Preparation and applicability of a test of speech perception with pictures

Construção e aplicabilidade de um teste de percepção de fala com figuras

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ABSTRACT

Purpose: To prepare and apply support material for responses to the Speech Recognition Percentage Index (SRPI) test in children. **Methods:** This is a descriptive, exploratory study conducted in two phases: in the first phase, 31 speech-language pathologists (referees) prepared material composed of regular, frequently used monosyllabic and disyllabic words belonging to the vocabulary of children and figures that could represent these words; the second phase consisted in the application of this material to 30 normal-hearing children aged 2 to 4 years and 11 months. **Results:** The material consisted of 25 words and six boards with six figures each. The word selection criterion adopted by the referees included the initial phoneme and real, colorful figures familiar to the children. The mean scores of the children in the SRPI test were 93% (SD ± 8%) with the support of figures and 64% (SD ± 25%) without figure support. Comparison between the results obtained with and without the support of figures showed significant difference for 15 of the 25 test words, with higher scores with the use of supporting figures. Comparison between correct and incorrect responses using the support of figures showed significant difference only for the word "dog" ("*cão*") (*p*=0.0079). **Conclusion:** There was agreement among the referees with respect to the words and figures. The SRPI test can be rapidly and easily applied, allowing evaluation and systematic monitoring of speech perception ability regardless of child verbalization capacity.

RESUMO

Objetivo: construir e aplicar um material de apoio para respostas ao teste do índice percentual de reconhecimento de fala em crianças. **Método:** estudo descritivo exploratório. A primeira etapa, elaboração de um material, foi realizada pela avaliação de 31 fonoaudiólogos (juízes), com palavras monossílabas e dissílabas, regulares e frequentes, que pertencem ao vocabulário das crianças e figuras que pudessem representar essas palavras. A segunda etapa constituiu-se da aplicabilidade do material em 30 crianças na faixa etária de 2 a 4 anos e 11 meses, com audição normal. **Resultados:** o material foi constituído por 25 palavras e seis pranchas com seis figuras. As palavras selecionadas pelos fonoaudiólogos tiveram como critério o fonema inicial e figuras reais, coloridas e próximas do cotidiano das crianças. A média de acertos apresentada pelas crianças no índice percentual de reconhecimento de fala com apoio das figuras foi de 93% (± 8% desvio padrão) e sem, de 64% (± 25% desvio padrão). Ao comparar os resultados obtidos com e sem o apoio das figuras, observou-se diferença significativa para 15 das 25 palavras do teste, sendo maior o número de acertos quando se utilizou com apoio de figuras. Na comparação entre os acertos e erros obtidos no teste, utilizando as figuras como apoio, houve diferença significativa apenas para a palavra "cão" (p=0,0079). **Conclusão:** houve concordância entre os juízes em relação às palavras e figuras; a aplicação foi rápida e fácil, possibilitando a avaliação e o monitoramento sistematizado da habilidade de percepção de fala independentemente da capacidade de verbalização da criança.

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INTRODUCTION

Basic audiological assessment comprises pure-tone threshold audiometry and speech perception tests that evaluate since the ability of individuals to perceive sound with minimal intensity (Voice Detection Threshold - VDT and Speech Reception Threshold - SRT) to the ability of recognizing words (Speech Recognition Percentage Index - SRPI), expressed in percentage of correct responses to words. Word recognition tests are of great importance in audiological diagnostics. To ensure efficiency, the hearing assessment of an individual should not be restricted to the ability to perceive pure tones, as in pure-tone audiometry, because speech recognition cannot be presumed by pure-tone thresholds, which makes logoaudiometry (speech discrimination) an essential clinical tool[1].

Speech recognition tests commonly use the verbal responses given by individuals to infer auditory input; however, when used with small children or individuals who do not master the oral code, this procedure hinders the interpretation of responses, because these children use phonological processes to simplify their speech, or simply cannot verbalize.

Phonological processes are used to simplify the phonological rules involving sequences of sounds in the pronunciation of words to approach their correct pronunciation[1,2]. When present, phonological processes hamper the interpretation of the results of speech perception tests, considering that these tests require correct production of sounds for scoring, preventing examiners from distinguishing whether the child auditorily recognizes or not the word and/or phoneme being assessed.

In clinical practice, during the application of audiological tests, most professionals perform the SRPI test in children under 5 years of age, and often find difficulties related to test application because the process of acquisition of phonemes occurs in this age range. In this situation, results obtained without graphic support often do not correspond to the actual auditory speech recognition ability of this population. The lack of standardized figures also hinders the systematization of results and, consequently, the monitoring of child auditory perception development, especially in the presence of speech and/or hearing disorders.

The national literature describes speech perception tests with the use of words and sentences[3-5], but does not report graphic material with figures to conduct the SRPI test in children. The international literature presents studies on speech perception tests that consider the difficulty in the choice of vocabulary and form of test presentation[6,7].

The preparation of a speech perception assessment tool should consider whether the words and/or figures are known by the children in order to ensure that they understand and recognize the figure being used, thus preventing them from pointing any figure because they ignore it, interfering with the evaluation results and producing distortions in the interpretation of these data.

The objective of this study was to prepare and verify the applicability of support material using figures for responses to the SRPI test in children according to gender and age.

METHODS

The present study was approved by the Research Ethics Committee of the institution where it was conducted - a hospital of high complexity care in the state of Sao Paulo - under protocol no. 600/2014.

All parents/guardians of the participating children and the speech-language pathologists were informed about the study objectives and agreed to participate by signing an Informed Consent Form (ICF) and a Child Assent Form (CAF) when necessary.

The study was designed in two phases: the first phase comprised the instrument development through careful analysis of the words and figures to be used in the Speech Recognition Percentage Index (SRPI) test - the material was evaluated by a panel of referees, 31 speech-language pathologists with expertise and clinical experience in the theme area; the second phase consisted in the instrument application to 30 normal-hearing children without complaints of changes in language acquisition and/or development.

