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Case Report
Relato de Caso

The use of software in cases of speech sound disorders

Intervenção fonoaudiológica com a utilização de software em casos de distúrbios dos sons da fala

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Keywords

Software
Speech
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ABSTRACT

To verify the effects of Speech Therapy focusing on phonological awareness and articulatory awareness in speech skills and in the literacy process of children with speech sound disorders. Seven children, aged between six and seven years old, male and female, and with speech disorders complaints participated in this study. These children were submitted to the following speech and language assessments: Children Phonological Assessment, Articulation Test, Articulatory Awareness Assessment, Phonological Awareness Testing by Oral Production and Word Writing Evaluation. Afterwards, they underwent speech and language therapy through the software "*Pedro em uma noite assustadora*". The sessions took place once a week, lasting approximately 30 minutes each. At the end of eight sessions, the children were reassessed with the same instruments used in the initial assessment. Data were analyzed qualitatively and quantitatively. Based on the analysis of data obtained, improvement in speech, articulatory awareness and phonological awareness skills, and Spelling Hypothesis of all children was observed. It can be concluded that speech therapy focusing on phonological awareness and articulatory awareness skills based on specific software has influenced the organization of speech patterns and acquisition of written language in most subjects.

Palavras-chave

Software
Fala
Criança
Fonoterapia
Transtorno Fonológico

RESUMO

Este estudo tem como objetivo verificar os efeitos da terapia fonoaudiológica com enfoque na consciência fonológica e fonoarticulatória nas habilidades de fala e no processo de alfabetização de crianças com distúrbios dos sons da fala. Participaram deste estudo sete crianças com idade entre seis e sete anos, de ambos os gêneros e com queixa de alterações na fala. As crianças foram submetidas às seguintes avaliações fonoaudiológicas: Avaliação Fonológica da Criança, Exame Articulatório, Avaliação Consciência Fonoarticulatória, Prova de Consciência Fonológica Por Produção Oral e Avaliação da Escrita de Palavras. Em seguida, foram submetidas à terapia fonoaudiológica por meio do *software* "Pedro em uma noite assustadora", semanalmente, com duração de aproximadamente 30 minutos cada. Ao final de oito sessões as crianças foram reavaliadas com os mesmos instrumentos utilizados na avaliação inicial. Os dados foram analisados qualitativa e quantitativamente. A partir da análise dos dados obtidos, constatou-se melhora na fala, nas habilidades de consciência fonoarticulatória e de consciência fonológica e da Hipótese de Escrita de todas as crianças. Pode-se concluir que a terapia fonoaudiológica com enfoque nas habilidades de consciência fonológica e fonoarticulatórias, a partir de *software* especifico, influenciou a organização dos padrões de fala e aquisição da linguagem escrita na maioria dos sujeitos.

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INTRODUCTION

Children with speech sound disorders, especially those of a phonological nature, require special attention when these symptoms persist into school age, since alterations in the phonological system may influence both speech production and perception, as well as the understanding and application of phonological rules[1]. These rules are crucial for the acquisition of reading and writing, since early literacy is largely mediated by oral language[2,3].

Therefore, it is crucial for speech sound disorders to be identified as early as possible in school-age and preschool-age children, so they can be placed in intervention programs which stimulate speech, but also phonological awareness, preventing future difficulties in the development of writing skills[4].

Phonological awareness is the ability to manipulate speech sounds and is important for the acquisition of literacy skills as it contributes to the understanding of the phoneme-grapheme correspondence, which provides the foundation for reading and writing ability[2,4]. Phonological awareness deficits are common in children with phonological disorders[5].

Articulatory awareness, a subskill of phonological awareness, allows children to identify and distinguish between the places of articulation for different speech sounds. This skill contributes to speech perception and production, as well as to the acquisition of alphabetic writing systems[6].

In recent years, computer software has been increasingly used in the context of speech therapy, emerging as an appealing and timely alternative for the remediation of phonological deficits[7].

