Effectiveness of using software for stimulation of phonological awareness abilities in children

Eficácia do uso de um software para estimulação de habilidades de consciência fonológica em crianças

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ABSTRACT

Purpose: To investigate whether the software called Peter in the Amusement Park is effective in both developing phonological awareness and building alphabetical writing. Methods: Twelve children, aged 4-5 years, from a nursery school in Porto Alegre, participated in this study. Each child was individually assessed in terms of phonological awareness and had his/her writing hypothesis analyzed. Children whose writing hypothesis was considered pre-syllabic were randomly assigned to two groups: study group (SG) and control group (CG). Children belonging to SG were stimulated through the use of the software, while those from CG were given only standardized school stimulation. At the end of 10 stimulation meetings, children were reassessed. Results: The results have shown a statistically significant difference in phonological awareness at the level of syllable and phonemes, as well as change in the writing hypothesis among SG children in comparison to the CG participants’ performance. Conclusion: The study evidenced that the software, by having a speech and language pathologist as a mediator, was effective to develop phonological awareness and facilitated the change in the spelling hypothesis from pre-syllabic writing to syllabic writing. Therefore, stimulation programs used in children education should be carefully selected in order to guarantee better results.

Keywords: Child Language; Learning; Handwriting; Auditory Stimulation; Software validation; Speech, Language and Hearing Sciences

RESUMO

Objetivo: Verificar a eficácia do uso do software “Pedro no Parque de Diversões” no desenvolvimento da consciência fonológica e na construção da escrita alfabética. Métodos: Participaram do estudo 12 crianças, com idades entre 4 e 5 anos, de uma escola particular de educação infantil da cidade de Porto Alegre. Cada criança foi avaliada individualmente quanto à consciência fonológica e hipótese de escrita. Por meio de sorteio, as crianças com hipótese de escrita pré-silábica foram divididas em dois grupos: o grupo estudo (GE) e o grupo controle (GC). As crianças do GE foram estimuladas com o uso do software e as do GC receberam, unicamente, a estimulação de linguagem e de consciência fonológica padrão da escola. Ao término da estimulação (dez encontros) as crianças foram reavaliadas. Resultados: Os resultados evidenciaram diferença significativa no que se refere à consciência fonológica, no nível da sílaba e do fonema, e à mudança da hipótese de escrita dos participantes do GE, em relação ao desempenho dos participantes do GC. Conclusão: O estudo verificou que o software, tendo o fonoaudiólogo como mediador, foi eficaz para desenvolver a consciência fonológica e facilitou a mudança da hipótese de escrita pré-silábica para a silábica. Dessa forma, programas de estimulação usados na educação infantil devem ser cuidadosamente selecionados, para garantir maiores resultados.

Descritores: Linguagem Infantil; Aprendizagem; Escrita Manual; Estimulação Auditiva; Validação de Programa de Computador; Fonoaudiologia

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Conflict of interests: No

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INTRODUCTION

In Brazil, Phonological Awareness (PA) has been widely studied over the last decades. Basically, the investigated areas fall into one of the following categories: a) design of assessment instruments; b) search for a PA development pattern in pre-school and school children showing either typical or atypical development; c) influence on reading and writing acquisition and development; d) preventive or rehabilitative stimulation of PA abilities.

Although studies have evidenced an association between the reading and writing learning process and phonological awareness development, there are few computer-based therapeutic resources with specific phonological awareness activities in Brazilian Portuguese. For this reason, the design of technological materials to develop PA in both clinical and school settings has become an object of study.

The clinical practice in Speech and Language Pathology has empirically evidenced that the activities presented by the software called Peter in the Amusement Park facilitate learning of language sounds and seem to contribute to the construction of the alphabetical writing. However, there are no researches focusing on its effectiveness.

Hence, this study aimed at investigating whether the use of Peter in the Amusement Park software helps develop children’s ability to think about language sounds and, consequently, whether it favors the change of stage in the development of writing. If such benefits are confirmed, speech and language pathologists will have one more tool available for their clinical and school work, based on scientific evidences.

METHODS

The present research, approved by the Ethics Committee of Centro Universitário Metodista – IPA, Porto Alegre (RS), Brazil, under the protocol number 159, was characterized as an exploratory, correlational field study that constructed the relationship between phonological awareness and the stages of writing development in children.

