OCCURRENCE OF PHONOLOGICAL ERRORS ACCORDING TO SEVERITY IN CHILDREN WITH SPEECH SOUND DISORDER

Ocorrência de erros fonológicos de acordo com a gravidade em crianças com transtorno fonológico

Haydée Fiszbein Wertzner[1], Perla Isabel dos Santos[2], Luciana de Oliveira Pagan-Neves[3]

ABSTRACT

Purpose: to describe and quantify speech errors in children with speech sound disorder according to severity calculated by the indexes percentage of consonants correct revised and process density index and also to determine whether children with different degrees of severity differ in the predominant error observed during speech production. **Methods:** speech samples of 21 children aged between 5;2 and 7;11 years-old with speech sound disorder were analyzed. Absolute indexes of substitution, omission and distortion, percentage of consonants correct revised and process density index were calculated based on two phonology tasks (picture naming and imitation of words). **Results:** there were differences in the predominant type of error in speech indicating that substitution was the most occurring type of error. Substitution was the most frequent type of error for the most severe children while for the less severe ones the study did not indicate a prevalent type of error. The analysis of the total sample the correlation analysis indicated that the higher the occurrence of substitution less the number of distortion. **Conclusion:** in general terms substitution was the most frequent type of error. Equivalence of the type of errors was observed for the less sever children while substitution was the most frequent type of error for the more sever group of children. Absolute indexes were effective and efficient to indicate the most frequent type of error according to the severity of the disorder.

KEYWORDS: Child Language; Language Disorders; Language Tests; Otitis Media; Evaluation

■ **INTRODUCTION**

The Speech Sound Disorders (SSD) is a speech and language disorder that is one of the most common difficulties in developing children. The disorder may be characterized by the presence of at least one atypical error (errors that are not observed for the typically developing children[1,2]. Those errors are the sound substitution, omission or distortion and may occur because an underlying difficulty with the organization of phonological rules and/or auditory perception and/or speech production[3,4].

The use of simplification of the phonological rules, called phonological processes (PP), is maintained after the expected age of acquisition in children with SSD and sometimes idiosyncratic processes may occur. There are different types of PP that may affect more or less the speech intelligibility[5] and involve sound´s substitution and omission.

Distortion is the third type of speech error referred to be a phonetic difficulty characterized by the articulatory imprecision during the production of specific sounds. Distortion does not represent a difficulty with the application of the phonological rules and does not commit the meaning of the words[6].

[1] Department of Physiotherapy, Communication Science & Disorders, Occupational Therapy, Faculty of Medicine, Universityof São Paulo, São Paulo, SP, Brazil.

[2] Department of Physiotherapy, Communication Science & Disorders, Occupational Therapy, Faculty of Medicine, University of São Paulo, São Paulo, SP, Brazil.

[3] Department of Physiotherapy, Communication Science & Disorders, Occupational Therapy, Faculty of Medicine, University of São Paulo, São Paulo, SP, Brazil.

Conflict of interest: non-existent

Researches points to evidences of different types of SSD[5,7]. Some of them[8,9] consider that such differentiation must be related to the underlying causes, while others[7,10] argue that it should be based on the cognitive-linguistic difficulties.

Severity calculus is one aspect that may assist in the identification of different types of SSD. Some used measures described by the literature are the percentage of Consonants Correct (PCC)[5,11,12], the absolute indexes of distortion, omission and substitution[5] and the *Process Density Index* (PDI)[13].

PCC-R[14] is a revised version of the PCC and accounts as errors only substitutions and omissions[5,11-13]. Absolute indexes (AI) proposed by the same authors are calculated by the division of the number of specific errors (omissions, distortions or substitutions) by the number of sounds of the speech sample[5].

PDI[14,15] reflects the frequency of use of the phonological processes on a speech sample and is calculated based on the number of phonological processes divided by the number of words.

Considering the heterogeneity of SSD the present study aimed to describe and to quantify the number of speech sound errors in children with SSD according to the children´s performance in the severity indexes PCC-R and PDI determining whether different degrees of severity interfere on the occurrence of a specific type of sound error.

■ METHODS

This retrospective and transversal research was approved by the Ethics Commission for the Analysis of Research Projects (CAPPesq) of the Clinical Board of the Clinical Hospital of the School of Medicine of the University of São Paulo (#229/11). Written, informed consent was obtained from a parent of each participant.

