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Original articles

Time-compressed speech test: adaptation and validation

Teste de fala comprimida: adaptação e validação

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ABSTRACT

Purpose: to adapt the Time-Compressed Speech Test and verify the applicability of the new test, correlating it with the original.

Methods: the adaptation of Time-Compressed Speech Test was possible through the criterion of phonetic balance. It was used an editing software called Free Audio Editor to cut the words from the original test and generate the new file. From fifty words already presented in the original test, twenty-five were preserved in the new test. For the validation, were evaluated 73 subjects aged from 16 to 30 years-old, who performed the procedures of Hearing Anamnesis and of Auditory Processing, Visual Inspection of the External Acoustic Canal, Pure Tone Audiometry, Speech Audiometry, Acoustic Immittance Measurement, Diotic Testing, original Time-Compressed Speech Test and adapted Time-Compressed Speech Test.

Results: a new list of 25 two-syllable words was created. There were differences between the number of errors and the percentages of correct answers by ear, between the original and the adapted Time-Compressed Speech Test. The strength correlation between the tests was moderate, thus the reference values of the original test could not be used in the adapted instrument.

Conclusion: it was possible to adapt the Time-Compressed Speech Test observing a moderate correlation between both tests and verify the applicability of the Adapted Time-Compressed Speech Test. Therefore, the adapted test needs new reference values, in other words, normality criteria are required.

Keywords: Hearing; Hearing Tests; Speech Discrimination Test; Validity of Tests; Auditory Perception

RESUMO

Objetivos: adaptar o Teste de Fala Comprimida e verificar a aplicabilidade do novo teste, correlacionando-o com o original.

Métodos: a adaptação do Teste de Fala Comprimida se deu por meio de critério de balanceamento fonético. Foi utilizado um programa de edição (*Free audio editor*) para recortar as palavras do teste original e gerar um novo arquivo. Mantiveram-se 25 palavras das 50 já existentes no teste original. Para validação foram avaliados 73 indivíduos com faixa etária de 16 a 30 anos, os quais realizaram os procedimentos de Anamnese Audiológica e de Processamento Auditivo, Inspeção Visual do Meato Acústico Externo, Audiometria Tonal Liminar, Logoaudiometria, Medidas de Imitância Acústica, Testes Dióticos, Teste de Fala Comprimida e Teste de Fala Comprimida adaptado.

Resultados: foi gerada a nova lista com 25 palavras dissilábicas. Houve diferença entre o número de erros e entre as porcentagens de acertos por orelha, entre o Teste de Fala Comprimida e o adaptado. A força de correlação entre os testes foi moderada, não podendo assim ser utilizados os valores de referência do teste original no instrumento adaptado.

Conclusão: foi possível adaptar o Teste de Fala Comprimida constatando uma correlação moderada entre os testes, e verificar a aplicabilidade do Teste de Fala Comprimida Adaptado. Sendo assim, o teste adaptado necessita de novos valores de referência, isto é, de critérios de normalidade.

Descritores: Audição; Testes Auditivos; Testes de Discriminação de Fala; Validade dos Testes; Percepção Auditiva

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INTRODUCTION

In order to communicate effectively with someone, it is necessary the integrity of the auditory pathway, in both peripheral and central processing of information, since hearing is the primary means of interaction of the individual with the world[1].

Auditory processing (AP) is the term that is used to describe a sequence of mental operations that the individual performs while dealing with the information that was received via the sense of hearing and that depend on an innate biological capacity, the process of maturation, experiences and stimuli in the acoustic environment[2]. Among these mental operations, there is the ability of auditory closure, which is defined as the process by which the individual must supplement what was heard even not getting all the acoustic features of the words[3].

To evaluate the central auditory nervous system (CANS), it is necessary that the extrinsic redundancy, in relation to the acoustic signal, is reduced so that the intrinsic, which refers to the multiple paths of CANS, might be evaluated[2]. For the evaluation of AP, there is a battery of tests that were created by Pereira and Schochat[3], which are divided according to the application form - diotic, monotic and dichotic – being each one evaluating a gnosis process and specific hearing ability[4].

