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Variability of the dichotic sentence test in the test and retest of normal hearing adults

Variabilidade do teste dicótico de sentenças no teste e reteste de adultos normo-ouvintes

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Keywords

Hearing
Auditory Perception
Reproducibility of Results
Hearing Tests
Adult

ABSTRACT

Purpose: to investigate the variability of the Dichotic Sentence Test through the test and retest in normal-hearing adults. **Method:** We evaluated thirty-six individuals aged 19 to 44 years old, right-handed and with normal hearing thresholds. We performed the basic audiological evaluation and then we applied the Dichotic Digit Test and Dichotic Sentence Test. The test and retest had two sessions, with an interval from 30 to 40 days, in the same shift. **Results:** In the integration task, there was an advantage of the right ear in both evaluation sessions. There was no significant difference between the measures obtained in the right ear in the two evaluation sessions, while in the left ear, we found a significant difference. In the analysis of the differences in ears between the test and the retest, we found that 64% of the individuals kept the same result in the right ear, while in the left one, only 36% of the individuals kept the same result in both stages and 44% showed a 10% difference between the two evaluations. We observed moderate positive correlation for both the right ear (r=0.420) and the left ear (r=0.550), with a tendency to improve retest scores. In the separation task, there was a small variability only in the left ear, also with improved retest scores. **Conclusion**: There was a significant difference between the measures obtained in the test and retest only in the integration task in the left ear, but there was a moderate positive correlation between the measures obtained in the two evaluation sessions, showing a tendency to improve scores in the second evaluation session.

Descritores

Audição
Percepção Auditiva
Reprodutibilidade dos Testes
Testes Auditivos
Adulto

RESUMO

Objetivo: investigar a variabilidade do Teste Dicótico de Sentenças por meio do teste e reteste em indivíduos normo-ouvintes. **Método**: foram avaliados 36 indivíduos na faixa etária de 19 a 44 anos, destros e com limiares auditivos dentro da normalidade. Realizou-se a avaliação audiológica básica e aplicação dos Testes Dicótico de Dígitos e Dicótico de Sentenças. Teste e reteste foram realizados em duas sessões, com intervalo de 30 a 40 dias, no mesmo turno. **Resultados:** na tarefa de integração: houve vantagem da orelha direita em ambas as sessões de avaliação; não houve diferença significante entre as medidas obtidas na orelha direita, nas duas sessões de avaliação, enquanto na orelha esquerda foi constatada diferença significante. Na análise das diferenças por orelhas entre teste e reteste, verificou-se que 64% dos indivíduos mantiveram o mesmo resultado na orelha direita; já na esquerda, apenas 36% dos indivíduos mantiveram o mesmo resultado em ambas as etapas e 44% apresentaram diferença de 10% entre as duas avaliações. Observou-se correlação positiva moderada tanto para a orelha direita (r = 0,420) quanto para a esquerda (r = 0,550) com tendência de melhora dos escores no reteste. Na tarefa de separação, houve pequena variabilidade apenas na orelha esquerda, também com melhora dos escores no reteste. **Conclusão:** foi verificada diferença significante entre as medidas obtidas no teste e reteste apenas na tarefa de integração na orelha esquerda, porém houve correlação positiva moderada entre as medidas obtidas nas duas sessões de avaliação, mostrando tendência de melhora dos escores na segunda sessão de avaliação.

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INTRODUCTION

Auditory processing is linked to the reception and efficiency in which the Central Nervous System processes acoustic information, being a conscious, intentional and learned function1. It includes the neural mechanisms required for a variety of auditory behaviors such as: sound localization, intelligibility of degraded signals or with competitive noise, discrimination and pattern recognition, and perception of acoustic temporal aspects[2].

