

# PHONOLOGICAL PROCESSING IN SUBJECTS WITH SPECIFIC LANGUAGE IMPAIRMENT

## *Processamento fonológico em crianças com distúrbio específico de linguagem*

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### ABSTRACT

**Purpose:** to compare the children performance with specific language impairment and normal language development in phonological memory, phonological awareness and lexical access abilities.

**Methods:** 40 subjects, aged between 7 and 10 years old were subdivided in 2 groups: 20 with Specific Language Impairment - Study Group - and 20 normal language development - Control Group and matched according to age and education. The following procedures were applied: Test of Phonology ABFW Language Test, Test of non word of the Phonological Working Memory Proof, Phonological Abilities Profile and the Rapid Automatized Naming - RAN. Qualitative analysis was performed in both groups. For statistical analysis chi square test ( $p \leq 0.05$ ) was performed. **Results:** we found statistical difference between groups in the phonological processing skills. The experimental group showed significantly worse performance compared to the control group. The proof of rapid naming of objects showed no statistically significant difference between groups. **Conclusion:** the majority of children with specific language impairment shows alterations in the abilities of phonological processing, and the performance, compared to normal children, was statistically significant.

**KEYWORDS:** Child Language; Language Development Disorders; Language Development; Child; Employee Performance Appraisal

### ■ INTRODUCTION

Specific Language Impairment (SLI) is a persistent alteration on language development, being identified when there is at least a 12 month delay in relation to expressive language, 6 months in relation to receptive, a difference of 12 months between mental and linguistic ages and performance IQ higher than 85<sup>1</sup>. These characteristics occur in the absence of neurological lesion, motor deficiency or behaviors in the autism spectrum. The term *specific* does not mean that the child would not possess other cognitive difficulties; in general, they

do possess them, however in a lesser degree than the language difficulties<sup>2</sup>.

Different conjectures have been formulated to explain the syntactical, phonologic, semantic, and verbal comprehension difficulties on SLI, and there are today still, debates on which would be the most appropriate way to enlighten the manifestations inside the frame of symptoms. Amongst the hypothesis, there are deficit at the specialized module on language learning, the hearing-perception alterations, memory deficit and the limitations on processing capacity<sup>3</sup>.

Taking in consideration this last hypothesis, several are the mental processes which allow the comprehension of a sentence and take precedent to the action of speech, and they involve perception, memory, meta-language, lexical access<sup>4</sup>. Inside this perspective, the oral and written language problems on SLI subjects are related to alterations on different levels of linguistic information analysis, amongst them, phonologic processing<sup>5,6</sup>.

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Phonologic Processing is a kind of mental operation in which it is used phonologic information during the processing of oral or written language<sup>7</sup>. When there are limitations in it, three aspects have been related to language alterations, in special those related to reading<sup>8</sup>: phonologic awareness, phonologic operational memory and lexical recovery. A deficit on phonologic processing implies on inaccurate or barely specific phonologic displays, which in turn affects, besides the phonologic system, the access to the meaning of words<sup>9</sup>. With this premise as a basis, phonologic working memory (PWM), phonologic awareness (PA) and lexical access (LA) skills have been being tested on subjects with SLI. Amongst these, the most studied is the memory, being that it performs a fundamental role in the acquisition of new words, being associated to the development of linguistic skills such as language comprehension, syntactic processing and reading comprehension<sup>10</sup>. Studies have been demonstrating that the development of SLI is inferior to their regular developed peers on several PWM tasks<sup>11-15</sup>. The skills for fast lexical access and phonologic awareness are also being verified on SLI children, even if with less emphasis.

The lexical access is an operation which allows us to, with ease and speed, understand and reproduce words to code ideas<sup>16</sup>. SLI children answer slower than typical language development (TLD) on lexical access tasks<sup>17-19</sup>. They also show risk of literacy difficulties and this risk appears from the limitations on their phonologic awareness<sup>20</sup>. Significant differences have been encountered between populations with SLI and TLD in relation to metaphonologic skills<sup>21-24</sup>. In spite of the large number of studies

about the difficulties on phonologic memory, lexical access and phonologic awareness on SLI children, these skills were never compared, to identify the most preserved or the most affected skill. This identification can contribute to the creation of more focused intervention plans, but can also minimize the impacts caused by the deficits on these same skills on acquisition and development of written language on these children.

With this on mind, this study has as goal to compare the development of children with SLI and TLD in relation to phonologic memory, lexical access and phonologic awareness skills.

## ■ METHODS

This work has been approved by the Ethics on Research Committee of the Faculdade de Odontologia de Bauru at Universidade de São Paulo (nº80/2007). All parents and responsible adults have authorized the participation of their children in the research, by means of oral explanation followed by signing a Term of Free and Enlightened Consent, as by the resolution nº196/96-CNS/MS.

