Speech errors in children with speech sound disorders according to otitis media history

Tipos de erros de fala em crianças com transtorno fonológico em função do histórico de otite média

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ABSTRACT

Purpose: To describe articulatory indexes for the different speech errors and to verify the existence of a preferred type of error in children with speech sound disorder, according to the presence or absence of otitis media history. **Methods:** Participants in this prospective and cross-sectional study were 21 subjects aged between 5 years and 2 months and 7 years and 9 months with speech sound disorder. Subjects were grouped according to the presence of otitis media history: experimental group 1 (EG1) with 14 subjects with otitis media history and experimental group 2 (EG2) with seven subjects without otitis media history. The amount of speech errors (distortions, omissions and substitutions) and the articulation indexes were calculated. Data were submitted to statistical analysis. **Results:** The performances from EG1 and EG2 regarding the indexes were different from each other in both phonological tasks applied. In all analyzes, the indexes evaluating substitutions indicated that this type of error was the most prevalent in children with speech sound disorders. **Conclusion:** The use of indexes was effective to indicate that substitution is the most prevalent type of error in children with speech sound disorders. The greater occurrence of speech errors observed in the picture naming task in children with otitis media history indicates that such errors are possibly associated to difficulties in phonological representation secondary to fluctuating conductive hearing loss.

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

INTRODUCTION

Speech Sound Disorders (SSD) are characterized by a disorder of the phonological system identified by the presence of substitutions, omissions and distortions at an inappropriate age and variable severity. The use of simplifications of phonological rules called phonological processes can result in a variable degree of unintelligible speech[1,2].

Different researches demonstrate the existence of different types of SSD[3,4]. Some authors[5,6] consider that such different types are related to the correlated causes while others[4,7] argument that there are different subtypes of SSD according to the cognitive-linguistic abilities that are affected by the disorder.

Studies[2,3,8,9] described a model of classification of speech disorders of unknown origin by aetiology termed the Speech Disorders Classification System (SDCS) based on the need to participate in the continuing advances in genomic and other biomedical sciences.

The most recent version of SDCS[2,9] presents two branches of the SDCS termed the Speech Disorders Classification System--Typology (SDCS-T) and the Speech Disorders Classification System-Etiology (SDCS-E). The three aetiologic sub-types of speech disorders are those associated with (a) cognitive-linguistic processing constraints that may be, in part, genetically transmitted; (b) auditory-perceptual processing constraints that are the consequence of the fluctuant conductive hearing loss associated with early recurrent otitis media with effusion; and (c) affective, temperamental processing constraints associated with developmental psychosocial involvement.

Auditory-perceptual difficulties that may co-occur with speech disorders especially as a consequence of the fluctuant conductive hearing loss associated with early recurrent otitis media interfere on the establishment of stable phonological representations which are essential for the verbal learning. In such cases articulatory difficulties may be derived from an auditory-perceptual deficit[10,11].

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Conflict of interests: None

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Besides the concern to identify possible causes of speech disorders studies also research on different tests to promote a better characterization of the manifestations presented by children who have this disorder.

To measure the severity of SSD one of the most commonly used indexes is the Percentage of Consonants Correct (PCC), which reflects the percentage of sounds correctly produced during speech. This index assigns equal weight to all three types of speech errors (omission, distortion, and substitution)[3,12,13] unlike the revised version termed PCC-R which scores distortions as correct[14].

Besides PCC and PCC-R there are also other indexes related to the types of speech errors[3]. The absolute indexes (AI) are calculated by dividing the number of specific errors (omission, substitution or distortion) by the number of sounds from the speech sample while the relative indexes (RI) are calculated by the division of the specific number of errors by the number of speech errors produced.

The Articulatory Competency Index (ACI)[3,8] is based on two characteristics of conversational speech: the percentage of consonants articulated correctly and the percentage of all incorrect consonants that is due to articulatory distortions. ACI reflects an upwards adjustment of PCC scores for speakers with proportionally more distortion errors and a downward adjustment of PCC scores for speakers with proportionally more omission and substitution errors.