Preparation of the instrument

In the first phase of this research, monosyllabic and disyllabic words were searched in articles from the specific literature[3-4]. These words were selected based on the following criteria: 1) being able to be represented graphically; 2) belong to the children's vocabulary, avoiding unfamiliar words and incoherent figures; and 3) occurrence of Brazilian Portuguese consonant and vowel phonemes in syllable onset regardless of the syllabic and stress patterns, considering that the purpose of the study was to evaluate whether the children perceived the sounds of the Portuguese language auditorily, and not to assess the speech performance of these individuals, limiting the number of words to 25, which corresponds to the number used in well-known speech recognition tests.

Ninety words were selected, but only 65 were in accordance with the three adopted criteria and were, therefore, included in the study.

The survey of figures that could represent the words chosen was conducted through Google search engine at public domain websites Pixabay[8] and Shutterstock[9].

After selection of the words and figures to compose the material, a first version of the instrument was created with at least one word of regular use (phoneme-grapheme correspondence) and more frequently used words, according to the referees' perception, and their respective figures - four for each word: two figures with real representation of the word (Figure 1A, B) and two with drawing representation (Figure 1C, D).

After preparation of the material and with the objective of selecting the words and figures, 31 speech-language pathologists were invited to conduct an assessment of the first version of the instrument. After acceptance, the professionals signed the ICF. All therapists worked in public health services of medium and high complexity and had clinical experience. The time of clinical experience ranged from 3 to 32 years, with mean of 13.6 and median of 17.5 years, with higher concentration in the
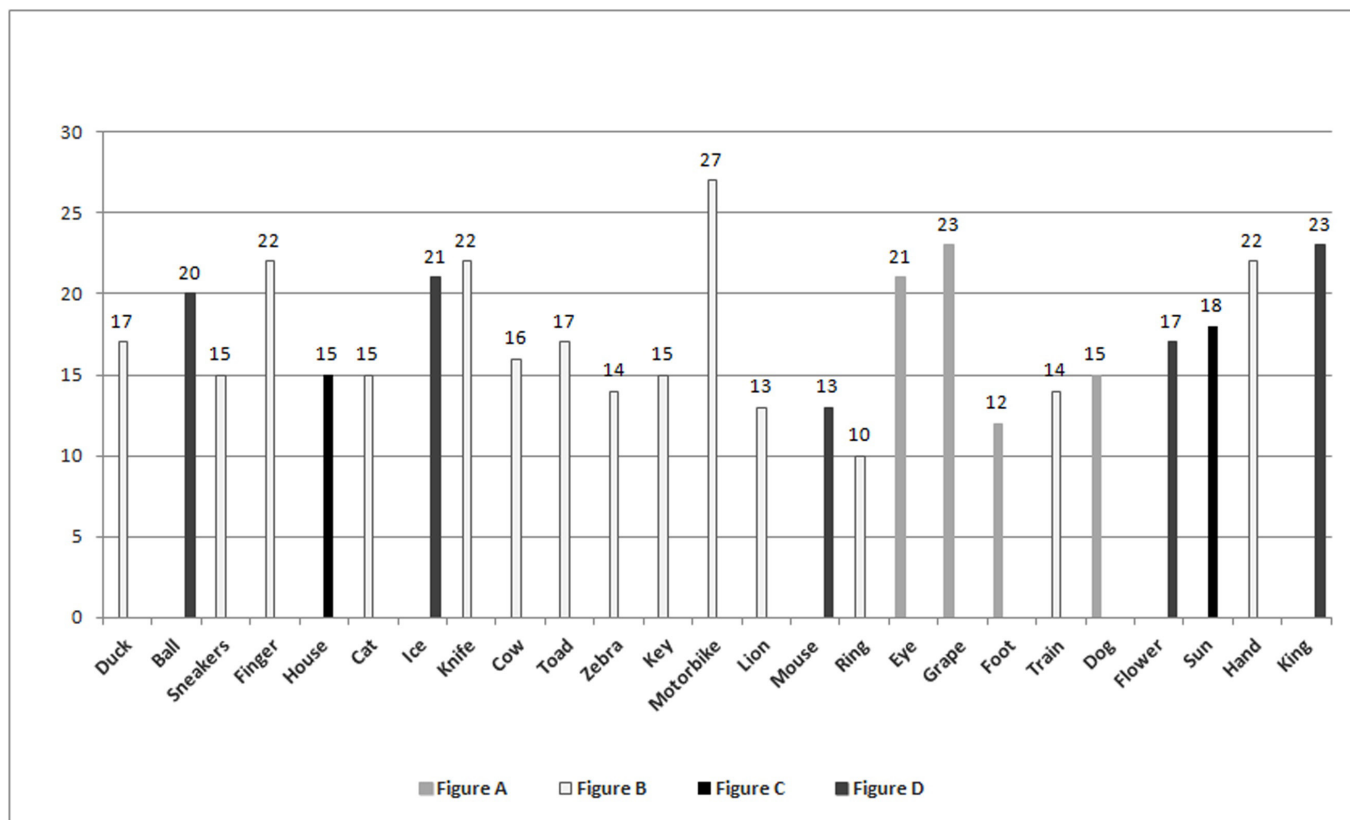
Figure 1. Distribution of the words most selected by the Speech-language Pathologists according to the options presented: real figures (A, B) and drawn figures (C, D)

group with ≥20 years of experience (39%), followed by ten to 20 years (11.35%), and three to nine years (8.26%).

The referees had at least a degree in graduate studies; therefore, all of them had already attended a specialization, improvement, or development course and 71% had a *strict sensu* degree (master's and/or doctorate). Most of them worked in the area of Audiology (15%), followed by Language (10%), Oropharyngeal Dysphagia (4%), Orofacial Motricity (5%), Public Health (3%), Voice (3%), and Stuttering (2%). Most of these speech-language pathologists worked preferably with children (26%).

By means of a questionnaire divided into three situations: identification, evaluation of the list of words, and assessment of the list of figures, the referees were requested choose from the "list of monosyllabic and disyllabic words" those they considered appropriate for the material and the figure that best represented the selected word from the boards containing four figures. The researchers did not mention any criterion of choice and did not demand an exact number of words, aiming to identify, spontaneously, the most common choice for both the words and the figures.