For the evaluation of auditory processing, there is a wide range of behavioral tests, which since the 90's began to be applied in the country, in different populations, becoming a frequent clinical practice due to its contribution in the audiological diagnosis and different pathologies. Dichotic listening tests are included in this battery, whose application is commonly the most used[3], recommended by the American Academy of Audiology (AAA, 2010)[4] and the American Speech-Language-Hearing Association (ASHA, 2005)[2] the inclusion of at least one dichotic listening task (digit, words or sentences) in the auditory processing evaluation.

Dichotic tests are composed of nonverbal and verbal stimuli of syllables, digits, words or sentences, which aim to evaluate the auditory ability of figure-bottom, through binaural integration and separation tasks. These tests make it possible to show the interhemispheric communication at corpus callosum[5]. In Brazil, two tests were developed for the evaluation of the aforementioned stages, which use as a stimulus the combination of sentences, the Dichotic Sentence Identification Test[6] and, recently, the Dichotic Sentence Test (TDS)[7].

The new TDS was developed based on the Portuguese Sentence List (PSL) test[8]. The PSL consists of a 25-sentence list named 1A and seven other lists named 1B, 2B, 3B, 4B, 5B, 6B, and 7B, each consisting of 10 phonetically balanced, affirmative sentences of simple periods, without proper names, representing common everyday situations. Such lists were analyzed for their variability[9], as well as their high reliability, with strong positive correlation10 and equivalents (1B, 2B, 3B, 4B, 5B, 6B)[11].

Based on this material, the composition of the TDS test was based on the sentence duration analysis of each list, which were again distributed in different lists, thus forming pairs of sentences combined according to the duration time[7]. From this combination, an application protocol was generated, contemplating the different stages that constitute the dichotic test, which, in turn, proved to be applicable to normal hearing adults[7].

Considering the need and usefulness of dichotic tests at different times of the auditory processing evaluation and rehabilitation process, and that TDS is a recently developed test, it is of paramount importance to conduct studies establishing psychometric measures of the new instrument[12,13], as it should be used in the audiologist's clinical and research activities. Thus, as this is a new test, this study aimed to investigate the variability of the TDS through the test and retest in normal hearing individuals.

METHOD

This study was approved by the Research Ethics Committee of a Federal University of Rio Grande do Sul, which is part of a research project registered under opinion number 2.764.720. Participants were advised on the intended objectives and after agreeing to participate voluntarily, signed the informed consent form.

To participate in the study, the following eligibility criteria were listed: being between 19 and 44 years old; have at least completed high school; right hand preference/right-handed; present hearing thresholds ≤25 dB HL, at frequencies from 250 Hz to 8000 Hz. In order to avoid factors that could interfere with the test, were excluded from de sample, individuals with excessive earwax, possible self-reported conductive aspects (otitis) and/or verified on the tympanometric curve, evident or self-reported neurological and/or verbal fluency disorders and alteration in the Dichotic Digit Test (TDD).

Initially, 56 individuals were evaluated, of which 50 were included according to the above eligibility criteria. These were submitted to the first application of TDS. On the date of the second test application, only 36 individuals returned, thus occurring a loss of 28.0% of the sample.

Thus, the sample group consisted of 15 males and 21 females, with a mean age of 30.1 years old (SD:7.8 years). Regarding education, nine participants had completed high school, 12 had not completed college and 15 individuals had completed college. The invitation to participate in the study was made, from the disclosure through social networks and verbal invitation of the researcher.

In the first stage, all participants underwent specific anamnesis in order to obtain information about personal data, manual dominance, educational level, ear history and possible hearing complaints. Then, they were submitted to visual inspection of the external acoustic meatus, Pure-Tone Threshold Audiometry (PTTA) and Logoaudiometry, as well as tympanometry. Subsequently, the TDD was applied to screen for possible alterations in the figure-background ability and, finally, the TDS.