Clarify the types of speech errors that occur in most children with SSD and the presence of otitis media history in Brazilian Portuguese-speaking children contributes to the diagnosis and facilitates the choice of the most adequate model of language intervention.

The aim of this study was to describe the articulatory indexes that measure the different types of errors verifying the existence of a preferential type of error in children with SSD according to the presence or absence of otitis media history.

METHODS

This study was approved by the Ethics Commission for the Analysis of Research Projects (CAPPesq) of the Clinical Board of the General Hospital and School of Medicine from the University of São Paulo (nº 0958/08). All legal guardians signed the free and informed consent term.

The present study is prospective and cross-sectional. Participants were 21 children (15 male and 6 female) aged between 5;2 and 7;9 years-old diagnosed as children with SSD between January 2007 and December 2009.

Inclusion criteria for participants were: age, diagnosis of SSD realized by the Investigation Laboratory of Phonology from the Department of Physical Therapy, Speech-Language Pathology and Audiology, and Occupational Therapy from the Medical School of the University of São Paulo and the presence of history of three or more episodes of otitis media (OM).

Subjects were grouped into two different groups according to the presence/absence of otitis media history: Experimental Group 1 (EG1) with 14 children with OM history and Experimental Group 2 (EG2) with seven participants without OM history.

SSD diagnosis procedure was the same for both groups. Picture naming and words' imitation tasks from the phonology test of the Infantile Language Test ABFW[15] developed for Brazilian Portuguese-speakers was applied. We used other complementary tests in order to identify the underlying deficits of the disorder such as: stimulability test[16-19], speech inconsistency test[16,20], diadochokinetic evaluation[21-23] and phonological sensitivity test for both auditory task (PST-A) and visual task (PST-V)[24].

The calculi of speech errors (distortions, omissions and substitutions) were based on both phonology tasks. The indexes applied were: percentage of consonants correct (PCC), percentage of consonants correct revised (PCC-R), Relative substitution index (RSI), Relative distortion index (RDI), Relative omission index (ROI), Absolute substitution index (ASI), Absolute distortion index (ADI), Absolute omission index (AOI) and Articulatory competence index (ACI)[3,12-14].

STATISTICAL ANALYSIS

Data was submitted to inferential analysis and significance level adopted was 0.05. Spearman correlation test correlated the indexes from the picture naming task and the words' imitation task with the total sample of subjects.

Intragroup comparisons were verified using Friedman test (for the comparison between indexes) and Wilcoxon test (for the comparison between tasks). Comparison between groups was analyzed by Mann-Whitney test.

RESULTS

Results indicated differences across the groups and also across tasks for the indexes PCC, PCC-R and RSI. EG1 presented differences across tasks for PCC and PCC-R (greater at the imitation task), not observed for EG2. RSI was greater at the picture naming task only for EG2.

General results pointed out that substitutions (evaluated by RSI and ASI) were the most frequent type of error produced by children with SSD.

Correlation of indexes at phonology tasks

Table 1 presents the correlation between indexes applied to the picture naming task and the words' imitation task for the total sample of subjects (21 children). Evidences point to a positive correlation between RI (relative indexes) and AI (absolute indexes) and also among PCC, PCC-R and ACI. ACI also presented positive correlation with RDI.

Intragroup comparison analysis

Table 2 compares the indexes applied to both phonology tasks (picture naming and imitation) for the EG1 (children with OM history) using the Wilcoxon test. ASI, PCC and PCC-R were different between tasks.

