Original Article

Artigo Original

Performance of students with dyslexia, learning disabilities and learning difficulties in metaphonological abilities tests (PROHFON)

Desempenho de escolares com dislexia, transtornos e dificuldades de aprendizagem em provas de habilidades metafonológicas (PROHFON)

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Keywords

Evaluation
Learning
Dyslexia
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Education

ABSTRACT

Purpose: To elaborate a procedure of metaphonological evaluation, and to characterize the performance of students with developmental dyslexia, learning disabilities and learning difficulties and good readers in this evaluation. **Methods:** Metaphonological abilities tests were elaborated based on the necessary skills for reading and writing development. Participants were 134 students from 3rd to 5th grades of elementary school of both genders, with ages between 7 and 13 years, divided into GI (20 students with developmental dyslexia), GII (20 students with learning disabilities), GIII (20 students with learning difficulties) and GIV (74 good readers). The assessment of metaphonological abilities – PROHFON – was applied. **Results:** Students from GI and GII differed from GIV in most of the tests; GI differed from GII only in the phonemic synthesis and analysis test, and from GIII in abilities of deletion and combination of phonemes. GIII differed from GIV in counting, identification, rhyming, deletion, and combination abilities. **Conclusion:** Students with developmental dyslexia, learning disabilities and learning difficulties, and good readers showed similar performances in identification, counting and combining phonemes, rhyme and alliteration abilities. The groups differed from each other regarding syllabic (counting, identification, synthesis and analysis, deletion, combination) and phonemic (deletion, synthesis and analysis) abilities. The PROHFON contributed to characterize the metaphonological profile of students with different learning deficits.

Descritores

Avaliação
Aprendizagem
Dislexia
Transtornos de aprendizagem
Educação

RESUMO

Objetivo: Elaborar um procedimento de avaliação de habilidades metafonológicas e caracterizar o desempenho de escolares com dislexia do desenvolvimento, transtornos e dificuldades de aprendizagem, e bom desempenho acadêmico. **Métodos:** Foram elaboradas provas de habilidades metafonológicas baseadas em habilidades necessárias para o desenvolvimento da leitura e da escrita. Participaram 134 escolares do 3º ao 5º ano do ensino fundamental, de ambos os gêneros, com faixa etária entre 7 e 13 anos de idade, divididos em GI (20 escolares com dislexia do desenvolvimento), GII (20 escolares com transtornos de aprendizagem), GIII (20 escolares com dificuldades de aprendizagem) e GIV (74 escolares com bom desempenho acadêmico). Foi aplicada a avaliação das habilidades metafonológicas – PROHFON. **Resultados:** GI e GII diferenciaram-se de GIV na maior parte das provas; GI diferenciou-se de GII apenas na prova de síntese e análise fonêmica e de GIII em habilidades de deleção e combinação de fonemas. GIII diferenciou-se de GIV nas habilidades de contagem, identificação, rima, deleção e combinação. **Conclusão:** Escolares com dislexia do desenvolvimento, transtornos e dificuldades de aprendizagem, e bom desempenho acadêmico apresentam desempenhos semelhantes nas habilidades de identificação, contagem e combinação de fonemas, rima e aliteração. Os grupos diferenciam-se em relação às habilidades silábicas (contagem, identificação, síntese e análise, deleção, combinação) e fonêmicas (deleção, síntese e análise). O PROHFON contribuiu para a caracterização do perfil metafonológico de escolares com diferentes comprometimentos em aprendizagem.

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INTRODUCTION

There are many existing learning problems that can interfere with children's school performance. Among them is the difficulty in the use of metaphonological abilities to acquire and to develop reading and writing[1].

The assessment of metaphonological skills has become important because of its relationship with reading and writing. The assumption that, in alphabetic systems, learning skills like reading and writing involve a deliberate reflection of speech, in order to make it the object of conscious attention and to enable the development of metalinguistic awareness, has been a consensus among diverse authors[2,3].

