Significance Analysis of RTI Tier 2 Metaphonological and Alphabetic Principle Program for Brazilian Schoolchildren at Risk for Dyslexia*

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Aim: to analyze the significance of RTI Tier 2 metaphonological and alphabetic principle program for Brazilian schoolchildren at risk for dyslexia. Methods: a bibliographic review was carried out in the Scielo and Pubmed databases using the descriptors “intervention studies”, “reading”, “dyslexia”, and “learning” in Portuguese and English for the elaboration of RTI Tier 2 metaphonological and alphabetic principle program for schoolchildren at risk for dyslexia. The program was designed based on the selection of strategies for metaphonological skills, knowledge of the alphabet, and grapheme-phoneme correspondence described in national and international literature. Linguistic stimuli (real words) and visual stimuli (pictures) were selected to be used in the intervention program tasks. These stimuli were selected from a word bank according to length, regularity, and frequency. The intervention program designed was composed of the following skills: letter-sound knowledge, syllable knowledge, syllabic segmentation, phonemic segmentation, syllabic addition, phonemic addition, syllabic subtraction, phonemic subtraction, syllabic substitution, phonemic substitution, syllabic combination, and phonemic combination. The program was structured with collective strategies and was applied in small groups of four to five schoolchildren aged six years and 11 months to seven years and 11 months in 50-minute sessions. Results: The results revealed that there was a change in the response pattern, showing better performance in the skills of the Early Identification of Reading Problems Protocol, demonstrating significance and positive change in post-testing situations when compared to pre-testing. Conclusion: the program developed in this study proved to be effective and, in this way, it can be used as an intervention instrument based on scientific evidence that helps in the acquisition of skills necessary for the development of reading.

Keywords: dyslexia, literacy, metaphonological skills, predictors for literacy, clinical significance

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Introduction

Dyslexia refers to differences in individual processing, often affecting the acquisition of reading, writing, and spelling, and failures in cognitive, phonological, and/or visual processes may also occur (Reid, 2016).

A considerable number of researchers agree that dyslexia, as well as other learning disorders, are much easier to prevent than to cure and that this requires early interventions to prevent or significantly reduce reading problems and their impact on academic learning (Vellutino, Scanlon, Zhang, & Schatschneider, 2008; Fletcher & Vaughn, 2009; O. V. C. Andrade, P. E. Andrade & Capellini, 2014; Fletcher, Lyon, Fuchs, & Barnes, 2018; Capellini et al., 2022).

In this way, early identification of reading problems is ideal, both from a cognitive and social point of view. From a cognitive point of view, the younger the student (five to eight years old), the greater the neuroplasticity and, consequently, the susceptibility of the student’s brain to modify its neurological connection patterns as a result of the interventions carried out, thus improving, the acquisition and development of the cognitive-linguistic skills necessary for learning to read. From a social point of view, the qualitative and quantitative improvement of these skills improves the quality of these students’ social and academic interactions (Vellutino, Fletcher, Snowling, & Scanlon, 2004; Santos & Capellini, 2020).

The Intervention Response Model (RTI) is an alternative approach to the traditional diagnosis based on performance discrepancy. Initially, in the RTI Model, all students must receive evidence-based academic instruction, that is, with content and strategies scientifically proven to be the most effective, and those who do not progress must receive additional support with varying intensity and frequency of intervention (Vellutino et al., 2008; Andrade et al., 2014; Capellini et al., 2022).

Briefly, through the use of the RTI Model, it is possible to identify children with academic and behavioral problems early, monitor the progress of children at risk of developing difficulties in these areas, and offer increasingly intensive interventions, based on the progress of the response, that is monitored by ratings (Fletcher & Vaughn, 2009).

According to Fletcher and Vaughn (2009) and Harlacher, Sanford, and Nelson Walker (2014), the RTI Tiers can be defined as described below: Tier 1—Classroom Interventions: Universal screening for academic and behavioral problems should be performed across all schoolchildren and the teacher should provide high-quality instruction and behavioral support to all students in the mainstream classroom. Start monitoring student progress; Tier 2—Interventions in groups: those students who did not respond to the intervention carried out in Tier 1 are identified as at risk for learning or behavioral problems, being elective to the second tier, where they receive high quality interventions. There is variation in the type and frequency of intensity of interventions depending on the outdated skills that must be stimulated; Tier 3—Intensive Interventions: students who do not respond to the intervention in the previous stage, Tier 2, will need interventions with greater frequency and intensity in an individualized environment in order to exclude or confirm the presence of learning disorders or behavioral disorders.