To quantify the degree of agreement among the speech-language pathologists during the revaluation process of the produced material, the percentage of agreement was used adopting values higher than 85%[10].

Based on the evaluation performed by the speech-language pathologists (referees), the study researchers prepared the second

version of the material, which was composed of 25 words with their corresponding figures.

All real and/or drawing figures with percentage of agreement higher than 85% were maintained, whereas those with an index lower than 85% were replaced following the suggestions of the participating referees. Finally, the boards were defined, one for training and five for the test, all containing six figures for the test, totaling 30 figures, 25 spoken and five (one on each board) not spoken, to ensure that identification would not occur by exclusion.

After performing the modifications suggested by the referees and considering each item (figure/word), the second version of the test (25 items) was developed, which was applied to a sample of 30 children under 5 years old (Figure 2).

Applicability of the instrument

In the second phase of the research, in order to improve the material prepared for the test, we applied it to a group of normal-hearing children aged 2 to 4 years and 11 months with no complaints of alterations in language acquisition and/or development. The children were approached in their family environment, by the contact of the researchers, and through spontaneous demand at the audiology clinic of the institution where this study was conducted.

Considering that in this age range variation regarding the acquisition of phonemes[11] may be observed, study participants
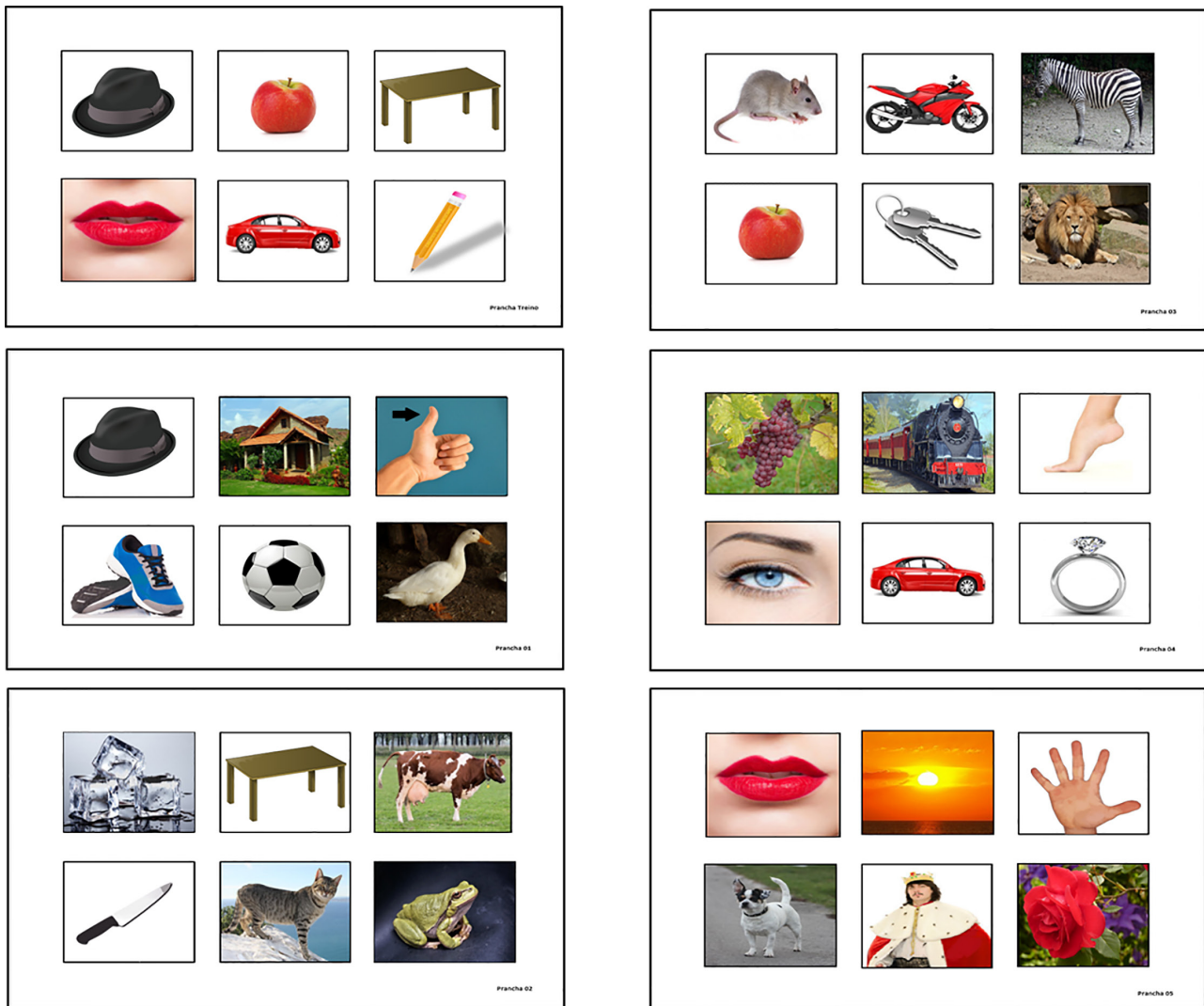
Figure 2. Board with figures for the Speech Recognition Percentage Index (SRPI) test

were divided into three age groups for analysis: children aged 2 to 2 years and 11 months, 3 to 3 years and 11 months, and 4 to 4 years and 11 months.

This phase was composed of the following procedures: free-field ludic audiometry of all individuals in the frequencies of 500, 1K, 2K, and 4K Hz. Subsequently, the Speech Recognition Percentage Index (SRPI) test was conducted with the prepared material in an acoustically-treated room, speakerphone, 60 dBHL, under free-field system. Aiming to control the acoustic signal at a specific point in space, a working distance of 60 cm between the chair and the speaker was established in this study. We also controlled the azimuth angle, which was fixed at 0° for binaural sound stimulation, and the elevation angle of the incident sound for each participant as a procedure for conducting measurements in free field, considering that the participants were normal-hearing individuals.

