Original Article

Artigo Original

Phonological remediation program in students with learning difficulties

Programa de remediação fonológica em escolares com dificuldades de aprendizagem

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Keywords

Learning disorders
Students
Evaluation
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ABSTRACT

Purpose: To verify the effectiveness of a phonological remediation program in students with learning difficulties. **Methods:** Forty students from 2nd to 4th grades, from both genders, ranging from eight years and one month to 12 years old, were divided into two groups: Group 1 (G1), composed by 20 students with learning disabilities; and Group 2 (G2), composed by 20 students without learning disabilities. The Cognitive-Linguistic Performance Test and the oral reading and comprehension were applied in pre-test and post-test situations in all students. After the pre-test, only the students from Group 1 were submitted to the phonological remediation program. **Results:** After the phonological remediation program, Group 1 presented differences for reading abilities, auditory and visual processing, and processing speed, evidenced by superior performance in the post-testing situation. **Conclusion:** The phonological remediation program was efficient to the development of cognitive-linguistic skills and reading and text comprehension of students with learning difficulties.

Descritores

Transtornos de aprendizagem
Estudantes
Avaliação
Reabilitação/métodos
Leitura

RESUMO

Objetivo: Verificar a eficácia do programa de remediação fonológica em escolares com dificuldades de aprendizagem. **Métodos:** Participaram 40 escolares, de 2ª a 4ª séries do município de Marília (SP), de ambos os gêneros, faixa etária de oito anos e um mês a 12 anos, que foram distribuídos em dois grupos: Grupo 1 (G1), composto por 20 escolares com dificuldades de aprendizagem; e Grupo 2 (G2), composto por 20 escolares sem dificuldades de aprendizagem. Foram aplicados o Teste de Desempenho Cognitivo-Linguístico e a prova de leitura oral e compreensão de textos em todos os escolares, pré e pós testagem. Os participantes do Grupo 1 foram submetidos ao programa de remediação fonológica após a pré-testagem. **Resultados:** Ao final do programa de remediação fonológica o Grupo 1 apresentou diferença para as habilidades de leitura, processamento auditivo, visual e velocidade de processamento, evidenciada por desempenho superior na pós-testagem. **Conclusão:** Houve eficácia do programa de remediação fonológica para o desenvolvimento de habilidades cognitivo-linguísticas e de leitura e compreensão de texto para escolares com dificuldade de aprendizagem.

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INTRODUCTION

There is no consensus on the definition of learning disabilities, nor is it agreed upon how, why or when it manifests itself. According to the literature, learning disabilities are characterized by a heterogeneous group of events that leads to low academic performance on tasks of reading, writing and mathematical calculus. They can be categorized as transient and occur at any time during the teaching-learning process[1,2].

Thus, the difficulty of learning can also be regarded as a specific difficulty in school activities and concerns the discrepancy between what is assumed that the child is potentially able to learn in a given situation in the classroom and what he/she actually performs[3].

In Brazil, there is no estimate on the prevalence of learning disabilities, because this diagnostic category is not within the educational system, however, the inability to read affects from 2 to 8% of elementary school students in Brazil[4].

There is a consensus among researchers that phonological awareness is important for reading acquisition and that most individuals with delayed reading skills present disorders on it[5,6]. The phonological deficit hypothesis has been supported by numerous studies which have identified delays for the sensitivity to rhyme, alliteration, and phonemic segmentation during the development of reading[7-9]. However, studies[6,8] indicate the existence of deficits in addition to problems with phonological processing, such as deficits in working memory, in perceptual-motor automaticity and in rapid naming, which may be present not only in students with learning disabilities, but also in students who have some difficulty in learning the mechanism of phoneme-grapheme conversion during literacy.

Thus, reading difficulties may originate from three kinds of deficits: phonological, naming and double deficit (phonological and naming). The existence of a double deficit causes the most severe reading difficulties resulting in difficulty in decoding words. The difficulty in decoding has implications such as a limitation on the reading of texts of increasing complexity, decreasing reader's exposure to new words, limiting the acquisition of vocabulary and hindering the development of expertise in reading comprehension[5].

There is scientific evidence that highlights the importance of using interventions in early school years[10] for children with learning difficulties, as there are indications that the initial problems with the acquisition of reading mechanisms may not completely disappear after the first school years if the child is not subjected to an intervention program[11].

Although there are international and national studies which describe the use of remediation programs[12-15], there are few national studies on children with learning difficulties, highlighting the need for research to adjust or develop remediation programs for the specific treatment of cognitive-linguistic change in this population.

Due to the above, the aim of this study was to verify the effectiveness of a phonological remediation program in students with learning difficulties.