Based on the above, this pilot study aimed to analyze the significance of RTI Tier 2 metaphonological and alphabetic principle for Brazilian schoolchildren at risk for dyslexia.
Methods

This study was carried out after approval by the Research Ethics Committee of São Paulo State University “Júlio de Mesquita Filho” (UNESP), Marília, São Paulo, Brazil, under protocol number 90293118.8.0000.5406.

Phase 1: Elaborated RTI Tier 2 Metaphonological and Alphabetic Principle Program for Brazilian Schoolchildren at Risk for Dyslexia

The RTI Tier 2 metaphonological and alphabetic program for Brazilian schoolchildren at risk for dyslexia, denominated “Metaphonological and Alphabetic Principle Program—PROF-CA” (Marguti, César, & Capellini, 2021), was elaborated from the systematic review of national and international literature. In this phase, linguistic visual stimuli (letters and real words) and non-linguistic (pictures) were chosen and organized by syllabic extension, which were grouped into sessions. The real words and figures were selected from the word database at the Investigation Learning Disabilities Laboratory (LIDA), Department of Speech and Hearing Sciences, São Paulo State University “Júlio de Mesquita Filho” (UNESP), Marília, São Paulo, Brazil.

The Program developed for this study was composed of 12 metaphonological and alphabetic principle tests, and these tasks were developed to be worked in six sessions. Following are the tasks that made up the program with their respective descriptions:

- Knowledge of the letter-sound: The alphabet was presented to the schoolchildren so that they could identify the name and sound of the letter of each letter presented;
- Syllable knowledge: A card with six syllables was presented to the student so that he could identify, through a syllable bingo, the syllables drawn by the applicator and mark the corresponding syllables on his card;
- Syllabic segmentation: The schoolchildren received three cards, containing a figure and its respective name, to carry out the syllabic segmentation. Three buckets were placed on a table with the indication of 1, 2, and 3 (numbers of syllables) in each one, so that the student could insert his card into the bucket corresponding to the number of syllables of the words;
- Phonemic segmentation: The schoolchildren received three cards, containing a picture and its respective name, to carry out the phonemic segmentation. Six buckets were placed on a table (three larger and three smaller), with the indication of 1, 2, 3 (numbers of syllables) in the larger buckets and (numbers of phonemes) in the smaller buckets. The smaller buckets were used to show the schoolchildren in a playful way that within the syllables there are smaller units, the phonemes. The schoolchildren counted how many phonemes each word on the card had, and inserted the cards in the buckets with their respective indications of numbers;
- Syllabic addition: Each student received a card containing three syllabic addition activities. Each card contained a plus sign (+), to represent the addition of the syllable in the word. The student added a syllable at the beginning or end of a word, forming a new word;
- Phonemic addition: Each student received a card containing three phonemic addition activities. Each card contained a plus sign (+), to represent the addition of the phoneme in the word. The student added a phoneme at the beginning or end of a word, forming a new word;
- Syllabic subtraction: Each student received a card containing three syllabic subtraction activities. Each card contained a minus sign (-), to represent the syllabic subtraction in the word. The student had to subtract a syllable at the beginning or end of a word, forming a new word;
Phonemic subtraction: Each student received a card containing three phonemic subtraction activities. Each card contained a minus sign (-), to represent the subtraction of the phoneme in the word. The student had to subtract a phoneme at the beginning or end of a word, forming a new word;

Syllable substitution: Each student received a card containing three syllabic substitution activities. Each card contained a word with its respective illustration and beside it a syllable (new) that would replace a syllable of the word that is in bold, in initial or final position to form a new word;

Phonemic substitution: Each student received a card containing three phonemic substitution activities. Each card contained a word with its respective illustration and next to it a phoneme (new) that replaced the phoneme that is in bold, in initial, or final position to form a new word;

Syllable combination: Each student received a card with three syllabic combination tasks. In this task, the student should combine an initial or final syllable of each presented figure to form a new word;

Phonemic matching: Each student received a card with three phonemic matching tasks. In this task, the student combined an initial or final phoneme of each picture presented to form a new word.

