The elderly were evaluated at the Audiology Clinic of the Department of Speech Pathology and Audiology, from UNIFESP, and they had been sent by the Gerontology sector and by the University of the Third Age, from the same university and by the audiological evaluation at the clinic.

Initially, participants were divided into two groups (G1—without hearing loss and G2—with hearing loss), and the test lists were presented in the silence situation and based on the signal/ noise (S/N) ratio of + 5dB, for comparing performances in both situations afterwards.

However, after evaluating the patients, it was observed that all participants in groups 1 and 2 showed 100% accuracy in the silence, revealing that this hearing situation could not detect speech difficulties and did not differentiate the elderly with and without hearing loss. Thus, it was concluded that this way of presenting the speech material would not be useful to evaluate the speech recognition with the developed tests.

It was also observed that the in the situation of S/N ratio +5 dB, the differences between groups 1 and 2 were subtle. It was inferred that in a noisier situation, differences in performances could be larger and could more clearly demonstrate the influence of hearing loss in aging. Furthermore, as the study aimed to analyze different performance at two different levels of difficulty, it has been proposed to use the test at two different S/N ratios. As the number of test lists was limited (a total of four) and repeating the lists in a new hearing situation could produce biased results (of learning), it was not possible to evaluate these two groups (G1 and G2) at two different levels of difficulty.

Thus, it was decided to form two groups, also with elderly people without hearing loss (G3) and with hearing loss (G4), and in these cases, the lists would be presented only in the noise situation at a S/N ratio of +5 dB and 0 dB.

Participants totaled 22 women (nine in G1, seven in G2, five in G3 and one in G4) and 14 men (one in G1, three in G2 and three in G3 and seven in G4). The average age of participants was 65.8 years at G1, 71.8 at G2, 65.1 at G3 and 71.1 at G4, with no significant difference (p=0.159).

For tonal thresholds, the 0.5 to 4 kHz average for the groups was as follows: G1=7.75 dB; G2=32.75 dB; G3=10.26 dB and G4=43.01 dB.

Procedures

Initially, the participants were submitted to a mild cognitive impairment test, using the Mini-Mental State Examination (MMSE) and with the cut-off value of ≥26.5 for participants having studied from five to eight years, ≥ 28 for those having studied from nine to 11 years, and ≥29 for individuals who have studied for more than 11 years[25]. They were also submitted to 15-item Geriatrics Depression Scale (GDS-15), with a cut-off value of 5/6[26].

The elderly who achieved values within the cutoffs of the afore mentioned medical tests were also submitted to anamnesis, pure tone audiometry, vocal audiometry[27,28] and acoustic impedance was measured.

After that, the elderly were assessed by the developed test, called Speech Recognition Test using High- and Low-Predictability Sentences in the Silence (RTHLPSS) and in the Noise (RTHLPSN). Each participant was instructed to repeat the last word of each sentence heard in earphones, both in the silence situation, and with an ipsilateral background noise. First, a training list with ten sentences was presented to them only in the silence situation. The stimuli were given at 40 dB above the average frequencies of 500, 1,000 and 2,000 Hz, or in the comfortable intensity reported by the patients. After that, 20 sentences (L1) were presented to one ear and then another list of 20 sentences (L2) to the other ear. Then, two more lists (L3 and L4) were presented, and again one list for each ear.

For situations in which the four lists were presented to groups 1 and 2, L1 and L2 were presented in the silence and

L3 and L4 with the ipsilateral noise, at the signal/noise ratio of +5 dB. For Groups 3 and 4, L1 and L2 were presented with the ipsilateral noise at the signal/noise ratio of +5 dB and L3 and L4 with the ipsilateral background noise at the signal/noise ratio of 0 dB. The results were produced based on the total percentage of words correctly repeated after each presentation.

In the statistical analysis, the Wilcoxon and Mann-Whitney tests, both used in the study, were non-parametric. In the descriptive data analysis, a 95% confidence interval was selected and the significance level used in this study was 0.05 (5%).