Participants were 21 male and female children aged between 5:2 and 7:11 years-old. Data used at the present study are from the initial evaluation of the children before they were enrolled in any speech therapy. Tests applied at that moment were: phonology (picture naming and words imitation tasks), vocabulary, fluency and pragmatics tests from the Infantile Language Test (ABFW)[16] and the evaluation of a spontaneous speech sample.

Inclusion criteria for this group was: diagnostic of SSD between the years of 2007 and 2010; age from 5:0 to 7:11 years old; no previous speech-language intervention; PCC-R in the same percentage range on both phonology tasks (picture naming and words imitation) adequate performance in other aspects of language (vocabulary, fluency and pragmatics) on Tests from the ABFW[16]; normal hearing evaluation results. All children were monolingual Brazilian Portuguese learners.

Phonology test analysis was based on video camera (JVC, model Everio) and audio (Panasonic, model RR-US450) recordings coupled to a Sennheiser (e-817) microphone obtained from the first initial evaluation of the children.Speech samples were transcribed to verify phonetic and phonological inventory systems. At the words imitation task children were asked to repeat 39 words (107 consonants) and at the picture naming task, 34 pictures (90 consonants) were named. Transcriptions were manually done by a student from the fourth grade of the Speech, Language and Audiology course of the University and also by a student from the post-graduation course of the same University. Accordance above 90% between transcriptions was required for the child to be able to participate on the study.

After transcriptions the types of errors were classified, the number of phonological processes was counted and PCC-R, PDI, Absolute indexes of substitution (ASI), distortion (ADI) and omission (AOI) were calculated.

PCC-R was calculated by the division of the number of correct consonants (distortions were considered as correct productions) by the total number of consonants from the words imitation task (107 consonants) and the picture naming task (90 consonants) multiplied by 100.

Absolute indexes were calculated by the number of specific errors (substitution for ASI; omission for AOI; distortion for ADI) by the total number of possible errors in each task separately multiplied by 100.

The calculus of PDI was based on the division of the number of phonological processes by the total number of words in each task (39 words for word imitation task and 34 for the picture naming task).

Children were distributed in groups according to the percentual range measured with the PCC-R. Group 1 (G1) participants were five children with PCC-R above 85%, group 2 (G2) were nine children with PCC-R between 84-65%, group 3 (G3) were five children with PCC-R between 64-50% and group 4 (G4) with only two remaining children with PCC-R below 49%. G4 children were not included for the inferencial comparisons intra and intergroups but these two subjects were included on the analysis involving the total sample of participants.

Results were submitted to the following analysis (significance level adopted 0.05 and 95%confidence interval): Spearman Correlation test was used to verify the correlation of the different indexes between the two phonology tasks; Friedman test was used to compare the performance measured by

the indexes among the different groups of children on both phonology tasks; Wilcoxon test determined which indexes differentiated groups and Kruskal-Wallis test was applied to compare indexes among groups. Mann-Whitney was used for the cases of difference.

■ **RESULTS**

Intragroup analysis

The indexes ASI, AOI and ADI were compared for each group (G1, G2, G3 and total sample) as observed in Table 1. Evidences pointed out to differences in G2, G3 and total sample (including G4). ASI was on average higher than the ADI and AOI in both phonology tasks. G4 mean values of the indexes are described in Table 1 but they were not analyzed due to the small sample (only two subjects).

Comparison two by two was used to identify the differences at G2, G3 and total sample (Table 2). Differences were observed for the ASI values compared to those of AOI and ADI in both phonology tasks.

Table 1- Intragroup comparison between the absolute indexes values for both picture naming and imitation of words tasks