In Brazil, there are many procedures with the purpose to evaluate metaphonological abilities, such as the Phonological Awareness Test[4], Phonological Awareness Skills[5], Profile of Phonological Skills[6], Sequential Assessment Instrument[7], Protocol for the Evaluation of Cognitive-linguistic Skills[8] and the Metalinguistic Skills and Reading Protocol[9]. However, most of them have not focused the classroom context and the importance of the teacher as the evaluator of these competences.

For the speech-language therapist to be able to assess metaphonological skills it is necessary that the choice of assessment procedure be performed carefully and consistently. The performance of the students could be influenced by various aspects of the procedures, such as the complexity of the terms used, the quality of the stimuli (auditory, visual), the overcharge of working memory due to an excessive number of items, the linguistic complexity of testing (manipulation of different size of units such as words, syllables, phonemes, segments of rhyme or alliteration) and specific cognitive operations required by different types of tests [10,11].

The choice of an evaluation procedure of metaphonological skills should allow the identification of which students tend to have difficulties that could negatively impact the development of reading and writing. Thus, the procedure may help professionals in the health and education areas in early identification and diagnosis of the problems of learning to read and write[12].

This discussion about the use of appropriate procedures to evaluate the metaphonological skills is needed because students with dyslexia, learning disabilities and learning difficulties have difficulties in accessing and retrieving phonological information which are necessary for good performance on tasks of oral reading and writing[13-19]. However, the establishment of the metaphonological profile of these different conditions that affect learning is still a subject of discussion in national and international literature[3,4,13-15,18].

Developmental dyslexia is a genetic condition, which consists of a pronounced and persistent difficulty in acquiring reading, resulting in a deficit in the phonological component of language[16,19,20]. Learning disabilities consist of a wide range of manifestations, such as disorders of listening, speaking, reading, writing and mathematics being the most prevalent type of learning diagnosis [21,22]. Regarding the learning difficulties, there is no consensus on its definition, or how, why neither when it manifests itself. According to literature, learning difficulties are characterized by a heterogeneous group of events leading to low academic performance on tasks of reading, writing, and mathematic calculus. It can also be categorized as transient and occur at any time of the teaching-learning process [23,24].

Based on the exposed, the aim of this study was to develop a metaphonological evaluation procedure and to characterize the performance of students with dyslexia, learning disabilities, learning difficulties, and good readers in this evaluation.

METHODS

This study was approved by the Ethics Committee of the School of Philosophy and Science – FFC/UNESP – Marília (SP), Brazil, under number 1880/2008. All the caretakers of the students signed the Term of Free and Informed Consent (TFIC).

The realization of the study was divided into two parts: the elaboration of the procedure of metaphonological evaluation – PROHFON[12]; and the application of this procedure in students from 3rd to 5th grades of elementary school, of both genders, with ages between 7 and 13 years, with developmental dyslexia, learning disabilities, learning difficulties, and good readers.

Elaboration of the metalinguistic evaluation procedure – PROHFON

The evaluation of students through tests of metaphonological abilities has become important because of the relationship between these skills and success in learning to read and to write in the alphabetic system of Portuguese. Such evaluation has become justified by the fact that these skills are developed as soon as the students initiate the literacy[25].

Moreover, this procedure is critical to identify the student with phonological deficit and to predict the ability of young children to develop their reading according to schooling. This reinforces the importance of the students to receive explicit instruction about phonological awareness[2,3].

The purpose of this evaluation procedure has taken into account that its application would be available for teachers in the classroom and also for other healthcare professionals in clinics or reference centers. Therefore, it was composed with words and figures, available in database banks of words and figures prepared for this study. Both were selected in accordance with the phonological principles of the Portuguese language, through language criteria for inclusion and exclusion of words[13]. The words were extracted from students' vocabulary in a database bank of words available at the Investigation Laboratory of Learning Disabilities of CEES/FFC/UNESP – Marília (SP), Brazil. This database consists of words that were extracted from the books used in the discipline Portuguese from 1st to 4th grades of elementary school, in the Municipal Schools[9,18]. The type of stimulus that has been chosen was the visual (noun pictures), in order to provide a model of the target phoneme or syllable for the evaluator and to alleviate the overcharge of the phonological working memory for the student.