RESULTS

A total of 36 respondents were divided into the groups, G1 and G2 had 10 participants each, and G3 and G4, eight participants each. The elderly in group 1 and 3 had normal audiometric thresholds of up to 4 kHz and the elderly in groups 2 and 4 had mild-to-moderate sensorineural hearing loss. Each group analysis were carried out based on the results achieved by the participants' right and left ear, totaling thus 20 ears in groups 1 and 2, and 16 ears in groups 3 and 4.

Based on speech audiometry tests results and through Mann-Whitney statistical test, a difference between groups 1 and 2 and between groups 3 and 4 has been noticed between the values of Speech Recognition Threshold (SRT) for the Speech Detection Threshold (SDT), and the Test using High- and Low-Predictability Sentences in the Noise (RTHLPSR) at a signal/noise ratio of +5 dB and 0 dB, to which groups 1 and 2 have given better performances and groups 3 and 4, worse performances. Only for the Test using High- and Low-Predictability Sentences in the Silence (RTHLPSS), no difference has been reported, with participants scoring a 100% in word recognition in groups 1 and 2. Since in the silence situation, there was also no difference between groups 1 and 2, the comparison analysis of the performance between these two groups was carried out based only on data in the noise situation at + 5dB.

Comparison results of medium values (%) of correct answers for words in high-predictability sentences (HP) and low-predictability (LP) of the RTHLPSR, at a signal/noise ratio of +5 dB, for groups 1 and 2 and of a signal/noise ratio of + 5 dB and 0 dB for groups 3 and 4 are shown in Table 1.

Table 1. Comparison for the performance in identifying the word in high- and low-predictability sentences at the signal/noise ratio of +5 dB, in groups 1 and 2, and at the signal/ noise ratio of +5 dB and 0 dB, in groups 3 and 4

List and signal/ noise ratio	Level of predictability	Group	Mean (%)	Median (%)	SD (%)	n	p-value
L3 S/N +5 dB	HP	G1	97	100	6.7	10	0.085#
		G2	91	90	8.8	10	
	LP	G1	95	100	7.1	10	0.042*
		G2	89	90	5.7	10	
L4 S/N +5 dB	HP	G1	100	100	0	10	1.000
		G2	100	100	0	10	
	LP	G1	99	100	3.2	10	0.234
		G2	95	100	8.5	10	
L1 S/N +5 dB	HP	G3	100	100	0	8	0.001*
		G4	77.5	80	14.9	8	
	LP	G3	100	100	0	8	<0.001*
		G4	66.3	70	15.1	8	
L2 S/N +5 dB	HP	G3	98.8	100	3.5	8	0.008*
		G4	68.8	70	25.9	8	
	LP	G3	96.3	100	5.2	8	0.031*
		G4	81.3	80	14.6	8	
L3 S/N 0 dB	HP	G3	70	60	21.4	8	0.005*
		G4	30	30	19.3	8	
	LP	G3	58.8	60	12.5	8	0.038*
		G4	37.5	35	26.6	8	
L4 S/N 0 dB	HP	G3	90	90	7.6	8	0.008*
		G4	46.3	45	29.2	8	
	LP	G3	81.3	80	9.9	8	0.009*
		G4	41.3	30	27	8	

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

#Value that tend to be significant

Subtitle: SD = standard deviation; L1 = list 1; L2 = list 2; L3 = list 3; L4 = list 4; G1 and G3 = groups with normal hearing thresholds of up to 4 kHz; G2 and G4 = groups with mild-to-moderate sensorineural hearing loss; S/N = signal/noise ratio; dB = decibel; HP = high predictability; LP = low predictability

Table 2. Comparison for the performance in identifying the keyword in high- and low-predictability sentences for groups 1 and 2, at the signal/noise ratio of +5 dB, and for groups 3 and 4 at the signal/ noise ratio of +5 dB and 0 dB