This was a control-case study, with the participation of 40 school age children (from 2<sup>nd</sup> to 5<sup>th</sup> grade), whose ages ranged from 7 to 10 years old, from both genders. The children were divided in two groups, study (SG) and control (CG), with pairs matching by chronological age and school grade. Figure 1 describes the case-by-case scenario, considering the number of children by school grade and group.

School Year	Number of Children for school year	Number of Children by Group
2 <sup>o</sup> . year	16	8 – EG 8 - CG
3 <sup>o</sup> . year	14	7 – EG 7 - CG
4 <sup>o</sup> . year	06	3 – EG 3 - CG
5 <sup>o</sup> . year	04	2 – EG 2 - CG
	<b>40</b>	<b>40</b>

Legend: EG = Experimental Group; CG = Control Group.

**Figure 1 - Number of children in the sample in each of the school years and in each group - experimental and control.**

The subjects on SG were selected amongst the patients diagnosed with SLI at the Speech-Therapy Clinic in the origin institution that have not been subjected to speech-therapy intervention. To fit in the SG the SLI diagnosis should be confirmed according to the criteria proposed by Leonard<sup>1</sup>: linguistic development under the expected to chronologic and mental age, considering the expression and/or comprehension of oral language; auditory threshold within normalcy standards; performance IQ equals or higher than 80; absence of behavioral and/or emotional issues; absence of classical neurological symptoms such as cerebral palsy, intellectual deficiency, children aphasia (acquired). Such criteria were met on basis on language, audiologic and neuropsychological evaluation data, as described on each patient's chart.

The subjects on CG were selected in two local public elementary schools in the state of São Paulo. The inclusion criteria for the CG subjects were: no historic of complaint and/or alteration on oral language development and hearing, and, compatible performance to chronological age in phonology test. To meet such criteria, first it was done an interview with the teachers questioning about any possible complaints on oral language and hearing. Those who have shown any complaints or history in one or more aspects, were readily excluded from the sample. The subjects without any complaints or history of alterations on oral communication and hearing were subjected to the Phonologic Test – Naming – from the Language Test for Young Children ABFW<sup>25</sup> to confirm the absence of phonologic alterations. Concurrent to applying the test, the children were encouraged to talk to each other, on goals of certifying the good performance in regards to communicative skills and verbal expression.

Once met the inclusion criteria, all of the research subjects were submitted to the study procedures. The data was collected in the Speech-Pathology Clinic of origin, being each subject evaluated individually. The procedures were applied in a session with maximum duration of 50 minutes.

For the working memory evaluation was utilized the Phonologic Working Memory Test<sup>26</sup>, which has the intent of evaluating the number of items that each child can retain and recover from immediate memory after verbal presentation of a list of non-words and digits in inverse and direct order. In this study, only the non-word repetition sub-test was used, in which it was required that the subject repeated 40 non-words (10 disyllabic, 10 trisyllabic and 20 polysyllabic words) immediately after their presentation and in identical manner in

which they were presented. The test is a measure of short-term verbal memory that does not involve concurrent activity. By means of phonologic simplification, in the case of the SLI children, these were previously written at the answers file and were not counted as repetition errors. This way, previously, the SLI subjects were submitted to the naming test of the Language Test for Young Children ABFW<sup>25</sup>, to highlight any possible phonologic alterations, being the phonologic processes considered during the analysis of the answers obtained in the test.

To evaluate the lexical access skill it was utilized the Rapid Automatized Naming test - RAN<sup>27</sup>. In this procedure the child must name as fast as possible the following categories: colors, objects, letters and digits. Each category is printed in a paper to the separately presented to the child, being the naming of each category timed by the evaluator.

The Phonologic Skills Profile<sup>28</sup> was used to evaluate phonologic awareness, which provides data about the individual's capacity to process phonologic aspects of the language.

On the order of procedural presentation, on SG the subjects were previously submitted to the naming test of the Language Test for Young Children ABFW<sup>25</sup> to evaluate phonologic processes. On the order of applying the procedures to evaluate PP, the subjects of both groups were submitted to the Working Memory Test<sup>26</sup>, Rapid Automatized Naming test - RAN<sup>27</sup> (colors rapid naming – CRN; objects rapid naming – ORN; digits rapid naming – DRN; letters rapid naming – LRN) and to the Phonologic Skills Profile<sup>28</sup>.