The procedure consisted of 12 tests, five of phonemes and syllables (counting, synthesis and analysis, identification, deletion, combination), and two tests of rhyme and alliteration.

Two examples were placed in each test, so the evaluator could explain the test proposal and to make sure that the student had understood what was required (training). We stress out that the examples were not used to compute responses of the students. The procedure consisted of an answer sheet for the use of the evaluator, and an answer sheet for the students to write their answers. This format has been designed to give children greater autonomy to respond the test and to feel less constrained by observation of the evaluator, and also to simulate a common activity in the classroom. The score was performed by assigning one point for correct answers and 0 for incorrect answers or absence of answers.

Application of the metalinguistic evaluation procedure – PROFON[12] in students with developmental dyslexia, learning disabilities, learning difficulties and good readers

Participants were 134 students from 3rd to 5th grade of elementary school, of both genders, with ages between 7 and 13 years. The students were divided into:

- Group I (GI): consisted of 20 students with interdisciplinary diagnosis of developmental dyslexia. The diagnosis was made according to criteria cited in the literature. The children were considered dyslexic when they presented the following criteria in situations of interdisciplinary assessment: disorder on the static balance and appendage coordination, motor persistence, dynamic balance, coordination, trunk-member and sensitivity in the evolutionary neurological examination, normal cognitive function and discrepancy between intellectual and verbal coefficient at the WISC-III-R scale in the psychological evaluation, alteration regarding memory, reading and writing in the neuropsychological battery; alterations regarding phonemes, syllables, rhyme and alliteration in tests of phonological awareness, level of alphabetic reading, oral reading speed lower than expected for age and education level, phonological disorder confirmed by a phonological assessment, oral reading of texts and of isolated words and writing under dictation of words and nonwords, thematic writing and partial understanding of text read[14,18].
- Group II (GII): consisted of 20 students with interdisciplinary diagnosis of learning disabilities. The diagnosis was made according to the same difficulties faced by students with dyslexia, accompanied by significant alterations in the syntactic and semantic language abilities and mathematic calculus, both for isolated calculus or dependent on reading and understanding the problem statement for their resolution.
- Group III (GIII): consisting of 20 students with learning difficulties of a school in Marília (SP), Brazil, who showed poor performance (scoring below 5.0) in two consecutive periods in tests of Portuguese Language and Mathematics, according to the indication of teachers.
- Group IV (GIV): composed of 74 students with good academic performance from a regular school in Marília (SP), Brazil. All showed satisfactory performance (scoring above 5.0) in two consecutive periods in tests of Portuguese and Mathematics, according to the indication of teachers. The students in this group were matched with those of GI, GII and GIII, according to school grades.

The students from GI, GII and GIII were registered in schools in the city of Marília (SP) and Botucatu (SP), Brazil, and at the waiting list of the Investigation Laboratory of Learning Disabilities of CEES/FFC/UNESP – Marília (SP), Brazil. The interdisciplinary diagnosis of these groups was carried out in a month by a team consisting of a speech language therapist, a neuropsychologist, a child neurologist and a psychopedagogist. After receiving the diagnosis, the application of the procedure (PROHFON) was started with all students at the Laboratory for Research on Learning Differences and the Clinic of Child Neurology – Learning Disabilities Hospital of the School of Medicine – HC/FM/UNESP – Botucatu (SP), Brazil. Data collection was performed at the same time period in the four groups that comprised the study.

The procedure lasted approximately three months, being held between May and August of 2010. It took 20 sessions, each lasting between 40 to 50 minutes to apply for a total of 134 students divided into groups of 10 students according to the groups to which they belonged.

The statistical analysis used was the Statistical Package for Social Sciences (SPSS) 17.0, performed by the Kruskal-Wallis test, in order to verify possible differences between the four groups compared simultaneously for the variables of interest. It was also applied the Mann-Whitney test adjusted by Bonferroni correction, which aimed to identify which groups differed from one another when compared. It was adopted a significance level of 5% (0.05).