List and signal/noise ratio	Group	Level of predictability	Mean (%)	Median (%)	SD (%)	n	p-value
L3 S/N +5 dB	G1	HP	97	100	6.7	10	0.157
		LP	95	100	7.1	10	
	G2	HP	91	90	8.8	10	0.527
		LP	89	90	5.7	10	
L4 S/N +5 dB	G1	HP	100	100	0	10	0.317
		LP	99	100	3.2	10	
	G2	HP	100	100	0	10	0.102
		LP	95	100	8.5	10	
L1 S/N +5 dB	G3	HP	100	100	0	8	1.000
		LP	100	100	0	8	
	G4	HP	77.5	80	14.9	8	0.238
		LP	66.3	70	15.1	8	
L2 S/N +5 dB	G3	HP	98.8	100	3.5	8	0.317
		LP	96.3	100	5.2	8	
	G4	HP	68.8	70	25.9	8	0.039*
		LP	81.3	80	14.6	8	
L3 S/N 0 dB	G3	HP	70	60	21.4	8	0.056#
		LP	58.8	60	12.5	8	
	G4	HP	30	30	19.3	8	0.221
		LP	37.5	35	26.6	8	
L4 S/N 0 dB	G3	HP	90	90	7.6	8	0.034*
		LP	81.3	80	9.9	8	
	G4	HP	46.3	45	29.2	8	0.389
		LP	41.3	30	27	8	

*Significant values (p≤0.05) – Wilcoxon Test

#Value that tend to be significant

Subtitle: SD = standard deviation; L1 = list 1; L2 = list 2; L3 = list 3; L4 = list 4; G1 and G3 = groups with normal hearing thresholds of up to 4 kHz; G2 and G4 = groups with mild-to-moderate sensorineural hearing loss; S/N = signal/noise ratio; dB = decibel; HP = high predictability; LP = low predictability

Comparisons between correct answers for keywords in high- (HP) and low-predictability (LP) sentences given to the Speech Recognition Test using High- and Low-Predictability Sentences in the Noise (TRFFPABR). Each list has used the S/N ratio of +5 dB in groups 1 and 2 and a S/N ratio of +5 dB and 0 dB in groups 3 and 4, as presented in Table 2.

The descriptive measures of the benefit of predictability (HP-LP) for groups 1 and 2, and for groups 3 and 4 are in Tables 3 and 4.

Table 3. Comparison for benefit of predictability between groups 1 and 2 for lists 3 and 4

Benefit of predictability (HP-LP)	List 3		List 4	
	G1	G2	G1	G2
Mean (%)	2	2	1	5
Median (%)	0	0	0	0
Standard deviation (%)	4.2	10.3	3.2	8.5
n	10	10	10	10
p-value	0.933		0.234	

Mann-Whitney Test (p≤0.05)

Subtitle: HP = high predictability; LP = low predictability; G1 = group with normal hearing thresholds of up to 4 kHz; G2 = group with mild-to-moderate sensorineural hearing loss

DISCUSSION

A joint and dynamic motor and cognitive function evaluation is an important tool for understanding better performance in speech recognition and has been considered necessary by some authors[2,4]. Its importance it is recognized as the best guidance for the rehabilitation process, from the broader diagnosis involving auditory and cognitive skills.

Among the speech recognition tests, the English-language test called SPIN[4], was a pioneer. For the test developed in Portuguese (RTHLPS), information on situational language has also been used, as well as only information on phonetic acoustic.

The audiological evaluation and performance in RTHLPS test were first considered, and the results showed differences

Tabela 4. Comparação do benefício da previsibilidade entre os grupos 3 e 4, para as listas 1, 2, 3 e 4

Benefit of predictability (HP-LP)	List 1		List 2		List 3		List 4	
	G3	G4	G3	G4	G3	G4	G3	G4
Mean (%)	0	11.3	2.5	-12.5	11.3	-7.5	8.8	5
Median (%)	0	20	0	-10	15	0	10	10
Standard deviation (%)	0	20.3	7.1	14.9	13.6	17.5	9.9	18.5
n	8	8	8	8	8	8	8	8
p-value	0.052#		0.017*		0.041*		0.912	

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

#Value that tend to be significant

Subtitle: HP = high predictability; LP = low predictability; G3 = group with normal hearing thresholds of up to 4 kHz; G4 = group with mild-to-moderate sensorineural hearing loss

between elderly with normal thresholds of up to 4 kHz and with mild-to-moderate hearing loss. The test in the silence has not been useful to differentiate elderly with and without hearing loss, and have not reflected complaints of speech understanding reported by the elderly.