Most commercial software for speech-language therapy focuses on phonological awareness and has been shown to contribute to the learning process by several published studies[8,9].

The computer is an important tool for communication, which promotes interactivity, provides multi-sensory stimulation and creates numerous learning opportunities, while facilitating the exchange of experiences[8].

The only currently available software tool with published evidence of effectiveness in the treatment of speech sound disorders is the SINFALA[7]. No studies to date have investigated the use of the "Pedro's Spooky Night" software to develop phonological and articulatory awareness skills in children with speech sound disorders.

The development of phonological and articulatory awareness skills is hypothesized to contribute to speech sound acquisition and literacy learning. Therefore, the aim of the present study was to verify the influence of a speech therapy program with a focus on phonological and articulatory awareness on the speech and literacy skills of children with speech sound disorders.

CASE PRESENTATION

This study was conducted according to the ethical recommendations outlined in resolutions 466/12 and 510/16 of the National Council of Health of the Ministry of Health, and was approved by the Research Ethics Committee under protocol number 1.969.101. All parents and guardians provided written consent to their children's participation in the study, and all participants assented to research involvement.

Participants

The sample was selected by convenience from the waiting list of a school-clinic in the south part of the country. Patients were recruited according to the following inclusion criteria: a previous diagnosis of phonemic disorder (as determined by the speech-language screening of children on the waiting list); written consent from parents or guardians; normal hearing; no impairments in receptive vocabulary (as determined by the Auditory Vocabulary Test)[10], expressive vocabulary (as evaluated by the Childhood Naming Test)[11] or auditory discrimination (as determined by the Phonological Discrimination Test)[11]; no diagnosed motor, cognitive, psychiatric, neurological and/or organic illnesses (according to anamnesis); no submucosal cleft palate or alterations in soft tissues such as adenoids, tonsils, soft palate, etc. (as determined by clinical observation).

The initial sample was composed of fifteen subjects. Three did not attend the initial evaluation and two were excluded due to perinatal risk factors. As such, ten subjects initiated treatment, and only seven completed all eight therapy sessions. These individuals were six to seven years old. One was female and six were male, and all were learning to read and write.

Procedures and instruments

Children who met inclusion criteria completed a pre-intervention assessment comprised of the following instruments:

Child Phonological Assessment (Avaliação Fonológica da Criança – AFC)[12]: the instrument allows for the collection of speech samples for all phonemes in Brazilian Portuguese in all possible word positions, through spontaneous speech and naming. The AFC was used to confirm the presence of a speech sound disorder, to identify phonological processes, and to determine the severity of the condition. The degree of severity was determined using the Percent Consonants Correct - Revised (PCC-R)[13] index and classified as follows: Mild (PCC-R from 86 to 100%); Mild-Moderate (PCC-R from 66 to 85%); Moderate-Severe (PCC-R- from 51 to 65%) and Severe (PCC-R below 50%).

Participants were also administered the Articulation Assessment in order to identify any speech distortions. This instrument evaluates the articulatory production of all phonemes in Brazilian Portuguese in all possible word positions, through the repetition of words read out by the therapist with no visual cues.

The Articulatory Awareness Instrument (Instrumento de Avaliação da Consciência Fonoarticulatória- CONFIART)[5] evaluates the ability to identify and execute the articulatory movements required to produce a given sound. This instrument is divided into four parts, to give a maximum score of 16. Part 1 involves the identification of the articulatory image associated with a given sound. Part 2 requires that children produce the sounds associated with a series of articulatory images. In part 3, children must identify the articulatory image corresponding to the first sound in a target word, presented in visual form as the image of an object. Lastly, part 4 requires that children produce a word based on its articulatory image. Each task has a maximum score of 4. Children's performance on this instrument was evaluated by adding up the scores of tasks evaluating sound identification (parts 1 and 3), sound production (parts 2 and 4), phoneme-level processing (parts 1 and 2) and word-level processing (tasks 3 and 4).