Imitation of words		N	Mean	SD	p-value	Picture Naming		N	Mean	SD	p-value
	ASI	5	8,0%	6,7%			ASI	5	6,3%	3,2%	
G1	ADI	5	8,5%	5,7%	0,311	G1	ADI	5	6,7%	5,7%	0,549
	AOI	5	4,9%	3,3%			AOI	5	3,5%	2,3%	
	ASI	9	23,3%	4,7%			ASI	9	28,2%	7,7%	
G2	ADI	9	3,5%	4,7%	**0,001***	G2	ADI	9	3,6%	2,3%	**0,001***
	AOI	9	2,0%	2,2%			AOI	9	2,8%	2,7%	
	ASI	5	36,8%	2,3%			ASI	5	34,6%	5,9%	
G3	ADI	5	0,0%	0,0%	**0,008***	G3	ADI	5	0,0%	0,0%	**0,009***
	AOI	5	3,7%	3,9%			AOI	5	2,8%	3,0%	
	ASI	2	44,5%	2,6%			ASI	2	47,9%	8,0%	
G4	ADI	2	5,5%	7,7%	0,223	G4	ADI	2	5,6%	8,0%	0,223
	AOI	2	9,8%	0,0%			AOI	2	15,5%	8,0%	
	ASI	21	24,9%	12,9%			ASI	21	26,4%	14,2%	
Total sample	ADI	21	4,1%	5,3%	**<0,001***	Total sample	ADI	21	3,7%	4,2%	**<0,001***
	AOI	21	3,8%	3,5%			AOI	21	4,2%	4,8%	

Legend: *significance, SD-standard deviation, N-number of subjects, ASI-absolute substitution index, AOI- absolute omission index, ADI- absolute distortion index.
Statistical Test: Friedman test

Table 2– Two by two comparison across the absolute indexes measurement for both picture naming and imitation of words tasks

		Imitation of words task			Picture naming task			
		ASI	ADI				ASI	ADI
G2	ADI	**0,008***		G2		ADI	**0,008***	
	AOI	**0,008***	0,600			AOI	**0,008***	0,610
G3	ADI	**0,043***		G3		ADI	**0,043***	
	AOI	**0,042***	0,068			AOI	**0,043***	0,109
Total sample	ADI	**<0,001***		Total sample		ADI	**<0,001***	
	AOI	**<0,001***	0,877			AOI	**<0,001***	0,897

Legend: *significance, ASI-absolute substitution index, AOI- absolute omission index, ADI- absolute distortion index.
Statisticaltest: Wilcoxon test.

The correlations between the AI, the PCC-R and the PDI for each group and also for the total sample in the two phonology tasks are presented in Table 3.

Strong positive correlation[17] for G1 and moderate for G2 was observed between PCC-R and PDI in the words imitation task. For the G3 strong positive correlation was verified between PDI and ASI and strong negative correlation between PCC-R and ASI. Strong positive correlation was observed for the total sample of subjects between PDI and ASI, strong negative correlation between PCC-R and PDI and also Between PCC-R and ASI, weak positive correlation between PCC-R and ADI and, weak negative correlation between ADI and ASI.

For the picture naming task mild positive correlation was noted between PDI and ADI and mild negative correlation between PCC-R and ASI for the G2. At the total sample of subjects analysis positive strong correlation was observed between PDI and ASI and strong negative correlation between PCC-R and ASI between PCC-R and PDI. No other correlation was found for both the G1 and the G3.

Intergroup analysis

Significant differences were observed in both phonology tasks for the indexes ASI and PDI with a punctuation order of G1<G2<G3. For the PCC-R and ADI the punctuation order was for the groups was G1>G2>G3 (Table 4). The AOI was not different between groups.

The comparison two by two between groups for the indexes that were different is presented in Table 5. Results indicated differences between groups for all the indexes.

■ DISCUSSION

This study indicated that children with SSD and PCC-R in different ranges present differences in relation to the predominant speech error. Results pointed out that substitution was the most occurring error in the speech of children with SSD.

The most sever groups G2 and G3 presented substitution as the most occurring type of error while for the G1, the less severe group of children, we observed a similar occurrence of both substitution and omission. The correlation analysis of the total sample of subjects indicated that the higher the occurrence of substitutions, the lower is the number of distortions.

The occurrence of ADI was higher in the less severe group of children (G1). The fact that this group of children, who presented PCC-R higher than 85%, produced more distortions than the others demonstrate that even the less severe children are still

facing a phase of motor speech refinement[2,18] that may be present in children up to 16 years of age[19].

It is important to remember that substitution of consonantal sounds generally result in a great speech unintelligibility that may influence the qualitative classification of severity in children with SSD[20].

The high occurrence of substitutions in children with SSD may reflect a cognitive-linguistic difficulty associated to an auditory perceptual or to a motor speech difficulty or even to an inter-relation between the three of them. When the underlying difficulty is a cognitive-linguistic deficit the child has difficulty in understanding and using phonological rules[2,18,21].