Table 3 compares the indexes applied to each phonology task (picture naming and imitation) separately for the EG1

Table 1. Correlation between indexes at phonology test

Imitation task		RSI	RDI	ROI	ASI	ADI	AOI	PCC	PCC-R
RDI	Corr	-64.10%							
	p-value	0.002*							
ROI	Corr	-26.30%	0.30%						
	p-value	0.249	0.99						
ASI	Corr	50.20%	-34.10%	29.80%					
	p-value	0.02*	0.131	0.189					
ADI	Corr	-63.30%	96.80%	4.70%	-21.90%				
	p-value	0.002*	<0.001*	0.841	0.34				
AOI	Corr	-9.20%	-11.60%	87.90%	55.50%	-3.70%			
	p-value	0.691	0.617	<0.001*	0.009*	0.872			
PCC	Corr	-26.70%	14.60%	-34.00%	-91.90%	1.50%	-58.00%		
	p-value	0.242	0.527	0.132*	<0.001*	0.948	0.006*		
PCC-R	Corr	-41.60%	34.90%	-40.70%	-96.50%	23.00%	-59.30%	89.70%	
	p-value	0.061	0.120*	0.067	<0.001*	0.316	0.005*	<0.001*	
ACI	Corr	-50.50%	60.70%	-38.30%	-91.10%	47.30%	-60.70%	79.60%	92.00%
	p-value	0.02*	0.004*	0.087	<0.001*	0.03*	0.004*	<0.001*	<0.001*
Picture naming task		RSI	RDI	ROI	ASI	ADI	AOI	PCC	PCC-R
RDI	Corr	-70.80%							
	p-value	<0.001*							
ROI	Corr	-55.20%	-7.00%						
	p-value	0.009*	0.763						
ASI	Corr	32.80%	-46.40%	18.80%					
	p-value	0.146	0.034*	0.414					
ADI	Corr	-66.70%	94.00%	-1.90%	-27.40%				
	p-value	0.001*	<0.001*	0.934	0.23				
AOI	Corr	-48.20%	-10.40%	93.50%	41.50%	-0.80%			
	p-value	0.027*	0.653	<0.001*	0.061	0.974			
PCC	Corr	1.50%	16.30%	-27.00%	-86.70%	-2.00%	-55.20%		
	p-value	0.95	0.481	0.236	<0.001*	0.933	0.009*		
PCC-R	Corr	-27.20%	51.80%	-28.40%	-95.10%	32.60%	-52.10%	87.80%	
	p-value	0.232	0.016*	0.212	<0.001*	0.15	0.015*	<0.001*	
ACI	Corr	-54.50%	81.30%	-18.20%	-74.60%	74.10%	-30.40%	55.50%	76.20%
	p-value	0.011*	<0.001*	0.43	<0.001*	<0.001*	0.18	0.009*	<0.001*

* Significant value ($p \leq 0.05$) – Spearman Correlation test

Note: Corr = correlation; PCC = percentage of consonants correct; PCC-R = percentage of consonants correct-revised; RSI = relative substitution index; RDI = relative distortion index; ROI = relative omission index; ASI = absolute substitution index; ADI = absolute distortion index; AOI = absolute omission index; ACI = articulatory competence index

(children with OM history) using the Friedman test. Results were similar to both tasks: RSI was different from RDI and ROI and also ASI was different from ADI and AOI. ACI was different from both PCC and PCC-R.

Table 4 demonstrates results for the comparison of indexes between the two phonology tasks (picture naming and imitation) for children with OM history, EG2 (Wilcoxon test). RSI and ASI were different for the two tasks.

Comparison between indexes for each phonology task for EG2 is observed at Table 5 (Friedman test). RSI was different from RDI and ROI and also ASI was different from ADI and AOI at picture naming task. Considering the imitation task, RSI was different from RDI and also ASI was different from ADI. No difference was observed between PCC and PCC-R. ACI was different from both PCC and PCC-R.