RESULTS

The results were analyzed quantitatively and were submitted to statistical analysis to compare the performance of students from GI, GII, GIII and GIV. The results indicate that there were differences between GI, GII, GIII and GIV in tests of syllable ($p=0.001$) and phonemes counting ($p=0.001$), synthesis and analysis of phonemes ($p=0.001$), identification of syllables ($p<0.001$) and of phonemes ($p<0.001$), rhyme ($p<0.001$), alliteration ($p<0.001$), syllable ($p<0.001$) and phonemes deletion ($p<0.001$), and combination of syllables ($p<0.001$) and phonemes ($p<0.001$). There was no difference in the test of synthesis and analysis of syllables (Table1).

The performance of GIV was higher in all the tests, and decreased to GIII, GI and GII (GIV>GIII>GI>GII) in the tests of syllable counting, synthesis and analysis of phoneme, identification of syllable and phoneme rhyme, alliteration, syllable and phoneme deletion, syllable and phoneme combination (Table 1). These data indicate that students with learning difficulties showed better domain of the use of metaphonological skills in relation to students with dyslexia and learning disabilities.

The performance of GIII was higher than GII and GI in most of the tests, except in the phoneme counting test. Thus, students with learning disabilities showed poorer performance only in that skill.

Table 1. Intergroup performance on tests of metaphonological skills – PROHFON

Tests	Groups	n	Mean	SD	p-value	Tests	Groups	n	Mean	SD	p-value
SC	I	20	12.15	2.56	0.001*	PC	I	20	12.15	2.56	0.001*
	II	20	10.60	4.36			II	20	10.60	4.36	
	III	20	12.80	3.47			III	20	12.80	3.47	
	IV	74	13.70	2.14			IV	74	13.70	2.14	
	Total	134	12.87	3.02			Total	134	12.87	3.02	
SAS	I	20	9.70	0.57	0.152	SAP	I	20	7.95	1.91	<0.001*
	II	20	9.85	0.49			II	20	6.10	2.17	
	III	20	9.55	0.89			III	20	8.65	3.12	
	IV	74	9.84	0.57			IV	74	9.68	1.27	
	Total	134	9.78	0.62			Total	134	8.73	2.26	
IS	I	20	11.85	2.48	<0.001*	IP	I	20	6.70	3.11	<0.001*
	II	20	10.20	3.76			II	20	3.95	3.05	
	III	20	12.25	2.20			III	20	7.50	4.11	
	IV	74	14.14	1.38			IV	74	11.65	3.26	
	Total	134	12.93	2.61			Total	134	9.14	4.45	
R	I	20	4.50	1.79	<0.001*	A	I	20	4.70	2.77	<0.001*
	II	20	2.65	2.25			II	20	2.65	2.50	
	III	20	4.55	1.19			III	20	6.35	3.28	
	IV	74	6.23	1.94			IV	74	8.43	2.73	
	Total	134	5.19	2.27			Total	134	6.70	3.52	
SDe	I	20	8.35	3.96	<0.001*	PDe	I	20	7.15	4.50	<0.001*
	II	20	5.35	3.73			II	20	4.70	4.32	
	III	20	11.00	3.45			III	20	11.00	4.12	
	IV	74	13.68	2.25			IV	74	13.24	2.38	
	Total	134	11.24	4.30			Total	134	10.72	4.69	
CbS	I	20	5.35	4.18	<0.001*	CbP	I	20	2.10	3.09	<0.001*
	II	20	3.15	3.94			II	20	1.75	2.49	
	III	20	8.50	5.06			III	20	5.85	4.34	
	IV	74	13.50	2.15			IV	74	12.18	2.78	
	Total	134	9.99	5.33			Total	134	8.17	5.54	