The underlying difficulty based on an auditory perceptual difficulty (usually derived from otitis media episodes) interferes on the establishment of stable phonological representation which provide the basis for the verbal learning[22,23].

The difficulties based on motor speech deficits are usually specific and related to the absence of one or more phonemes or even to the difficulty with the articulation rate which may point to coarticulatory problems[24].

Considering that the effectiveness of speech reflects the proper interaction of the three processings (the cognitive-linguistic, auditory perceptual and the motor speech) there is evidence that children with SSD exhibit a difficulty associated to the network link between these processings. It is important to say that the commitment of one specific processing interferes on the whole system functioning since there is a huge interaction between them[25,26].

The strong negative correlation (for the children from G1 and for the total sample of children) and moderate (for the children from G2) for the indexes PDI and PCC-R showed that the greater the occurrence of phonological processes, the smaller is the number of phonemes correctly produced[27-29]. This finding indicates a commitment of the substituted sound in relation to its use within the phonological system of the language which result in a damaged message.

The presence of a strong positive correlation between the ASI and the PDI and strong negative between ASI and PCC-R in both phonology tasks for the total sample of children with SSD reinforces the fact that the substitution is the most occurring type of error contributes to the severity of the children with SSD[5].

Data analysis based on the total sample of children showed weak negative correlation between the indexes ASI and ADI in the imitation indicating that the children demonstrated an increased number of distortions and a decreasing number of substitutions.

Table 3 – Intragroup correlation for the indexes, PCC-R and PDI for both picture naming and imitation of words tasks

Imitação			IAS	IAD	IAO	PCC-R
G1	ADI	Corr	-76,3%			
		p-value	0,133			
	AOI	Corr	-46,2%	35,9%		
		p-value	0,434	0,553		
	PCC-R	Corr	-23,7%	15,8%	-66,7%	
		p-value	0,701	0,800	0,219	
	PDI	Corr	10,3%	-15,4%	70,0%	-97,5%
		p-value	0,870	0,805	0,188	**0,005***
G2	ADI	Corr	-13,9%			
		p-value	0,721			
	AOI	Corr	58,1%	48,9%		
		p-value	0,101	0,182		
	PCC-R	Corr	-11,7%	22,3%	-10,0%	
		p-value	0,764	0,564	0,798	
	PDI	Corr	31,9%	-11,0%	48,1%	-71,3%
		p-value	0,402	0,779	0,190	**0,031***
G3	ADI	Corr	- x –			
		p-value	- x –			
	AOI	Corr	30,0%	- x –		
		p-value	0,624	- x –		
	PCC-R	Corr	-87,2%	- x –	5,1%	
		p-value	**0,054***	- x –	0,935	
	PDI	Corr	90,0%	- x –	60,0%	-66,7%
		p-value	**0,037***	- x –	0,285	0,219
Total sample	ADI	Corr	-48,2%			
		p-value	**0,027***			
	AOI	Corr	21,8%	38,0%		
		p-value	0,343	0,089		
	PCC-R	Corr	-90,7%	46,0%	-19,2%	
		p-value	**<0,001***	**0,036***	0,403	
	PDI	Corr	84,3%	-35,9%	38,3%	-92,2%
		p-value	**<0,001***	0,110	0,087	**<0,001***
Nomeação			**IAS**	**IAD**	**IAO**	**PCC-R**
G1	ADI	Corr	-80,0%			
		p-value	0,104			
	AOI	Corr	10,3%	35,9%		
		p-value	0,870	0,553		
	PCC-R	Corr	-70,0%	50,0%	-61,6%	
		p-value	0,188	0,391	0,269	
	PDI	Corr	20,5%	35,9%	81,6%	-35,9%
		p-value	0,741	0,553	0,092	0,553
G2	ADI	Corr	17,1%			
		p-value	0,660			
	AOI	Corr	-29,2%	14,8%		
		p-value	0,446	0,704		
	PCC-R	Corr	-75,2%	-16,2%	-12,4%	
		p-value	**0,019***	0,676	0,750	
	PDI	Corr	59,4%	69,1%	28,2%	-62,8%
		p-value	0,092	**0,039***	0,462	0,070
G3	ADI	Corr	- x –			
		p-value	- x –			
	AOI	Corr	-20,5%	- x –		
		p-value	0,741	- x –		
	PCC-R	Corr	-40,0%	- x –	-41,0%	
		p-value	0,505	- x –	0,493	
	PDI	Corr	10,0%	- x –	56,4%	-70,0%
		p-value	0,873	- x –	0,322	0,188
Total sample	ADI	Corr	-25,2%			
		p-value	0,271			
	AOI	Corr	5,4%	21,7%		
		p-value	0,816	0,344		
	PCC-R	Corr	-90,2%	38,8%	-23,7%	
		p-value	**<0,001***	0,082	0,301	
	PDI	Corr	85,6%	-23,2%	30,5%	-93,7%
		p-value	**<0,001***	0,312	0,179	**<0,001***