The elaborated program consisted of six sessions to be applied in approximately 50 minutes of duration. The activities were structured in the sessions in the following ways:

- Session 1: Letter-sound knowledge and Syllable knowledge;
- Session 2: Letter-sound knowledge and Syllable knowledge;
- Session 3: Syllable and Phonemic Segmentation, Syllabic and Phonemic Addition, Syllable and Phonemic Subtraction;
- Session 4: Syllable and Phonemic Segmentation, Syllabic and Phonemic Addition, Syllable and Phonemic Subtraction;
- Session 5: Syllable and Phonemic Substitution and Syllable and Phonemic Combination;
- Session 6: Syllable and Phonemic Substitution and Syllable and Phonemic Combination.

In order to verify the applicability of the program developed in this phase of the study, a pilot study I was carried out with five Brazilian schoolchildren that showed the need to modify the activities proposed for the program, as shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Modifications in the Intervention Response Program After Pilot Study I Application</th>
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<tbody>
<tr>
<td>Sections</td>
<td>Activities</td>
</tr>
<tr>
<td>Session 1: Knowledge of the alphabet</td>
<td>Some schoolchildren had difficulty in relation to task 1, corresponding to letter/sound knowledge, regarding the marking of accented vowels /é/ and /ó/. In the same activity, there was difficulty for the schoolchildren in relation to the identification of lowercase letters/sounds, with exchanges with /p/, /q/, /b/, and /d/.</td>
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<tr>
<td>Session 4: Phonemic Segmentation</td>
<td>In the description of the instruction and the applicability of the task, there was a lack of support material for carrying out the phonemic segmentation activity.</td>
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</table>
Phase 2: Significance of RTI Tier 2 Metaphonological and Alphabetic Principle Program for Brazilian Schoolchildren at Risk for Dyslexia

Participating in pilot study II, nine Brazilian schoolchildren from the first grade of Elementary School I, aged between six and seven years and 11 months of age, being six male schoolchildren and three female schoolchildren, identified at risk for dyslexia.

The risk for dyslexia was identified from the application of the Protocol for Early Identification of Reading Problems—IPPL (Capellini, César, & Germano, 2017) which obtained the performance classified as “under attention” and “expected”, in which it is used as cutoff criterion the 25th percentile.

All schoolchildren who participated in this study underwent pre-testing, intervention, and post-testing. In pre- and post-testing situations, the IPPL was applied. This protocol consists of the following tests: alphabet knowledge, rhyme production, rhyme identification, syllabic segmentation, word production from a given phoneme, phonemic synthesis, phonemic analysis, initial phoneme identification, phonological working memory, rapid automatic naming, silent reading, reading words and nonwords, and listening comprehension from pictures. Study results were analyzed using the JT Method (Jacobson & Truax, 1991; Z. A. P. Del Prette & A. Del Prette, 2008) for single-case analysis. The JT Method provides a comparative analysis between pre- and post-intervention scores in order to establish whether the differences between them represent reliable changes and whether they are clinically relevant, thus allowing the verification of therapeutic efficacy through the measurement of clinical significance.

This method therefore implies two complementary processes, namely: (a) calculation of the reliability of changes that occurred between the pre- and post-intervention assessment, described in terms of a Reliable Change Index (BMI); and (b) analysis of the clinical significance of these changes. The difference is calculated based on the difference between pre- and post-test divided by the standard error of the difference. In this way, the change from pre- to post-testing can be positive and reliable (when there is improvement); reliable negative (when there is worsening); with clinical significance (which makes or will make a difference in the clinical scope); or absence of change; this analysis is described by means of graphs that can be transformed into tables based on the values presented.

The choice of such a method for statistical analysis is given since statistical significance tests are limited for evaluating the effectiveness of an intervention, as they do not provide sufficient information about the variability of the response within a given sample, that is, they show the way the group reacted to the intervention, but not individually (Jacobson & Truax, 1991). In addition, there is a difference in the effect of an intervention from the statistical point of view to the clinical point of view, regardless of the number of subjects (Maronesi, de Oliveira Figueiredo, dos Santos, Gonçalves, & de Campos, 2015; Wise, 2011). The JT method is also proven to be effective in verifying clinical significance and control of change by comparing the subject to himself (Wise, 2011).