Dichotic Sentence Test Application

The presentation of the material was performed by digital recording, in CD with stimulus presentation level of 50 dB SL from the Tritone Average (air thresholds of the frequencies of 500, 1000 and 2000Hz)[7]. Measures were obtained using one of the test sequences, consisting of a predetermined sentence presentation protocol, distributed in different Compact Disc tracks: track 1 - pure calibration tone; track 2 - list 1A, for training; track 3 - for binaural integration stage: composed by lists 1B presented in the right ear (RE) and 2B in the left ear (LE); track 4 – for right-directed listening step: lists 3B are shown on the right ear and 4B on the left ear; track 5 – intended for the left-directed listening stage: formed by the presentation of lists 5B in the right ear and 6B in the left ear[7].

Initially, the participants were instructed on how stimuli were presented and the response requested for each stage of the evaluation. After the test calibration (Track 1), training was performed using Track 2 - with list 1A (12 pairs of sentences), in the following order: the first three pairs of sentences were used for the verbal repetition of both the sentences, thus corresponding to the integration stage; the next three pairs of sentences were intended for repetition of the sentences of the right ear only, separation step - RE, the following three pairs of the left ear, for the separation step - LE and the last three pairs, again for repetition of both sentences, resuming the integration step. After the training, the presentation of the protocol was continued, with Track 3 (10 pairs of sentences) for the binaural integration stage and tracks 4 and 5 of the material (10 pairs of sentences each track) for the binaural separation stages at the right ear and later at the left ear. The test application time was approximately 15 minutes.

Regarding the performance analysis obtained in the TDS, each test track is composed of a set of 10 pairs of sentences, which are presented simultaneously in both ears. Thus, the determined score was 10% for each sentence, totaling a maximum score of 100% per ear in each step. For analysis of the responses obtained in the different stages of this study, it was considered correct the complete repetition of the whole sentence presented, so any error (substitution or omission of words or the whole sentence) was considered 10% error. Therefore, considering the form of quantitative analysis (%) of the responses, the two evaluation sessions and the interpretation of the results were made by the same researcher, since it is considered that there is no subjectivity in the interpretation.

The test protocol was applied at two different times, being the first (Test) performed after the basic audiological evaluation and TDD application and, the second moment of the evaluation (retest), occurred after a period of 30 to 40 days in the same shift.

Considering the importance of investigating the consistency of results obtained in different applications and the controversy in the literature about the time required between the test application and retest, the authors point out the importance of considering a long enough interval so that the results are not contaminated by the effect of memory, but not so extensive as to modify the individual as a result of new learning[14-16]. Thus, this time period was determined in order to minimize the potential impact of the previous exposure, thus avoiding the effect of memory on the responses in the second stage, considering that the sentences presented are familiar, which represent everyday conversation situations.

Audiological measures were obtained in an acoustically treated cabin using an Interacoustics AC33 two-channel digital audiometer with Telephonics TDH-39 P earphones. Auditory processing testing applications will be presented through a *Toshiba 4149 Compact Disc Player Digital*, coupled to the audiometer.

Data were analyzed descriptively and received statistical treatment using the SPSS program. To verify the normality of the variables, the Shapiro Wilk test was applied and the level of 5% was adopted as the criterion for determining significance. To investigate the variability in the performance of individuals in the different time of application of the TDS, the nonparametric Wilcoxon test was used, because the hypothesis of normality was rejected. Correlation analysis was performed using Spearman's correlation coefficient, and as a classification of the degree of correlation, the following correlation coefficient parameter[17] was used: weak when r = 0.10 to 0.30; moderate r = 0.40 to 0.6 e; strong when r = 0.70 to 1.0. Correlations with statistical significance were considered as those with p≤0.05 and moderate or strong degree of correlation.

RESULTS

It can be observed in figure 1 the advantage of the right ear over the left ear, in the stages of binaural integration and separation, and this advantage was also kept in the retest.

