

Development of the Brazilian Portuguese Dichotic Sentence List Test

Desenvolvimento do teste Listas de Sentenças Dicóticas em Português Brasileiro

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ABSTRACT

Purpose: To develop Brazilian Portuguese Dichotic Sentence List Test, check its applicability and propose an application protocol for auditory processing assessment. **Methods:** The lists of sentences were taken from the original material, analyzed in detailed and adapted to form the new test. To compose pairs of sentences with as much of the same duration as possible, the duration of each sentence was statistically analyzed within the same list and among lists. The lists were combined in increasing order of length, within each list; and combinations of the lists were formed according to the length of sentences, resulting in 42 different sets of lists. Then, the test was performed with 42 normal hearing individuals. Individuals were instructed on how to answer: initially, they should repeat the sentences presented to both ears (attention divided between the right and the left ears). Then, the steps for the right ear phrases (attention directed to the right ear), and finally for the left ear (attention directed to the left ear) were performed. **Results:** The new material was composed as follows: track 1, pure tone calibration; track 2, modified 1A list; and tracks 3 to 44, the 42 possible combinations among the lists. After the test was applied, an application protocol was suggested. **Conclusion:** The Brazilian Portuguese Dichotic Sentence List Test was developed and proved to be an instrument that can be used in adults. Therefore, a protocol was proposed with two different combinations of lists and presentation sequence for auditory processing assessment.

Keywords: Hearing; Speech discrimination tests; Auditory perception; Audiology; Hearing Tests

RESUMO

Objetivo: Desenvolver o teste Listas de Sentenças Dicóticas em Português Brasileiro, verificar sua aplicabilidade e propor um protocolo de aplicação para avaliação do processamento auditivo. **Métodos:** As listas de frases foram extraídas do material original, submetidas a uma análise criteriosa e ao processo de adaptação, para compor o novo teste. Para formar pares de frases com duração mais aproximada possível, foi analisado estatisticamente o tempo de duração de cada sentença, dentro de uma mesma lista e entre listas. Estas foram combinadas em ordem crescente de duração, dentro de cada lista, e realizadas as combinações das listas entre si, de acordo com a duração das sentenças, gerando 42 conjuntos distintos de listas. Em seguida, o teste foi aplicado em 42 indivíduos normo-ouvintes. Os indivíduos foram instruídos sobre a forma de resposta, devendo repetir, inicialmente, as sentenças de ambas as orelhas (atenção dividida entre orelha direita e esquerda), em seguida, as frases da orelha direita (atenção direcionada para a orelha direita) e, finalmente, as da orelha esquerda (atenção direcionada para a orelha esquerda). **Resultados:** O novo material ficou composto da seguinte forma: faixa 1, tom puro de calibração; faixa 2, lista 1A modificada e faixas 3 a 44, as 42 possibilidades de combinação entre as listas. Após a realização do teste, foi sugerido um protocolo de aplicação. **Conclusão:** O teste Listas de Sentenças Dicóticas em Português Brasileiro mostrou-se um instrumento passível de ser utilizado em adultos e, sendo assim, foi proposto um protocolo com duas diferentes combinações de listas e sequências de apresentação, para avaliação do processamento auditivo.

Descritores: Audição; Testes de discriminação da fala; Percepção auditiva; Audiologia; Testes auditivos

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INTRODUCTION

The efficiency whereby the central nervous system processes auditory information can be called auditory processing, which refers to the mechanisms responsible for sound location and sound lateralization, auditory discrimination, recognition of temporal and frequency patterns, as well as information ordering and resolution. These processes are closely related and responsible for giving meaning to verbal and non verbal sounds of our daily life⁽¹⁾.

Tests that evaluate these functions include dichotic verbal tests, which enable the understanding and quantification of auditory perception skills, e.g., checking hemispheric specialization and the consequent presence of changes in the temporal lobe⁽²⁾.