An AC40, Interacoustics®, audiometer was used to record the measures. In this phase, the children were told that they would hear several words and should point to the corresponding figures. To conduct the auditory recognition of words by means

of identification of their corresponding figures, boards containing six figures each were provided, in which children should identify the figure that corresponded to the word spoken by the examiner. For this procedure, a second examiner, inside the cabin, changed the boards according to the presentation of the words.

Initially, a training session was conducted with a list of six words (Figure 2 - Training Board), so that the child could understand the test strategy and had no difficulty regarding the stimulus or the type of response required during the procedure.

The same list of words was applied under the same conditions previously presented, but without the support of figures. Thus the children were verbally instructed that they would hear several words and should repeat them one by one. During this procedure, a second examiner annotated the children's responses on a registration form, and used a voice recorder as an aid for further analysis and comparison of the phonation of words. Once the data were collected and recorded, the phonetic transcription and analysis of the observed phonological processes were conducted, allowing the researchers to identify the particularity of each

child with respect to the incorrect responses given in the SRPI test, without the support of figures.

In both procedures, the examiner applied the complete list of words, without the use of repetitions and pauses between the phonemes. Introductory phrases were used during both procedures. For the presentation of the list of figures, the introductory sentence "Point to the _____" was used, whereas for the list of words the sentence "Repeat the word _____" was used. For both procedures, shields were used to prevent lip reading, as in the conventional SRPI test.

To meet the proposed objectives, the following statistical analyses were conducted: the Student's t-test was used for independent samples, the Pearson's correlation coefficient was used to quantify the correlation between two quantitative variables, and the Fisher's exact test was applied to verify the association between gender and responses (figures or list, for each word). All analyses were performed using the SAS® 9.2 software program at 5% statistical significance level.

The two-way ANOVA test was used to compare the application time of the SRPI test with and without figures at the different age ranges.

RESULTS

The results of the present study are presented in two phases: development of the instrument and test application.

Development of the instrument

Table 1 shows the 25 most selected words and the number of speech-language pathologists (referees) that chose them. The list of words for the Speech Recognition Percentage Index (SRPI) test was prepared based on this information.

The referees showed preference for real, colorful figures that belonged to the participants' daily lives, as it can be observed in Figure 1.

Preference was shown for the figures of groups A and B; consequently, of the figures selected by the referees, 68% were "real" and only 32% were "drawing" (C and D). Hence, we tried to standardize the figures and choose the most selected among the real ones, so that all figures presented the same standard, "real" or "drawing"; the figures representing ball, house, ice, mouse, train, sun and king, preferably chosen in the drawing format, were replaced with the most selected figures among the real ones.

Of the 25 final figures, which were substituted by public domain images, four (16%) were replaced again because figures with index of agreement lower than 85% were considered inadequate to compose the final material (Figure 3).

In addition to these four figures deemed inadequate (index of agreement <85%), six other figures were selected, all from public domain websites, and reevaluated by the referees to compose the training board. The criterion used for selecting these last six figures was the number of choices made by the referees, that is, the most selected ones.

Thus six boards were prepared, namely, Training Board, Boards 1, 2, 3, 4 and 5 (Figure 2). For each board with six figures, one of them, randomly positioned, was not spoken by

the examiner to prevent the child from identifying one of the figures by exclusion, thus compromising the test reliability. Those same figures/words that were not spoken during the test were used in the training board prior to the beginning of the assessment, ensuring that the child understood the test strategy.

Test application

All participants underwent ludic Pure-tone Threshold Audiometry in free field. After confirmation of auditory thresholds within the normal range, the SRPI test was conducted with and without the support of figures, according to the previously described criteria.

The children's ages ranged from 2 years and 1 month to 4 years and 11 months: 8 (26.66%) children aged 2 to 2 years and 11 months, 12 (40%) aged 3 years to 3 years 11 months, and 10 (33.33%) aged 4 to 4 years and 11 months. With respect to gender, most volunteers were boys (60%; n=18), whereas girls represented 40% (n=12) of the study sample.

With regard to mean application time, the whole procedure, with and without the support of figures, was conducted in 5.23 min for the 2-year-old group of children, 3.81 min for the 3-year-old group, and 3.59 min for the 4-year-old group. The SRPI test with the support of figures was applied with mean time of 3.42 min to the 2-year-old group of children, 2.50 min to the 3-year-old group, and 2.25 min to the 4-year-old group. The SRPI test without the support of figures was

Table 1. Distribution of the most selected words, by phonemes, and the number of audiologists that have chosen them (n=31)

Phoneme	Word	No. of selections
/p/	Pato - Duck	22
/b/	Bola - Ball	26
/t/	Tênis-Sneakers	16
/d/	Dedo - Finger	24
/k/	Casa - House	24
/g/	Gato - Cat	26
/ʒ/	Gelo - Ice	10
/f/	Faca - Knife	26
/v/	Vaca - Cow	25
/s/	Sapo - Toad	24
/z/	Zebra - Zebra	18
/ʃ/	Chave - Key	18
/m/	Moto-Motorbike	16
/l/	Leão - Lion	20
/r/	Rato - Mouse	27
/a/	Anel - Ring	14
/o/	Olho - Eye	25
/u/	Uva - Grape	22
/p/	Pé - Foot	26
/tr/	Trem - Train	22
/k/	Cão - Dog	24
/fl/	Flor - Flower	26
/s/	Sol - Sun	26
/m/	Mão - Hand	25
/r/	Rei - King	15

Caption: nº = number

applied with mean time of 1.81 min to the 2-year-old group of children, 1.31 min to the 3-year-old group, and 1.34 min to the 4-year-old group (Table 2).

Comparison of the application times of the SRPI test with the support of figures among the three age groups investigated showed statistically significant difference between the 2-year-old participants and the other two age groups (p=0.0360 between the 2 and 3-year-old groups; p=0.0138 between the 2 and 4-year-old groups). No statistically significant difference was

observed regarding the application times of the SRPI test without the support of figures among the three age groups analyzed. Comparing the application times of the SRPI test with and without the support of figures among the three age groups studied, the following statistical differences were identified: p=0.0015 for the 2-year-olds, p=0.005 for the 3-year-olds, and p=0.0085 for the 4 year-olds (Table 2).