* Significant values (p≤0.05) – Kruskal-Wallis test

Note: SC = syllable counting; PC = phoneme counting; SAS = synthesis and analysis of syllable; SAP = synthesis and analysis of phoneme; IS = identification of syllable; IP = identification of phoneme; R = rhyme; A = alliteration; SDe = syllable deletion; PDe = phoneme deletion; CbS = combination of syllable; CbP = combination of phoneme; SD = standard deviation

The results also indicated that there were differences in the comparisons: GI and GII in the test of phonemic analysis and synthesis (p=0.008), GI and GIII in the tests of phoneme deletion (p=0.007) and phoneme combination (p=0.003), GI and GIV in the tests of syllable (p=0.002) and phoneme counting (p=0.005), synthesis and analysis of phoneme (p<0.001), syllable (p<0.001) and phoneme identification (p<0.001), rhyme (p=0.001), alliteration (p<0.001), syllable (p<0.001) and phoneme deletion (p<0.001), syllable (p<0.001) and phoneme combination (p<0.001) (Table 2).

There were also differences in the comparisons between GII and GIII in the tests of synthesis and analysis of phoneme (p=0.001), phoneme identification (p=0.006), rhyme (p=0.002), alliteration (p=0.001), syllable (p<0.001) and phoneme deletion (p<0.001), syllable (p=0.001) and phoneme combination (p=0.001). GII and GIV differed on tests of syllable (p=0.001) and phoneme counting (p=0.001), synthesis and analysis of phoneme (p<0.001), syllable (p<0.001) and phoneme identification (p<0.001), rhyme (p<0.001), alliteration (p<0.001), syllable (p<0.001) and phoneme deletion (p<0.001), syllable (p<0.001) and phoneme combination (p<0.001). In the comparison between GIII and GIV there was difference in the tests of phoneme counting (p<0.001), syllable (p<0.001) and phoneme identification (p<0.001), rhyme (p<0.001), syllable

Table 2. Performance of the groups on tests of metaphonological skills – PROHFON

Tests	Groups					
	I x II	I x III	I x IV	II x III	II x IV	III x IV
SC	0.411	0.163	0.002*	0.087	0.001*	0.159
PC	0.690	0.411	0.005*	0.901	0.001*	<0.001*
SAS	0.243	0.844	0.079	0.205	0.949	0.063
SAP	0.008*	0.048	<0.001*	0.001*	<0.001*	0.176
IS	0.195	0.593	<0.001*	0.069	<0.001*	<0.001*
IP	0.014	0.431	<0.001*	0.006*	<0.001*	<0.001*
R	0.011	0.777	0.001*	0.002*	<0.001*	<0.001*
A	0.026	0.123	<0.001*	0.001*	<0.001*	0.011
SDe	0.022	0.024	<0.001*	<0.001*	<0.001*	<0.001*
PDe	0.105	0.007*	<0.001*	<0.001*	<0.001*	0.014
CbS	0.037	0.035	<0.001*	0.001*	<0.001*	<0.001*
CbP	0.667	0.003*	<0.001*	0.001*	<0.001*	<0.001*

*Significant values (p≤0.05) – Mann-Whitney test adjusted by Bonferroni correction

Note: SC = syllable counting; PC = phoneme counting; SAS = synthesis and analysis of syllable; SAP = synthesis and analysis of phoneme; IS = identification of syllable; IP = identification of phoneme; R = rhyme; A = alliteration; SDe = syllable deletion, PDe = phoneme deletion; CbS = combination of syllable; CbP = combination of phoneme

Table 3. Classification of groups on tests of metaphonologicalskills – PROHFON

Groups	Performance		
	Inferior	Average	Superior
GI	SC, PC, SAP, IS, IP, R, A, SDe, DF, CbS, CbP	SC	SAS
GII	SC, PC, SAS, SAP, IS, IP, R, A, SDe, DF, CbS, CbP		
GIII	PC, SAP, IS, IP, R, A, SDe, DF, CbS, CbP		SC, SAS, SAP
GIV	PC, IP, R, A, CbP		SC, SAS, SAP, IS, SDe, DF,CbS

Note: SC = syllable counting; PC = phoneme counting; SAS = synthesis and analysis of syllable; SAP = synthesis and analysis of phoneme; IS = identification of syllable; IP = identification of phoneme; R = rhyme, A= alliteration; SDe = syllable deletion, PDe = phoneme deletion; CbS = combination of syllable; CbP = combination of phonem

deletion (p<0.001), syllable (p<0.001) and phoneme combination (p<0.001).