A dichotic task consists in the simultaneous presentation of a different auditory stimulus in each one of the ears. The type of response required, at the time of assessment, can measure different capabilities, such as in binaural separation, figure-ground discrimination ability in the directed listening task and the possibility to check perceptual symmetry between the ears, in the case of binaural integration⁽³⁾.

To evaluate dichotic listening functions relative to verbal stimuli, there are some tests that were developed in Brazil^(4,5). However, only one of them⁽⁵⁾ uses sentences as stimuli; it is based on the Synthetic Sentence Identification test, in which words form meaningless sentences that must be identified through a printed list.

Considering the importance of the auditory processing information provided by dichotic tests, arose the interest in proposing a test that would also use phrases as stimulus, from the Sentence List Test⁽⁶⁾ (SLP-BR), developed in Brazilian Portuguese language, containing sentences with meaning, as a stimulus. The test consists of a list of 25 sentences and seven lists with ten sentences. Rather than using isolated sentences, this material has features that resemble a communicative situation.

In recent years, the SLP-BR test proved to be very versatile for research purposes^(7,8,9,10) and have different goals and strategies of implementation, hence it can be used in various ways, according to the objective of raters. Therefore, a decision was made to develop the new proposal.

The objective of the present study was to adapt the SLP-BR, develop the Brazilian Portuguese Dichotic Sentence List Test (DSLBP-BR), check its applicability in adult normal listeners and propose a protocol of application to compose the auditory processing assessment battery.

METHODS

Developing the dichotic test

The list of 25 sentences of the SLP test is named 1A and the

seven lists with ten sentences⁽⁶⁾ were called 1B, 2B, 3B, 4B, 5B, 6B and 7B. The sentences of the test, used to produce the new material, contain the following features: they are short, familiar and easily repeatable; they represent everyday conversational situations; they are positive, have simple periods, consist of a maximum of up to seven words and do not contain names. Each list was phonetically balanced to reflect the distribution of classes of sounds that occur in the language spoken in everyday life. In addition, all the sentences are different, but the lists are similar both in phonetic content and in sentence structure in order to enable equivalent performance of individuals with the different lists.

Before the preparation of the new material, the lists of sentences were extracted from the original material by using the WinISO 6.0 software, so that they could be used and, thus, carefully reviewed, as described below.

For the development of the dichotic test, in which different sentences are presented in each ear simultaneously, each sentence in the same list was measured for duration, using the software Sound Forge Pro 10.0. After measuring the duration values of each sentence, all the sentences were arranged in increasing order of duration. The combined sentences had a difference of up to 243 milliseconds. This measurement intended to compose pairs of sentences with similar duration, to avoid the stimulation of one of the ears from finishing before the stimulus of the opposite ear. This goal was achieved, considering the average duration of a syllable, which can range from 200 to 300 milliseconds⁽¹¹⁾.

After that, to analyze the duration of sentences within the same list, the Shapiro-Wilk statistical test was applied. There was normal distribution among the sentences, i.e., the 25 sentences of list 1A and the ten sentences of the seven lists had similar duration within each list.

To analyze the duration of sentences across the different lists, the lists were compared with each other, using the t-test for independent groups. There was no statistically significant difference, which showed that all lists can be combined with one another.

Despite these results, for the selection of the pairs of sentences to be combined, the sentences were carefully combined in order of increasing duration within each list. Subsequently, the lists were combined with one another in all possibilities, resulting in 42 different sets of lists. In this way, the software SoundForge Pro 10.0 was used to put a list on channel 1 and another list on channel 2 in order to form pairs of different sentences, but with similar duration. The same list was never used in both ears simultaneously.

Because a previous study confirmed that the lists of ten sentences are equivalent to one another⁽¹²⁾ and, therefore, any list in use will have similar results, the lists were not broken down for the creation of new lists. Only list 1A, which is composed of 25 sentences and was usually used to familiarize the individuals with the test, was divided in two, resulting in a list

of 12 sentences. As this list has an odd number of sentences, the longest one was not used. Thus, the two 12-sentence lists were organized and paired with each other, as described previously. They were used only for training and familiarizing the individuals with the test. It should be noted that, throughout the process, the quality of the original material has not been changed.

