

Causal factors and application of complementary tests in speech sound disorders

Fatores causais e aplicação de provas complementares relacionadas à gravidade no transtorno fonológico

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ABSTRACT

Purpose: To determine whether the severity index that measures the percentage of consonants correct distinguishes children with speech sound disorders (SSD) according to measures of stimulability and speech inconsistency, as well as to the presence of heritability (familial history) and history of early recurrent otitis media. **Methods:** Participants were 15 subjects aged between 5 and 7 years and 11 months, diagnosed as phonologically disordered. The PCC-R index was calculated for both words imitation and picture naming tasks, separately. The need to apply stimulability test was considered according to the criteria proposed in previous research for Brazilian Portuguese-speaking children. Speech inconsistency allowed the classification of subjects as either consistent or inconsistent. Data were statistically analyzed. **Results:** Comparison between PCC-R calculated for picture naming and words imitation tasks demonstrated difference only for the need for the application of the stimulability test. Such difference was not observed in the speech inconsistency test. No difference was found at PCC-R values considering both familial and otitis media histories. **Conclusion:** The present research indicates that children who were submitted to the stimulability test presented lower values of PCC-R. However, PCC-R values were not determinant for differences among children, regarding the speech inconsistency test and familial and otitis media histories.

Keywords: Child language; Language disorders; Language tests; Otitis media; Heredity

INTRODUÇÃO

Speech sound disorder (SSD) is a speech and language disorder characterized by inappropriate use of sounds which may involve errors in production, perception or organization of speech sounds. One of the main characteristics of children with speech difficulties is the heterogeneity in severity, underlying deficits and speech errors.

The first aspect observed in children with SSD is its manifestation related to the speech errors. Current researches demonstrate that the types of errors produced by these children seem to be related to specific difficulties involving the cognitive processing, language, motor processing of speech and/or auditory perceptual processing⁽¹⁾.

Although in most cases it is not possible to determine the underlying cause of SSD literature^(2,3) indicates the importance of a detailed description of the child at the moment of diagnosis. Sub-types of SSD can be classified according to aetiology where heritability (usually identified by familial history presence of a communication/language disorder) and history of early recurrent otitis media with effusion (OME) are the two most studied⁽⁴⁻⁶⁾.

Several indexes are proposed by literature in order to verify the severity of the disorder. The most used⁽⁷⁻⁹⁾ is the index Percentage of Consonants Correct-Revised (PCC-R)⁽⁶⁾ which analyzes the percentage of consonants correct in speech production considering substitutions and omissions of consonants as errors. PCC-R is a measure of speech appropriate for comparisons involving speakers of different ages and different speech characteristics^(3,6,10).

Besides measuring the severity of SSD diagnostic evaluation requires the use of complementary tests in order to identify

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which abilities are the most difficult to each child. Two tests can be used for this purpose: the speech inconsistency test (SI) and the stimulability test (S)^(11,12).

SI is a measure applied to verify whether the production of a word varies within each repetition. The presence of such variation indicates a difficulty at the phonological planning⁽¹³⁻¹⁵⁾ which is the processing responsible for the selection and organization of the production of a specific phoneme^(16,17) reflecting a possible deficit at the cognitive-linguistic abilities.

S is a measure applied only when the child presents one or more than one missing sound at the phonetic inventory. It is a measure related to the presence or absence of difficulties at the oro-motor execution of specific gestures needed for sound production^(11,18-20).

Considering the importance of complementary tests to the diagnosis of SSD the aim of this study was to determine whether the severity index that measures the percentage of consonants correct distinguishes children with SSD according to both the complementary tests of stimulability and speech inconsistency as well as to the presence of heritability (familial history) and the history of early recurrent otitis media.

METHODS

This study was approved by the Ethics Committee for the Analysis of Research Projects (CAPPesq) of the Clinical Board of the General Hospital and School of Medicine of the Universidade de São Paulo (n° 0958/08). All parents signed the free and informed consent term.

Participants were eight male and seven female children aged between 5 years and 2 months and 7 years and 11 months with the diagnosis of SSD evaluated at the Laboratory of Investigation in Phonology from the Department of Physical Therapy, Speech-Language Pathology and Audiology, and Occupational Therapy from the School of Medicine of the Universidade de São Paulo.

