Cognitive-linguistic indicators in students with phonological disorder at risk for dyslexia

Indicadores cognitivo-linguístico em escolares com transtorno fonológico de risco para a dislexia

Indicadores cognitivo-lingüístico en escolares con trastorno fonológico de riesgo para la dislexia

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Abstract

Introduction: The phonological disorder is characterized by a disorganization of speech that impairs the development of language, being one of the main risk signs for dyslexia, since the phonological skills that should be developed naturally and spontaneously, for the acquisition of oral language were not acquired. This breakdown in acquisition may hinder the development of other skills, such as analysis, synthesis, segmentation and phonemic manipulation, influencing the acquisition of the phoneme-grapheme conversion mechanism for reading and writing learning. **Objective:** This study aims to identify the cognitive-linguistic indicators in students with phonological disorder at risk for dyslexia. **Method:** Participated on this study 40 students from 1st grade of elementary school, aged between 5 years and 11 months to 6 years and 7 months. The students were divided into two groups, GI (20 students without phonological disorder) and GII (20 students with phonological disorder), both groups were submitted to application of the Assessment Protocol of the Cognitive-Linguistics Skills - collective and individual version, composed of skills of reading, writing, phonological awareness, auditory processing and

processing speed. **Results:** The results showed a statistically significant difference for the subtests of all skills evaluated, demonstrating that the students from GI group showed means higher performance when compared to the students from GII. **Conclusion:** It was concluded that the lower performance of GII in the evaluated skills indicates a cognitive-linguistic limitation of these students when compared to students of GI, showing the signs of risk for dyslexia.

Keywords: Child development; Learning; Dyslexia.

Resumo

Introdução: O transtorno fonológico caracteriza-se por uma desorganização da fala que prejudica o desenvolvimento da linguagem, sendo um dos principais sinais de risco para a dislexia, uma vez que, as habilidades fonológicas que deveriam se desenvolver de forma natural e espontânea, para a aquisição da linguagem oral, não foram adquiridas. Esta quebra na aquisição pode dificultar o desenvolvimento das demais habilidades, como análise, síntese, segmentação e manipulação fonêmica, influenciando na aquisição do mecanismo de conversão fonema-grafema para o aprendizado da leitura e da escrita. **Objetivo:** Este estudo tem como objetivo identificar os indicadores cognitivo-linguísticos em escolares com transtorno fonológico de risco para a dislexia. **Método:** Participaram deste estudo 40 escolares do 1º ano do ensino fundamental, com idade entre 5 anos e 11 meses a 6 anos e 7 meses. Os escolares foram divididos em dois grupos, GI: composto por 20 escolares sem transtorno fonológico e GII: composto por 20 escolares com transtorno fonológico, ambos os grupos foram submetidos à aplicação do Protocolo de Avaliação das Habilidades Cognitivo-Linguísticas - versão coletiva e individual, composto por habilidades de leitura, escrita, consciência fonológica, processamento auditivo e velocidade de processamento. **Resultados:** Os resultados apresentaram diferença estatisticamente significante para os subtestes de todas as habilidades avaliadas, demonstrando que os escolares do grupo GI apresentaram médias de desempenho superior quando comparados com os escolares do grupo GII. **Conclusão:** Conclui-se que o desempenho inferior de GII nas habilidades avaliadas indica uma limitação cognitivo-linguística desses escolares quando comparados com os escolares do GI, evidenciando os sinais de risco para a dislexia.

Palavras-chave: Desenvolvimento infantil; Aprendizagem; Dislexia.

Resumen

Introducción: El trastorno fonológico se caracteriza por una desorganización del habla que perjudica el desarrollo del lenguaje, siendo uno de los principales signos de riesgo para la dislexia, ya que, las habilidades fonológicas que debían desarrollarse de forma natural y espontánea, para la adquisición de la lenguaje oral, no se han adquirido. Esta ruptura en la adquisición puede dificultar el desarrollo de las demás habilidades, como análisis, síntesis, segmentación y manipulación fonémica, influenciando en la adquisición del mecanismo de conversión fonema-grafema para el aprendizaje de la lectura y la escritura. **Objetivo:** Este estudio tiene como objetivo identificar los indicadores cognitivo-lingüísticos en escolares con trastorno fonológico de riesgo para la dislexia. **Método:** Participaron de este estudio 40 escolares del 1º año de la enseñanza fundamental, edad entre 5 años y 11 meses a 6 años y 7 meses. Los escolares fueron divididos en dos grupos, GI: compuesto por 20 escolares sin trastorno fonológico y GII: compuesto por 20 escolares con trastorno fonológico, ambos grupos fueron sometidos a la aplicación del Protocolo de Evaluación de las Habilidades Cognitivo-Lingüísticas - versión colectiva e individual, compuesto por habilidades de lectura, escritura, conciencia fonológica, procesamiento auditivo y velocidad de procesamiento. **Resultados:** Los resultados mostraron una diferencia estadísticamente significativa para las pruebas de todas las habilidades evaluadas, demostrando que los escolares del grupo GI presentaron promedios de desempeño superior en comparación con los escolares del grupo GII. **Conclusión:** Se concluye que el desempeño inferior de GII en las habilidades evaluadas indica una limitación cognitivo-lingüística de estos escolares cuando se comparan con los escolares del GI, evidenciando los signos de riesgo para la dislexia.

