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Phonological remediation in schoolchildren with ADHD and dyslexia

Remediação fonológica em escolares com TDAH e dislexia

Keywords

Attention Deficit Disorder with Hyperactivity
Dyslexia
Students
Speech
Language and Hearing Sciences
Learning

ABSTRACT

Purpose: To compare the performance in phonological processing skills, reading speed and reading comprehension before and after phonological remediation in a restricted group of schoolchildren with Attention Deficit Hyperactivity Disorder (ADHD) and with dyslexia. **Methods**: Thirty-two schoolchildren from the 2nd to 8th year of Elementary School of both genders, with diagnosis of ADHD and Dyslexia according to the DSM-5, participated in this study. All patients underwent Phonological Remediation Program consisted of 18 weekly sessions. **Results**: The results, expressed in z scores, showed a statistically significant difference between before and after remediation assessments in phonological processing skills, such as syllabic and phonemic awareness, working memory and lexical access. Rhyming task was analyzed separately because it represents another level of segmentation and, for this result, there was no significance. Besides these results, there was a statistically significant difference in reading speed and reading comprehension. **Conclusion**: The phonological remediation program contributes to the development of phonological processing, reading speed and reading comprehension in this population.

Descritores

Transtorno do Déficit de Atenção com Hiperatividade
Dislexia
Estudantes
Fonoaudiologia
Aprendizagem

RESUMO

Objetivo: Comparar o desempenho da avaliação do processamento fonológico, velocidade de leitura e compreensão de texto antes e depois da aplicação de um programa de remediação fonológica em um grupo restrito de escolares com Transtorno do Déficit de Atenção e Hiperatividade (TDAH) e dislexia. **Métodos**: Participaram deste estudo 32 escolares do 2º ao 8º ano do Ensino Fundamental, de ambos os sexos, com diagnóstico de TDAH e dislexia de acordo com o DSM-5, atendidos no Ambulatório de Neurologia Infantil do IPPMG/UFRJ. Todos os pacientes foram submetidos ao programa de remediação fonológica, que consistiu em 18 sessões semanais. **Resultados**: Os resultados, expressos em escore z, indicaram diferença estatisticamente significativa entre as avaliações pré e pós-remediação nas habilidades do processamento fonológico, como em consciência silábica e fonêmica, memória de trabalho e acesso lexical. A tarefa de rima foi analisada separadamente, pois é considerada uma tarefa com nível de segmentação distinto de outros níveis silábicos e, para este resultado não houve significância. Além desses, houve diferença estatisticamente significativa também nos testes que medem velocidade de leitura e compreensão de texto. **Conclusão**: O programa de remediação fonológica contribui para o desenvolvimento do processamento fonológico, leitura e compreensão textual nesta população.

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INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common psychiatric conditions of childhood, affecting around 5% of school-age children (American Psychiatric Association, 2002). According to the fifth edition of the Diagnostic and Statistics Manual for Mental Disorders (DSM-5), the ADHD is characterized by a pattern of behavior, present in various environments (for example, school and home), which results in performance problems in social, educational or work relationships. Symptoms are divided into two dimensions: inattention and hyperactivity/impulsivity[1].

Dyslexia is a specific learning disorder, of neurological origin, characterized by changes in reading speed and difficulty in decoding and spelling[2].

Studies in general show that children with ADHD may have academic failure due to changes in information entry, causing impairments in reading and/or writing, in addition to poor performance in phonological processing skills such as phonological awareness, working memory and lexical access. The cognitive profile of both disorders, ADHD and dyslexia, is distinct and, when comorbid, these disorders give rise to a third profile with greater severity in the impairment of functions [3].

Language disorders are frequently found in individuals with ADHD. The most common are: scarce language skills, textual disorganization, difficulty in reading decoding, and may present processes of omissions and substitutions of words and phonemes, also occurring, in writing, alteration of the logical order of sentences and disorganized textual production, changes in the organization sequential and temporal phonemes, in speech and writing. The most affected linguistic aspects are the phonological, syntactic and pragmatic[4-7].

In speech-language therapy evaluation, the diagnosis of ADHD concomitant with reading and writing disorder[8], Dysgraphia[9] and/or Dyscalculia[8-11] is common.

Remediation programs based on phonological processing offer phonological awareness activities, both syllabic and phonemic. The effectiveness of such phonological remediation programs, in children with learning disabilities or disorders is proven in several studies [12-15].

This research aimed to compare the performance of phonological processing assessment, reading speed and text comprehension before and after the application of a phonological remediation program in a restricted group of students with ADHD and dyslexia.

METHODS

This is an observational longitudinal study. The data from the speech-language therapy assessment, participation in the phonological remediation program, as well as the reassessment, were collected through the analysis of medical records.