The students were classified according to their performance on tests of the metaphonological evaluation procedure – PROHFON (Table 3). We observed that the students of GI, GII and GIII showed lower performance in most tests, both for syllabic and phonemic skills. We also observed that the students of GIV had superior performance in most of the syllabic tests and inferior performance in the phonemic tests.

DISCUSSION

It was possible to elaborate a metaphonological skills procedure, from the use of visual and linguistic criteria for inclusion and exclusion of words. Moreover, the procedure was easy to use for students and can be applied both in classrooms and in health services.

Concerning the application of the procedure, the results allowed us to observe that the groups GI, GII, GIII and GIV showed different performance on tests of metaphonological skills. The average of GI was lower than GIV in most tests. These results agree with literature which indicates that students with dyslexia have lower performance on tests of metaphonological skills due to the phonological deficit and the overcharge of phonological working memory[16,19,20,26-28].

The results of this study also showed that GI differed from GII only in the phonemic synthesis and analysis test, with lower average rate of GII. These findings revealed that both groups showed similar performance in most tests. GII differed from GIV in most tests, except in the syllabic synthesis and analysis test. These results indicate that the students of GII had a greater difficulty in separating and uniting the parts of the word into phonemes – the smallest constituent of the speech chain, that is, to coordinate various related reading processes and maintain verbal information in short-term memory (phonological storage)[17,21,22,29].

The results also indicate that the students of GI differed from GIII only in phoneme deletion and combination skills. The students of GI had lower average. Several studies reported that dyslexia refers to a deficit in linguistic processing, implying a lack of ability to perceive critical elements of the speech accurately, not allowing, thus, access to formation of phono-

logical coding. However, students with learning difficulties also had poor performance in these tests, but due to difficulties in understanding or assimilating the contents of the proposed learning during literacy[23,24,30].

These results also demonstrated that students in GIII had lower averages than students in GIV in the skills of counting, identification, rhyming, deletion and combination. These results suggest that students of GIII did not acquire the mechanisms of grapheme-phoneme conversion, failing in the perception of the segments of words. These findings suggest that both GIII and GIV have not developed the phonemic representations in working memory and therefore did not acquire the generative mechanism and grapheme-phoneme conversion, failing to execute tests which require the skill of manipulation, as described in the national literature[13-15,18].

Therefore, our findings indicate that in students with dyslexia and learning disabilities, due to the fact that they have phonological deficits, the impairment of the formation of internal representations of the phonological structure of the word is present. These findings are consistent with research conducted with students with dyslexia, learning disabilities and learning difficulties, who showed difficulties in the perception and execution of skills of counting, synthesis and analysis, identification, rhyme, alliteration, deletion and combination of both syllables and phonemes[13-15,18,22,24,30].

However, we highlight that in future studies one of the major limitations of this study should be resolved. They should characterize and compare a larger number of students with different learning problems. Furthermore, they should include private school education, which will help in knowledge about the impact of different teaching methodologies in the development of metaphonological skills.

CONCLUSION

Students with developmental dyslexia, learning disabilities, learning difficulties, and good readers had similar performance in the skills of phoneme identification, counting and combination, rhyme and alliteration. The groups differ in relation to the syllabic (counting, identification, synthesis and analysis, deletion, combination) and phonemic (deletion, analysis and synthesis) skills. The PROHFON contributed to the characterization of the metaphonological profile of students with different implications in learning.

The PROHFON could help health and education professionals in identifying difficulties in metaphonological skills. This will allow a better understanding of the relation of these difficulties and the development of reading and writing of students with different problems that affect learning.

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