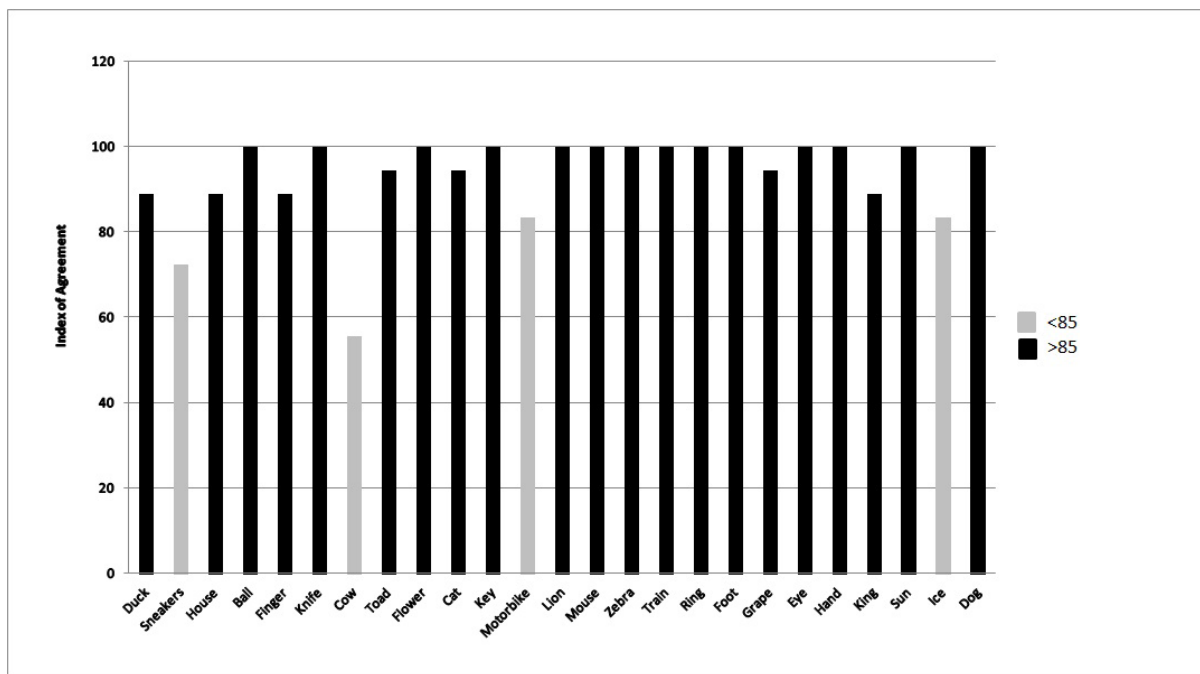Association between the number of incorrect responses during the application of the SRPI test with and without the

Figure 3. Statement of the index of agreement of the Audiologists' choices of figures/words

Table 2. Comparison between the application time of the Speech Recognition Percentage Index (SRPI) test, with and without the support of figures, for the three age groups assessed

Comparison	Mean (min)	Estimated difference	p value in the two-way ANOVA test	L.L.	U.L.
Groups in the 2-3-year age range - application of the SRPI **with** the support of Figures	3.42	0.9343	0.0360*	0.06750	1.8010
Groups in the 2-4-year age range - application of the SRPI **with** the support of Figures	2.50	1.1633	0.0138*	0.2661	2.0604
Groups in the 3-4-year age range - application of the SRPI **with** the support of Figures	2.25	0.2290	0.4990	–0.4665	0.9245
Groups in the 2-3-year age range - application of the SRPI **without** the support of Figures	1.81	0.5009	0.2012	–0.2909	1.2927
Groups in the 2-4-year age range - application of the SRPI **without** the support of Figures	1.31	0.4656	0.2487	–0.3533	1.2844
Groups in the 3-4-year age range - application of the SRPI **without** the support of Figures	1.34	–0.03535	0.9119	–0.6952	0.6245
Application time of the SRPI with and without the support of Figures - 2 years to 2 years and 11 months old	-	1.6217	0.0015*	0.7082	2.5352
Application time of the SRPI with and without the support of Figures - 3 years to 3 years and 11 months old	-	1.1883	0.0005*	0.5962	1.7805
Application time of the SRPI with and without the support of Figures - 4 years to 4 years and 11 months old	-	0.9239	0.0085*	0.2649	1.5830

*Statistically significant ($p < 0.05$)
Caption: SRPI = Speech Recognition Percentage Index; L.L. = Lower Limit; min = minutes; U.L. = Upper Limit

support of figures showed statistically significant difference for 15 of the 25 words, with higher number of correct responses when the test was conducted with the support of figures, as shown in Table 3.

When the SRPI test was applied with the support of figures, the number of incorrect responses varied according to age, with children aged 2 to 2 years and 11 months presenting 23 incorrect responses. Children aged 3 to 3 years and 11 months presented 26 incorrect responses, whereas those aged 4 to 4 years and 11 months presented only five incorrect responses, most of them related to the identification of the following figures: ice, knife, zebra, dog, and king (Table 4).

Table 3. Correlation between correct and incorrect responses in the Speech Recognition Percentage Index (SRPI) test with and without the support of figures