Assessment of Phonological Awareness through Oral Production (Prova de Consciência Fonológica por Produção Oral – PCFO)[11] This instrument evaluates the child's ability to manipulate speech sounds and express the results of this manipulation in the form of spoken language. The instrument comprises ten subtests: syllable synthesis and segmentation; phoneme synthesis and segmentation; detection of rhyme and alliteration; phoneme and syllable manipulation; and phoneme and syllable transposition. Each subtest contains two training items followed by four test items. Performance on the PCFO is quantified as the number or percentage of correct answers out of a possible 40.

The Word Writing Test[14] classifies children's writing skills into one of the following categories: presyllabic (no correspondence between graphic and sound segments), syllabic (letters represent syllables), syllabic-alphabetic (a transition stage where some letters still represent syllables while others represent phonemes) and alphabetic (all letters represent phonemes). The instrument contains four words (one monosyllabic, one disyllabic, one trisyllabic, and one polysyllabic) as well as a sentence with similar semantic content. The words and the sentence used in this assessment were the following: Bread, Cat, Horse, Butterfly and "The cat drinks milk." (*Pão, Gato, Cavalo, Borboleta, "O gato bebe leite*".)

The pre-intervention assessment was performed over the course of two sessions, with an approximate duration of 30 minutes each. Testing was conducted in a quiet, well-ventilated room, by the second author of this study.

Phonological intervention

After the assessment, children received individual speech therapy, conducted by the first author, in a quiet setting. All treatment sessions involved the "Pedro's Spooky Night" software, which focuses on the development of phoneme-level phonological awareness, articulatory awareness as well as letter-sound correspondence skills[15]. The game has seven stages: "Pendulum," "Ferris Wheel," "Pirate Ship 1," "Pirate Ship 2," "Cemetery," "Spaceships" and "Roller Coaster." Each session focused on a different skill and was structured around a different stage of the game, except for stage two, which included more activities and therefore took up two treatment sessions. The program therefore consisted of eight weekly sessions, with a duration of 30 minutes each.

The first session was structured around the "Pendulum" stage, which helps the child identify the initial (level I) and final (level II) phonemes in a series of words. The phonemes are grouped into categories in order to emphasize different classes of sound (vowels, fricatives, plosives, nasals and liquids). In this session, children were provided with the audio recordings of two words, and were asked to identify and compare their initial and final phonemes. If necessary, images of the target words in written form were shown by the software for the children to analyze. If patients still had trouble identifying the target phonemes, the therapist provided perceptual auditory cues, by elongating the phoneme and producing it herself, both in the target word and on its own.

The second session involved the "Ferris Wheel" stage of the software, which deals with phoneme synthesis, with an emphasis on fricatives, nasals, liquids and plosives. In this session, the child was asked to listen to the phonemes in a target word and identify the corresponding image. The activity was initially performed with no additional cues. However, if necessary, the software could be used to provide visual images of the letters during the task. After identifying the corresponding image, the therapist would ask the child to write down the word.

The third session was also structured around the "Ferris Wheel" stage and involved the same activities as the previous session. However, this time, all four phoneme classes were emphasized: the first target words contained up to four different sounds, while later stimuli contained five to seven sounds each.

The fourth session involved the "Pirate Ship 1" stage, which helped children with phoneme segmentation and counting skills. In this activity, target words were elicited through an image-naming task. After identifying each word, children were asked to break them up into their constituent phonemes. If children were unable to complete the task, the software itself could execute the segmentation procedure. The therapist would then encourage the development of phoneme-grapheme correspondence by asking children to listen closely and transcribe every phoneme, before selecting the number of letters they thought were present in the target word.

The fifth session involved the "Pirate Ship 2" stage, which focused on phoneme segmentation and counting. In this stage, children picked a random number, then selected one out of five possible images which contained the same number of phonemes as that drawn in the beginning of the task. After the activity, the therapist asked the child to write down the chosen word on a sheet of paper.