Inclusion criteria were: age, speech errors identified at the phonology test⁽²¹⁾, age appropriate performance for semantic, pragmatic and fluency tests, absence of hearing disorders, children should be living within the same house of both their natural parents and Brazilian Portuguese as the mother language for both the child and their parents.

Initially all subjects and their parents were interviewed and the free and informed consent term was signed. The interview was to investigate the presence of two or more episodes of early recurrent otitis media (OM) (to be considered as present) and the presence of heritability considered by the familial history (FH) of any language or communication disorder (presence was considered as positive when presented by parents, siblings, uncles or cousins). Application of tests procedure was the same for all the subjects.

Speech samples were obtained by the phonology test from the Child Language Test ABFW⁽²¹⁾. PCC-R⁽⁶⁾ was calculated for both the imitation of words task (PCC-RI) and the picture naming task (PCC-RN).

The initial analysis of the data allowed us to observe the absent sounds of the child's phonetic inventory. Stimulability test (S)⁽¹⁸⁾ was applied for each of them. At the present study

we just computed the need for the application of the S test according to the criteria proposed in previous studies^(3,11).

SSI test was applied according to the proposal of the authors^(3,12). The test consists in naming 25 figures in three different orders. The word was considered as consistent when it was repeated three times in the same way and as inconsistent when there were one or more different productions. The classification of consistent (C) or inconsistent (I) was based on the cutoff values established in previous studies^(3,12): for children aged between 5 and 7 years and 6 months this value was 21.5% (for girls) and 31.9% (for boys) and for children aged above 7 years and 7 months, 14.5% (for girls) and 17.6% (for boys).

Statistical analysis used non parametric tests and significance level adopted was 0.05 (confidence interval of 95%). The comparison between variables from the study used Mann-Whitney test.

RESULTS

The mean value of the index PCC-R for the picture naming task was 70.76% and for the words' imitation task was 74.11%. Regarding the presence of FH and the presence of OM the study indicated that five participants presented the FH and two the presence of OM. The occurrence of both histories was observed in seven children. We considered the number of occurrence of HF and the presence of OM and not the number of subjects that presented them. Thus the number of occurrences for the presence of OM was nine and for the HF was 12.

Six children were classified as consistent and nine as inconsistent by the SI test. The mean value of SI for the consistent children was 14% and for the inconsistent ones 38%. Mean value of PCC-R for consistent children was 73.58% and for the inconsistent ones 78.67%.

The need for the application of the S test was observed in ten children who presented missing sounds in their phonetic inventory (five subjects had no missing sounds). The mean value of PCC-R for the subjects who did not need the S test was 88.62% and for the ones who needed the S test was 64.69%.

Comparison of PCC-RN and PCC-RI according to the classification of SI test and the need for the application of the S test

There was no difference on the comparison between consistent and inconsistent children for both PCC-RN and PCC-RI (Table 1).

Statistical difference was observed for both PCC-RN and PCC-RI on the comparison of children according to the need for the application of the S test (Table 2). Children with absent sounds whose S test was applied demonstrated lower values of PCC-R.

Comparison of PCC-R values according to the presence of FH and OM

There was no difference on the comparison between the presence and absence of OM for both PCC-RN and PCC-RI (Table 3).

Table 1. Comparison between mean values of PCC-RN and PCC-RI according to the classification of the speech inconsistency test

Classification of SI	PCC-RN		PCC-RI	
	C (%)	I (%)	C (%)	I (%)
Mean	73.8	68.8	73,4	74,6
Median	85.5	74.7	83,6	79,4
SD	22.8	13.5	23,3	12,9
Q1	66.0	57.1	59,0	64,5
Q3	88.0	77.7	87,4	84,1
n	6	9	6	9
CI	18.3	8.8	18,7	8,5
p-value	0.239		0.768	

Mann-Whitney test ($p \leq 0.05$)

Note: SI = speech inconsistency; PCC-RN = percentage of consonants correct revised at the picture naming task; PCC-RI = percentage of consonants correct revised at the words imitation task; C = consistent; I = inconsistent; SD = standard deviation; Q1 = first quartile; Q3 = third quartile; CI = confidence interval

Table 2. Comparison between mean values of PCC-RN and PCC-RI of children who needed the application of the stimulability test.