Different from data collected by this study, other researchers[9] had noticed differences between the groups in the silence situation. In other studies, the elderly without hearing loss gave better performance in speech recognition of sentences with and without the benefit of the context.

Different results for speech recognition in the silence could be justified by different characteristics of the participants, differences between the languages of the tests compared and differences between the materials of SPIN and RTHLPS tests. The English-language test uses monosyllabic keywords, instead of dissyllables. Therefore, there is a higher level of difficulty in recognizing the word.

With the background noise, all analyzed measures underlined differences between the 4 groups. Better performances were given by groups with normal thresholds of up to 4 kHz. These results were already expected.

In studies using the SPIN test in the noise, an overall better performance has been noticed in the elderly with better audiometric thresholds, confirming data presented[6,8,910,13,15,16].

Also in the noise situation, there was a negative impact of more intense noise (S/N ratio of 0 dB), reporting the worst performance in the test and in correctly identifying keywords (Tables 1 and 2). The greatest loss of signal/noise ratio had been previously reported[8], revealing that the noise can reduce the amount of audible information and create difficulties in the auditory and cognitive processes.

When comparing medium amount of correct answers for the words in high- and low-predictability sentences (Table 1), data have also revealed better performances in groups with normal pure tone thresholds. However, when comparing groups 1 and 2, the difference was significant only in low-predictability sentences from one of the lists. For groups 3 and 4, the differences were significant in all comparisons. This more clear evidence of performance differences may have been produced by a higher average (approximately 10 dB) of pure tone thresholds of group 4, compared with group 2, which has clearly differentiated the group without hearing loss.

Other researches using the SPIN test have also showed the deleterious influence from presbycusis in speech recognition in the noise[5,6,8,9,10,13,15,16], which are more evident in sentences having low contextual redundancy.

When comparing the results for each group of words in high- and low-predictability sentences and low (Table 2), it was, in general, possible to notice a higher score in high--predictability sentences. However, this score was significant only in the second list (L2), at a signal/ noise ratio of +5 dB for group G4, and at a signal/ noise ratio of 0 dB for group 3. It is noteworthy that, different from expected, the score was higher in the low predictability sentences for group 4.

About better results in high-predictability sentences or with greater benefit of the context, other authors have also reported positive values[7,8,10,11,13,14,15,16], regardless the speech rate[10]. This result seems to reveal that despite the lower performance as aging advances, the linguistic knowledge is preserved in older age[2].

Analyzing only the different behavior of group 4, which reported higher scores for low-predictability sentences, one can infer that the low frequencies of pure-tone thresholds have negatively affected the group when using contextual cues, both in acoustic recognition of words semantically connected and of the keywords themselves, as in accessing cognitive abilities for speech recognition.

There was no significant difference between groups 1 and 2 about the benefit of predictability or context (Tables 3 and 4) and data revealed positive values for the benefit of predictability. Between groups 3 and 4, the difference has been noticed in the second and third test list. In both situations, group 4 showed negative values of the benefit of predictability, which has been already reported at the results for low-predictability sentences. For the other lists, the values were positive, which has led to question whether, in addition to a possible interference of the greatest hearing loss reported in this group, which was already discussed, there might be a difference between the lists on the difficulty level of speech recognition. It is also worth mentioning that the behavior of

the groups has not shown consistency in presenting greater or lesser degree of benefit of predictability.

Among the conducted researches evaluating the extent of the benefit of the context, some of them reported significant differences among the elderly, with greater benefit for those with higher degrees of hearing loss[8,9]. In another study[13], a similar result was achieved when using a S/N ratio of +3 dB and +6 dB, but at the 0 dB ratio, the elderly without hearing loss showed greater benefit of the context.

Although the effect of the context can be measured by the SPIN test, it has no regularity in affecting the total test results. Thus, both the much lower, as the excellent performance, reduce the apparent usefulness of the benefit of the context, ie individuals who do not understand the speech with background noise may simply not be able to use the context clues, and for the patients who understand every word without difficulty, the context may be redundant. To be a useful indicator of higher cortical function, the effect of context must be considered by its performance level[12].