The activities in the "Cemetery" stage were carried out in session six, with the aim of helping children identify phonemes in complex words and syllables. In this session, children were asked to locate phonemes in a series of words. The child would first hear the word, before being asked to identify the position of a target phoneme within it.

In session seven, children completed the "Spaceships" stage of the software, which helped children associate sounds and letters with their respective articulatory images. In this session, the therapist would reproduce articulatory patterns to help children identify the place and manner of articulation associated with different phonemes. After identifying the target phoneme, children were asked to write down its alphabetic equivalent.

The eighth session was planned around activities in the "Roller Coaster" level, which focused on phoneme-grapheme conversion. In this stage, the child was asked to identify the grapheme corresponding to an auditorily presented target phoneme. The therapist helped by producing the target phonemes together with the child, so the latter could obtain additional information about the sound and the manner of articulation. In this activity, the child was also asked to write down the alphabetic equivalent of the target phoneme.

During the sessions, children were given visual, tactile and auditory cues for the place and manner of articulation of every phoneme, in order to encourage the development of articulatory consciousness.

After treatment, all children were reevaluated by the second author of this study using the same instruments administered before the intervention.

Data analysis

Quantitative data were analyzed using descriptive methods, while qualitative analysis was used to evaluate participant performance. Additionally, pre- and post-intervention scores on the CONFIART were compared using modified t-tests.

Tables 1 and 2 show the results of the Child Phonological Assessment and Articulation Assessment for each subject before and after the intervention.

As can be seen in Table 1, speech improvements were observed in all subjects after treatment, and the three children with mild speech sound disorders no longer showed any impairments after the intervention. Though the other children still presented with some alterations after treatment, their PCC-R scores increased over time.

Table 2 shows that some subjects who had a lisp prior to treatment were able to correct their articulatory patterns. However, for some children, the articulation difficulties present in the pre-intervention assessment persisted after treatment. Table 3 shows participants' scores on the Phonological Awareness through Oral Production (PCFO) test both before and after therapy.

As can be seen in Table 3, no changes in performance were observed in the syllable synthesis, alliteration, phoneme and syllable segmentation, or the phoneme and syllable transposition tasks. In these tasks, performance remained the same after treatment, regardless of its classification. Improvements were observed, however, in the phoneme synthesis, rhyme, syllable manipulation and phoneme manipulation tasks. In the syllable manipulation task, only two subjects (S1 and S6) failed to achieve adequate performance after treatment. In the phoneme segmentation task, only S1 was able to perform at the level expected for their age upon reassessment. The analysis of total scores showed that, though their classification did not change for any of the participants, raw scores tended to increase after treatment. Table 4 shows the results of the CONFIART for each subject before and after the intervention.

Table 1. Pre- and post-intervention scores on the Child Phonological Assessment (Avaliação Fonológica da Criança – AFC) for each participant

Subjects	Pre-intervention severity of SSD	PCC-R	Pre-intervention Phonological processes	Post-intervention severity of SSD	R*PCC-R	Post-intervention phonological processes
S1	Mild	91%	RCC Omission of /s/ in MC	-	100%	No alterations
S2	Mild	92%	RCC with the phoneme /r/ Omission of /s/ in MC	-	100%	No alterations
S3	Mild-Moderate	77%	Omission of /r/ in MC, FC, MO Omission of /s/ in MC Semi-vocalization of /l/ and /ʎ/ Semi-vocalization of /r/ RCC /s/ fronting Voicing of /ʃ/	Mild	86%	Omission of /r/ in MC, FC, MO and IO Semi-vocalization of /ʎ/
S4	Mild-moderate	84%	Semi-vocalization of /r/ RCC /s/ fronting	Mild	94%	/s/ fronting Voicing of /s/
S5	Mild	94%	RCC Omission of /r/ in MC and FC	-	100%	No alterations
S6	Mild-Moderate	74%	RCC Omission of /r/ in MC and FC	Mild	86%	Semi-vocalization of /r/
S7	Mild-moderate	70%	Semi-vocalization of /ʎ/ Devoicing of /g/ and /z/ /s/ fronting Omission of /r/ in MC RCC	Mild-moderate	85%	RCC; Omission of /r/ in MC and FC /s/ fronting Semi-vocalization of /ʎ/ and /r/