Stimulability	PCC-RN		PCC-RI	
	Not applied (%)	Applied (%)	Not applied (%)	Aplicado (%)
Mean	86.7	62.8	89,2	66,6
Median	86.8	60.3	87,9	70,5
SD	3.0	15.7	4,1	16,0
Q1	85.5	54.3	87,9	54,0
Q3	88.9	75.6	88,0	79,5
n	5	10	5	10
CI	2.6	9.7	3,6	9,9
p-value	0.005*		0.002*	

* Significant values ($p \leq 0.05$) – Mann-Whitney test

Note: PCC-RN = percentage of consonants correct revised at the picture naming task; PCC-RI = percentage of consonants correct revised at the words imitation task; SD = standard deviation; Q1 = first quartile; Q3 = third quartile; CI = confidence interval

The same results were observed on the comparison between the presence and absence of FH for both PCC-RN and PCC-RI (Table 4).

DISCUSSION

The complexity of the SSD demonstrated by the heterogeneity of manifestations becomes increasingly evident with the advance of the research studies. Based on this complexity recent studies have been trying to define which tests are better to identify different SSD sub-types considering the interrelationships among cognitive-linguistic, oro-motor and hearing processing^(1,22,23).

The analysis of the underlying deficit, severity and cognitive-linguistic aspects in children with SSD may provide evidences for better targeting the most suitable intervention for each child as well as selecting the best therapeutic model.

Table 3. Comparison between mean values of PCC-RN and PCC-RI according to the presence of otitis media history

OM history	PCC-RN		PCC-RI	
	Absence (%)	Presence (%)	Absence (%)	Presence (%)
Mean	75.8	67.4	78,0	71,5
Median	85.5	74.7	83,6	79,4
SD	17.5	17.2	16,4	17,9
Q1	64.2	59.5	68,7	59,0
Q3	86.5	77.7	87,4	84,1
n	6	9	6	9
CI	14.0	11.3	13,1	11,7
p-value	0.289		0.376	

Mann-Whitney test ($p \leq 0.05$)

Note: OM = otitis media; PCC-RN = percentage of consonants correct revised at the picture naming task; PCC-RI = percentage of consonants correct revised at the words imitation task; SD = standard deviation; Q1 = first quartile; Q3 = third quartile; CI = confidence interval

Table 4. Comparison between mean values of PCC-RN and PCC-RI according to the presence of familial history

Familial History	PCC-RN		PCC-RI	
	Absence (%)	Presence (%)	Absence (%)	Presence (%)
Mean	68.5	71.3	73,9	74,2
Median	82.2	75.3	88,0	79,5
SD	30.7	14.3	31,9	13,6
Q1	57.8	58.9	62,7	63,1
Q3	86.1	85.5	92,2	84,6
n	3	12	3	12
CI	34.7	8.1	36,1	7,7
p-value	0.773		0.386	

Mann-Whitney test ($p \leq 0.05$)

Note: PCC-RN = percentage of consonants correct revised at the picture naming task; PCC-RI = percentage of consonants correct revised at the words imitation task; SD = standard deviation; Q1 = first quartile; Q3 = third quartile; CI = confidence interval

Comparison of PCC-RN and PCC-RI according to the classification of SI test and the need for the application of the S test

SI is a measure that reflects the functioning of cognitive-linguistic processing⁽¹⁷⁾. When comparing this measure with PCC-R values it was observed that inconsistent children were not necessarily the more severe. Inconsistent children with SSD can omit or substitute one sound in the same context suggesting difficulties at the level of the phonological planning and on the selection of the target sound.

The fact that there is no evidence of significant difference on the values of PCC-R for the SI test indicates that consistent children who always named the pictures from the test⁽³⁾ in the same way (correct or incorrectly) showed approximately a similar number of consonants correct when compared to the inconsistent children who named pictures in different ways

among the three repetitions (according to the target, substituted or omitted)⁽²⁴⁾.