As recorded in the medical records, students submitted to medical evaluation and diagnosed with ADHD at the Child Neurology Outpatient Clinic of the *Instituto de Puericultura e Pediatria Martagão Gesteira/Universidade Federal do Rio de Janeiro* (IPPMG/UFRJ), who had complaints about learning, were referred to speech evaluation. The evaluation was carried out by two speech-language therapists, one of whom is the author of this project. The students diagnosed with dyslexia were invited to participate in the research, and the other students who had complaints arising from other issues were referred to the specialized professional, if necessary. Students should be medicated during evaluations and program sessions, in order to minimize attention and executive function failures. All data were collected through the analysis of medical records, therefore, exempted from Informed Consent Forms (ICF).

Inclusion criteria: schoolchildren aged seven to 12 years, with ADHD and dyslexia, according to the DSM-5 criteria; be medicated with methylphenidate in the standard dosage for your weight during speech-language therapy evaluation and phonological remediation.

Exclusion criteria: Intellectual disability (IQ less than 70); history of delayed psychomotor development, including chronic progressive and non-progressive childhood encephalopathies; not being medicated during the speech-language therapy evaluation; be in speech-language therapy assistance outside the institution.

After analyzing the data in the medical records and according to the inclusion and exclusion criteria, 32 patients were selected, 22 male and 10 female, from the 2nd to the 8th grade of elementary school, diagnosed with dyslexia through speech-language therapy evaluation and ADHD patients with the three forms of presentation (inattentive, hyperactive and combined), seen at the specific outpatient clinic for this condition at IPPMG/UFRJ. Two children in the 2nd year were not literate at the time of the assessment.

The instruments used in the evaluation were:

1) Phonological Awareness Test (PAT)[16].
2) Rapid Automatized Naming (RAN) Test[17].
3) Repetition of non-words[18].
4) Speed of oral reading and comprehension of texts [19].

The material used for Phonological Remediation was the Phonological Remediation Program - Phonological Intervention Proposal for dyslexia and Learning Disorders[20], consisting of 18 sessions held once a week, in a room located at IPPMG/UFRJ. The program is cumulative and progressive, that is, the first session includes one activity, the second session includes two activities, and so on, until 10 activities are completed in the 10th session. From the 10th session, 10 activities are carried out until the end of the program, with 18 sessions. Therefore, the duration of the session varied between 10 to 40 minutes. All requests from the applicator and the student's responses were made orally.

In the post-phonological remediation stage, the students were submitted to a speech-language reassessment in order to verify whether there was an improvement in reading performance and skills involved after the program.

The data were collected through the analysis of medical records, compiled into a data collection form and stored with the aid of the Statistical Package for the Social Sciences (SPSS) program. The average performance of the students was obtained individually in each test, and then the results were converted into a z-score. In order to compare the same population at two different times, the parametric t student test for paired samples

was applied. The result of "t" is the value of the comparison, while the value of "p" is of the significance analysis, considering a value less than 0.05 as a significant difference.

This research was approved by the Ethics and Research Committee of IPPMG under protocol number 1.459.164.

RESULTS

Several scales are used to determine an individual's position in relation to a sample. Among these scales, there is the z-score. The z-score measures express, in a standardized way, the relative position of a result in a distribution and are used in studies that express the z-score as a parameter by the group-class. The results of this study were expressed in the measure of z-score in order to manage the great difference between the normality patterns of each schooling and to group the students in the same sample.

Phonological awareness assessment

When comparing the means, in the pre- and post-phonological remediation stages, it was possible to observe an improvement in all the phonological awareness measures evaluated (Table 1). There was a statistically significant difference for the syllabic and phonemic awareness tasks between the pre- and post-remediation assessments. The rhyme task was not statistically significant.

Table 1. Pre- and post-phonological remediation performance in rhyme, syllabic and phonemic awareness through the mean in percentage of correct answers and the z-score

Variables	pre		post			
	A	SD	A	SD	t	*p
Rhyme	82.03	25.59	97.66	7.40	-3.62	0.315
Rhyme score	6.19	11.47	8.19	5.62	-1.02	**.000
Syllab awar	78.13	21.31	96.87	5.62	-5.45	**.000
Z-score Phon awar	.47	7.18	5.3436	3.37	-4.14	**.000
Phon awar	40.64	29.78	81.09	16.20	-10.83	**.000
Z-score Phon awar	.55	7.38	9.373	4.49	-7.79	**.000

Captions: Syllab awar = Syllabic awareness, Phon awar = Phonemic awareness

Phonological working memory assessment

Table 2. Pre- and post-phonological remediation performance in the phonological working memory task through the mean in percentage of correct answers and the z-score

Variables	pre		post			
	A	SD	A	SD	t	*p
Phono Work Mem	89.38	.07	96.04	.03	-6.12	**.000
Z-score Phono Work Mem	.07	1.10	.78	.54	-3.81	**.001

Captions: Phono Work Mem = Phonological Working Memory

All students evaluated obtained 100% correct answers in the repetition of pseudowords of one, two and three syllables, in the pre-remediation stage. In the comparison of means, in the stages before and after phonological remediation, it was possible to observe performance maintenance of 100% in the repetition of pseudowords of one, two and three syllables and improvement in the phonological working memory measures of four, five and six syllables. There was a statistically significant difference between the pre- and post-remediation stages (Table 2).