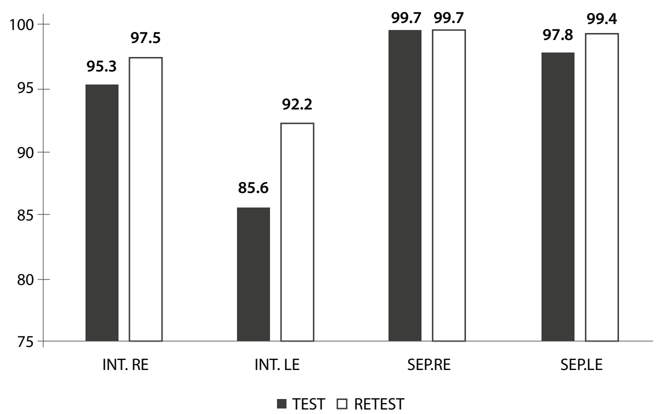

Figure 1. Distribution of right and left ear average scores with the Dichotic Sentence Test in the Binaural integration and separation stages, obtained in two evaluation moments (test and retest)
Captions: Int. RE: right ear binaural integration stage; Int. LE: left ear binaural integration stage; Sep. RE: right ear binaural separation stage; Sep. LE: ear binaural separation stage

Table 1 shows a significant difference in the variability in the performance of normal hearing adults in the left ear integration stage at different application times. It was verified that the score obtained in the retest stage was significantly better in relation to the test stage.

Table 1. Variability analysis in the TDS of the measures obtained in the test and retest of normal hearing adults (n=36)

TDS	Test				Retest				
	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	p-value
Int RE%	95.3	8.1	70	100	97.5	5.0	80	100	0.097
Int LE%	85.6	10.3	60	100	92.2	8.3	70	100	<0.001*
Sep RE%	99.7	1.7	90	100	99.7	1.7	90	100	1.00
Sep LE%	97.8	4.8	80	100	99.4	2.3	90	100	0.083

Statistically significant Wilcoxon * test (≤0.05)
Captions: Int. RE: right ear binaural integration stage; Int. LE: left ear binaural integration stage; Sep. RE: right ear binaural separation stage; Sep. LE: ear binaural separation stage

Table 2 shows the correlations between the test and retest stages, in which there is a moderate positive correlation for the RE and LE integration stages.

Based on the analysis of the differences according to the ear side, obtained in the two moments of TDS application, it was observed that the right ear presented greater stability in the integration stage in both applications, and it was observed that 64% of individuals (23) kept the same result in both stages and 28% (10) 10% difference between the evaluations. Regarding the left ear, there was greater variability in the performance of individuals, with 36% (13) of individuals kept the same result in both stages and 44% (16) showed a 10% difference between the two evaluations. (Figure 2).

In the binaural separation task, in the analysis of the differences in ears obtained in the test and retest, there was less variability in this task, and in the right ear, 94.4% (34) of the participants kept the same result in both applications; while in the left ear, 75% (27) of the individuals showed no variation in the results obtained and 22.2% (8) obtained a 10% difference between the two evaluations, also with a tendency for better performance in the retest. (Figure 3).

Table 2. Correlation between the Dichotic Sentence Test results obtained in the test and retest of normal hearing subjects (n=36)

TDS	Test				Retest					
	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	R	p-value
Int RE%	95.3	8.1	70	100	97.5	5.0	80	100	0.420	0.011*
Int LE%	85.6	10.3	60	100	92.2	8.3	70	100	0.550	0.001*
Sep RE%	99.7	1.7	90	100	99.7	1.7	90	100	-0.029	0.869
Sep LE%	97.8	4.8	80	100	99.4	2.3	90	100	-0.119	0.490

* There is a statistically significant correlation (p<0.05)
Captions: Int. RE: right ear binaural integration stage; Int. LE: left ear binaural integration stage; Sep. RE: right ear binaural separation stage; Sep. LE: ear binaural separation stage; r: correlation coefficient