Results

The results of this pilot study II were analyzed in order to detect possible errors, evaluating the quality of the phonological intervention program associated with the knowledge of the alphabet, the practical aspects of its application and verify the applicability, index of change, and clinical significance between the performance in the skills evaluated in pre- and post-testing, in addition to the index of change and clinical significance in the performance of schoolchildren in the intervention program.
The performance of the schoolchildren in this study in the IPPL tests was analyzed. Through the JT Method, the changes between pre- and post-testing of each skill tested in this study were analyzed in each of the nine schoolchildren who will be denominated S1, S2, S3, S4, S5, S6, S7, S8, and 9, presented in the following table.

Table 2
Reliability of Change and Clinical Significance After Intervention in IPPL Tests in Schoolchildren at Risk for Dyslexia

<table>
<thead>
<tr>
<th>Schoolchildren</th>
<th>KA</th>
<th>RP</th>
<th>RI</th>
<th>SS</th>
<th>WPGP</th>
<th>PS</th>
<th>PA</th>
<th>IPI</th>
<th>PWM</th>
<th>FAN</th>
<th>SR</th>
<th>WNWR</th>
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<tbody>
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<td>S1</td>
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Notes: * clinically significant change; RPC = reliable positive change; KA = knowledge of the alphabet; RP = rhyme production; RI = rhyme identification; SS = syllabic segmentation; WPGP = word production from given phoneme; PS = phonemic synthesis; PA = phonemic analysis; IPI = initial phoneme identification; PWM = phonological working memory; FAN = fast automatic naming; SR = silent reading; WNWR = word and nonword reading; LCSP = listening comprehension of sentences from pictures.

In Table 2, we can verify the reliability of the change in the IPPL metaphonological skills tests, since in these, the schoolchildren from S1 to S4, S6, S8, and S9, showed a reliable positive change in the tests of rhyme production, rhyme identification, syllabic segmentation, and word production from phoneme, as well as clinical significance; in these tests, student 5 showed reliable positive change only in the tests of production and identification of rhyme and subject 7 in syllabic segmentation.

In the phonemic segmentation test, schoolchildren S3, S4, S8, and S9 and in the phonemic analysis test, schoolchildren S2 and S7 obtained reliable positive change, that is, an improvement that can be attributed to the applied intervention. In initial phoneme identification, schoolchildren S4, S5, S6, and S8 showed reliable positive change, with schoolchildren S4 and S5 also showing clinical significance, passing to the functional population in this skill. In phonological working memory, schoolchildren S1 and S8 showed improvement that can be attributed to the intervention and passed to the functional population.

In the rapid automatized naming, silent reading, and listening comprehension of sentences from pictures tests, there was no reliable index of change and the schoolchildren remained in the dysfunctional population. In reading words and nonwords, schoolchildren S3, S4, and S8 showed a reliable positive change, in which schoolchild S8 went from the dysfunctional to functional population, that is, it achieved clinical significance.

Discussion

In literature (Andrade, Prado, & Capellini, 2014; Machado & Capellini, 2014; Machado & Almeida 2014; Pinheiro, Correa, & Mousinho, 2012; Carney & Stiefel, 2008; Van Viersen, de Bree, Kroesbergen, Slot, & de Jong, 2015; Vaughn et al, 2010; Wanzek & Vaughn, 2011) there is a description of studies that used
phonological intervention programs as part of the RTI Tier 2 to work on the skills selected for this study. Some studies have demonstrated the effectiveness of early intervention in identifying schoolchildren at risk for dyslexia (Vellutino et al., 1996; Torgesen et al., 1999; Vaughn, Linan-Thompson, & Hickman, 2003; O’Connor & Freeman, 2012).

During this study, it was possible to verify that in the Brazilian literature (Andrade, Prado, & Capellini, 2011; Machado & Capellini, 2014; Machado, Silva, & Capellini, 2015; Pinheiro, Correa, & Mousinho, 2012) there are still few programs or strategies that use the metaphonological intervention and alphabetic principle collectively, as part of the RTI Tier 2 in Brazil.