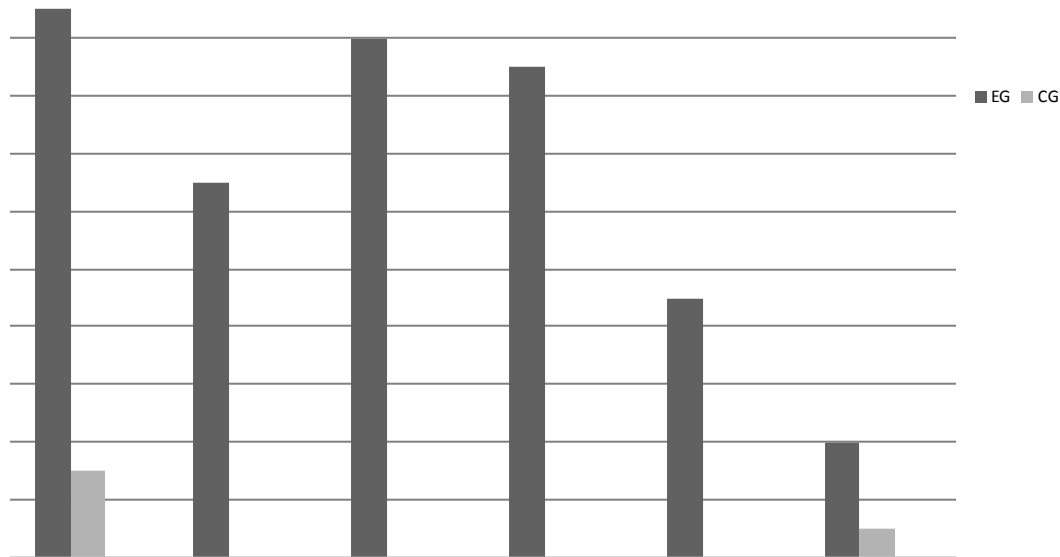
The results were analyzed statistically. To compare the performance of the subjects of the SG and CG at the tests which evaluated PP the statistical analysis was made by means of chi-squared test. In relation to the statistical significance level, on the analysis was adopted a significance level lower or equal than 0.05.

## ■ RESULTS

Figure 2 shows the occurrence percentage of alterations in both groups on tested skills.

Subject analysis has shown that there is statistical difference between the performance of subjects of SG and CG on tests to evaluate PP skills. Subjects on SG have shown significantly worse performances on PP skills when compared to subjects in CG. Only the object rapid naming test has not shown significant statistical difference between groups.

Table 1 shows the *p* values obtained in statistical associations between SG and CG at PP tests.



**Figure 2 - Performance of the subjects of the Experimental Group and the Control Group in tests evaluating the skills of Phonological Processing**

**Table 1 - Values of p obtained in statistical associations between the Experimental**

Test	P Value
Nonword repetition	0,00000037*
Rapid naming of colors	0,00044914*
Rapid naming of letters	0,00000005*
Rapid naming of digitit	0,01318437*
Rapid naming of objects	0,07652250
Phonological Awareness	0,00001141*

Group and the Control Group on tests of phonological Processing  
 \* Qui-quadrado statistical test– considered statistically significant value p smaller or equal to 0.05

In regards to alteration occurrences on PP skills on subjects with SLI, the performance was analyzed in each of the sub-tests of the tests utilized to evaluate the skills in question. The chi-squared statistical test has shown that there is statistical difference on the skills of the SLI subjects, being the  $p$  value  $<0.001$ . Considering the absolute value (percentage of alteration occurrence) the skill which presented the highest gap was Working Phonologic Memory.

## ■ DISCUSSION

In this study, a gap was noticed on the three PP dimensions on SLI subjects (Figure 2). Their bad performance in all tasks suggests that the three dimensions have in common phonologic representations which lack specification. The term phonologic representation is used to describe the storage of information about the phonology of words in long-term memory. The construction process of these representations is still not sufficiently comprehended, but it is known that it allows the speakers to process phonologic information on syllable level, from phoneme and at the beginning of the word before the vowel, and evolves during the first years of children's development<sup>29</sup>. SLI children present phonologic representation deficit when compared to children with TLD and this difference in performance may be explained by the differences in creation and retention of representations in working memory, hearing discrimination and motor planning and execution<sup>30</sup>.

The phonologic shape of words children build has an impact on learning new words, on the comprehension and recovery of mental lexicon<sup>9</sup>. SLI children first recover the meaning, and after the phonologic shape of words in naming drawings tasks, data which can be justified by diffuse lexical representations and incorrectly built phonologic representations<sup>31</sup>. This way, SLI children can fail on the construction of these representations, affecting different parts of phonologic processing, which by turn can draw them to more ample language

alterations, such as verbal comprehension and lexical acquisition.

Literature reinforces the findings on the present study in regards to performance deficit in lexical access tasks<sup>17-19</sup> (Figure 2). The LA is an action which allows access to phonologic data stored in mental lexicon with ease and speed, by means of long-term memory. SLI children may present themselves slower in this process. A study<sup>32</sup> with goals to analyze the performance of 15 subjects, diagnosed with SLI and learning difficulties, at Rapid Automatized Naming test (RAN) has shown that the majority of the children has presented lower-than-expected performance at the test, being that the tests with the highest occurrence of alterations were the rapid naming of numbers and letters, as in this work. The slowness in LA is also related to alterations on phonological representations of the lexical item<sup>9</sup>.