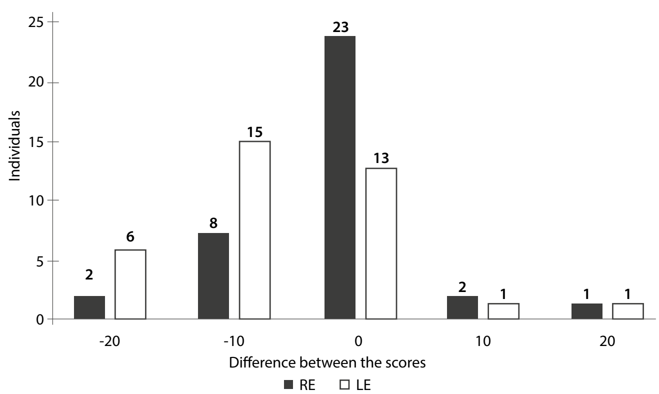

Figure 2. Difference between the scores obtained in the test and retest stages of the right ear and left ear in the binaural integration task (n=36)
Captions: RE: right ear; LE: left ear; negative scores: test stage <retest stage; 0: test stage = retest stage; positive scores: test stage> retest stage

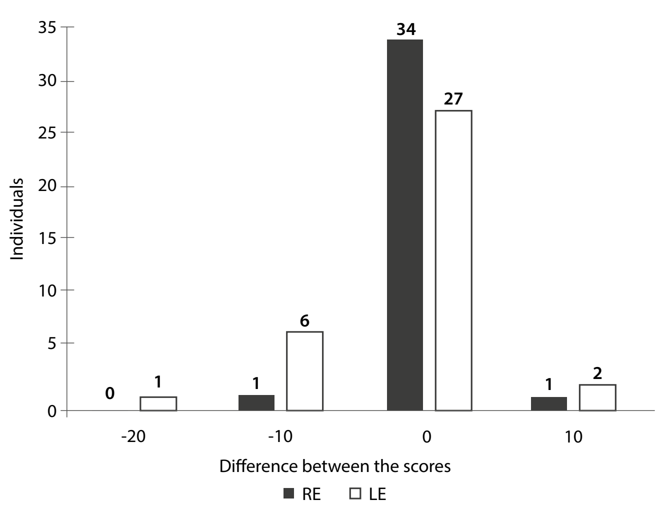

Figure 3. Difference between the scores obtained in the test and retest stages of the right ear and left ear in the binaural separation task (n=36)
Captions: RE: right ear; LE: left ear; negative scores: test stage <retest stage; 0: test stage = retest stage; positive scores: test stage> retest stage

DISCUSSION

Psychometric analysis of new instruments is essential to ensure the quality of the tests and, in particular, to be considered as generators of consistent and replicable measures of the construct of interest[13,14]. Therefore, in order to verify the variability of TDS, a performance investigation was performed in normal hearing adults evaluated in different sessions, according to the interval period considered in this study.

The presentation of two competitive stimuli, simultaneously in both ears, in the dichotic tests, makes it possible to show the effectiveness of the contralateral pathway, through the advantage of the contralateral ear to the dominant hemisphere for speech stimuli, and the advantage of the right ear for verbal stimuli is frequently observed when compared to the left ear[5-18,19-22].

Based on the application of TDS, a slight advantage of the right ear was observed in the binaural binaural integration and separation stage (Figure 1), corroborating the above studies. It is also noteworthy that all subjects had right hand preference, which allows greater inference of left hemispheric dominance for verbal sounds[23].

On the other hand, when comparing the results obtained in the two stages of the test, a tendency of greater variability in the responses in the left ear was observed, as well as improvement in the performance of the individuals (Figure 1 and Table 1), in the retest stage. This aspect may be associated with familiarization with the test (application strategy and stimulus), as well as with the possibility of learning, corroborating the findings reported in the consulted literature[24,25]. In addition, familiarity with the sentences is an aspect that can be considered, since the sentences presented are common everyday situations, which may favor performance in the second evaluation session.

Regarding the correlation analysis, a statistically significant moderate positive correlation was found between the results obtained in the different evaluation sessions (test and retest) for the binaural integration stage of the TDS, both for the right ear (r = 0.420) as for the left ear (r = 0.550) (Table 2). These findings suggest a direct correspondence between the applications of TDS in the binaural integration stage, thus confirming the tendency to improve retest results.