Between-groups comparison analysis

Figure 1 presents the comparison across the indexes between EG1 and EG2 at the imitation task. Figure 2 demonstrates the comparison across the indexes between EG1 and EG2 at the picture naming task (Mann-Whitney test). No difference between groups was observed at both phonology tasks

Even though no statistical difference was verified at the

analysis between groups we observed that RSI values were higher for the EG1 (with OM history) at the imitation task and for EG2 (without OM history) at the picture naming task. Mean value of RDI was also higher for EG1 while ROI followed by RSI were higher for EG2. PCC and PCC-R means values were lower for EG1.

Table 2. Comparison of indexes at phonology test for children with otitis media history

EG1		Mean	Median	SD	Q1	Q3	n	CI	p-value
RSI	Imitation	78.1	86.5	28.6	71.8	99	14	15	0.307
	Picture naming	76	79.6	22.7	74.2	93.4	14	11.9	
RDI	Imitation	16.4	0	29.9	14.1	15.5	14	15.7	0.906
	Picture naming	16.7	7.9	22.5	16.1	22.8	14	11.8	
ROI	Imitation	5.5	3.8	6.7	14.1	9.4	14	3.5	0.074
	Picture naming	7.6	5.4	8.4	9.7	9.3	14	4.4	
ASI	Imitation	23.8	23.8	15.1	47.7	37.4	14	7.9	0.016*
	Picture naming	26.4	26	14.9	51.1	37.1	14	7.8	
ADI	Imitation	3.9	0	7.2	9.3	4.4	14	3.8	0.12
	Picture naming	4.9	1.1	8.9	11.1	6.1	14	4.7	
AOI	Imitation	3.5	0.9	5.6	9.3	5.6	14	2.9	0.438
	Picture naming	3.2	1.1	4.5	6.7	3.9	14	2.3	
PCC	Imitation	70	73.8	17.1	33.6	81.5	14	9	0.003*
	Picture naming	65.5	67.2	17.7	31.1	75.3	14	9.3	
PCC-R	Imitation	73.1	78	19.5	37.4	86.9	14	10.2	0.016*
	Picture naming	67.7	72.4	19.8	33.3	80.3	14	10.4	
ACI	Imitation	43.2	37.4	18.8	23.9	48	14	9.8	0.637
	Picture naming	43.1	39.7	15.2	51.1	56.5	14	7.9	

* Significant value (p≤0.05) – Wilcoxon test

Note: EG1 = experimental group 1; Q1 = first quartile; Q3 = third quartile; SD = standard deviation; CI = confidence interval; PCC = percentage of consonants correct; PCC-R = percentage of consonants correct-revised; RSI = relative substitution index; RDI = relative distortion index; ROI = relative omission index; ASI = absolute substitution index; ADI = absolute distortion index; AOI = absolute omission index; ACI = articulatory competence index

Table 3. Comparison between indexes at phonology test for the group of children with otitis media history

		RSI	RDI	ROI	ASI	ADI	AOI	PCC	PCC-R
Imitation task	RDI	0.006*							
	ROI	0.001*	0.441						
	ASI	0.001*	0.177	0.001*					
	ADI	0.001*	0.028*	0.313	0.006*				
	AOI	0.001*	0.333	0.160	0.001*	0.906			
	PCC	0.187	0.002*	0.001*	0.002*	0.001*	0.001*		
	PCC-R	0.245	0.001*	0.001*	0.002*	0.001*	0.001*	0.307	
	ACI	0.030*	0.002*	0.001*	0.048*	0.001*	0.001*	0.002*	0.001*
Picture naming task	RDI	0.003*							
	ROI	0.001*	0.255						
	ASI	0.001*	0.330	0.002*					
	ADI	0.001*	0.012*	0.305	0.005*				
	AOI	0.001*	0.116	0.005*	0.001*	0.529			
	PCC	0.271	0.002*	0.001*	0.003*	0.001*	0.001*		
	PCC-R	0.363	0.001*	0.001*	0.003*	0.001*	0.001*	0.327	
	ACI	0.009*	0.001*	0.002*	0.059	0.001*	0.001*	0.002*	0.002*