Thus, at first, the new material was composed as follows: track 1, pure tone calibration; track 2, modified list 1A, and tracks 3 to 44, the 42 combination possibilities among lists.

Test application

This study was approved by the Research Ethics Committee of *Universidade Federal de Santa Maria*, as part of a research project registered under number 029457. To participate in the study, the subjects should meet the following eligibility criteria: age between 18 and 40 years; hearing thresholds within the normal range, i.e. a maximum of 25 dB at frequencies between 250 Hz and 8000 Hz, and at least complete secondary education, in order to avoid the variable “schooling” from interfering with the responses⁽¹³⁾.

Individuals who did not accept to participate, did not meet the selection criteria or presented any factor that could interfere with the test, such as neurological changes and/or verbal fluency disorders, were excluded from the sample.

Participants were invited through posters displayed in the place where the study was carried out and by verbal invitation of the researcher. The sample consisted of 42 subjects, 21 women and 21 men, who were informed about the goals and procedures of the study, and signed an informed consent form. The average age of the participants was 27 years old. Twenty-three subjects had complete secondary education, 7 had incomplete higher education and 12 had complete higher education.

All the participants were initially subjected to anamnesis, with questions about personal data, educational level, otologic history and hearing complaints, followed by visual inspection of the external acoustic meatus. After that, pure-tone air-conduction threshold audiometry was performed at frequencies from 250 Hz to 8,000 Hz and pure-tone bone-conduction threshold audiometry, at the frequencies from 500 Hz to 4,000 Hz. Also, speech recognition thresholds and percentage rates of speech recognition were measured. These assessments were made using an Interacoustics® Affinity 33 AC two-channel digital audiometer and Telephonics® TDH-39P audiometric earphones.

After the basic audiological assessment was performed, the dichotic SLP test was applied. For the present research, a group of lists was created for each subject to avoid presenting a list more than once in the same assessment situation (Chart 1).

Prior to application of the test, all individuals were instructed on the type of response requested for each stage of the assessment. Then, a training session was conducted with list 1A, as follows: with the first four pairs of sentences, the subjects

were asked to repeat the sentences presented to both ears; for the following four pairs of sentences, they were asked to repeat only the phrases presented to the right ear (attention directed to the RE) and, in the last four, to the left ear (attention directed to the LE). These parameters were followed for all individuals. The responses were considered correct only when the subjects repeated the entire phrase.

The intensity used for stimulus presentation was NS 50 dB added to the three-tone average, measured from the average of the air-conduction audiometric thresholds at the frequencies of 500 Hz, 1000 Hz and 2000 Hz⁽⁵⁾.

The test was presented through a Toshiba® 4149 digital compact disc (CD) player, fitted to the audiometer previously described. The sentences were calibrated using the 1000 Hz tone, present on the first track of the CD, which was placed on the zero level of the VU Meter, both on channel 1 and on channel 2.

RESULTS

The duration (in seconds) of the sentences of each list and the analysis of normality are displayed on Chart 2.

The comparative analysis of the duration between the different lists are presented on Table 1.

The data on the average, median, standard deviation, minimum and maximum age, medium-sized tritonais and application of dichotic SLP testing, are set out on Table 2.

The average, median, standard deviation, minimum and maximum of the scores achieved by the different lists are shown in Table 3.

The comparative analysis of the score achieved between the different lists is shown in Table 4.

DISCUSSION

The Brazilian Portuguese Sentence List Test (SLP-BR) has been widely used in research and in clinical practice, with different assessment goals and in diverse populations^(14,15,16,17,18,19,20,21,22,23,24).

Thus, the objective of developing a dichotic version of SLP-BR was to create a material that enabled research on the ability of figure-ground discrimination for verbal stimuli, through the task of binaural integration and separation, using sentences that represent conditions of everyday communication⁽²⁴⁾.