The sample was composed of children aged 4 years, 1 month to 5 years, 11 months attending a children education school in Porto Alegre. The children included in the research were at the pre-syllabic writing stage and had neither speech nor hearing alterations. Their caretakers allowed their participation in the research by signing a Consent Form.

Twelve of the 60 children in the age group above mentioned attended the inclusion criteria and were randomly assigned to one of two groups: SG (Study Group) and CG (Control Group). Twenty-seven children whose parents did not sign the Consent Form, 6 that presented with hearing loss, 7 that were not present on the collection day, 3 that were at the syllabic writing stage and 5 that showed speech alteration were excluded from the study.

Procedures individually performed for sample selection

- Hearing assessment: Meatoscopy to verify the presence of cerumen, and audiological pure-tone evaluation at frequencies of 500 Hz, 1000 Hz and 2000 Hz using Diagnostic Audiometer® AP 25.
- Speech screening: A shortened version of the book Avaliação fonológica da criança was designed. The child was shown a thematic picture and asked to provide a word for each sound in different positions. On the whole, 34 words were evoked.
- Writing hypothesis: The children were invited to write four words (one disyllable, two trisyllables and one polysyllable) based on pictures that were individually presented. They were supposed to say the word and, immediately after that, write it the way they could. The pictures used showed a cat, a ghost, a bat and a skeleton, as they were instigating, little familiar words, except for the word ‘cat’. A specialist evaluator that did not participate in the study classified the children according to their writing development stage: pre-syllabic stage (no relationship between orality and writing), syllabic stage (partial relationship between spoken word and writing), alphabetic-syllabic stage (transition from the syllabic to the alphabetical stage) and alphabetic stage (direct correspondence between phonemes and graphemes).

Study procedures

1) Initial evaluation: The phonological awareness of 12 children at the pre-syllabic writing stage was assessed by a junior Speech and Language Pathology student in two 15-minute sessions in a room at the school. The Instrument of Sequential Evaluation of Phonological Awareness (CONFIAS) was used, as it evaluates two levels of PA by means of different tasks. A mean of 18 right answers is expected at the pre-syllabic writing stage and 6 right answers at the phoneme stage, with the use of this instrument to evaluate PA.

At the syllabic stage, tasks that investigate the capacity of synthesis, segmentation, (initial, final and medial) syllable identification, rhyme production, exclusion and transposition were applied. At the phonemic stage, the items of investigation involved the production of a word beginning with a determined sound, identification of initial and final phoneme, exclusion, synthesis, segmentation and transposition. The highest score expected was 40 at the syllable stage, and 30 at the phoneme stage.

2) Stimulation: It was performed by a senior Speech and Language Pathology student who did not know the results of the initial evaluation. The children at the pre-syllabic writing stage were randomly
assigned to two groups:
- Control Group (CG): Six children who received only language and phonological awareness stimulation provided by the school along the study period.
- Study Group (SG): Six children who were stimulated with the use of Peter in the Amusement Park software along the month of October, besides receiving language and phonological awareness stimulation at school. The school follows a constructivist approach and its pedagogical proposal includes the stimulation of phonological awareness through stories, rhymes and games to stimulate the knowledge of speech sounds.

Ten individual sessions were carried out with the use of a computer in a room provided by the school coordination, three times a week, lasting around 20 minutes each, and totaling three hours and 20 minutes of stimulation in a period of approximately one month.

The first stimulation session started with the Carrousel game, which aims to develop the syllabic synthesis. In order to stimulate segmentation and counting, the Circus game was used in the second session. In this task, each child was instructed to pronounce the word and use colored caps before giving the answer. The objective of the third session was to develop the ability to detect syllables with the help of the Cups game. The fourth session was dedicated to rhyme identification with the Target Shooting game. The fifth session used the Alligator Realm aiming to stimulate the identification of syllables at the initial, final and medial position. In this game, the child was instructed to say the word and use colored caps to perceive the syllable position within the word before giving the answer. The sixth session used the Balloon game, in which the child should click on the word that did not rhyme with the presented stimulus. The Electronic Games were used in the seventh session to stimulate the syllabic exclusion in words and pseudo-words. In the eighth session, the child should perform manipulation tasks in the Haunted Castle, a game designed for the identification of syllable position (Mummy), exclusion (Witch) and replacement (Frankenstein). The Toboggan game was used in the ninth session. The child should perform the syllabic transposition and word formation after listening to one or two syllables. The last stimulation session was free, i.e. each child could choose one of the games to play again.