On the other hand, to evaluate the ability of auditory closure, there is the Speech-in-Noise Test, Binaural Fusion and Time-Compressed Speech Test (TCST). The last one was created in 1972 by Beasley et. al[5] and translated and adapted in 2007 by Rabelo and Schochat[6]. This test is originally comprised of 50 dissyllable words, being applied a list to each ear, which is formed by the same words, but arranged in different orders. During the application of this test, the compression percentage of the words by the listeners is 60%.

Thus, the importance of this study is centered on the need of expanding the application of TCST in normal hearing adults, with the aim of improving the applicability of the test by the evaluator and its execution by the patient. Based on that, this study aimed to adapt TCST and verify the applicability of the proposed material, correlating it with the original TCST.

METHODS

This is a quantitative and transversal study. The procedures for its execution were performed at the audiology ambulatory of a teaching hospital of Rio Grande do Sul state, after the approval by the Research Ethics Committee, under the CAAE number: 25933514.1.0000.5346.

The TCST adaptation occurred through phonetic balancing criteria, which was attended by an experienced professional in the linguistics area. Thus, the phonetic segments were distributed in the different positions of syllables and words: simple and complex onset in initial and medial positions, with plosive, fricative, nasal and liquid phonemes, in addition to coda in the medial and final positions. TCST originally consists of two lists of 50 two-syllable words, being applied one list for each ear, with the same words, but distributed differently. In order to make the adaptation, new words were not created. So, we decided to select a total of 25 words among the lexical items already present on the original instrument. From this, two lists with the same 25 words, but with different order in each list, were created. One of the advantage to adapt TCST consists in improving its applicability by decreasing the time of application.

To perform this adaptation, we used a software named Free Audio Editor, version 2013, maintaining the same speaker of the words of the original test. The editing occurred as follows: the selected words were cut and randomly numbered from one to 25, and interstimulus interval of four seconds was maintained as the original test.

In the validation stage of the adapted test, only subjects aged from 16 to 30 years were included, with hearing thresholds within normal ranges in all frequencies, with tympanometric curve type A and acoustic reflex collaterals present in both ears. In addition, they should present sound localization skills and verbal and nonverbal sequential memory within the normality level.

Thus, individuals who agreed to participate in this research signed the Informed Consent Form (ICF) and then passed through the following procedures: audiological and auditory processing, visual inspection of the external auditory canal, pure tone audiometry, speech audiometry, tympanometry, investigation of contralateral acoustic reflexes, sound localization test, test for verbal and non-verbal memory, as well as original and adapted TCST. These procedures lasted approximately one hour.

From a total of 85 evaluated individuals, 12 were excluded due to change in one of the sound localization skills or verbal or non-verbal sequential memory, so

that only 73 subjects were included in the study. People whose results indicated in the original TCST changes remained in the survey in order to verify the correlation with the adapted TCST.

After that, the data were tabulated in Excel spreadsheet. For the statistical analysis of this research, we used the Spearman correlation coefficient test, and the significance level for the statistical tests was 5% ($P < 0.05$).

RESULTS

In order to demonstrate the test adaptation, the results at first will be presented with the new list of disyllabic words which were proposed for the adapted TCST (Figure 1).

	Intensity of speech RE:	**Intensity of speech LE:**
	List – 01 (60%)	**List – 02 (60%)**
01	DISCO	BLUSA
02	JARRA	DISCO
03	PAGO	BRANCO
04	RODA	PAGO
05	BRILHO	FAROL
06	NADA	RODA
07	LINHA	CALHA
08	CAMPO	BRILHO
09	BRAÇO	MANHÃ
10	NUVEM	NADA
11	ZELO	NARIZ
12	TELA	LINHA
13	GOTA	ZEBRA
14	CHEIO	CAMPO
15	SANTO	VALSA
16	VALSA	BRAÇO
17	ZEBRA	SANTO
18	GEMA	NUVEM
19	NARIZ	CHEIO
20	MANHÃ	ZELO
21	CALHA	GOTA
22	FAROL	JARRA
23	BRANCO	FLAUTA
24	BLUSA	TELA
25	FLAUTA	GEMA
	Correct answers RE: RE: % of correct answers	Correct answers LE: LE: % of correct answers

Figure 1. List of words of the adapted time-compressed speech test

For the validation stage, the relationship between the values was analyzed (number of errors and percentage of correct answers) of the original and adapted TCST in each ear (Table 1).