Palabras clave: Desarrollo infantil; Aprendizaje; Dislexia.

Introduction

Phonological disorder is characterized by speech disruption that impairs language development, due to the presence of substitutions, distortions and omissions of sounds, delayed language acquisition and difficulties in the perception and production of speech sounds, with or without associated neurological factors[1-3].

Such disorder has been identified as one of the main risk signs for dyslexia, since the phonological abilities that should develop naturally and spontaneously during oral language acquisition were not acquired. Failure to acquire these skills may hamper the development of others, such as analysis, synthesis, segmentation and phonemic manipulation, influencing in the acquisition of the phoneme-grapheme conversion mechanism for future learning of the reading and writing[4-8].

Even though the phonological disorder, considered the main sign of risk for dyslexia, should be taken into consideration the set of signs indicative of the condition, being them: difficulty in recognizing letters, not associating the letter/sound relationship, altered sound discrimination, difficulty distinguishing letters with close sounds, recurrent exchanges in speech and early writing learning, difficulty processing sound sequences, difficulty accessing fast and accurately of the visual information, characterizing cognitive-linguistic changes[9].

Dyslexia may be characterized by difficulties in processing linguistic and non-linguistic stimuli brief, rapid and successive. It is related to dysfunctions in perception mechanisms responsible for the temporal auditory processing of information and changes in speech perception, starting with the disruption of the normal development of the phonological system. Such breaks result in problems in reading and spelling learning that are directly associated with oral and written language processing[10,11].

Currently, studies have shown the importance of phonological disorder survey for the early identification of students at risk for dyslexia, aiming at early intervention and the reduction of late diagnoses, which hinder the acquisition and development of reading and writing during the literacy process[12-14]. Thus, early identification of dyslexia has as its initial stage the survey of the main risk signs and their linguistic characteristics[8].

Thus, the presence of phonological disorder associated with poor school performance and the other characteristics described above allow us to identify which students should be submitted to the assessment of the skills necessary for learning to read and write. However, early assessment instruments are still scarce in Brazil and what is found in the international literature involves the use of assessments with predictive skills for literacy, for syllabic and phonemic awareness, auditory discrimination and speed processing skills[15,16].

As a result of the above, this study aimed to identify cognitive-linguistic indicators in students with phonological disorder at risk for dyslexia.

Methods

Participated in these study 40 students from 1st year of elementary education, 17 (%) female and 23 (%) male genders, with ages between 5 years and 11 months and 6 years and 7 months, being divided into:

- **Group I (GI)**: composed of 20 students without phonological disorder who underwent the assessment cognitive-language skills, 10 female gender students and 10 male gender students, aged between 5 years and 11 months to 6 years and 7 months, regularly enrolled in the 1st year of elementary education.

The students from the GI group were indicated by the teachers following the satisfactory performance criterion in two consecutive bimesters, compared to their class group. The data collection from this group was performed at school after the approval of the board; the consent form was signed by the parents or guardians and the consent of the teacher.

- **Group II (GII)**: composed of 20 students diagnosed with phonological disorder who underwent the assessment cognitive-language skills, 7 female gender students and 13 male gender students, with ages between 5 years and 11 months to 6 years and 3 months, regularly enrolled in the 1st year of elementary education.

Group GII students were identified by applying the Child Language Test in the areas of phonology, vocabulary, fluency and pragmatics (ABFW)[17] to identify and confirm the diagnosis of phonological disorder, as well as, by indication of teachers fol-

lowing the criteria of manifestation of risk signs for dyslexia in two consecutive bimesters, compared to their class group.

To determine the severity of the phonological disorder was used the index of Correct Consonant Percentage - PCC[1]; this index verifies the number of correct consonants produced in a speech sample according to the total consonants contained in the sample, which is considered as incorrect consonants omissions, substitutions and distortions, common and unusual.