Caption: SSD=speech sound disorders; R*= reassessment; MC = Medial coda; FC= Final coda; IO= Initial onset; MO= Medial onset; RCC= Reduction of consonant clusters

Table 2. Pre- and post-intervention scores for each subject on the articulation assessment

Subjects	Pre-intervention	Post-intervention
S1	No articulatory alterations	No articulatory alterations
S2	No articulatory alterations	No articulatory alterations
S3	No articulatory alterations	No articulatory alterations
S4	Lateral lisp during /s/	Lateral lisp during /s/
S5	Frontal lisp during /s/	No articulatory alterations
S6	Frontal lisp during /s/	Frontal lisp during /s/
S7	Frontal lisp during /s/	No articulatory alterations

Table 3. Pre- and post-intervention scores for each subject on the Oral Phonological Awareness Test (Prova de Consciência Fonológica por Produção Oral; PCFO)

Subtest	Subjects	Pre-intervention score	Classification	Post-intervention score	Classification
Syllable Synthesis/4	S1	4	Moderate	4	Moderate
	S2	4	Moderate	4	Moderate
	S3	4	Moderate	4	Moderate
	S4	4	Moderate	4	Moderate
	S5	4	Moderate	4	Moderate
	S6	4	Moderate	4	Moderate
	S7	4	Moderate	4	Moderate
Phoneme Synthesis/4	S1	1	Moderate	1	Moderate
	S2	0	Low	0	Low
	S3	0	Low	0	Low
	S4	1	Moderate	2	Moderate
	S5	0	Low	2	Moderate
	S6	0	Low	2	Moderate
	S7	0	Low	0	Low
Rhyme/4	S1	2	Moderate	2	Moderate
	S2	2	Moderate	3	Moderate
	S3	1	Low	1	Low
	S4	2	Moderate	4	High
	S5	3	Moderate	4	High
	S6	3	Moderate	3	Moderate
	S7	0	Low	2	Moderate
Alliteration/4	S1	1	Low	1	Low
	S2	2	Moderate	2	Moderate
	S3	0	Low	1	Low
	S4	2	Moderate	2	Moderate
	S5	3	Moderate	2	Moderate
	S6	1	Low	0	Low
	S7	0	Low	0	Low
Syllable Segmentation/4	S1	4	Moderate	4	Moderate
	S2	4	Moderate	4	Moderate
	S3	0	Low	3	Moderate
	S4	4	Moderate	4	Moderate
	S5	4	Moderate	4	Moderate
	S6	4	Moderate	4	Moderate
	S7	4	Moderate	4	Moderate
Phoneme Segmentation/4	S1	0	Low	2	Moderate
	S2	0	Low	0	Low
	S3	0	Low	0	Low
	S4	1	Moderate	0	Low
	S5	0	Low	0	Low
	S6	0	Low	0	Low
	S7	0	Low	0	Low
Syllable Manipulation/4	S1	0	Low	0	Low
	S2	0	Low	1	Moderate
	S3	0	Low	1	Moderate
	S4	3	High	3	High
	S5	2	Moderate	3	High
	S6	1	Low	0	Low
	S7	0	Low	1	Moderate
Phoneme Manipulation/4	S1	0	Low	0	Low
	S2	0	Low	0	Low
	S3	0	Low	0	Low
	S4	0	Low	2	High
	S5	1	Moderate	2	Moderate
	S6	0	Low	2	Moderate
	S7	0	Low	0	Low

Table 3. Continued...