It was possible to observe (Table 2) the correlation between the two tests with moderate value in the correlation range. This correlation shows that it is not possible to use the reference values of the original TCST to adapted TCST, since the forces of correlation between the test is not strong.

It was also possible to observe the dispersion of the points in the graphic, when comparing the two tests (Figure 2). There are errors and distant percentages, which does not allow that the values of the adapted TCST could be used based on the values of the original TCST.

Table 1. Descriptive analysis of numerical variables in relation to errors and percentage of correct answers per ear

VARIABLE	N	MEAN	S.D.	MIN	Q1	MEDIAN	Q3	MAX
AGE	73	21.05	2.87	16.00	19.00	20.00	23.00	30.00
CS Error RE	73	6.85	4.06	0.00	3.00	7.00	10.00	17.00
CSP % RE	73	86.47	8.03	66.00	80.00	86.00	94.00	100.00
CS Error LE	73	5.58	3.33	0.00	3.00	5.00	8.00	16.00
CSP % LE	73	89.07	6.21	72.00	84.00	90.00	94.00	100.00
ASP Error RE	73	1.97	1.69	0.00	1.00	2.00	3.00	7.00
ASPP % RE	73	92.11	6.77	72.00	88.00	92.00	96.00	100.00
ASP Error LE	73	1.90	2.11	0.00	0.00	1.00	3.00	14.00
ASPP % LE	73	92.66	7.06	64.00	88.00	96.00	100.00	100.00

Caption: N: number of subjects; SD: standard deviation; Q1: Quartile 1; Q3: Quartile 3; CS: Compressed speech; CSP: Compressed Speech Porcentage; RE: Right Ear; LE: Left Ear; ASP: Adapted Compressed Speech; ASPP: Adapted Compressed Speech Porcentage.
Spearman correlation coefficient test.

Table 2. Correlations between original time-compressed speech test and adapted time-compressed speech test by ear

	CS Error RE	CS Porc RE	CS Error LE	CS Porc LE
CompSpeechAErrorRE	r=0.69316 p= <.0001			
CompSpeechAPorcRE		r= 0.69756 p<.0001		
CompSpeechAErrorLE			r=0.59177 p<.0001	
CompSpeechAPorcLE				r=0.59468 p<.0001

Caption: CS: Compressed Speech; A: Adapted; Porc: Porcentage; RE: Right Ear; LE: Left Ear, r= Spearman correlation coefficient, p = value.