METHODS

This study is characterized as experimental and longitudinal realized with students after the approval of the Ethics in Research Committee of the Universidade Estadual Paulista (UNESP), under protocol number 2576/2007.

Participants were 40 students from both genders aged between 8 years and 1 month old to 12 years old, from 2nd to 4th grade of elementary education in a public school in Marília – São Paulo - Brazil, divided in the following groups: Group 1 (G1): composed by 20 students, being twelve females and eight males with learning difficulties submitted to a remediation program; Group 2 (G2): composed by 20 students, being ten females and ten males with learning difficulties not submitted to a remediation program.

The students were selected by teachers based on academic performance in two consecutive periods. Those with poor performance are considered students with learning difficulties, and those who had sufficient performance on tests of Portuguese and Mathematics in two consecutive periods are considered students without learning difficulties. From this first selection, the researcher analyzed the student's files following the inclusion criteria: parent signing the Instrument of Consent, no family history of development dyslexia or attention deficit hyperactivity disorder (ADHD), lack of diagnosis of hearing, visual, motor or cognitive disorders, and exclusion criteria: no signing of the Instrument of Consent by parents.

The students were submitted to the following procedures in pre and post-testing:

- Cognitive-Linguistic Performance Test – Collective Version[16]: This version is composed of five subtests: Recognition of the alphabet in sequence, copying forms; Arithmetics (addition, subtraction, multiplication and division); Dictation of 30 real words and ten nonwords, Short-term memory (writing of 16 digits sequence, which can contain from two to nine digits). The results of the subtests of the collective version were registered in the form of scoring, one point being assigned to each correct mark of the student.
- Cognitive-Linguistic Performance Test – Individual Version[16]: This version is composed of ten subtests: Reading words and nonwords (reading of words, reading of correct words in one minute and reading of nonwords), phonological awareness (alliteration and rhyme); mathematical ability (arithmetic and counting down), auditory processing (discrimination of sounds, repetition of numbers, repetition of inverse numbers, rhythmic beats, word repetition and nonword repetition), writing (word spelling, nonword spelling, total spelling) visual processing (visual memory for shapes), processing speed (rapid naming of pictures and rapid naming of numbers); sequencing (alphabet and strings); motor skill (motor skills in right, left and both hands); reversals (reversals of numbers). The results of the subtests of the individual version were registered in the form of scoring, which varied from one to 40 points, one point being assigned to each correct mark of the student.
- Assessment of oral reading and text comprehension: three texts were selected out of the suggestions of 14 teachers

from 2nd to 4th grade of Municipal Schools of Marília - SP. The texts with higher approval ratings from teachers were selected to each grade. Each student was individually evaluated. The texts and questions were presented on A4 paper, typed in Arial, size 16, black, double-spaced. The analysis of the texts was done by counting the errors of words read (reading accuracy), total time of reading and reading speed, which was expressed in words per minute, as described in the literature[17,18]. The number of words per minute was calculated by multiplying the number of words per sixty seconds, and this value was divided by the total time of reading in seconds. The comprehension was analyzed by four questions presented sequentially in the text, to which the students wrote their answers. The questions of the texts were analyzed for comprehension from the count of correct answers in written form, with four correct answers = 100% accuracy (full comprehension), three correct answers = 75% correct, two correct answers = 50% correct, one correct answer = 25% accuracy (partial comprehension), no correct answer = no reading comprehension.

Upon completion of the pre-testing, students with learning difficulties were subjected to a remediation program[19]. Strategies were drawn up for the program from the description of the original research[19], based on psycholinguistic criteria of adaptation for Portuguese[20,21]. The program had a total of 18 cumulative sessions, i.e., every session crafted a new activity associated with the activities from the previous session. The order of activities within the program is described below:

1) Identification of sound and letter: every letter of the alphabet was presented on A4 paper and the students should name them and identify the sounds of the alphabet.
2) Words identification in a sentence: seven statements were spoken and the students were supposed to divide each one into words, marking them by clapping.
3) Syllable identification and manipulation in the word: two words were spoken for the students to identify their syllables and then manipulate the syllables to form new words in initial, medial and final position. In each session, six words were provided to students.
4) Phonemic synthesis: seven words were spoken separated by sounds and the students should recognize them.
5) Rhyme: students were solicited to say words that ended with the same sound and identify pictures that presented rhymes when named.
6) Phonemes identification and discrimination: a phoneme was spoken and the students were asked to say a word that began with this sound. Then, seven words were spoken to the students and they were asked if the target phoneme was in each word or not. The phonemes were presented by following the order of development of speech and language.
7) Phoneme segmentation: a word was presented orally and the students were asked to speak all of the phonemes on it. In this phase of the program colored cards were used to help the students segment the sounds of words spoken. In each session seven words were provided.
8) Phoneme subtraction: six words were presented to the students and they were asked to withdraw the final phoneme, and then six more words for them to withdraw the initial phoneme.
9) Phoneme substitution: a word was presented orally and the students were asked to withdraw the initial phoneme and substitute it with another, forming thus a new word. In each session students were provided with seven words.
10) Phoneme transposition: the students were asked to speak the words in reverse order to form new words.