The results reinforce that SI is a useful test to evaluate the involvement of the cognitive-linguistic processing in children with SSD. Despite the presence of different types of production (also called variability) is considered as an important characteristic of children with SSD it is also observed in children with typical development^(24,25) reflecting the functioning of that processing during the period of speech and language acquisition. A recent study on the effectiveness of SI test demonstrated that SI measure is related to a more accurate diagnosis providing better clinical evidences for the diagnosis⁽¹²⁾.

In addition to the evaluation and to a possible relation between SI measure and PCC-R values the present research also studied the relation between the need for the application of the S test and the mean values of PCC-R. Results indicated that the higher the PCC-R (in both tasks) the lower is the need for the application of the S test demonstrating that the higher the number of consonants correct, the lower is the number of absent sounds in the phonetic inventory.

The need for the application of the S test in this research was related to a more severe SSD due to the absence of sounds in the phonetic inventory. This fact indicates that the difficulty is related to the mental representation of a sound⁽²⁶⁾ and demonstrates the importance of stimulability as a complementary test in determining the severity of the disorder⁽¹⁸⁾.

In order to consider a subject as stimuable for a particular sound it is essential the integrity (in some degree) of the sensory aspect, the language processing and the oro-motor production⁽¹⁹⁾. As demonstrated in the present study the need for the application of the S test points to a difficulty of the neuromotor adjustment for the production of the target sound in children with SSD. The fact of being stimuable indicates that after being presented to the model the child is able to regulate his/her own articulatory movements in order to produce the sound according to the adult target. Probably children with SSD do not use such control and therefore adopt approximation strategies that can be identified as speech errors (substitutions

and/or distortions)⁽²⁷⁾.

A study based on the application of S test associated to acoustic analysis as complementary tests to the diagnosis of SSD elucidated the importance of establishing facilitating motor parameters (articulatory and visual cues) and acoustic parameters (frequency, duration and intensity) for the acquisition of a particular sound⁽²⁸⁾.

Comparison of PCC-R values according to the presence of FH and OM

Results indicated that PCC-R measured on both picture naming and words imitation tasks was not an effective index to separate children according to the presence of FH and OM. The absence of a correlation between PCC-R and the presence of such historical suggests that the fact of having had OM history and FH does not interfere on the phonology of children from this age group.

CONCLUSION

The present research indicated that children who demonstrated absent sounds presented lower values of PCC-R. However PCC-RN or PCC-RI mean values were not different for children according to the SI results considering both FH and OM history.

It is important to reinforce that the number of participants from the present research was reduced and larger studies should be done for both compliment of these previous data and also as a contribution to the improvement of the diagnosis of SSD.

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RESUMO

Objetivo: Verificar se o índice de gravidade, que mede a porcentagem de consoantes corretas, distingue as crianças com transtorno fonológico em relação às medidas de estimulabilidade e inconsistência de fala, bem como à presença dos históricos familiar e de otite média. **Métodos:** Participaram da pesquisa 15 sujeitos com idades entre 5 e 7 anos e 11 meses, com diagnóstico de transtorno fonológico. O índice Porcentagem de Consoantes Corretas – Revisado (PCC-R) foi calculado para as provas de imitação de palavras e de nomeação de figuras, separadamente. A partir destas provas também foi computada a necessidade de aplicação da prova de estimulabilidade, de acordo com os critérios propostos em pesquisas anteriores. A prova de inconsistência de fala permitiu classificar os sujeitos como consistentes ou inconsistentes. Os dados foram submetidos à análise estatística. **Resultados:** Na comparação entre os valores do PCC-R medido na prova de nomeação e de imitação foi observada diferença em relação à necessidade da aplicação da estimulabilidade. Em relação à prova de inconsistência de fala, não houve evidência desta relação. Não foi verificada diferença no PCC-R considerando-se a presença dos históricos de otite média e familiar. **Conclusão:** O estudo indica que as crianças que precisaram da aplicação da prova de estimulabilidade apresentaram valores mais baixos de PCC-R. Entretanto, em relação à prova de inconsistência de fala e aos históricos de otite ou familiar, o PCC-R não determinou diferenças entre as crianças.

Descritores: Linguagem infantil; Transtornos da linguagem; Testes de linguagem; Otite média; Hereditariedade

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