In general, the differences in the recognition of words in low- and high-predictability sentences have revealed how the semantic cues may benefit for the correct identification of the words, especially in more difficult listening situations.

Finally, it was observed that the speech recognition test developed by the study provided relevant data on the dynamic hearing and cognitive processes, demonstrating the ability to use the benefit of predictability for auditory recognition by the majority of the elder research participants. Peripheral hearing loss and background noise have also created a negative impact on speech recognition. However, since the developed test has not been validated yet, it has not been possible to determine the final parameters, i.e. the satisfactory or unsatisfactory level of the performance using the word predictability, considering age and hearing thresholds and, finally, the recommended signal/noise ratio.

CONCLUSION

For the evaluated elderly and noting the differences in one of the groups, it was not possible to properly understand how the elderly benefit from the predictability hearing aid. It was found that the hearing loss and the background noise adversely affected the test result. In the silence situation, the test presented no difference between the performance of elderly with and without hearing loss, and the background noise has negatively affected speech recognition, especially under the most adverse condition.

Research replication with larger number of participants is necessary to better understand the use of the predictability benefit and it is necessary to validate the produced material. For validation, it is fundamental to analyze the need to reformulate the lists with the formulated sentences, to analyze the signal/noise ratio in order to achieve the appropriate ratio and, finally, it is fundamental to define the level of performance for low- and high-predictability sentences, according to age group and hearing loss.

REFERENCES

1. Kiessling J, Pichora-Fuller MK, Gatehouse S, Stephens D, Arlinger S, Chisolm T et al. Candidature for and delivery of audiological services: special needs of older people. Int J Audiol. 2003;42 Suppl 2:S92-101. http://dx.doi.org/10.3109/14992020309074650
2. Wingfield A, Tun PA, McCoy SL. Hearing loss in older adulthood. What it is and how it interacts with cognitive performance. Curr Dir Psychol Sci. 2005;14(3):144-8.
3. Argimon IIL. Aspectos cognitivos em idosos. Aval Psicol. 2006;5(2):243-5.
4. Kalikow DN, Stevens KN, Elliot LL. Development of a test of speech inteligibility in noise using sentence materials with controlled word predictability. J Acoust Soc Am. 1977;61(5):1337-51. http://dx.doi.org/10.1121/1.381436
5. Thomas PD, Hunt WC, Garry PJ, Hood RB, Goodwin JM, Goodwin JS. Hearing acuity in a health elderly population: effects on emotional, cognitive, and social status. J Gerontol. 1983;38(3):321-5.
6. Dubno JR, Dirks DD, Morgan DE. Effects of age and mild hearing loss on speech recognition in noise. J Acoust Soc Am. 1984;76(1):87-96.
7. Humes LE, Watson BU, Christensen LA, Cokely CG, Halling DC, Lee L. Factors associated with individual differences in clinical measures of speech recognition among the elderly. J Speech Hear Res. 1994;37(2):465-74.
8. Pichora-Fuller MK, Schneider BA, Daneman M. How young and old adults listen and remember speech in noise. J Acoust Soc Am. 1995;97(1):593-608.
9. Frisina DR, Frisina RD. Speech recognition in noise and presbycusis: relations to possible neural mechanisms. Hear Res. 1997;106(1-2):95-104. http://dx.doi.org/10.1016/S0378-5955(97)00006-3
10. Gordon-Salant S, Fitzgibbons PJ. Selected cognitive factors and speech recognition performance among young and elderly listeners. J Speech Lang Hear Res. 1997;40(2):423-31. http://dx.doi.org/10.1044/jslhr.4002.423
11. Dubno JR, Ahlstrom JB, Horwitz AR. Use of context by young and aged adults with normal hearing. J Acoust Soc Am. 2000;107(1):538-46. http://dx.doi.org/10.1121/1.428322
12. Divenyi PL, Stark PB; Haupt KM. Decline of speech understanding and auditory thresholds in the elderly. J Acoust Soc Am. 2005;118(2):1089-100.
13. Humes LE, Burk MH, Coughlin MP, Busey TA, Strauser LEJ. Auditory speech recognition and visual text recognition in younger and older adults: similarities and differences between modalities and the effects of presentation rate. J Speech Lang Hear Res. 2007;50(2):283-303.
14. Dubno JR, Lee F-S, Matthews LJ, Ahlstrom JB, Horwitz AR, Mills JH. Longitudinal changes in speech recognition in older persons. J Acoust Soc Am. 2008.123(1):462-75. http://dx.doi.org/10.1121/1.2817362