Evaluation of rapid automatized naming

The purpose of this test is that the values decrease after the intervention, because, thus, access to the lexicon will be faster, that is, the lower the values, the better the performance.

All students evaluated obtained a better result in the post-phonological remediation stage, that is, reduced time to lexical access. There was a statistically significant difference for all tasks of rapid automatized naming both by time in seconds and by z-score, except for the z-score measure for rapid automatized digit naming (Table 3).

Table 3. Pre- and post-phonological remediation performance in the task of rapid automatized naming of objects, colors, digits and letters through the average time in seconds and the z-score

Variables	pre		post			
	A	SD	A	SD	t	*p
RN objects	77.81	28.67	66.47	21.18	5.63	**.000
Z-score objects	2.41	2.014	1.59	1.64	3.91	**.000
RN colors	65.94	23.95	56.50	17.75	5.00	**.000
Z-score colors	2.31	1.93	1.59	1.76	3.97	**.000
RN digits	38.19	12.59	33.94	12.70	6.23	**.000
Z-score digits	1.38	1.54	1.06	1.87	1.50	.143
RN letters	38.53	19.78	31.28	14.81	6.78	**.000
Z-score letters	1.88	2.338	1.06	2.094	5.13	**.000

Captions: RN= Rapid Naming

Evaluation of reading and text comprehension

Table 4. Pre- and post-phonological remediation performance in reading tests through the average time in words per minute and textual understanding through the average of the percentage of correct answers and the z-score

Variables	pre		post			
	A	SD	A	SD	t	*p
Reading speed	54.84	26.83	65.78	29.13	-1.66	.108
Z-score read speed	-1.36	.77	-1.26	.65	-2.07	*0.047
Text comprehension	.34	.48	.63	.49	-3.48	**0.001
Z-score text compr	-.34	.45	-.14	1.37	-1.02	.317

Captions: read speed = reading speed, text compr = text comprehension

Two 2nd year students were not literate in the phonological pre-remediation stage. In the post-remediation evaluation stage, they were already literate.

There was a statistically significant difference in the comparison between the z-scores of reading speed in the pre- and post-phonological remediation assessments, as well as in the comparison between the means of textual comprehension performance in the pre- and post-phonological remediation assessments (Table 4).

DISCUSSION

The efficacy of phonological remediation programs in children with learning disabilities or disorders is proven in studies in Brazil[12-15], however, no study comprises, in its sample, individuals with ADHD and dyslexia. The assessments used, despite analyzing the same skills, differ from the protocols used in the present study. International research has studied the population with ADHD and dyslexia, however, in Brazil, research with the same population is scarce. The main focus of these studies is on instruction in phonological awareness and grapheme-phoneme correspondence in children in preschool and early schooling with delays in phonological skills as a way to prevent reading disabilities.[22,23] Therefore, the importance of developing phonological awareness prior to literacy is highlighted. According to the findings in the present study, the difference in performance was evidenced with statistically significant results, both by measures of *z*-score and by means, in situations before and after phonological remediation, in syllabic awareness, phonemic awareness, memory phonological work, rapid automatized naming, reading speed and text comprehension (Tables 1, 2, 3 and 4), confirming that phonological awareness instruction alters performance in skills prior to literacy and reading itself. Such findings are in line with international literature, which advocates intervention in reading and writing skills with a primary focus on training and awareness of phonological skills in children at risk for dyslexia, especially those tasks that involve the development of the phonological route[24,25]. Thus, phonemic awareness and knowledge of grapheme and phoneme are necessary in combination for the acquisition of the alphabetical principle and, once it is acquired, the alphabetical perception is relatively strong.