The analysis of the findings during the development of this material shows, in Chart 2, that the shortest sentence lasted 1.116 seconds (“You have to wait in line”) and belonged to list 1B, while the longest sentence lasted 1.845 seconds (“I left the sheets on the table”) and belonged to list 7B.

In order to prevent one of the sentences of each pair of sentences from being longer, thus continuing after its counterpart, the sentences of each list were combined in ascending order of duration. In all combinations, the largest difference found

Chart 1. Example of application sequence

Integration			
List 1B-RE		List 2B-LE	
1	Tem que esperar na fila.	1	Elas viajaram de avião.
2	Esqueci de ir ao banco.	2	Ainda não está na hora.
3	Não pude chegar na hora.	3	Parece que agora vai chover.
4	Ela não está com muita pressa.	4	Encontrei seu irmão na rua.
5	O avião já está atrasado.	5	Ouvi uma música linda.
6	O preço da roupa não subiu.	6	Esqueci de comprar os pães.
7	Avisei seu filho agora.	7	A bolsa está dentro do carro.
8	O jantar da sua mãe estava bom.	8	Acabei de passar um cafezinho.
9	Elas foram almoçar mais tarde.	9	Seu trabalho estará pronto amanhã.
10	Ganhei um carro azul lindo.	10	Hoje não é meu dia de folga.
Directed attention – right ear			
List 3B-RE		List 4B-LE	
1	Não posso dizer nada.	1	Ela viaja em dezembro.
2	Não encontrei meu filho.	2	Amanhã não posso almoçar.
3	A chuva foi muito forte.	3	Você teve muita sorte.
4	É perigoso andar nessa rua.	4	Não paguei a conta do bar.
5	Esqueci de levar a bolsa.	5	Essa estrada é perigosa.
6	Meu irmão viajou de manhã.	6	A chuva inundou a rua.
7	Os pães estavam quentes.	7	Ainda não pensei no que fazer.
8	Ela acabou de bater o carro.	8	O aluno quer assistir ao filme.
9	Os preços subiram na segunda.	9	Meu filho está ouvindo música.
10	Elas já alugaram uma casa na praia.	10	Sua mãe pôs o carro na garagem.
Directed attention – left ear			
List 5B-RE		List 6B-LE	
1	Depois, a gente conversa.	1	Esta rua é perigosa.
2	Esta carta chegou ontem.	2	Não falei com sua filha.
3	Minha viagem foi ótima.	3	Os preços não devem subir.
4	Eles foram comprar pães.	4	Cheguei atrasada na aula.
5	Não posso esquecer a mala.	5	Vou viajar às nove da manhã.
6	A rua estava muito escura.	6	Ela comprou os últimos pães.
7	Ela acabou de servir o almoço.	7	Meu irmão bateu o carro ontem.
8	A data do exame foi adiada.	8	Esqueci da bolsa na sua mesa.
9	Preciso terminar o meu trabalho.	9	A casa de campo já foi alugada.
10	Elas alugaram um carro no verão.	10	Prometi a ele não contar o segredo.

between the duration of the sentences was 243 milliseconds, between the sentences “today is not my day off” from the list 2B and “I left the sheets on the table” from the list 7B. This was not considered significant, because the average duration of a syllable is between 200 and 300 milliseconds⁽¹¹⁾, hence it does not interfere in the response of the evaluated subject. In this way, the seven lists had sentences with equivalent duration times (Table 1) because there was no significant difference between them.

The analysis of the application of the new material to the group of normal listeners showed that the examiner had no

difficulty applying the test, and the evaluated subjects had no difficulty either in understanding the test strategy and the response.

It was also found that the average time of application of the test was approximately 15 minutes, between training and assessment itself, in three different conditions. It is believed that this time is appropriate, since it is not considered long for audiologic testing in adults. Thus, the attention of the evaluated subjects was held without difficulty.