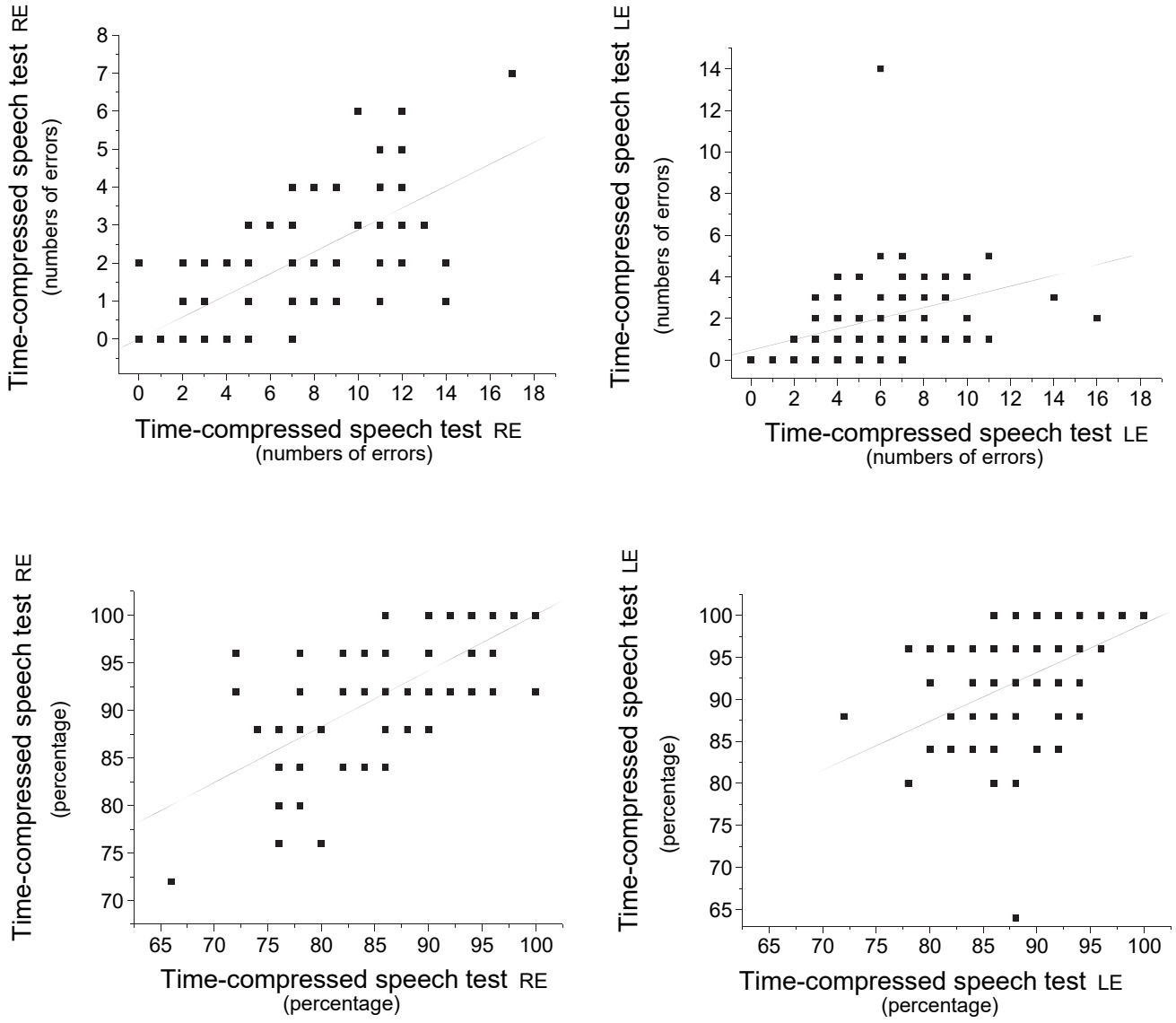

Figure 2. Scatterplots: numbers of errors per ear and percentage of correct answers per ear

DISCUSSION

This study was motivated by the problems related to the use of TCST in clinical practice, including the fatigue of the patients and the difficulty of maintaining sustained attention throughout the test execution. With this in view, in order to make the test adaptation (Figure 1), the original list of words was reduced in half of the total list through the phonetic balancing criteria of the words, as already mentioned.

This criterion was also used by a study[7] that performed the translation and adaptation of the Screening Test for Auditory Processing Disorders (SCAN) to Brazilian Portuguese for the development of an Auditory Processing Screening battery that could be applied to students. So, the author held a phonetic balancing of word lists, with subsequent studio recording. The SCAN adapted to the Portuguese was applied in 60 children with normal development and in ten children with diagnosis for Auditory Processing Disorder in the Auditory Processing Screening Battery. It was verified that SCAN was sensitive for evaluating students from six to 11 years old.

In this study, as already verified[1], the linguistic material of a test, for evaluating the central auditory pathways, should not offer another difficulty, in addition to the intrinsic and extrinsic ones, for the recognition of the speech signal. Then, the phonetic balancing was performed so that the phonemes would be distributed according to their frequency in the language.

Another study[8] carried out the translation and adaptation of Dislexya Early Screening Test (DEST-2) in order to proceed to the early identification of language

and learning disorders, being verified its applicability and effectiveness in preschool native speakers of Brazilian Portuguese. The study included 120 children aged from four years and six months to six years and five months, from both genders, distributed according to the age classification age of the test. From these children, 20 were part of the control group, and 100 were part of the experimental group. It was found that there were no significant changes in the original test structure and that DEST-2 may be able to identify changes in language development process in speakers of Brazilian Portuguese. However, our study found some differences in comparison to this study, since there were significant changes in the original test structure when it was reduced. It is important to note that this procedure occurred because TCST was already written in Portuguese and the original words were appropriate to the context of the patients (common words). However, it was considered necessary to reduce the list of words, due to the time that such extent occasioned regarding the application of the original version.