Words	Correct		Incorrect		Correct responses × Incorrect responses Fisher's exact test p value
	Figure	List	Figure	List	
Pato-Duck	30 100%	29 96.66%	0 0%	1 3.33	1.0000
Bola-Ball	30 100%	23 76.66%	0 0%	7 23.33%	0.0105*
Tênis-Sneakers	29 96.66%	22 73.33%	1 3.33%	8 26.66%	0.0257*
Dedo-Finger	30 100%	24 80%	0 0%	6 20%	0.0237*
Casa-House	30 100%	22 73.33%	0 0%	8 26.66%	0.0046*
Gato-Cat	29 96.66%	16 53.33%	1 3.33%	14 46.66	<.0001*
Gelo-Ice	25 83.33%	19 63.33%	5 16.66%	11 36.66%	0.1432
Faca-Knife	24 80%	21 70%	6 20%	9 30%	0.5520
Vaca-Cow	28 93.33%	21 70%	2 6.66%	9 30%	0.0419*
Sapo-Toad	30 100%	19 63.33%	0 0%	11 36.66%	<.0001*
Zebra-Zebra	24 80%	6 20%	6 20%	24 80%	<.0001*
Chave-Key	30 100%	17 56.66%	0 0%	13 43.33	<.0001*
Moto-Motorbike	30 100%	26 86.66%	0 0%	4 13.33%	0.1124
Leão-Lion	27 90%	15 50%	3 10%	15 50%	0.0015*
Rato-Mouse	27 90%	18 60%	3 10%	12 40%	0.0153*
Anel-Ring	28 93.33%	25 83.33%	2 6.66%	5 16.66%	0.4238
Olho-Eye	29 96.66%	8 26.66%	1 3.33%	22 73.33%	<.0001*
Uva-Grape	28 93.33%	27 90%	2 6.66%	3 10%	1.0000
Pé-Foot	30 100%	28 93.33%	0 0%	2 6.66%	0.4915
Trem-Train	29 96.66%	4 13.33%	1 3.33%	26 86.66%	<.0001*
Cão-Dog	17 56.66%	23 76.66%	13 43.33%	7 23.33%	0.1702
Flor-Flower	30 100%	2 6.66%	0 0%	28 93.33%	<.0001*
Sol-Sun	29 96.66%	21 70%	1 3.33%	9 30%	0.0122*
Mão -Hnad	30 100%	28 93.33%	0 0%	2 6.66%	0.4915
Rei-King	22 73.33%	19 63.33%	8 26.66%	11 36.66%	0.5796

*Statistically significant (p<0.05)

Table 4. Number of incorrect responses per word in the Speech Recognition Percentage Index (SRPI) test, with and without the support of figures, according to age range

Words	2 years old SRPI		3 years old SRPI		4 years old SRPI		Total SRPI		Variables Incorrect response Word × Age Student's t-test p value	
	Without figures	With figures	Without figures	With figures	Without figures	With figures	Without figures	With figures	Without figures	With figures
Pato Duck	1	0	0	0	0	0	1	0	0.2376	-
Bola Ball	5	0	2	0	0	0	7	0	0.0006*	-
Tênis Sneakers	5	0	2	1	1	0	8	1	0.0035*	0.6846
Dedo Finger	4	0	1	0	1	0	6	0	0.0436*	-
Casa House	5	0	2	0	1	0	8	0	0.0111*	-
Gato Cat	6	1	6	0	2	0	14	1	0.0059*	0.3248
Gelo Ice	6	2	5	2	0	1	11	5	<.0001*	0.3981
Faca Knife	6	3	1	2	1	1	8	6	0.0097*	0.1567
Vaca Cow	7	1	0	1	2	0	9	2	0.0007*	0.4274
Sapo Toad	7	0	4	0	0	0	11	0	<.0001*	-
Zebra Zebra	8	2	10	3	6	1	24	6	0.0446*	0.5039
Chave Key	8	0	4	0	1	0	13	0	0.0011*	-
Moto Motobike	2	0	1	0	1	0	4	0	0.2852	-
Leão Lion	7	1	7	2	1	0	15	3	0.0004*	0.1684
Rato Mouse	6	1	3	2	3	0	12	3	0.0717	0.4298
Anel Ring	3	1	2	1	0	0	5	2	0.0444*	0.2241
Olho Eye	8	0	9	0	5	0	22	0	0.0066*	0.1137
Uva Grape	3	1	0	1	0	0	3	2	0.0143*	0.6543
Pé Foot	2	0	0	0	0	0	2	0	0.0292*	-
Trem Train	8	0	11	1	7	0	26	1	0.0709	0.6846
Cão Dog	5	6	1	6	1	1	7	13	0.0031*	0.0079*
Flor Flower	8	0	12	0	8	0	28	0	0.1538	-
Sol Sun	4	1	5	0	0	0	9	1	0.0254*	0.1387
Mão Hand	1	0	1	0	0	0	2	0	0.3156	-
Rei King	6	3	3	4	2	1	11	8	0.0084*	0.1440
Total	**131**	**23**	**92**	**26**	**43**	**5**	**266**	**54**	**-**	**-**

*Statistically significant (p<0.05)
Caption: SRPI = Speech Recognition Percentage Index

Statistically significant difference was observed only for the word "dog" (*p*=0.0079) in the comparison between correct and incorrect responses in the SRPI test with the support of figures.

In the SRPI test without the support of figures, the incorrect responses also varied according to age, with children aged 2 to 2 years and 11 months presenting 131 incorrect responses. Children aged 3 to 3 years and months presented 92 incorrect responses, whereas those aged 4 to 4 years and 11 months presented only 43 incorrect responses. Association between the correct and incorrect responses obtained in the SRPI test without the support of figures showed statistically significant difference for 19 of the 25 words when compared among the age groups (Table 4).

Statistical analysis using the Pearson's correlation coefficient showed association between the variable age with the results found during the application of the SRPI test with the support of figures (*p*=0.0050), as well as without the support of figures (*p*<0.0001).

No statistically significant difference was observed in the correlation between both genders and the number of incorrect responses obtained in the SRPI test with and without the support of figures (Table 5).

In addition to identifying the children's correct and incorrect responses, the SRPI test with the support of figures allowed the examiner to transcribe the phonological processes used by the children. Although this was not the purpose of the present study, we considered elucidating to present the phonological processes recorded in the age range investigated (Figure 4).