The severity index of the phonological disorder was calculated after the classification of the phonological processes, the amount and the productivity of each process, observed in the speech sample obtained through naming and imitation tests of the ABFW. This index was calculated by dividing the correct consonants issued by the total consonants of the test multiplied by 100%. Thus, phonological disorder was considered mild if the Correct Consonant Percentage (PCC) rate is 85% to 100%, mildly moderate from 65% to 85%, moderately severe from 50% to 65%, and severe if lower from 50%.

Table 1. Comparison of the severity index of phonological disorder - PCC in the naming and imitation test of GII students

Appointment severity score	Appointment severity score		Total
	1	**2**	
1	16 80.00%	0 0.00%	16 80.00%
2	3 15.00%	0 0.00%	3 15.00%
3	0 0.00%	1 5.00%	1 5.00%
Total	19 95.00%	1 5.00%	20 100.00%
Imitation Degree of severity	**Imitation Degree of severity**		**Total**
	1		
1	17 85.00%		17 85.00%
2	3 15.00%		3 15.00%
Total	20 100.00%		20 100.00%

* Significant values for appointment (p=0.125) – *Signal Test*
* Significant values for imitation (p=0.250) – *Signal Test*
Legend: 1: mild degree of severity; 2: mild-moderate degree of severity; 3: moderately severe degree of severity

All students in this study underwent the same assessment procedure. The choice of the procedure was guided by an instrument that verified the reading of words and non-words, syllable manipulation, phonological ability (rhyme and alliteration), writing and auditory processing skills, so that the skills considered as predictors for acquisition of reading and writing could be evaluated, and belonging to cognitive-linguistic development. Thus, the following procedures were used:

The Cognitive-Linguistic Performance Test - collective version[18], composed of six subtests. They are: alphabet recognition in sequence and

in random order, word and pseudoword dictation, digit dictation, mute dictation with pictures.

The Cognitive-Linguistic Performance Test - individual version[18], composed of 12 subtests. These include: word reading, non-word reading, rhyme, alliteration, syllabic segmentation, auditory discrimination, word and non-word repetition, inverted number play, rapid automatic picture naming, rapid automatic digit naming, rapid automatic colors of the Automatic Naming Test - RAN[19].

The evaluation tests were applied in two sessions, one session for the collective version and

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one session for the individual version, lasting 50 minutes each.

The results were statistically analyzed using the SPSS program (*Statistical Package for Social Sciences*), version 20.0, based on the number of correct answers presented by groups GI and GII. As statistical test, the *Mann-Whitney Test* was used to verify possible differences in the comparison of the studied groups. The significance level adopted was 5% (0.05) and the statistically significant results were marked with an asterisk (*).

This study was submitted and approved by the Research Ethics Committee and approved under protocol number 686/2009.

Results

The presentation of the results regarding the performance of students from GI and GII was organized through tables, for a better visualization of the results obtained in the Cognitive-Linguistic Performance Test - collective and individual version. The subtests were divided into the following skills:

1) Reading Ability: consists of tests of sequential alphabet recognition tests, random alphabet recognition, word reading, non-word reading and correct word reading in 1 (one) minute;

2) Writing Ability: consisting of tests of alphabet writing, word dictation, non-word dictation, total dictation and mute dictation;

3) Phonological Awareness Ability: consisting of tests of alliteration, rhyme and syllable segmentation;

4) Auditory Processing Skill: consisting of tests of sound discrimination, word repetition, non-word repetition, number sequence and inverted number sequence;

5) Processing Speed Skill: consisting of tests of rapid picture naming, rapid number naming and rapid color naming.

Comparing the performance of students from the GI and GII group, we can verify that there was a statistically significant performance for subtests of Alphabet Recognition, Alphabet Recognition in Random Order and Correct Word Reading in 1 (one) minute. The results indicate superior performance for GI compared to GII, in activities involving the alphabet domain, suggesting the reflection of this performance for the decoding required in the subtest of correct word reading in one minute.