During the stimulation process, qualitative data such as the ability addressed, the level of difficulty shown by the child, the need for help and repetition of stimuli, time for performing the task, and the need for concrete material and phono-articulatory support were recorded by the researcher on the Intervention Protocol (Appendix 1). Such data will not be discussed in the present paper.

3) Final evaluation: Carried out by a junior Speech and Language Pathology student who did not participate in the intervention sessions (blind to the group to which the child belonged).

After ten stimulation sessions, each participant (six in SG and six in CG) was individually reassessed in two 15-minute sessions. The same instruments used in the initial evaluation were applied, considering PA and writing stage.

Data analysis

The description of the sample profile according to the variables under study was performed through tables of frequency of categorical variables (writing stages), with values of absolute frequency (n), percentage (%) and descriptive statistics of continuous variables (age and number of right answers in the PA test), with mean, standard deviation and minimum and maximum values.

The analysis of variance for repeated measures (ANOVA) was used to compare the parameters of the PA test between the two groups (control and study) and between the two evaluations. Tukey’s Multiple Comparison Test was applied to compare the groups at each moment, and the contrast profile test was intended to analyze the parameters between both evaluations. In order to compare the categorical variables between the initial and final evaluations in each group, McNemar’s test for related samples was used. The significance level for the inferential statistical tests was 5%.

RESULTS

Children from both groups achieved results under the minimum expected in the beginning of the study in terms of phonological awareness, according to the normative standard described by CONFIAS. At the syllabic stage, the minimum of right answers was 12 in CG and 15 in SG. At the phoneme stage, children from CG showed the minimum of four right answers, and those from SG gave only one right answer.

As to the final evaluation, the results of ANOVA pointed difference between the groups (CG and SG) and evaluations for the three parameters (right answers at the syllable stage, at the phoneme stage and in the total of CONFIAS). We also found increased number of right answers in tasks involving the syllable stage (from 18.50 to 35.67), phoneme stage (from 4.5 to 12.33) and CONFIAS (from 23 to 48), between the initial and final evaluations, for the study group. There was a difference between the number of right answers at the syllable stage and the total number of CONFIAS between both groups (CG and SG) (Table 1).

With regard to the writing stages, CG and SG participants were at the same writing level in the initial evaluation, i.e. in the pre-syllabic stage. In the final evaluation, only SG participants had passed from the pre-syllabic to the syllabic stage (Table 2).

Although CG children obtained in the final evaluations similar results to those found in the initial evaluations, all children involved in this study improved their phonological abilities. However, it became evident that SG participants had
more improvements in comparison to CG subjects (Table 1 and Figure 1).

In the initial evaluation, CG and SG participants obtained similar scores in relation to PA ability. However, in the final evaluation, SG participants achieved better results in comparison to both CG children’s performance and their own results in the beginning of the study (Figure 1).

In relation to writing, again, there were significant changes in SG participants. Of the 6 SG children, 5 (83.33%) moved from the pre-syllabic stage to the syllabic stage, and 1 (16.67%) remained at the pre-syllabic writing stage. On the other hand, all CG children (100%) remained at the same writing stage they were in the beginning of this study (Figure 2).

**DISCUSSION**

The poor performance of participants in the PA evaluation carried out in the beginning of this study may be related to the lack and/or insufficiency of previous PA stimulation in both their school and family routine. The phonological awareness may vary according to environmental, familial and methodological stimulation, social-economic level and gender, and not only according to the writing stage at which the child is.

PA is an essential component for the beginning of the literacy process and the discovery of grapho-phonological relationships in an alphabetic writing system. The alphabetic system does not directly represent the meaning of words, but the sequence of their sounds. As other studies that performed the stimulation of PA abilities and found a positive relationship between PA degree and performance in the initial reading and writing phase, this study also revealed that the children that participated in the specific stimulation had significant gains in both phonological knowledge and writing development.
The process of construction of alphabetic writing goes through specific stages. Initially, children infer that the mark in writing is performed by the signified, rather than the signifier (initial stage of children participating in this study). As the children perceive that the relationship between what is spoken and what is written is not marked by either the properties of objects or concepts such as size, color and shape, but by the sound sequence (final stage of SG children, i.e. when children start realizing that every time they separate the speech into articulated parts, these are represented by letters), they understand and master the alphabetic code.