Table 5. Number of incorrect responses per word in the Speech Recognition Percentage Index (SRPI) test according to gender

| Words	Incorrect responses		Fisher's exact test p value
	Female	Male	
Pato - Duck	0	1	1.0000
Bola - Ball	2	5	0.6913
Tênis - Sneakers	3	6	0.7290
Dedo - Finger	1	5	0.3866
Casa - House	2	6	0.4571
Gato - Cat	5	10	0.5576
Gelo - Ice	6	10	1.0000
Faca - Knife	7	8	0.5587
Vaca - Cow	4	7	1.0000
Sapo - Toad	5	6	0.7412
Zebra - Zebra	9	21	0.1872
Chave - Key	4	9	0.5336
Moto - Motorbike	1	3	0.6434
Leão - Lion	6	12	0.5731
Rato - Mouse	5	10	0.7618
Anel - Ring	3	4	1.0000
Olho - Eye	8	15	0.5939
Uva - Grape	3	2	0.3803
Pé - Foot	1	1	1.0000
Trem - Train	10	17	0.7927
Cão - Dog	7	13	0.7804
Flor - Flower	11	17	1.0000
Sol - Sun	4	6	1.0000
Mão - Hand	1	1	1.0000
Rei - King	6	13	0.4095
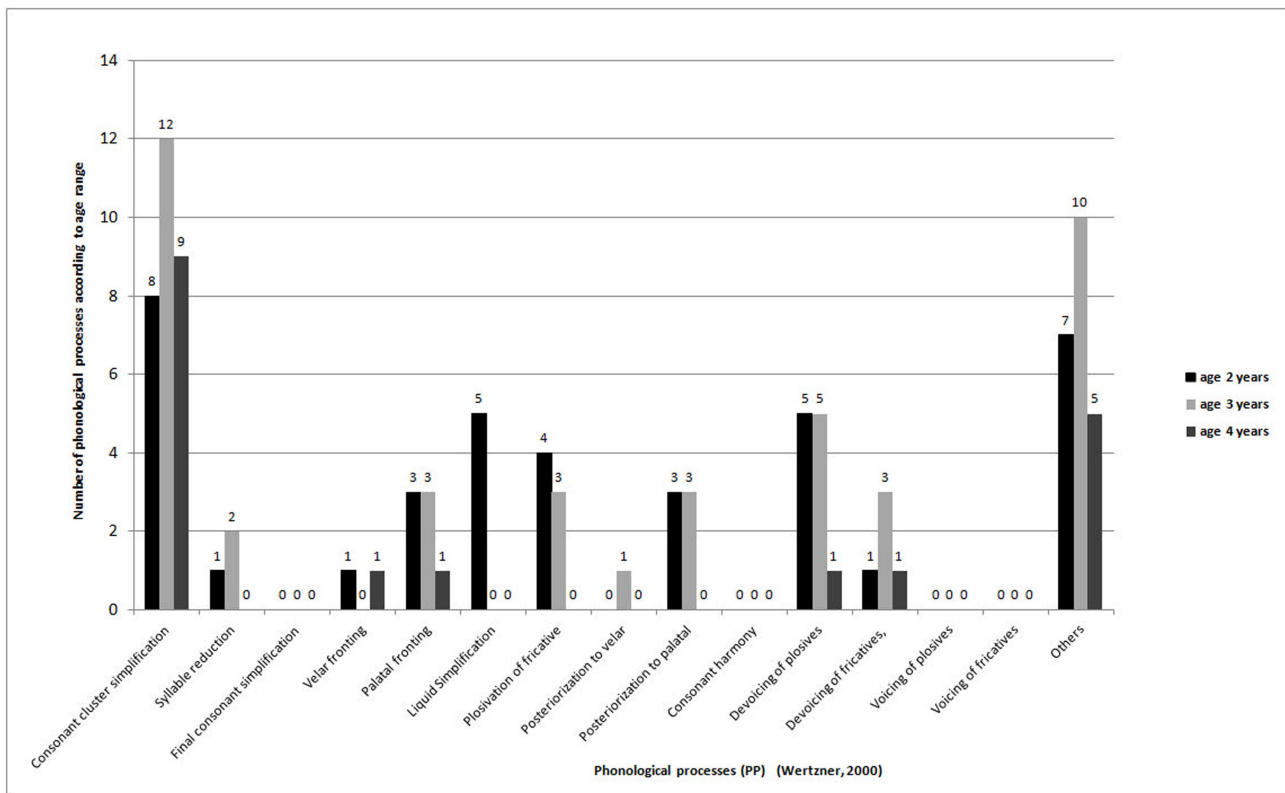
Figure 4. Phonological processes used by the children in the Speech Recognition Percentage Index (SRPI) test, with and without the support of figures, according to age range

DISCUSSION

A possible way to assess the reliability of an instrument concerns the degree of agreement between responses at two different "application moments" to the same individuals - the higher the index of agreement, the more reliable the instrument. In this study, analysis of the results showed a degree of agreement higher than 85% between the two applications to the same individuals[12].

Based on the evidence of the responses analyzed statistically, high agreement was observed among the participating individuals.

Therefore, the instrument proposed in this study offers reliable bases for its use to assess the Speech Recognition Percentage Index (SRPI), in accordance with the arguments of previous studies which state that a test with known reliable and valid measures provides researchers and practitioners with possibilities of evaluating children in this age range. Most of the words selected by the speech-language pathologists were dissyllable. During the test application, the words used allowed rapid determination of the auditory speech recognition percentage index of children. This information is consistent with findings of other studies[3,4], showing that disyllable words, mainly those of (cvcv) syllabic structure, can be satisfactorily used for testing the auditory speech perception of children.

For the selection of figures during the preparation of the instrument material, the speech-language therapists showed a greater tendency to choose real images, some inserted in a context, others not.

The training conducted with six words and figures (Training Board) prior to the actual application of SRPI test with the support of figures proved to be effective in ensuring the understanding of the activity and the task to be performed by the children. We verified that the children had no difficulty in understanding the strategy. Some researchers[3-4,13] have emphasized the importance of training before the actual test, proving to be important both for its rapid application and for the understanding of the proposed activity and the response to it. Although no training was conducted for the SRPI test without the support of figures, the children did not present difficulties in the repetition of the words heard, probably because this test was applied after the SRPI test with the support of figures.

The application time for the SRPI test with the support of figures was significantly longer than that of the test without figures, possibly because it was applied before the procedure without the support of figures, and the training part was not conducted during the second test (Table 2). Another factor to be considered was the fact that application time was significantly longer for the group of children aged 2 years compared with the other groups for the procedure with the support of figures (p=0.0360 and p=0.138 compared with the 3 and 4-year-old groups, respectively). Similar duration was observed for the application of tests with and without the support of figures when comparing the 3 and 4-year-old groups.