Table 2. Comparison of GI and GII students' performance for Reading Ability

Variables	Groups	Mean	Standard deviation	Minimum	Maximum	p-value
Alf	GI	26.00	0.00	26.00	26.00	0.000*
	GII	23.15	4.60	7.00	26.00	
Alf Al	GI	25.85	0.67	23.00	26.00	0.000*
	GII	21.40	5.55	6.00	26.00	
LP	GI	180.75	108.84	60.00	493.00	0.133
	GII	373.45	398.75	0.00	1453.00	
LNP	GI	56.65	31.05	0.00	145.00	0.357
	GII	91.75	91.91	0.00	337.00	
Cor1m	GI	23.15	11.31	0.00	40.00	0.010*
	GII	13.00	11.48	0.00	37.00	

* Significant Values (p≤0.05) – *Mann-Whitney Statistical Test*
Legend: Alf: alphabet recognition in sequence, Alf Al: alphabet recognition in random order, LP: word reading, LPN: non word reading, Cor1m: reading correct words in 1 (one) minute

For the writing ability, when comparing the performance of GI and GII, there was a statistically significant difference for the Alphabet Writing, No-Word Dictation, Total Dictation and Mute Dictation subtests, indicating superior performance for GI students. The results suggest that the lower performance of GII in subtests involving alphabet recognition may be reflecting the ability to manipulate the letters of the alphabet for writing/coding.

Table 3. Comparison of GI and GII students' performance for Writing Ability

Variables	Groups	Mean	Standard deviation	Minimum	Maximum	p-value
E Alf	GI	25.85	0.49	24.00	26.00	0.000*
	GII	20.75	6.46	7.00	26.00	
DitP	GI	17.75	4.51	8.00	26.00	0.065
	GII	12.65	9.19	0.00	28.00	
DitNP	GI	5.15	1.76	2.00	9.00	0.000*
	GII	2.30	2.39	0.00	7.00	
DitT	GI	30.70	5.12	23.00	39.00	0.000*
	GII	14.95	10.66	0.00	33.00	
DM	GI	16.95	1.99	13.00	20.00	0.000*
	GII	5.90	4.90	0.00	14.00	

* Significant Values (p≤0.05) – *Mann-Whitney Statistical Test*
Legend: E Alf: alphabet writing, DitP: word dictation, DitNP: no word dictation, DM: mute dictation

In the comparison of GI and GII, in the performance for the phonological awareness ability, it was verified superior performance average with statistically significant difference for the alliteration and rhyme subtests. The results indicate superior performance of GI, since the students of GII present failures in the phonological perception of sounds. The perception of small sound segments requires the development of the ability to identify, discriminate and manipulate sound segments, suggesting alteration in GII. As well as the proximity in the average performance of the syllabic segmentation tests can be explained by the fact that working with syllables is the sound perception of larger units and easier perception for these students.

Table 4. Comparison of GI and GII students' performance for Phonological Awareness Ability

Variables	Groups	Mean	Standard deviation	Minimum	Maximum	p-value
Alit	GI	18.20	1.61	15.00	20.00	0.000*
	GII	12.85	4.78	0.00	20.00	
Rhyme	GI	17.25	2.29	12.00	20.00	0.000*
	GII	11.05	3.93	3.00	17.00	
SegS	GI	8.70	1.49	4.00	10.00	0.876
	GII	8.45	1.93	3.00	10.00	

* Significant Values (p≤0.05) – *Mann-Whitney Statistical Test*
Legend: Alit: alliteration, SegS: syllabic segmentation

In the auditory processing ability, there was a statistically significant difference for the Sound Discrimination, Word Repeat and Number Dictation subtests. The results allow verifying that the students of GI presented superior average of performance when compared with the performance of GII, suggesting an alteration in the auditory processing of the information, as well as alteration in sequential memory auditory and of short term for the students of GII.

Table 5. Comparison of GI and GII students' performance for Auditory Processing Ability

Variável	Grupo	Média	Desvio-padrão	Mínimo	Máximo	Valor de p
DS	GI	17.40	3.78	5.00	20.00	0.000*
	GII	13.80	2.53	9.00	19.00	
RepP	GI	4.95	0.95	3.00	6.00	0.000*
	GII	3.20	1.20	2.00	6.00	
RepNP	GI	2.30	0.73	1.00	4.00	0.592
	GII	2.40	0.68	2.00	4.00	
Núm	GI	7.05	1.19	4.00	8.00	0.000*
	GII	4.45	1.96	0.00	8.00	
NInv	GI	3.35	1.46	0.00	6.00	0.749
	GII	3.45	1.28	0.00	6.00	

* Significant Values (p≤0.05) – *Mann-Whitney Statistical Test*
Legend: DS: sound discrimination, RepP: words repetition, RepNP: no words repetition, Núm: numbers, NInv: invert numbers

When comparing the performance of GI and GII for processing speed ability, there was a statistically significant difference for the rapid automatic naming of figure and number subtests. The decrease in performance averages refers to the time taken to perform the subtest, so that students from GI had a higher average performance than students from GII, suggesting slower information processing for these students.