Subtest	Subjects	Pre-intervention score	Classification	Post-intervention score	Classification
Syllable Transposition/4	S1	0	Low	0	Low
	S2	0	Low	0	Low
	S3	0	Low	0	Low
	S4	4	High	3	High
	S5	4	High	1	Moderate
	S6	0	Low	0	Low
	S7	0	Low	0	Low
Phoneme Transposition/4	S1	0	Low	0	Low
	S2	0	Low	0	Low
	S3	0	Low	0	Low
	S4	0	Low	0	Low
	S5	0	Low	0	Low
	S6	0	Low	0	Low
	S7	0	Low	0	Low
Total score/40	S1	12	Moderate	14	Moderate
	S2	12	Moderate	14	Moderate
	S3	05	Low	10	Low
	S4	21	Moderate	24	Moderate
	S5	21	Moderate	22	Moderate
	S6	13	Moderate	15	Moderate
	S7	08	Low	11	Low

Table 4. Pre- and post-intervention scores for each subject on the Articulatory Awareness Test

Subjects	Task	Pre-intervention			Post-intervention			p^*
		Subtest scores	Total scores	Classification	Subtest scores	Total scores	Classification	
S1	Identification (1 and 3)	4/8	4/16	Low	8/8	11/16	Moderate	≤ 0.001
	Production (2 and 4)	0/8			3/8			
	Phoneme-level processing (1 and 2)	3/8			6/8			
	Word-level processing (3 and 4)	1/8			5/8			
S2	Identification (1 and 3)	8/8	9/16	Low	8/8	12/16	Moderate	≤ 0.01
	Production (2 and 4)	1/8			4/8			
	Phoneme-level processing (1 and 2)	5/8			7/8			
	Word-level processing (3 and 4)	4/8			5/8			
S3	Identification (1 and 3)	7/8	8/16	Low	6/8	10/16	Moderate	0.07
	Production (2 and 4)	1/8			4/8			
	Phoneme-level processing (1 and 2)	5/8			5/8			
	Word-level processing (3 and 4)	3/8			5/8			
S4	Identification (1 and 3)	6/8	8/16	Low	7/8	12/16	Moderate	≤ 0.01
	Production (2 and 4)	2/8			5/8			
	Phoneme-level processing (1 and 2)	6/8			7/8			
	Word-level processing (3 and 4)	2/8			5/8			
S5	Identification (1 and 3)	5/8	9/16	Low	8/8	12/16	Moderate	≤ 0.01
	Production (2 and 4)	4/8			4/8			
	Phoneme-level processing (1 and 2)	5/8			6/8			
	Word-level processing (3 and 4)	3/8			6/8			
S6	Identification (1 and 3)	2/8	3/16	Low	4/8	8/16	Low	≤ 0.001
	Production (2 and 4)	1/8			4/8			
	Phoneme-level processing (1 and 2)	2/8			4/8			
	Word-level processing (3 and 4)	1/8			4/8			
S7	Identification (1 and 3)	1/8	4/16	Low	7/8	11/16	Moderate	≤ 0.001
	Production (2 and 4)	3/8			4/8			
	Phoneme-level processing (1 and 2)	3/8			7/8			
	Word-level processing (3 and 4)	1/8			4/8			

Caption: * = p value of the comparison of total scores using a modified t -test

Table 5. Pre- and post-intervention scores for each subject on the Word Writing Test Oral Phonological Awareness Test

Test	Subjects	Classification	
		Pre-intervention	Post-intervention
Word Writing Test	S1	Syllabic	Syllabic-alphabetic
	S2	Pre-syllabic	Syllabic
	S3	Pre-syllabic	Pre-syllabic
	S4	Syllabic	Alphabetic
	S5	Syllabic	Alphabetic
	S6	Syllabic	Alphabetic
	S7	Pre-syllabic	Syllabic

As shown in Table 4, the scores obtained by most participants were classified as low before the intervention, but medium afterwards, which suggests improvements in articulatory awareness. The comparison of pre- and post-intervention scores revealed that six of the seven participants showed significant improvements after treatment. Table 5 shows the scores of each subject on the word writing test before and after the intervention.