Legend: *significance, ASI-absolute substitution index, AOI- absolute omission index, ADI- absolute distortion index, PCC-R-percentage of consonants correct revised, PDI-process density index, Corr-correlation.
Statistical Test: Spearman Correlation test.

Table 4- Comparison between groups for the indexes, PCC-R and PDI for both picture naming and imitation of words tasks

Imitation of words		N	Mean	SD	p-value	Picture naming		N	Mean	SD	p-value
	G1	5	8,0%	6,7%			G1	5	6,3%	3,2%	
ASI	G2	9	23,3%	4,7%	**0,001***	ASI	G2	9	28,2%	7,7%	**0,003***
	G3	5	36,8%	2,3%			G3	5	34,6%	5,9%	
	G1	5	8,5%	5,7%			G1	5	6,7%	5,7%	
ADI	G2	9	3,5%	4,7%	**0,028***	ADI	G2	9	3,6%	2,3%	**0,022***
	G3	5	0,0%	0,0%			G3	5	0,0%	0,0%	
	G1	5	4,9%	3,3%			G1	5	3,5%	2,3%	
AOI	G2	9	2,0%	2,2%	0,282	AOI	G2	9	2,8%	2,7%	0,780
	G3	5	3,7%	3,9%			G3	5	2,8%	3,0%	
	G1	5	90,1%	4,0%			G1	5	89,3%	2,0%	
PCC-R	G2	9	77,6%	2,8%	**<0,001***	PCC-R	G2	9	74,1%	6,1%	**<0,001***
	G3	5	57,4%	6,5%			G3	5	58,3%	5,3%	
	G1	5	35,0%	24,0%			G1	5	32,0%	17,0%	
PDI	G2	9	61,0%	10,0%	**0,002***	PDI	G2	9	65,0%	16,0%	**0,001***
	G3	5	117,0%	25,0%			G3	5	115,0%	19,0%	

Legend: *significance, ASI-absolute substitution index, AOI- absolute omission index, ADI- absolute distortion index, PCC-R-percentage of consonants correct revised, PDI-process density index, SD-standard deviation
Statistical Test: Kruskal-Wallis test.

Table 5- Two by two comparison across groups for the absolute indexes, PCC-R and PDI measurements for both picture naming and imitation of words tasks

		Imitation of words task			Picture naming task		
		G1	G2			G1	G2
ASI	G2	**0,004***		ASI	G2	**0,003***	
	G3	**0,009***	**0,003***		G3	**0,009***	0,142
ADI	G2	**0,116***		ADI	G2	0,343	
	G3	**0,018***	**0,052***		G3	**0,019***	**0,012***
PCC-R	G2	**0,003***		PCC-R	G2	**0,003***	
	G3	**0,009***	**0,003***		G3	**0,009***	**0,003***
PDI	G2	**0,052***		PDI	G2	**0,008***	
	G3	**0,009***	**0,003***		G3	**0,009***	**0,003***

Legend: *significance, ASI-absolute substitution index, AOI- absolute omission index, ADI- absolute distortion index, PCC-R-percentage of consonants correct revised, PDI-process density index.
Statistical Test: Mann-Whitney test.

Furthermore, no differences between the types of errors for the children of G1 and high PCC-R values were observed. However, when looking at the absolute value of the ADI we verified that the measure of this index was higher for G1compared to G2 and G3 indicating that these are in an attunement phase of the phonological rules. It is also possible to suggest that the children from G2 and G3 who had the highest number of substitutions present more difficulty in the interaction between the cognitive-linguistic aspects of speech.