All students in this study were subjected to evaluations of pre-testing and post-testing, and only the students from G1 were submitted to a phonological remediation program. All data collection was performed at the school by the researcher in a room designated by the director so that the collection could be accomplished individually. The application of the procedures in this study began in February 2008 and ended in April of the same year. Each student was submitted to two sessions for the implementation of the procedures of pre-testing and post-testing, lasting 40 minutes each, and attended the program twice a week during regular class. Each session lasted 40 minutes, totaling 18 therapy sessions.

Statistical analysis was performed based on the number of correct marks between the two groups. The Wilcoxon Signed Rank Test was applied with the objective of verifying possible differences between the situations of pre-and post-testing in the groups. The results were analyzed statistically at a significance level of 5%, with an asterisk when there was a statistically significant difference.

RESULTS

To better present the results of this study, data will be presented from the grouping of the skills assessed in the Cognitive-Linguistic Performance Test. Thus, the data are presented according to the following skills: reading, phonological awareness, auditory processing, processing speed and visual processing.

Table 1 shows the description of the mean, standard deviation and p-value comparison of performance of students from G1 and G2 in pre- and post-testing in the tests of reading skills and phonological awareness of the Cognitive-Linguistic Performance Test.

It was observed that G1 presented a statistically significant difference between pre- and post-testing in the reading skills tests, and there was an increase in the average score in reading words and nonwords and a decrease of reading time, showing that students submitted to the remediation program presented improvement in this skill.

No statistically significant difference was found between the scores obtained by students from G1 in pre- and post-testing on the skill of phonological awareness (rhyme and alliteration).

Table 2 shows the description of the mean, standard deviation and p-value comparison of performance of students from G1 and G2 in the pre- and post-testing in the tests of auditory processing and processing speed of the Cognitive-Linguistic Performance Test.

After applying the Wilcoxon Test, a statistically significant difference was verified, when pre-testing was compared to post-testing, only on the direct memory test for G1. As for processing

Table 1. Performance of students in the pre-testing and post-testing in subtests of reading and phonological awareness skills of the Cognitive-Linguistic Performance Test

	Variable	Group	Evaluation moment	Mean	SD	p-value
Reading abilities	Alp	G1	Pre	24.50	5.84	0.414
			Post	25.80	0.70	
	Alp	G2	Pre	26.00	0.00	0.011*
			Post	24.20	3.61	
	WR	G1	Pre	334.15	174.91	<0.001*
			Post	237.30	131.53	
	WR	G2	Pre	90.50	40.24	0.007*
			Post	79.05	31.57	
	NWR	G1	Pre	33.95	14.38	0.013*
			Post	26.20	13.99	
	NWR	G2	Pre	13.45	5.74	0.005*
			Post	10.80	3.30	
	Cor1m	G1	Pre	13.45	12.95	<0.001*
			Post	22.00	13.11	
	Cor1m	G2	Pre	49.80	17.13	0.009*
			Post	54,65	14,08	
Phonological awareness	Allit	G1	Pre	7.10	2.40	0.254
			Post	8.00	1.52	
	Allit	G2	Pre	9.35	1.57	0.776
			Post	9.55	0.69	
	Rhyme	G1	Pre	12.35	5.20	0.176
			Post	14.10	4.76	
	Rhyme	G2	Pre	17.50	4.94	0.181
			Post	19.15	0.88	

* Statistically significant value ($p \leq 0.05$) – Wilcoxon signed-rank test

Legend: Alp = alphabet recognizing; WR = word reading; NWR = nonword reading; Cor1m = word reading correctly in one minute; Allit = alliteration; SD = standard deviation

speed, there was statistically significant difference in pre-testing and post-testing between the scores obtained by G1 for rapid automatized naming of pictures and rapid automatized naming of digits with the reduction of naming time.

Table 3 is the description of the mean, standard deviation and p-value of the performance of students in pre-testing and post-testing regarding visual processing skills of the Cognitive-Linguistic Performance Test.