15. Wilson RH, McArdle R, Watts KL, Smith SL. The Revised Speech Perception in Noise Test (R-SPIN) in a multiple signal-to-noise ratio paradigm. J Am Acad Audiol. 2012;23(8):590-605. http://dx.doi.org/10.3766/jaaa.23.7.9
16. Wilson RH, McArdle R. Speech-in-noise measures: variable versus fixed speech and noise levels. Int J Audiol. 2012;51(9):708-12. http://dx.doi.org/10.3109/14992027.2012.684407
17. Costa MJ, Iorio MCM, Mangabeira-Albernaz PL. Desenvolvimento de um teste para avaliar a habilidade de reconhecer a fala no silêncio e no ruído. Pro Fono. 2000;12(2):8-16.
18. Bevilacqua MC, Banhara MR, Da Costa EA, Vignoly AB, Alvarenga KF. The Brazilian Portuguese Hearing in noise test. Int J Audiol. 2008;47(6):364-5. http://dx.doi.org/10.1080/14992020701870205
19. Calais LL. Reconhecimento de fala em idosos: elaboração e aplicação de um teste considerando a previsibilidade da palavra [tese]. São Paulo: Universidade Federal de São Paulo; 2011.
20. Cristófaro-Silva T, Almeida LS, Fraga T. ASPA: a formulação de um banco de dados de referência da estrutura sonora do português contemporâneo. In: Anais do 25° Congresso da Sociedade Brasileira de Computação; 24 a 27 jun 2005; São Leopoldo, RS. São Leopoldo: Sociedade Brasileira de Computação; 2005. p. 2268-77.
21. Calais LL, Lima-Gregio AM, Arantes P, Gil D, Borges ACLC. Um julgamento de concretude de palavras. J Soc Bras Fonoaudiol. 2012;24(3):262-8.http://dx.doi.org/10.1590/S2179-64912012000300012
22. Costa MJ, Iorio MCM, Mangabeira-Albernaz PL, Cabral Jr EF, Magni AB. Desenvolvimento de um ruído com espectro de fala. Acta Awho. 1998;17(2):84-89.
23. Costa MJ. Listas de sentenças em português: apresentação e estratégias de aplicação na audiologia. Santa Maria: Palloti; 1998.
24. Russo ICP, Pereira LD, Carvallo RMM, Anastásio ABT. Encaminhamentos sobre a classificação do grau de perda auditiva em nossa realidade. Rev Soc Bras Fonoaudiol. 2009;14(2):287-8. http://dx.doi.org/10.1590/S1516-80342009000200023
25. Brucki SMD, Nitrini R, Caramelli P, Bertolucci PHF, Okamoto IH. Sugestões para o uso do Mini-Exame do estado mental no Brasil. Arq Neuropsiquiatr. 2003;61(3B):777-81. http://dx.doi.org/10.1590/S0004-282X2003000500014
26. Paradela EMP, Lourenço RA, Veras RP. Validação da escala de depressão geriátrica em um ambulatório geral. Rev Saúde Pública. 2005;39(6):918-23. http://dx.doi.org/10.1590/S0034-89102005000600008
27. Rossi AG. Efeitos do alcoolismo no processamento auditivo [tese]. São Paulo: Universidade Federal de São Paulo; 1999.
28. Pereira LD, Shochat E. Fala com ruído (teste 1). In: Pereira LD, Shochat E. Processamento auditivo central: manual de avaliação. São Paulo: Lovise; 1997. p. 99-102.