Evidences pointed to the fact that children from G1 have a higher number of correct consonants and fewer occurrence of phonological processes involving substitution but more distortions are present. The greater the severity of the SSD (G2 and G3), the greater the occurrence of substitutions and phonological processes and the smaller the

number of consonants produced correctly, resulting in a commitment of the speech intelligibility.

The absolute indexes of substitution, omission and distortion were effective and efficient to identify the types of the most frequent types of errors in children with SSD with varying degrees of severity.

■ CONCLUSION

The results from the present study indicated that Brazilian Portuguese- speaking children with SSD have the substitution as the most prevalent type of error. The less severe children with PCC-R index greater than 85% showed equivalence between the types of errors but, when compared to the more severe children with PCC-R below 85%, showed more distortion and less number of substitutions. On the other hand the most severe participants from the study demonstrated greater occurrence of substitutions, and those with PCC-R between 64 and 50% had no distortion at all.

The ASI, ADI and AOI indexes were both effective and efficient to indicate the type of the most frequent type of error according to the SSD severity measured by the indexes PCC-R and PDI. Further studies with a larger sample of subjects should be conducted in order to detail the linguistic characteristics of Brazilian Portuguese-speaking children with SSD.

RESUMO

Objetivo: descrever e quantificar os erros de fala de crianças com transtorno fonológico de acordo com seu desempenho no índice porcentagem de consoantes corretas-revisado e *process density index*, além de determinar se as crianças com diferentes graus de gravidade diferem quanto ao erro articulatório predominante na fala. **Métodos:** foram analisadas as amostras de fala de 21 crianças com transtorno fonológico de ambos os gêneros, com idades entre 5;2 e 7;11 anos. A partir de duas provas de fonologia (nomeação de figuras e imitação de palavras) foram calculados os índices absolutos de substituição, omissão e distorção, a porcentagem de consoantes corretas-revisado e o *process density index*. **Resultados:** houve diferenças quanto ao tipo de erro predominante na fala indicando que a substituição foi o tipo de erro mais ocorrente. Para as crianças com maior gravidade a substituição foi o tipo de erro de fala predominante e, para aquelas com grau menor gravidade, observou--se ocorrência semelhante dos diferentes tipos de erros. Na análise da amostra total as correlações apontaram que quanto maior a ocorrência de substituição menor o número de distorção. **Conclusão:** de forma geral, a substituição foi o tipo de erro mais ocorrente. As crianças menos graves apresentaram equivalência entre os tipos de erros e as mais graves, maior ocorrência de substituições. Os índices absolutos foram efetivos e eficientes para indicar o tipo de erro mais frequente em função da gravidade do transtorno.

DESCRITORES: Linguagem Infantil; Transtornos da Linguagem; Testes de Linguagem; Otite Média; Avaliação

■ REFERENCES

1. Dodd B. Differentiating speech delay from disorder: does it matter? Topics in Language Disorders. 2011;31(2):96-111.

2. Wertzner HF, Pagan-Neves LO. Differentiating speech delay from disorder: does it matter? Rev Soc Bras Fonoaudiol. 2011;16(4):490-1.

3. Fey ME. Phonological and treatment articulation and phonology: inextricable constructs in speech pathology. Lang Speech Hear Serv Sch.1992;23:225-32.

4. Shriberg LD, Fourakis M, Hall SD, Karlsson HB, Lohmeier HL Mcsweeny JL et al. Extensions to the Speech Disorders Classification System (SDCS). Clin Linguist Phonet. 2010; 24(10):795-824.

5. Shriberg LD. Four new speech and prosody-voice measures for genetics research and other studies in developmental phonological disorders. J Speech Lang Hear Res. 1993;36:105-40.

6. Wertzner HF, Sotelo MB, Amaro L. Analysis of distortions in children with and without phonological disorders. Clinics. 2005;60(2):93-102.

7. Dodd B, Mcintosh B. The input processing, cognitive linguistic and oro-motor skills of children

with speech difficulty. Int J Speech Lang Pathol. 2008;10(3):169-78.

8. Shriberg LD. Classification and misclassification of child speech sound disorders. Paper presented at the America Speech-Language-Hearing Association Convention, Atlanta, GA, November 2002.

9. Shriberg LD et al. Toward diagnostic and phenotype markers for genetically transmitted speech delay. J Speech Lang Hear Res. 2005;48:834-52.