The mean time allocated to the application of a speech perception test in children in this age range is satisfactory and feasible in services where protocols tend to comply with resolution principles and must meet regional demands. In this study, the children presented a mean of correct responses in the SRPI test with the support of figures of 93%, with standard deviation of 8%, and a mean of correct responses in the test without the support of figures of 64%, with standard deviation of 25%. A low percentage of correct responses for the recognition of words without the support of figures had already been observed in a previous study[14], with word recognition percentage below 88%.

The percentage of incorrect responses for the recognition of words in both procedures was higher for the younger children, decreasing significantly with increasing age. These data corroborate those of other studies[3,15], whose findings showed that word recognition difficulty was also lower as children's age increased.

Association between the results obtained in the SRPI test, with and without the support of figures, showed significant difference for the following words: Ball, Sneakers, Finger, House, Cat, Cow, Toad, Zebra, Key, Lion, Mouse, Eye, Train, Flower, and Sun, with higher percentage of correct responses when the test was conducted with the support of figures (Table 3).

During the application of the SRPI test with the support of figures, the number of incorrect responses varied according to age, considering that children aged 2 to 2 years and 11 months (n=8) presented 23 incorrect responses, children aged 3 to 3 years and 11 months (n=12) had 26 incorrect responses, and those aged 4 to 4 years and 11 months (n=10) presented only five incorrect responses. The group of children aged 3 to 3 years and 11 months presented the highest number of incorrect responses; however, it is worth noting that this is the largest group (40% of the sample). It can be observed that the high percentage of correct responses in the SRPI test with figures is related to age, type of response required (pointing the figure), and familiarity with the words and figures.

We noticed that familiarity with the word and the meaning that it represents for the child is as important as the speech stimuli used (monosyllabic or disyllabic). All of the words selected by the speech-language pathologists were recognized by most participants, except the word "dog" ("cão"), which showed the highest rate of incorrect responses during the test with the support of figures for all ages (43.33%). This may be related to the fact this word is not part of the repertoire of children in the age range studied - the most commonly used word is "dog" ("cachorro") or the onomatopoeia "arf-arf" ("au-au") for younger children.

Comparison between the correct and incorrect responses obtained in the test using the support of figures showed statistically significant difference only for this word ("dog") ("cão") (p=0.0079). The literature describes several studies on the familiarity of words to children; some of them[3,4,14,16-18] report that children obtained higher percentage of correct responses for familiar words.

During the application of the SRPI test with the support of figures, we observed that the younger children presented a tendency to point to their own body when they were requested to identify, on the boards, figures of body parts such as "hand", "foot", "mouth", or "eye". They also showed longer latency to trigger a response, whereas the older children, in addition to presenting faster responses, in some situations realized that

the extra figures (used to prevent a response by exclusion) had not been spoken.

No statistically significant difference was observed regarding the association between both genders and the incorrect responses obtained in the SRPI test with the support of figures. Similar results were found in a study[19], in which the authors observed no significant difference when comparing the phonological processes of individuals of both genders.

With respect to the SRPI test without the support of figures, the children presented many incorrect responses, most of them related to phonological processes and characteristic of the age range[1,20]. Two-year-old children presented 131 incorrect responses, three-year-old children had 92 incorrect responses, and the four-year-olds presented 43 incorrect responses.

Statistically significant difference was found for most of the words in the comparison of correct and incorrect responses obtained in the SRPI test without the support of figures, as shown in Table 3. This fact can be explained by the number and variability of phonological processes used by children of this age range. In this study, even with increasing age, children aged 4 to 4 years and 11 months still presented some phonological processes, which may justify the important percentage of incorrect responses presented by some of these children in the SRPI test without the support of figures.

The number of phonological processes decreased with increasing age. This finding is in agreement with those in the studies by Ferrante et al.[19] and Silva et al.[21], who reported that the number of phonological processes used by children decreased gradually with increasing age, as well as the variability of phonological processes. In this study, children aged 2 to 2 years and 11 months used 10 phonological processes during the time of test application, children aged 3 to 3 years and 11 months used nine phonological processes, and those aged 4 to 4 years and 11 months used only six phonological processes; these findings corroborate those reported in a study by Silva et al.[21]. Those authors observed that, as children complete their phonological inventory, there is a reduction of the variability of phonological processes.

The phonological processes most commonly used by children according to Wertzner's classification[11] were as follows: consonant cluster simplification, syllable reduction, velar fronting, palatal fronting, liquid simplification, plosivation of fricative, posteriorization to velar, posteriorization to palatal, devoicing of plosives, devoicing of fricatives, among others. Of all the processes used, a higher rate of incorrect responses was observed for words with consonant cluster for all ages. According to the authors[11,19,21-23], consonant cluster is the last process to stabilize in the child phonological system.

Therefore, the study results suggest that the material developed can be feasibly applied in the auditory speech perception test and that both the words and the figures are appropriate for use in the SRPI test with children aged 2 to 4 years and 11 months. Thus it was possible to observe how important the SRPI with the support of figures can be in the assessment of children under 5 years old.

CONCLUSION

We conclude that the material prepared with figures and regular, frequently used monosyllabic and disyllabic words can be rapidly and easily applied to the Speech Recognition Percentage Index (SRPI) test in children in the age range studied, allowing assessment and systematic monitoring of speech perception ability regardless of child verbalization capacity.

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Author contributions

LFS participated in the design and schedule of the study, literature survey, collection and analysis of data, writing of the manuscript, and approval of the article final version; GRABB participated in the collection, analysis and interpretation of data, writing of the manuscript, and approval of the article final version; ALRM participated in the collection, analysis and interpretation of data, writing of the manuscript, and critical revision of the article final version; NEZA participated in the analysis and interpretation of data, writing of the manuscript, and critical revision of the article final version; ACMBR was the study advisor and main researcher, participated in the design and schedule of the study, literature survey, collection and analysis of data, writing of the manuscript, and approval of the article final version.