After applying the Wilcoxon Test, it was observed that there was a statistically significant difference between pre-testing and post-testing of the scores obtained by G1 on the tests of access to visual processing, copying forms, visual memory for two cards, visual memory for three cards, visual memory for four cards, visual memory for five cards, and there was an increase in the number of correct answers in these tests.

Table 4 shows the description of the mean, standard deviation and p-value of the performance of students in G1 and G2 in pre- and post-testing on reading and reading comprehension.

After applying the Wilcoxon Test, it was observed in relation to G1 statistically significant difference between pre- and post-testing, with an increased number of words read correctly, less time and increased speed in reading and enhanced skills in reading comprehension. As for G2, we found statistically significant difference in reading accuracy, speed and total time of reading, however, no statistically significant difference in reading comprehension. These results demonstrate that the improvement in the reading comprehension of G1 is due to the remediation program.

DISCUSSION

The analysis revealed the difference in performance of participants from G1 in relation to G2 in reading skills, phonological awareness, auditory processing, visual processing speed, assessed by the Cognitive-linguistic Performance Test. These results corroborate studies[5,22,23] showing that the difficulties of poor readers compared to good readers are primarily related to phonological processing, including phonological awareness, auditory memory and discrimination, access to the recovery of phonological information and phonological working memory. In this study, the participants from G1 pre-

Table 2. Performance of students in the pre-testing and post-testing in auditory processing and speed processing skills of the Cognitive-Linguistic Performance Test

	Variable	Group	Evaluation moment	Mean	SD	p-value
Auditory processing abilities	SDi	G1	Pre	18.35	2.23	0.153
			Post	17.45	2.54	
	SDi	G2	Pre	19.40	1.64	0.865
			Post	19.45	1.32	
	WRep	G1	Pre	3.35	1.27	0.120
			Post	3.90	1.48	
	WRep	G2	Pre	4.25	1.41	0.008*
			Post	5.00	1.03	
	NWRep	G1	Pre	4.00	0.97	0.681
			Post	3.90	1.12	
	NWRep	G2	Pre	4.85	1.39	0.448
			Post	5.00	1.03	
	NumRep	G1	Pre	6.20	2.75	0.046*
			Post	7.75	2.28	
	NumRRep	G2	Pre	8.00	1.56	0.190
			Post	8.60	1.90	
	NumRRep	G1	Pre	2.65	0.88	0.337
			Post	2.95	1.15	
	NumRRep	G2	Pre	4.35	1.60	0.661
			Post	4.50	1.54	
Processing speed	RANf	G1	Pre	54.85	10.61	<0.001*
			Post	41.00	8.04	
	RANf	G2	Pre	33.40	5.77	0.190
			Post	32.10	5.38	
	RANd	G1	Pre	117.55	31.83	<0.001*
			Post	91.30	19.98	
	RANd	G2	Pre	68.80	20.56	0.003*
			Post	61.50	16.39	

* Statistically significant value ($p \leq 0.05$) – Wilcoxon signed-rank test

Legend: SDi = sounds discrimination; WRep = word repetion; ReNP = nonword repetition; NumRep = number repetition; NRRep= number reverse repetition; RANf = rapid automatized naming of figure; RANd = rapid automatized naming of digits; SD = standard deviation

sented lower performances when compared to G2 in the skills of phonological awareness, auditory processing (words and nonwords repetition), direct and indirect memory for digits, indicating the presence of phonological deficits.

The ability to recognize a pattern of letters within words as a unit is important for fluent reading[23]. This skill is based on previously established memory representations of common letter patterns and can be impaired if there is a deficit in naming speed. These deficits are related to the difficulty in accessing and retaining phonological information in long-term memory[24].

These results demonstrate that the students from G1 presented inferior performance in relation to G2 in pre-testing in tests of rapid automatized naming of digits and figures, as shown the literature[25], which indicates the presence of alteration in auditory memory in children with learning difficulties. These results also corroborate a study[26] which described inferior results in phonological awareness and rapid naming in children with learning difficulties when compared to children without difficulty.

By analyzing results of G1 on reading skills in pre- and post-testing, statistically significant difference was found for word reading, nonwords reading and words read correctly in one minute, and there was an increase in the average of correct answers and reduction of reading time in post-testing. These results are in line with a study[27] which describes the increase in performance of children in words and nonwords reading after the application of a therapeutic procedure that included explicit teaching of phonological awareness and grapheme-phoneme correspondence. In this study, the influence of the remediation program in the progress of students with reading difficulties was also evidenced by a statistically significant difference between pre-testing and post-testing for accuracy and speed of reading, but only G1 presented statistically significant difference between the pre- and post-testing for reading comprehension. These results are consistent with a study[28] which described that after participation in interventions that focused on phonological awareness the children demonstrated superior skills in the post-testing of nonwords reading and reading comprehension tasks.