* Significant value (p≤0.05) – Friedman test

Note: PCC = percentage of consonants correct; PCC-R = percentage of consonants correct-revised; RSI = relative substitution index; RDI = relative distortion index; ROI = relative omission index; ASI = absolute substitution index; ADI = absolute distortion index; AOI = absolute omission index; ACI = articulatory competence index

Table 4. Comparison of indexes at phonology test for children without otitis media history

EG2		Mean	Median	SD	Q1	Q3	n	CI	p-value
RSI	Imitation	58.4	73.7	34.0	81.0	81.3	7	25.2	0.043*
	Picture naming	82.1	86.5	18.9	82.4	96.3	7	14.0	
RDI	Imitation	11.2	0.0	16.4	14.3	17.7	7	12.1	0.285
	Picture naming	4.9	0.0	8.4	17.6	8.3	7	6.2	
ROI	Imitation	16.1	5.7	17.9	4.8	23.5	7	13.3	0.248
	Picture naming	13.0	7.5	15.8	0.0	23.4	7	11.7	
ASI	Imitation	15.2	13.1	14.1	15.9	23.4	7	10.5	0.027*
	Picture naming	17.8	15.6	15.1	15.6	26.1	7	11.2	
ADI	Imitation	1.7	0.0	2.3	2.8	3.3	7	1.7	0.157
	Picture naming	0.8	0.0	1.4	3.3	1.1	7	1.0	
AOI	Imitation	3.1	1.9	3.0	0.9	4.7	7	2.3	0.343
	Picture naming	2.5	3.3	2.5	0.0	4.4	7	1.8	
PCC	Imitation	80.6	82.2	14.5	80.4	87.8	7	10.7	0.491
	Picture naming	78.4	83.3	15.6	81.1	85.6	7	11.6	
PCC-R	Imitation	80.3	85.9	16.2	81.3	90.7	7	12.0	0.207
	Picture naming	78.0	85.6	17.0	85.6	87.7	7	12.6	
ACI	Imitation	45.6	47.3	12.5	47.3	50.8	7	9.3	0.249
	Picture naming	41.7	43.9	9.5	49.4	49.4	7	7.0	

* Significant values (p≤0.05) – Wilcoxon test

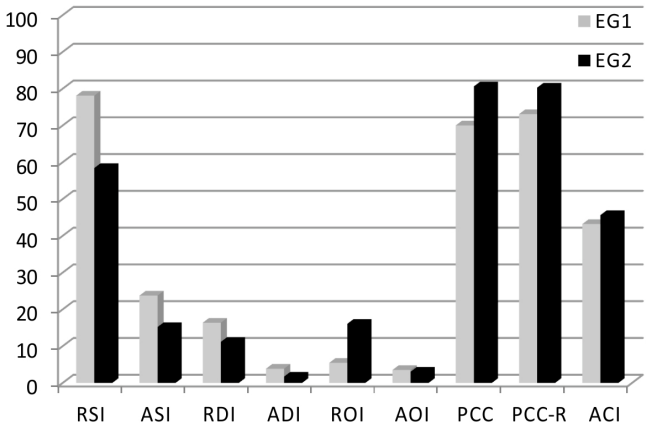
Note: EG2 = experimental group 2; Q1 = first quartile; Q3 = third quartile; SD = standard deviation; CI = confidence interval; PCC = percentage of consonants correct; PCC-R = percentage of consonants correct-revised; RSI = relative substitution index; RDI = relative distortion index; ROI = relative omission index; ASI = absolute substitution index; ADI = absolute distortion index; AOI = absolute omission index; ACI = articulatory competence index

Table 5. Comparison between indexes at phonology test for the group of children with otitis media history