10. Broomfield J, Dodd B. The nature of referred subtypes of primary speech disability. Child Lang Teach Ther. 2004;20(2):135-51.

11. Shriberg LD, Kwiatkowski J. Phonological disorders I: A diagnostic classification system. J Speech Lang Hear Disorders. 1982;47:226-41.

12. Shriberg LD, Kwiatkowski J. Phonological disorders III: a procedure for Assessing severity of involvement. J Speech Lang Hear Disorders. 1982;47:256-70.

13. Edwards ML. Phonological assessment and treatment in support of phonological processes. Lang Speech Hear Serv Sch. 1992;23(3):233-40.

14. Shriberg LD et al. The percentage of consonants correct (PCC) metric: extensions and reliability data. J Speech Lang Hear Res. 1997;40:708-22.

15. Wertzner HF, Papp ACCS, Galea DES. Provas de nomeação e imitação como instrumentos de diagnóstico do transtorno fonológico. Rev Pró-Fono Atual Cient. 2006;18(3):303-12.

16. Andrade CRF, Befi-Lopes DM, Fernandes FDM, Wertzner HF. ABFW: Teste de Linguagem Infantil nas Áreas de Fonologia, Vocabulário, Fluência e Pragmática. São Paulo: Pró-Fono; 2004.

17. Field A. Descobrindo a estatística usando o SPSS. . Tradução Lorí Viali. 2ª. Ed. Porto Alegre: Artmed, 2009. 688p.

18. Shriberg LD et al. Perceptual and acoustic reliability estimates for the Speech Disorders Classification System (SDCS). Clin Linguist Phonet. 2010;24(10):825-46.

19. Kent RD. Motor control: neurophysiology and functional development. In: Caruso, A Strand, E. Clinical management of motor speech disorders in children. New York: Thieme Medical Publishers, 1999.

20. Rvachew S, Chiang P, Evans N. Characteristics of speech errors produced by children with and without delayed phonological awareness skills. Am Speech Lang Hear Assoc. 2007;38:60-71.

21. Wertzner HF, Ramos ACO, Amaro L. Índices fonológicos aplicados ao desenvlovimento fonológico típico e ao transtorno fonológico. Rev Soc Bras Fonoaudiol. 2004b;9(4):199-204.

22. Shriberg LD, Flipsen PJ, Kwiatkowski J, Mcsweeny JL. A diagnostic marker for speech delay associated with otitis media with effusion: the intelligibilityspeech gap. Clin Ling Phonetics. 2003;17(7):507-28.

23. Shriberg LD, Kent RD, Karlsson HB, Mcsweeny JL, Nadler CJ, Brown RL. A diagnostic marker for speech delay associated with otitis media with effusion: backing of obstruents. Clin Ling Phonetics. 2001;15(8):631-50.

24. Smith A. Speech motor development: Integrating muscles, movements, and linguistic units. J Com Dis. 2006;39:331-49.

25. Dodd B, McCormack P. A model of the speech processing for differential diagnosis of phonological disorders. In: Dodd B. Differential diagnosis and treatment of children with speech disorder. London: Whurr; 1995.p. 65-89.

26. Dodd B, Seeff-Gabriel B, Shula C. Research report sentence imitation as a tool in identifying expressive morphosyntactic difficulties in children with severe speech difficulties. Int J Lang Commun Disord. 2010;45(6):691-702.

27. Wertzner HF, Papp ACCS, Galea DES. Provas de nomeação e imitação como instrumentos de diagnóstico do transtorno fonológico. Rev Pró-Fono Atual Cient. 2006; 18(3):303-12.

28. Wertzner HF, Herrero SF, Pires SCF, Ideriha PN. Classificação do distúrbio fonológico por meio de duas medidas de análise: Porcentagem de consoantes corretas (PCC) e índice de ocorrências dos processos (PDI). Rev Pró-Fono Atual Cient. 2001;13(1):90-7.

29. Wertzner HF, Oliveira MMF. Semelhanças entre os sujeitos com distúrbio fonológico. Rev Pró-Fono Atual Cient. 2002;14(2):143-52.

Mailing address:
Haydée Fiszbein Wertzner
R. Cipotânea, 51 – Cidade Universitária – Butantã
São Paulo – SP – Brasil
CEP: 05360-160
E-mail: hfwertzn@usp.br