In a literature review[9] about systematic and formal evaluation tools of language in the process of adaptation and validation of tools, the authors referred to the Test of Early Language Development: Third Edition (TELD-3), which is applicable in children from two years to seven years and 11 months. This test was translated and adapted to Brazilian Portuguese, without facing major cultural or language problems, demonstrating that their application is valid for the diagnostic process, as in monitoring the clinical course in cases of communication disorders. In this research, it was observed that the adapted TCST is as sensitive as the original TCST, but it needs some reference values.

As observed in Table 1, the mean age of the study sample was 21 years, which is similar to other recent studies[10,11] which used young adults in their samples to evaluate AP. One of the criteria for the choice of subjects in this study was the age that could range from 16 to 30 years. According to the literature[12], hearing tests are dependent on the neural function and they must be interpreted within a neuromaturational context. Thus, young adults were selected in order to avoid the influence of age on the results of AP behavioral evaluation, since tests are influenced by the maturation process and degeneration of the central auditory pathways[13].

According to Table 1, it is also possible to observe that there was no difference between the two tests as the mean number of errors and the percentage of correct answers for each ear, since the original TCST presented a higher number of errors and consequently the adapted TCST obtained the highest percentage of correct answers. This result might be explained by the possible effect of learning, due to the fact that the presented words were always the same. The author of the TCST written in Portuguese[6], for producing it, performed its application in 144 normal-hearing young subjects by using a list of words with compression of 50, 60 and 70% and it found that, as the list was exposed in ascending order compression, the subject of the research was subjected to a workout. This fact favored its performance due to the learning of the task, which directed the participant to achieve a higher score in the word list with the highest compression.

In another study[14], the authors adapted the Clinical Evaluation of Language Functions - 4th Edition (CELF 4) for the Brazilian linguistic reality. The results showed that it was possible to apply the translated version in Brazilian children, without the need for significant modifications in the number of items in the test. In our study, the results differ from the ones found in this research, since it is believed that TCST needed to be adjusted depending on the time required for application of the original test and consequently the propensity to error due to the difficulty in maintaining the sustained attention.

By correlating the original TCST and the adapted TCST (Table 2), it can be noticed that there was a correlation between the two tests, with moderate value. This correlation shows that it is not possible to use the reference values of the original TCST to the adapted TCST, since the correlation of forces between the test is not strong. The fact that the adapted test is shorter may have provided some level of easiness for the execution to the subjects, as well as a learning effect, since we first applied the original TCST and then we applied the adapted TCST. Thus, the percentage of correct answers on the adapted TCST was higher, which decreased the correlation of forces between the test results.

A study[15] aimed to verify the performance of children exposed to lead and to investigate whether there is a correlation between the level of lead in the blood and the performance on AP tests. 90 children who were exposed to an above permitted level of lead particles participated in this study. As the result of Spearman correlation test, there was no significant difference between the level of lead and the results of the Auditory Fusion Test Revised (AFT-R), subtest 1 and dichotic listening test (binaural integration stage). This study

showed distinct results from the ones mentioned above, since there was a moderate correlation between the test results (original and adapted).

In another research[16], 48 patients with complains of tinnitus were subjected to audiometric tests and to Minimum masking level (MML), Tinnitus Handicap Inventory (THI) and Beck Depression Inventory (BDI) questionnaires. In this research, the aim was to evaluate the correlation between the intensity which the patient perceived tinnitus with the loss caused by it, as well as to verify if the correlation between MML, THI and BDI questionnaires would have any interference from depression. There was no significant correlation between the psychoacoustic measurements of tinnitus, the audiometric thresholds and the evaluation questionnaires. The findings of this study differ from the ones mentioned above, because the correlation was significant when comparing the results of the correct answers from the original TCST and adapted TCST.

In Figure 2, it is possible to observe on the scatterplot that there are errors and distant percentages, confirming that values of the adapted TCST cannot be used based on the values of the original TCST. Thus, it is recommended to continue this study, applying the reference values of the adapted test for different ages and degrees of hearing loss. Another possibility is to generate a new list to be used in speech therapy, since it is not possible to use the original list of TCST for auditory training because it is a test that makes part of the AP evaluation battery.

CONCLUSION

Based on the information which was exposed in this article, it is possible to conclude that it was possible to adapt TCST by verifying a moderate correlation between the tests and also to verify the applicability of ATCST. Thus, the adapted test needs new reference values, in other words, other criteria of normality.

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