		RSI	RDI	ROI	ASI	ADI	AOI	PCC	PCC-R
Imitation task	RDI	0.046*							
	ROI	0.068	0.753						
	ASI	0.028*	0.753	1.000					
	ADI	0.028*	0.109	0.028*	0.046*				
	AOI	0.028*	0.345	0.026*	0.066	0.596			
	PCC	0.310	0.018*	0.018*	0.018*	0.018*	0.018*		
	PCC-R	0.248	0.018*	0.018*	0.018*	0.018*	0.018*	0.799	
	ACI	0.398	0.018*	0.028*	0.043*	0.018*	0.018*	0.018*	0.018*
Picture naming task	RDI	0.018*							
	ROI	0.018*	0.345						
	ASI	0.018*	0.176	0.612					
	ADI	0.018*	0.157	0.080	0.018*				
	AOI	0.018*	0.686	0.068	0.018*	0.176			
	PCC	0.498	0.018*	0.018*	0.018*	0.018*	0.018*		
	PCC-R	0.612	0.018*	0.018*	0.018*	0.018*	0.018*	0.799	
	ACI	0.028*	0.018*	0.018*	0.063	0.018*	0.018*	0.018*	0.018*

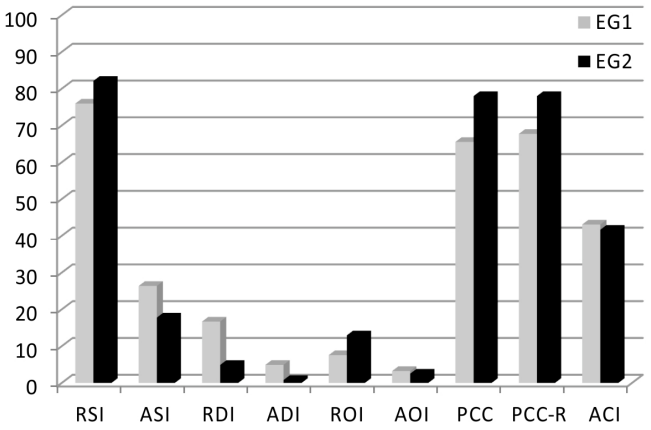
* Significant values (p≤0.05) – Friedman test

Note: PCC = percentage of consonants correct; PCC-R = percentage of consonants correct-revised; RSI = relative substitution index; RDI = relative distortion index; ROI = relative omission index; ASI = absolute substitution index; ADI = absolute distortion index; AOI = absolute omission index; ACI = articulatory competence index



Note: PCC = percentage of consonants correct; PCC-R = percentage of consonants correct-revised; RSI = relative substitution index; RDI = relative distortion index; ROI = relative omission index; ASI = absolute substitution index; ADI = absolute distortion index; AOI = absolute omission index; ACI = articulatory competence index

Figure 1. Comparison between EG1 and EG2 according to the indexes calculated at the imitation task



Note: PCC = percentage of consonants correct; PCC-R = percentage of consonants correct-revised; RSI = relative substitution index; RDI = relative distortion index; ROI = relative omission index; ASI = absolute substitution index; ADI = absolute distortion index; AOI = absolute omission index; ACI = articulatory competence index

Figure 2. Comparison between EG1 and EG2 according to the indexes calculated at the picture naming task

DISCUSSION

Studies developed over the past years involving children with SSD have been indicating that these children need to be classified into different subgroups of the disorder since they present differences in severity, aetiology and type of speech errors made. The co-occurrence of OM history with the disorder is frequently observed in this population but few is described about their speech characteristics.

The correlation between relative and absolute indexes at both phonology tasks is an evidence of their effectiveness on the identification of the most frequent type of error produced but they do not differentiate the groups according to the history of OM.

ACI as well was not an effective index to differentiate one group from the other since we observed positive correlation between this index and PCC, PCC-R and RDI at both tasks. Such finding revealed that the higher the number of correct productions and distortions are, the lower will be the number of both substitutions and omissions resulting into better articulatory competence results[3].