The values in the task of binaural integration ranged from 70% to 100% of correct sentences and, in the binaural

Chart 2. Duration of the sentences of each list (in seconds) and normality analysis

Lists													
1B		2B		3B		4B		5B		6B		7B	
Sentence	Duration	Sentence	Duration	Sentence	Duration	Sentence	Duration	Sentence	Duration	Sentence	Duration	Sentence	Duration
8	1.116	5	1.306	3	1.213	9	1.21	1	1.201	5	1.116	8	1.19
4	1.277	7	1.323	10	1.236	8	1.213	3	1.213	10	1.275	2	1.201
10	1.41	8	1.349	4	1.282	10	1.219	9	1.265	9	1.414	6	1.248
6	1.416	4	1.367	2	1.381	5	1.259	10	1.3	4	1.456	1	1.439
1	1.462	10	1.375	6	1.389	4	1.346	5	1.387	1	1.469	5	1.468
2	1.474	9	1.497	9	1.393	7	1.381	6	1.387	7	1.469	3	1.491
7	1.48	2	1.515	7	1.399	3	1.451	2	1.471	2	1.543	7	1.497
3	1.515	1	1.532	1	1.462	2	1.48	7	1.593	6	1.589	10	1.544
9	1.584	6	1.532	5	1.689	6	1.48	4	1.619	8	1.708	4	1.555
5	1.627	3	1.602	8	1.804	1	1.695	8	1.654	3	1.752	9	1.845
p-value	0.31690	-	0.17670	-	0.20140	-	0.2107	-	0.30991	-	0.78439	-	0.25767

Shapiro-Wilk test (p<0.05)

Table 1. Comparative analysis of duration between the lists

Lists	1B	2B	3B	4B	5B	6B	7B
1B	-	0.336087	0.165556	0.862465	0.700513	0.478943	0.405297
2B	0.336087	-	0.231950	0.258501	0.182538	0.101075	0.079039
3B	0.165556	0.231950	-	0.221033	0.309212	0.485520	0.566922
4B	0.862465	0.258501	0.221033	-	0.832269	0.591527	0.508201
5B	0.700513	0.182538	0.309212	0.832269	-	0.744514	0.651530
6B	0.478943	0.101075	0.485520	0.591527	0.744514	-	0.899507
7B	0.405297	0.079039	0.566922	0.508201	0.651530	0.899507	-

Test t (p<0.05)

Table 2. Average, median, standard deviation, minimum and maximum age, three-tone averages and Brazilian Portuguese Dichotic Sentence List test application in the integration and directed attention tasks (n=42)

	All						
	Age	TTA RE	MTT LE	Int RE %	Int LE %	Att RE %	Ate LE %
Average	27.54	8.97	8.24	93.33	90.24	98.57	96.67
Median	27.00	8.66	6.66	95.00	95.00	100.00	100.00
SD	5.15	4.18	4.24	7.54	11.58	3.54	5.70
Minimum	18.00	1.33	0.00	80.00	70.00	90.00	80.00
Maximum	36.00	20.00	15.00	100.00	100.00	100.00	100.00

Subtitle: TTA = Three-tone average; RE = right ear; LE = left ear; Int = integration; Att = Attention; SD = Standard deviation

Table 3. Average, median, standard deviation, minimum and maximum age, of the scores obtained with different lists

Lists	1B	2B	3B	4B	5B	6B	7B
Average	95.65	96.96	94.29	94.58	92.50	94.55	94.55
Median	100.00	100.00	100.00	100.00	100.00	100.00	100.00
SD	7.88	4.70	8.70	7.79	10.42	8.00	8.58
Minimum	70.00	90.00	70.00	80.00	70.00	80.00	70.00
Maximum	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 4. Comparative analysis of the score achieved between the lists

Lists	1B	2B	3B	4B	5B	6B	7B
1B	-	1.000000	0.751830	0.772830	0.579100	0.789268	1.000000
2B	1.000000	-	0.723674	0.546494	0.772830	0.751830	0.772830
3B	0.751830	0.723674	-	0.723674	1.000000	0.683091	0.723674
4B	0.772830	0.546494	0.723674	-	0.546494	1.000000	0.751830
5B	0.579100	0.772830	1.000000	0.546494	-	1.000000	1.000000
6B	0.789268	0.751830	0.683091	1.000000	1.000000	-	1.000000
7B	1.000000	0.772830	0.723674	0.751830	1.000000	1.000000	-