Deficits on PA have also been found on SLI children<sup>21-24</sup>, as in this study (Figure 2). One of the explanations for the literacy difficulties on SLI children come from a psycho-linguistics perspective. It is assumed that young children establish a speaking processing system while they manipulate oral language. This system is used as basis for the development of speech and literacy. All of the problems existent in this system will result not only in spoken language difficulties, but also in PA, which by turn, will have an impact on literacy skills<sup>33</sup>. This way, children with language alterations end being at risk of developing phonologic awareness problems, and consequently, literacy difficulties.

Figure 3 shows *p* values considered statistically significant obtained on associations made between SG and CG over the performance of subjects on tests to evaluate their PP skills. Considering the absolute value (occurring of alterations percentage) the skill which has shown more deficit occurrence was Phonologic Working Memory. Studies<sup>11-15</sup> have been showing that subjects with SLI show limited phonologic storage capacity, pointing that such limitation can be the source to the language difficulties existent on SLI cases. The alteration on non-words repetition tests is appearing to be a linguistic marker in this symptom frame, justifying most of the linguistic alterations, such as sentences comprehension and shortened vocabulary<sup>12,15,34,35</sup>. The hypothesis in which such alterations on the creation of phonologic representations come from PWM deficits has been kept in discussion. When there is a PWM deficit, the phonologic representations are not kept for enough time to build and store a lasting phonologic shape in the mental lexicon<sup>36</sup>. If

there are flaws on the storage of phonologic representations and if such representations, many times, are not created in a correct way, the access and use of such data when required by linguistic processing becomes difficult.

The ascertainment of limitations of phonologic processing on children with SLI has as main objective to bring contributions for intervention, in particular those with basis on the Psycho-Linguistic model. The referred model was based on developed with the purpose of helping to establish hypothesis about the underlying mechanisms of language development and to define intervention strategies which consider the several mental processes which allow the comprehension of a statement and precede the act of speaking<sup>37</sup>. The speech-therapist's role, on this model's outlook, consist on determining, by means of differential diagnosis, the cause of the presented symptoms, the implicated psycho-linguistic factors and, according to those, drawing an individualized intervention program which allows to eliminate not only the symptoms, but also the alterations of the psycho-linguistic processes that created them<sup>38</sup>.

Although children with language Impairments, including those associated with reading, generally show phonologic processing deficits, there is still no understanding on the nature of such deficit. That being, investigations which can bring identifying elements for these alterations are reasonable. This was a cross-sectional study, being that, it has the limitations of a non-procedural investigation, so, it is indicated to perform cross-sectional studies on SLI children to reach a more accurate comprehension on their deficit's nature and its impact on literacy development.

## ■ CONCLUSION

This study has concluded that the majority of SLI children show alterations on PP skills, being the difference in performance when comparison to TLD children statistically significant. Anyway, it is important to highlight that even being the phonologic deficit very important to understanding the source of SLI linguistic difficulties, it is not the only, considering the multi-factorial nature of the symptom's frame.

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**RESUMO**

**Objetivo:** comparar o desempenho de crianças com Distúrbio Específico de Linguagem e com Desenvolvimento Típico de Linguagem em relação às habilidades de memória fonológica, acesso lexical e consciência fonológica. **Métodos:** 40 sujeitos (20 com diagnóstico de distúrbio - Grupo de Estudo e 20 sem distúrbio - Grupo Controle) de 7 e 10 anos de idade, ambos os gêneros, pareados de acordo com a idade cronológica e série escolar. Aplicou-se: Prova de Fonologia do Teste de Linguagem Infantil ABFW; Prova de não palavras da prova de Memória de Trabalho Fonológica; Perfil de Habilidades Fonológicas e Teste de Nomeação Automática Rápida – RAN. Realizaram-se análises estatísticas descritivas e inferenciais, utilizando o teste Qui Quadrado (significância menor ou igual a 0,05). **Resultados:** houve diferença estatística entre os grupos nas habilidades do processamento fonológico. O grupo experimental apresentou desempenho significativamente pior comparado ao Grupo Controle. Apenas a prova de nomeação rápida de objetos não apresentou diferença estatística significativa entre os grupos. **Conclusão:** a grande maioria das crianças com DEL apresentaram alteração nas habilidades do PF, sendo a diferença de desempenho em comparação com crianças com DTL estatisticamente significativa.

**DESCRITORES:** Linguagem Infantil; Transtornos do Desenvolvimento da Linguagem; Desenvolvimento da Linguagem; Criança; Avaliação de Desempenho

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