Between-indexes comparison for the group of children with OM history (EG1) indicated that ASI presented the highest mean value while PCC and PCC-R presented the lowest means values at the picture naming task. The worst performance at the picture naming task is an indication that these children have difficulty on assessing the phonological representation of the sound once they are not exposed to a model of production at this task. We believe that this fragility at the phonological representation is associated to a poor ability of discriminating speech sounds, probably caused by the episodes of OM history[10,25-27].

It is interesting to note that children without OM history (EG2) presented omissions as the second most frequent type of error (ROI and AOI) indicating that this error is less frequent than substitutions but more frequent than distortions for this group of children. For the group of children with OM history (EG1) the most frequent type of error was omission. Maybe their auditory-feedback control is committed because of the presence of previous episodes of OM hindering their speech production refinement[26,28].

Between-groups comparison analysis demonstrated that mean values of PCC were lower than PCC-R for children from EG1. Even though this comparison was not significantly different it indicates that PCC-R is more effective to evaluate the severity of children with SSD.

Results showed that participants from this study did not present high values of absolute indexes demonstrating low occurrence of substitutions, omissions and distortions for this population. Thereby the application of these indexes to a good phonology test can provide an overview of the involvement of the oral production of the subject once the absolute indexes relate the number of sounds from the test to the number of errors made.

General findings demonstrated that substitution was the most frequent type of error in children with SSD. Furthermore it is interesting to observe that ACI values as well as the low occurrence of distortions indicate that participants from this study produced errors that can be associated to a deficit at the phonological representation that seems to be influenced by the presence of OM history. The fact that indexes that analyze distortions (RDI, ADI and ACI) were not different between groups suggests that this type of error is not influenced by the phonological representation deficit.

Type and occurrence of errors influence the severity of SSD[14] and speech intelligibility is more committed when substitutions and omissions are presented at these children's speech production.

CONCLUSION

The findings of the study reported here indicate that abso-

lute and relative indexes were effective to indicate substitution as the most frequent type of error presented by children with SSD. This finding is an evidence of the cognitive-linguistic as an important underlying deficit for these children.

RSI, PCC and PCC-R were the indexes that most differentiated the groups between both phonology tasks. The higher occurrence of errors was observed for the group with otitis media history at the picture naming task indicating that this group's difficulty is associated to a deficit at the phonological representation probably caused by the fluctuant hearing loss they experienced.

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RESUMO

Objetivo: Descrever os índices articulatórios quanto aos diferentes tipos de erros e verificar a existência de um tipo de erro preferencial em crianças com transtorno fonológico, em função da presença ou não de histórico de otite média. **Métodos:** Participaram deste estudo prospectivo e transversal, 21 sujeitos com idade entre 5 anos e 2 meses e 7 anos e 9 meses com diagnóstico de transtorno fonológico. Os sujeitos foram agrupados de acordo com a presença do histórico otite média. O grupo experimental 1 (GE1) foi composto por 14 sujeitos com histórico de otite média e o grupo experimental 2 (GE2) por sete sujeitos que não apresentaram histórico de otite média. Foram calculadas a quantidade de erros de fala (distorções, omissões e substituições) e os índices articulatórios. Os dados foram submetidos à análise estatística. **Resultados:** Os grupos GE1 e GE2 diferiram quanto ao desempenho nos índices na comparação entre as duas provas de fonologia aplicadas. Observou-se em todas as análises que os índices que avaliam as substituições indicaram o tipo de erro mais cometido pelas crianças com transtorno fonológico. **Conclusão:** Os índices foram efetivos na indicação da substituição como o erro mais ocorrente em crianças com TF. A maior ocorrência de erros de fala observada na nomeação de figuras em crianças com histórico de otite média indica que tais erros, possivelmente, estão associados à dificuldade na representação fonológica causada pela perda auditiva transitória que vivenciaram.

Descritores: Linguagem Infantil; Transtornos da linguagem; Testes de linguagem; Otite média; Avaliação

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