For this reason, reading and writing acquisition, from the linguistic perspective, is a complex phenomenon that is strongly related to the learner’s ability to analyze, reflect on and synthesize the units that compose the spoken words.

Although the linguistic challenges of the computerized program used in the present study required explicit manipulation of PA's syllabic and intra-syllabic levels, every game, besides developing a specific phonological ability, also helped improve neurocognitive functions, such as hearing attention, working (operational) memory and executive functions.

In order to perform a PA task, it is necessary to plan, categorize, have cognitive flexibility, inhibit the wrong answer and choose the best procedure. These are likely to be the reasons why the phonemic level changed, even though the education level remained the same. This is worth mentioning because the phonemic abilities are the last ones to be developed and are strongly linked to alphabetic-orthographical writing.

The activities used in this study helped the participants develop their meta-phonological abilities in a broad manner and construct new learning in a short period because the tasks were not merely intended at auditory training; rather, they required linguistic-auditory reasoning.

Despite the software being self-explanatory, the presence of a mediator (speech and language pathologist) with knowledge of metalanguage (capacity to think about language) and metacognition (capacity to know and manage one’s knowledge) was found important to help children understand the tasks. The mediator’s function is to identify whether the difficulty shown by children is caused by their poor ability to deal with linguistic manipulation or by the complexity of the proposed task from a cognitive point of view. Hence, the presence of a speech and language pathologist would prevent children from giving right answers by chance or clicking on the mouse unadvisedly.

The results in PA abilities achieved by children that underwent the software stimulation, i.e. those whose total highest score passed from 30 to 58, were possibly due to stimulation performed with the use of the software and the role of the speech and language pathologist as a mediator in the process.

Not only was such advancement accomplished by the subjects as it would be expected of children at the writing stage the participants were at in the beginning of the research, but it also went beyond the expected of the writing stage reached at the end of the study. According to the PA\(^{(2)}\) normative standard for the syllabic writing stage, the minimum of right answers is 23 and the maximum is 32 at the syllable stage, and the minimum is 5 and the maximum is 11 at the phoneme stage. SG children obtained the minimum of 29 right answers and the maximum of 44 at the syllable stage, and the minimum of seven and the maximum of 19 at the phoneme stage.

Therefore, in the beginning of this study, SG moved from a mean below the expected of the pre-syllabic stage to a mean above the expected of the syllabic writing stage. CG, in turn, despite remaining at the pre-syllabic writing stage, increased the total number of right answers in PA from 22.17 to 24, reaching the normative mean proposed by CONFIAS, i.e. 23\(^{(2)}\).

To prove that the software used in this study was really responsible for the change in the children’s metalinguistic behavior and seek for evidence of the mediator’s role, it would be important to replicate the study methodology with four intervention groups: a group receiving exclusive software stimulation, with no mediator; a group with mediator; a third group receiving the same stimulation of PA abilities without the use of the software, but with a mediator; and a control group receiving the same PA stimulation, without software, in the classroom.

The major limitation of this research, besides the reduced number of subjects, was CG participants did not receive any kind of intervention. A suggestion would be replicating the study with the control group receiving training in a specific neurocognitive function, such as working (operational) memory.

**CONCLUSION**

By analyzing the results, it is possible to conclude that the stimulation of phonological awareness with the use of Peter in the Amusement Park software was effective to improve PA in 4-5 year-old children and change their writing stages.

It is believed that the random linguistic stimuli, the cognitive operations needed for performing the tasks, the presence
of auditory and visual feedback of the wrong answers in the software and the participation of a speech and language pathologist as a mediator in the process were effective to develop phonological awareness and facilitate the change from the pre-syllabic writing stage to the syllabic stage. For this reason, stimulation programs used in children education should be carefully selected in order to guarantee better results.

Finally, despite the positive result, the PA activities used in this study should be used as a tool at the service of a pedagogical (if used at school) or clinical approach (if used in phonoaudiological habilitation or rehabilitation), rather than a teaching-learning methodology.

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REFERENCES

Appendix 1. Peter in the Amusement Park Software

Phonological awareness – syllable stage

Intervention Protocol

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Child’s meaningful speech: _______________________________________________________________