Table 6. Comparison of GI and GII students' performance for Processing Speed Ability

Variables	Groups	Mean	Standard deviation	Minimum	Maximum	p-value
NRF	GI	43.30	7.28	32.00	58.00	0.007*
	GII	50.05	7.08	40.00	64.00	
NRN1	GI	43.30	8.26	32.00	63.00	0.002*
	GII	54.65	17.68	0.00	83.00	
NRN2	GI	43.45	7.63	31.00	64.00	0.005*
	GII	53.65	17.84	0.00	83.00	
NRC	GI	73.25	19.30	44.00	116.00	0.155
	GII	83.75	22.30	49.00	117.00	

* Significant Values (p≤0.05) – *Mann-Whitney Statistical Test*
Legend: NRF: rapid naming of figures, NRN1: rapid naming of numbers/first, NRN2: rapid number naming/second, NRC: rapid color naming

Discussion

The results revealed that, in Reading Skill, the GII students presented lower performance than GI students regarding the Alphabet Recognition, Random Order Alphabet Recognition and Correct Word Reading in 1 (one) minute subtests. This allows us to consider that these students have difficulty identifying and storing letters, which reflects at the time of word decoding, suggesting an initial change in reading accuracy to phonological decoding for both real words as to invented words[2,9,20].

Our results are in line with research that seeks to guide the profile of students at risk for dyslexia, since the initial difficulty in the representation and recognition of letters implies the predictor factor for learning to read and later to write.[5,7,21].

Poor performance for the GII group was recurrent in the Writing Skill subtests. The deficit alphabet writing influences negatively in the word coding, since the storage of information in phonological memory is altered, consequently, its retrieval will be ineffective, reflecting the errors presented during word writing. The deficit in the storage and retrieval of phonological information

is characteristic of children with phonological disorder, as well as those who present with the diagnosis of dyslexia, limiting reading and writing language performance[4,6,8,22].

Difficulties in the processing of auditory information, as well as the sound perception of speech elements are perceptible in the performance of students with phonological disorder, belonging to the GII group. These difficulties are indicative of the poor performance in the Alliteration and Rhyme subtests, which make up the Phonological Awareness Skill. The phonological alteration for the discrimination of sounds is characteristic of students with speech changes, and these changes are identified in students with dyslexia. Thus, perceptual-language changes can be identified early of the literacy process, according to the results of this study and previous research[16,23].

Still in the Phonological Awareness Skill, we can verify the similar average performance for the students of GI and GII, in the Syllabic Segmentation subtest. This performance can be explained due to the ease in the identification and perception of larger sound segments, as observed in this subtest; besides, this skill already tends to be worked in the educational field since the early literacy grades, fact that makes the sound better performance of students with phonological disorder[8].

For auditory processing ability, GII students presented lower average performance when compared to the performance of GI students. In order to perform this type of activity, components such as working phonological memory are involved, lexical access, as well as recuperation of information, and discrimination for the information received, and these components are usually altered in students with dyslexia. It is also known that, for students with phonological disorder, it is suggested a change in the processing of auditory information, interfering with the storage and retrieval of phonological information, which strengthens the characterization of the picture of students at risk for dyslexia and justifies the lower performance of students from group GII[24,25].

The alteration in the phonological memory of these students of group GII can also be observed in the performance in the subtests that compose the processing speed ability. The activities proposed in this skill require the recovery, retention and manipulation of different stimuli quickly and successively and if any of these components is changed, there will be failure to perform this skill and tasks involving this mechanism[20,26,27].

Thus, the recovery in working phonological memory and access to the phonological lexicon needs to occur together and harmoniously to result in fluent reading of words and texts, which will be later represented by writing. A possible alteration in the storage and retrieval of phonological information, as can be observed in the students of group GII, cause alteration in the cognitive-linguistic performance[28,29].

Conclusion

According to the data obtained in this study, we can conclude that students with phonological disorder presented alterations in skills of reading, writing, phonological awareness, auditory processing and processing speed, indicating a deficit in cognitive-linguistic performance. Since, for students without phonological disorder, it can be observed a higher average performance in all skills evaluated.

Thus, the results show the need for follow-up of these students with phonological disorder through early intervention, since the main characteristic signs of the risk for dyslexia, involving cognitive-linguistic skills, were identified in this population. Aiming at that, we hope that in the future, it can be determined the evidence or refutation of the dyslexia diagnosis, lowering the late diagnosis rates and/or erroneous.

However, due to the small number of research and instruments developed for students in this age group, studies such as the present one allows us to open new possibilities for future research, with the development of intervention work in groups and individualized in clinical and educational scope.

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