As can be seen in Table 5, six subjects evolved from presyllabic to syllabic writing or from syllabic to alphabetic-syllabic or alphabetic writing. Only one subject showed no improvement in their writing skills, and continued to display presyllabic writing, as they did before treatment.

DISCUSSION

The present findings confirm the initial hypothesis, since most children who received the intervention showed improvements in both phonological and articulatory awareness, as well as writing skills and speech patterns.

All subjects showed improvement in PCC-R scores, and only one had no change in the severity of their phonological disorder after the intervention (Table 1). Articulation impairments also showed a significant decrease after treatment (Table 2). These findings showed that the intervention with a focus on phonological and articulatory awareness was effective in improving speech patterns.

The present findings are similar to those of previous studies in which children with phonological disorders received treatments with a focus on phonological awareness skills[1,5]. However, the use of a software platform combined with the training of articulatory and phonological awareness skills had not yet been studied in the literature.

In speech-language therapy, phonological and articulatory awareness training involves both phonemic awareness, and also the idea that every phoneme has a corresponding motor image[6]. This association is crucial for subjects to understand their own speech sound disorder and manipulate phonemes in both oral and written language.

Another important reason for the success of the software-based intervention may be the role of the mediator (therapist), who could provide visual, tactile and auditory cues whenever these would benefit the child, and emphasize the place and manner of articulation for different phonemes, complementing the stimuli provided by the software[8]. Though the software is self-explanatory and provides activities which address both phonological and articulatory awareness, its use must be supervised by a mediator who is familiar with the metaphonological skills being trained, so as to ensure that children pay attention to the underlying skills as they carry out each task. Additionally, it is important to note that positive results were observed after only eight treatment sessions.

The results of phonological awareness tests (Table 3) revealed that all subjects performed within the expected range for their age in measures of syllable synthesis and segmentation, even though these skills were not specifically addressed by the software, as its focus is on phoneme-level phonological awareness[15]. According to the literature, syllable synthesis and segmentation skills are easier for children to acquire, since the syllable is a more natural phonological unit[4]. The present findings also demonstrate the importance of stimulating phoneme-level phonological awareness for the acquisition of written language[4] (Table 4).

Articulatory awareness is a sub-skill of phonological awareness, and influences both the perception and production of speech sounds, while also contributing to the development of alphabetic writing[6]. These observations were supported by the present findings, which showed post-intervention improvements in phonological and articulatory awareness, as well as writing skills, in children with speech sound disorders.

The fact that most patients showed improvements in writing skills corroborates the current literature (Table 5). Studies which focused on the stimulation of phonological awareness have found these interventions to have an impact on the acquisition of alphabetic writing[4,5].

Only one subject continued to display pre-syllabic writing after the intervention (Table 5). Even after treatment, this individual (S3) obtained a low total score on the phonological awareness test and was unable to complete phonological tasks (Table 3). These skills are directly associated with the written language development[4].

Though the present findings are certainly relevant, they must be interpreted in light of some limitations, especially with regards to the small sample size, which prevented the use of more detailed analysis. We therefore recommend that similar investigations involving larger samples be conducted in the future.

FINAL COMMENTS

The present findings showed that a phonological and articulatory awareness training program based on the "Pedro's Spooky Night" software made positive contributions to speech patterns and written language acquisition in most subjects.

These observations underscore the importance of working on these skills in the context of speech-language therapy, given their potential to bring sizable benefits even after a short treatment period.

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Author contributions

LKBS collected all data and performed the writing of the manuscript; KCP delineated the study, conducted pre and post-intervention evaluations, analyzed the results and contributed to the writing of the manuscript.