These results are in accordance with research[27] that linked the improvement in word recognition with the improvement in reading comprehension. Participants in the G1 had a statistically significant difference between pre-testing and post-testing on

Table 3. Performance of students in the pre-testing and post-testing in visual processing skills of the Cognitive-Linguistic Performance Test

	Variable	Group	Evaluation moment	Mean	SD	p-value
Visual processing abilities	PC	G1	Pre	3.80	1.96	0.013*
			Post	5.05	1.73	
	PC	G2	Pre	4.85	1.87	0.019*
			Post	5.90	1.33	
	VM2	G1	Pre	3.25	1.07	0.035*
			Post	3.90	0.45	
	VM2	G2	Pre	3.70	0.73	0.083
			Post	4.00	0.00	
	VM3	G1	Pre	4.05	1.50	0.010*
			Post	5.15	1.09	
	VM3	G2	Pre	5.25	1.12	0.387
			Post	5.55	0.83	
	VM4	G1	Pre	3.30	3.11	0.020*
			Post	5.40	1.73	
	VM4	G2	Pre	5.25	2.59	0.190
			Post	6.30	1.87	
	VM5	G1	Pre	3.25	3.73	0.022*
			Post	5.65	2.48	
	VM5	G2	Pre	5.65	2.46	0.003*
			Post	8.05	1.76	

* Statistically significant value (p≤0.05) – Wilcoxon signed-rank test
Legend: PC = Picture copy ; VM2 = visual memory with two cards; VM3 = visual memory with three cards; VM4 = visual memory with four cards; VM5 = visual memory with five cards; SD = standard deviation

Table 4. Performance of students in the pre-testing and post-testing in reading skill and reading comprehension

	Variable	Group	Evaluation moment	Mean	SD	p-value
Reading and reading comprehension	RA	G1	Pre	88.85	77.24	0.003*
			Post	47.15	51.81	
	RA	G2	Pre	9.20	21.36	0.024*
			Post	3.45	3.66	
	TT	G1	Pre	787.70	472.50	0.001*
			Post	533.55	316.53	
	TT	G2	Pre	196.55	91.95	0.006*
			Post	176.90	66.28	
	S	G1	Pre	22.14	13.81	<0.001*
			Post	32.29	17.06	
	S	G2	Pre	89.59	54.55	0.012*
			Post	89.77	30.39	
	COMP	G1	Pre	5.00	13.08	0.002*
			Post	23.75	27.48	
	COMP	G2	Pre	41.25	28.42	0.058
			Post	52.50	21.31	

* Statistically significant value (p≤0.05) – Wilcoxon Signed-rank Test
Legend: RA= reading accuracy; TT = total time of reading; S = reading speed; COMP = reading comprehension; SD = standard deviation

word reading tests and number of words read correctly in one minute, showing an improvement in decoding skills after the intervention program, as well as in the text comprehension test.

These results are consistent with the literature[29] which noted that efficient decoding relieves the cognitive load, allowing more attention to be directed to comprehension. Literature[30] has indicated that reading comprehension is based on working memory. In this study, children with reading difficulties (G1) showed a statistically significant difference in the situation of pre-and post-testing among the scores for rapid automatized naming of figures and rapid automatized naming of digits, indicating an improvement in working memory after the program intervention, and improved skills in reading comprehension.

However, it is noteworthy that students from G2, who were not submitted to a phonological remediation program, showed improvement in post-testing compared to pre-testing, highlighting that the work of teachers in the classroom favored the acquisition and development of the alphabetic principle of the writing system in Portuguese, however, if not carried out systematically and instructionally it can cause delays in the development of cognitive-linguistic skills for reading acquisition. What proves this assertion is the fact that students in G1, even after being submitted to a phonological remediation program, could not reach the average performance of students from G2.

CONCLUSION

It can be concluded that the remediation program was effective for students with learning disabilities to obtain improved performance with regard to reading skills, auditory processing, visual processing speed and reading comprehension.

The results of this study indicate the necessity of using instruments of intervention with children with learning disabilities which have the basic structure of the writing system in Brazilian Portuguese. Only through the explicit teaching of rules associated with the phoneme-grapheme conversion and reading and text comprehension practices in the classroom can we minimize the number of students who have learning problems due to lack of systematic education and focus on the alphabetic principle of Portuguese, as the students from G1 could only parallel in the performance of reading skills, auditory processing, visual processing speed and reading comprehension with G2 after they took part in the intervention proposed.

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