Variations in the results obtained in the left ear in both applications (TABLE 1) may be due to the difficulty in the ability to process verbal information as the linguistic load increases[26], in addition, speech-related stimuli presented in the right ear are typically remembered more accurately than those in the left ear[27]. These factors are the result of left hemispheric dominance for linguistic stimuli, and by crossing the contralateral auditory pathway, it provides lower efficiency in speech recognition when verbal stimuli are presented in the left ear[5-21].

Such performance variation is clearly showed in the analysis of the differences in ears, obtained at the two moments of TDS application, where there is greater stability in the right ear scores when compared to those of the left ear in the binaural integration stage (Figure 2).

In the binaural separation stage, there was greater stability in responses when comparing the results obtained in the test and retest, and the slight variation occurred in the left ear, but without statistical significance, with a tendency for better performance in the retest. (Figure 3). The performance observed in the separation stage in this study corroborates the findings of the literature[7-18], since the variability is lower when compared to the integration stage.

Based on these findings, it was evident that the expected response pattern between the right and left ears differed in the binaural integration stage, in which there is a tendency for greater stability in the right ear responses, once in the second evaluation session, 63% of individuals had the same results, 27.77% had better scores, and only 8.33% had worse responses, while in the left ear, 58% had better performance in the second evaluation session, 36% had the same results, and only 5.55% got worse.

Thus, it can be inferred that an improvement in the performance in the second evaluation session, more evident in the left ear, of 10%, is expected. Thus, it is suggested that the evaluator consider these aspects in the final interpretation of the results obtained to determine the diagnosis, emphasizing that it should be analyzed together with the other tests, as well as with the environmental and individual conditions, to determine if in some cases there is a need to reapply the test in another evaluation session, thus avoiding false negative results.

Therefore, considering the findings of this study and because it is a new auditory processing test, in order to minimize the effects that generate variability, highlights the importance of the professional being aware of inter and intra-subject aspects that may influence individual performance during the evaluation session. It is noteworthy that, because it is a competitive listening test (dichotic), with high linguistic load, if the intra-subject factors are not considered, can lead to misdiagnosis, which compromises the conduct and has serious consequences for the patient. In addition, the conditions of the test environment should also be closely monitored to avoid any interference that may compromise patient performance.

Based on the application of the instrument to this study, we found that aspects of motivational character, stress, physical and mental tiredness, hunger, insecurity (due to lack of knowledge of the test), among others, may contribute to performance variation of some individuals at different times of application. During the evaluations it was observed that in some cases, the attentional factor was responsible for the occurrence of minor errors (such as omission or substitution of a single sentence word) which, in turn, contributes to the difference in performance between ears in dichotic listening activities[26] and, consequently, increased variability of findings.

The patient's response pattern should also be considered, as the alternation of the strategy for the tasks performed by the subject may cause variation in the response pattern, especially in the integration task. For example, if in the first evaluation session, the individual started repeating the ear sentence with less difficulty first, and in the second evaluation started with the most difficult one, there may be greater difference between the results obtained in the different sessions.

It is believed that the limitations of the study are related to the difficulty to control all environmental and individual conditions and may interfere with the results of a behavioral test, when it needs to be applied in different evaluation sessions, with a considerable time interval.

CONCLUSION

The analysis of the variability of the measures with the TDS applied to normal hearing adults, in different evaluation sessions (test and retest) showed a tendency for better scores in the second evaluation session, both in the binaural integration stage and in the binaural separation, but with a statistically significant difference only between the measures obtained in the left ear integration task. It was also observed a moderate positive correlation between the measures obtained in the two evaluation sessions in this task.

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Authors contributions

GCF carried out the study design, collection, analysis and interpretation of results, writing and reviewing the article; MJC carried out the study design, analysis and interpretation of results, writing and revising the article, and final approval of the version to be published.