However, in the international literature, there is a greater number of articles and works described for this age group with a focus on metaphonological and alphabetic principle skills, for all beds of the RTI Model, references to programs in all Tiers of the RTI are found (Carney & Stiefel, 2008; Vaughn & Fletcher, 2012; Van Viersen et al, 2015; Vaughn et al, 2010; Wanzek & Vaughn, 2011; Rodríguez et al, 2021; Jiménez, 2021).

Thus, in phase I of this study, it was possible to develop a collective program of metaphonological alphabetic principle, in RTI Tier 2, for schoolchildren at risk for dyslexia.

The American National Literacy Panel reported that the metaphonological skill worked on in the initial phase of literacy was considered one of the most robust predictors of literacy for decoding reading, reading comprehension, and spelling skills. Thus, it is present in the international literature (Carney & Stiefel, 2008; Vaughn & Fletcher, 2012; Van Viersen et al, 2015; Vaughn et al, 2010; Wanzek & Vaughn, 2011; Rodríguez, Areces, García, Cueli, & González-Castro, 2021; Jiménez, 2010) the use of intervention models focusing on this skill for proficient reading performance.

Brazilian public educational policies are aligned towards the use of metaphorical strategies and alphabetic principle for the proficient development of reading, however, although the National Curricular Common Base (BNCC) and the National Literacy Policy (PNA) determine that the fluency of oral reading needs to be developed by schoolchildren, the results are not yet fully effective, since school failure is something recurrent in the educational scenario, demonstrated through failure, low performance, and learning difficulties that, in a way, end up compromising the acquisition and development of other skills such as the decoding mechanism, fluency, and reading comprehension, in addition to emotional and cognitive skills (Batista & Pestun, 2019).

According to Ouellette and Haley (2013), the difficulty in the metaphonological skills of schoolchildren at risk for dyslexia presents itself at different levels of evolution, since the rhyming, alliteration, and syllabic skills are of less complexity than the skills of phonemic level.

According to the literature (Lerner & Lonigan, 2016; Morris et al, 2012) when a student breaks a word into syllables, performs the rhyme, or presents the ability to form a word from a given phoneme, the student accesses its underlying phonological representations in your lexicon. In this way, the performance of the student in the skills of Rhyme Production, Rhyme Identification, Syllabic Segmentation, Production of Words from the Given Phoneme, Phonemic Synthesis, Phonemic Analysis, Initial Phoneme Identification, Phonological Working Memory, Reading of Words and Nonwords, demonstrates the students’ awareness of the linguistic units from which the phonological representations of words are formed.

This demonstrates the importance of carrying out intervention programs such as the one developed in this study to work on the metaphonological skills associated with the alphabetic principle, as they can be used to
improve the reading skills of the population at risk for dyslexia both in the clinical context and in the context educational.

The scarcity of studies on this topic in the Brazilian scenario was a limitation of this research, as it was not possible to carry out a more detailed and complete comparison of the results obtained with other national studies. Thus, it would be important and relevant to continue studies with the program developed in this study so that new findings can be analyzed, compared, and discussed with the results found in the population of schoolchildren at risk for dyslexia described in this study.

Conclusion

We concluded that the use of the RTI Tier 2 metaphonological and alphabetic principle developed in this study, denominated PROF-CA, had positive effects, as it promoted reliable change and presented significance evidenced by the modification of the IPPL response in the skills of Rhyme Production, Identification of Rhyme, Syllabic Segmentation, Production of Words from the Given Phoneme, Phonemic Synthesis, Phonemic Analysis, Identification of the Initial Phoneme, Phonological Working Memory, Reading of Words and Nonwords, when comparing the performance of schoolchildren at risk for dyslexia in pre- and post-testing situations.

We finalize by concluding that the PROF-CA Program, elaborated in this study, proved to be effective, as demonstrated in the pilot study II, and that, in this way, it can be used as an intervention instrument based on scientific evidence that helps in the acquisition of skills necessary for the development of reading and, consequently, for the improvement of the performance of the use of the reading decoding mechanism of schoolchildren at risk for dyslexia.

References