Wilcoxon Test ($p < 0.05$)

separation task, from 80% to 100% of correct responses (Table 2). Based on these findings, it can be suggested that the strategy in use allowed the evaluated subjects to submit responses similar to those found in the literature^(25,26), although the responses requested in this phase of the research were the reproduction of the full sentence they heard, without support of the written material, as proposed by other materials.

Although the aim of this study was not to establish parameters, the analysis of the results of the integration task (in which the two sentences heard should be repeated) showed a slightly lower performance of the left ear (90.24%) compared with the right ear (93.33%). A similar phenomenon has been found in other studies^(25,26,27,28). In the binaural separation task, the results for attention in the right and left ears (98.57 percent and 96.67%, respectively) were also slightly lower in the left ear, taking into account the average of the results. However, when considering the results of the medians, the performance of individuals in the binaural integration task was the same both in the right ear and in the left ear (95%). In binaural separation, performance was 100%.

In this way, both in the stage of divided attention and in the stage of directed listening, it was found that the test developed in this study could be applied in adults with normal hearing, and they showed good performance in the test. This was expected, since they had no auditory complaints and probably had not been assessed for changes in their auditory processing skills. It should be noted that these findings should be further investigated in later studies, with larger numbers of subjects and in different populations.

When combining the percentages of correct responses of different lists, measured in the three situations (Table 3), seven lists showed similar responses to one another, because there were no significant differences when they were compared (Table 4). These results demonstrate that the lists have similar behavior and, therefore, any one of them can be applied, as long the order of presentation of the sentences and combinations is maintained as suggested, without the risk of influence from the list being used.

Also regarding combinations of lists that can be used, one must be careful not to use the same list in the same condition, in case the test is applied more than once, or in different sessions.

It should be noted that a list can be presented three times in each ear; however, the requested response must always be different. In the situation of directed attention, for example, when their attention is on the right ear, the list should be repeated and, when their attention is on the left ear, the list will be presented to the opposite ear. Finally, in the integration task, it will be repeated along with another list.

Therefore, after editing and analyzing the material, in order to enable the use of this new test in future research and in clinical practice, an evaluation protocol was created. It suggests, after pure-tone calibration, track 1 and list 1A for training, and track 2, two sequences of application. In this way, the lists will not be submitted under the same conditions (ear and/or task), if they more than three combinations of sentences have to be used, for any interference during the assessment, namely: Sequence 1 - track 3- binaural integration with the lists 1B in the right ear and 2B in the left ear; track 4 - attention directed to the right, with lists 3B on the right ear and 4B in the left ear; track 5 - attention directed to the left, with lists 5B in the right ear and 6B in the left ear. Sequence 2: Track 6 - binaural integration with lists 7B in the right ear and 4B in the left ear; track 7 - attention directed to the right, with lists 5B in the right ear and 3B in the left ear; track 8 - attention directed to the left, with lists 2B in the right ear and the 1B in the left ear.

It should be noted that this first stage of the research was aimed only at developing the test and check its applicability in adult individuals with normal hearing. This was carried out and confirmed. However, based on the proposed protocol, different research studies must be carried out while using this material, with different objectives, populations and age groups, with or without auditory complaints, with or without hearing loss, in order to establish standardization parameters.

In addition, it is believed that other forms of response should be explored, such as identification of the sentence presented in written form, or using different forms of score of correct responses.

CONCLUSION

This study enabled the adaptation of the Brazilian

Portuguese Sentence List Test (SLP-BR) and the development of the Brazilian Portuguese Dichotic Sentence List Test (DSL-PP-BR), which turned out to be an instrument to be applied to normal hearing adults.

Based on that, a protocol was proposed with two different combinations of sentences lists and presentation sequences.

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