Studies report that the most frequent language changes found in individuals with ADHD are: scarce language skills, textual disorganization, difficulty in reading decoding, and may present processes of omissions and substitutions of words and phonemes; also occurring, in writing, changes in the logical order of sentences and disorganized textual production, changes in the sequential and temporal organization of phonemes in speech and writing[4-7]. The study in question evaluated skills prior to the development of reading and writing (phonological awareness, phonological working memory and lexical access), and it was possible to observe that the altered phonological processing skills did not come only from a difficulty in entering information and, yes, they were part of a set of altered abilities that closed a picture of dyslexia (Tables 1, 2, 3 and 4). The training in phonological skills of the remediation program demonstrated that there was a statistically significant difference between the situations before and after remediation in skills of phonological awareness (Table 1), being possible to conclude that the phonological processing needs formal instruction to be developed. In addition, there was a failure in reading decoding, a question in which all students had a measurement of words per minute below the expected for their schooling, and a statistically significant difference between the tests of textual reading speed in the comparison between the pre- and post-phonological remediation (Table 4). This component also plays an important role in the diagnosis of dyslexia, which is defined as a specific learning disorder of neurological origin, characterized by changes in reading speed and difficulty in decoding and spelling[3].

The performance of the students in the study showed a statistically significant difference in the phonological awareness tests (Table 1), for the tests that involve syllabic and phonemic skills, however, there was no statistically significant difference in the rhyme test. This data is in line with a study with children with learning disabilities[13], however it is opposed to what was discussed in a study with children at risk for learning disabilities[15] and with students with learning disabilities[14], in which it was possible to verify that there was a statistically significant difference in post-phonological remediation situation in rhyme activity. The tests used in the study in comparison were different from the tests used in the present study.

The impairment in phonological working memory, evidenced in the tests used in the present study, showed a statistically significant difference after exposure to the remediation program (Table 2). When evaluating the working memory of children in the 1st year of elementary school, in a study with students with learning disabilities[6], it was found that, after the program offered based on phonological awareness, there was no significant difference in the general ability of information storage in working memory, however there was a significant difference in the storage of information in phonological working memory, revealing impairment of information of a phonological nature when compared to more skilled children.

A better performance was observed in the processing speed of the students in the present study, postulated by the statistically significant difference in the comparison of the situations of pre- and post-phonological remediation, in the rapid automatized naming tests (Table 3). Regarding the ability to process speed and working memory, other studies have also found a statistically significant difference in the post-testing situation[13,14].

The students in question showed a statistically significant difference in reading speed when comparing the pre- and post-remediation assessments (Table 4), corroborating the comparison of pre- and post-testing in the reading speed performance of a study, in which there was improvement only for the remedied group with learning disorder[14].

In the present study, there was a statistically significant difference in textual comprehension in the comparison before and after remediation (Table 4). Such results support the strong relationship between adequate phonological processing and fluent reading speed with textual comprehension. It should be noted that one student had zero comprehension in the pre-remediation stage and total comprehension in the post-phonological remediation stage, demonstrating a significantly positive effect of the phonological remediation program in textual comprehension. In addition to this fact, another highlight was the performance of two 2nd year students who were not literate in the pre-phonological remediation stage and, in the post-remediation evaluation stage, they were literate, suggesting that formal instruction in phonological skills may have contributed to the literacy process. The two students who were literate during the phonological remediation program obtained partial understanding of the text in the post-remediation evaluation, demonstrating influence not only in the reading decoding, but

also in the comprehension of the content read. Although the flaws in textual comprehension have not been completely overcome, this result deserves a positive highlight.

The present study inferred that the improvement in skills prior to literacy (Tables 1, 2 and 3) also contributed to better performance in reading and textual understanding (Table 4), as reported by another research[12], concluding that awareness training phonology stimulates the emergence of phonological and syntactic awareness, with a positive impact on learning to read and write.

There is a consensus, in several studies, about the importance of instruction in phonological awareness to facilitate the acquisition of reading and that phonemic awareness and knowledge of letters are important, but not sufficient for the acquisition of the alphabetical system[24]. It was possible to confirm that the stimulation of phonological skills had positive effects on reading and text comprehension, which confirms the close relationship between these skills. As described in the literature, these altered mechanisms, both in individuals with ADHD and dyslexics, whether comorbid or not, are interrelated and would all be stimulated in phonological remediation. The surprising thing was to quantify the results, observe the discrepancy between the pre- and post-phonological remediation phases and confirm the importance of this program in the development of reading.

CONCLUSION

The findings of this study allow us to conclude that the Phonological Remediation Program contributes positively to the performance of phonological processing, reading speed and text comprehension, the main characteristics of the individual with dyslexia, although comorbid with ADHD, and they deserve to be highlighted in the work performed by professionals of the education and health.

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Authors' contributions

RAM was responsible for the collection, tabulation, analysis and interpretation of data and preparation of the manuscript; MGR supervised the study and was responsible for substantial support to the conception or design of the study; GMCP was responsible for substantial support to the conception or design of the study, guided the research design, contributed to the analysis and interpretation of data and preparation, supervision and revision of the manuscript; MCM was responsible for substantial support to the conception or design of the study, guided the research design, contributed to the analysis and interpretation of the data and preparation, supervision and revision of the manuscript.