Appendix 1. List 1

1. The mother organized in details the party (LP).
2. The old man rested on the park bench (HP).
3. It's a beautiful wood door (LP).
4. The sun is far kilometers from the earth (HP).
5. It was lovely that house's decoration (LP).
6. The young man wished to buy a car (LP).
7. The Church named the new Pope (LP).
8. The women bought chairs for the table (LP).
9. Yesterday afternoon it fell a heavy rain (HP).
10. The master advised the text production (LP).
11. The young man played sports in the club (LP).
12. The soccer ball disappeared before the game (HP).
13. The student read each page of the book (HP).
14. The boy ran and jumped the fence (HP).
15. The grandmother sews with needle and thread (HP).
16. Cancer treatment is painful (HP).
17. The tree dropped a leaf (HP).
18. The old man writes using a pen (LP).
19. A boy rolled and another one kicked the ball (HP).
20. The ballet dancer fainted in the middle of the dance (LP).

Appendix 2. List 2

1. The choreographer created a new dance (HP).
2. Men pruned the trees in the square (LP).
3. The system collects rainwater (LP).
4. That bishop can become Pope (HP).
5. The young man wrote a poem on the paper (LP).
6. The kid threw through the window the ball (LP).
7. The best pools are in the club (HP).
8. The animal ran away through a hole at the fence (LP).
9. The old man fell asleep at the steering wheel (HP).
10. The athlete practiced to win the game (LP).
11. Everybody danced and had a lot of fun at the party (HP).
12. The couple's story became a book (LP).
13. The boy highlighted several parts of the text (HP).
14. The family gathers around the table (HP).
15. The bird flew and dropped a feather (HP).
16. The girl has drawn above the line (LP).
17. They covered the huge hole with soil (LP).
18. The police had to break down the door (HP).
19. The thief planned to break into the house (HP).
20. The test confirmed the suspect cancer (LP).

Appendix 3. List 3

1. The young student painted the entire face (LP).
2. The woman arrived in the square and sat on the bench (HP).
3. The cook bought twenty kilos of meat (HP).
4. The secretary called the boss' cell phone (LP).
5. The mother swings the daughter in the hammock (LP).
6. The siblings have the same blood type (HP).
7. Many people watched that play (LP).
8. The flour is an ingredient of the pasta (LP).
9. The teacher showed the parts of the body (HP).
10. Even with pain, the boy opened his mouth (LP).
11. The man was arrested for shoplifting (LP).
12. To go to the beach everybody goes down the mountain (HP).
13. The girl had the best score in the test (LP).
14. The grandfather plays every day with his grandson (HP).

15. The principal put my name on the list (HP).
16. The best-selling flower today is the rose (HP).
17. From the newspaper page, he took the picture (LP).
18. The mother burned herself to extinguish the flames (HP).
19. The mass was performed by Father. (HP).
20. The referee favored the best team (LP).

Appendix 4. List 4

1. The party decoration was entirely pink (LP).
2. The ballet dancer moved her body (LP).
3. On the man's body, there were bloodstains (LP).
4. The man cut wood for the fire (LP).
5. Someone forgot the folder on the bench (LP).
6. The fish were caught in the net (HP).
7. The dentist examined the entire mouth (HP).
8. Who control the job is the boss (HP).
9. The boy wanted to play for this team (HP).
10. It is normal to be nervous before the test (HP).
11. Italian people eat a lot of pasta (HP).
12. The boy was slapped in the face (HP).
13. The man cut wood with the saw (LP).
14. The old woman spoiled a lot her grandson (LP).
15. That church had no priest (LP).
16. The old man went to the theater to watch the play (HP).
17. The woman signed her name on the list (LP).
18. The mother cut into several pieces the meat (LP).
19. That camera takes the best photo (HP).
20. Clothes are better in that store (HP).

Appendix 5. Training List

1. The reporter talked to many people (HP).
2. At the beginning of the war, they exploded a bomb (HP).
3. The director scheduled the group meeting (LP).
4. The thief broke the window of the room (LP).
5. The mother tenderly took care of her son (HP).
6. Students got lost in the woods (LP).
7. Water spoiled the fabric paint (LP).
8. The man seemed to be from another planet (HP).
9. The boys went to the concert of the band (LP).
10. She bought an envelope for the letter (HP).