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Phonological awareness intervention and attention efficiency in children at risk: evidence of effectiveness on visual attention

ABSTRACT

Using a pretest and posttest comparison group design, this 20 weeks study investigated the effects of a phonological awareness training program (PATP) on attention efficiency (AE) in 57 children (age = 5 to 6 years) at risk. The experimental group received the PATP (EG; n=30). We obtained pretest and posttest measures of phonological awareness and AE. The ANOVA showed significant interaction effects of the PATP and time on phonological awareness and AE. For both groups, posttest AE score means were higher than pretest score means. Pretest measures showed that the AE score mean for the EG was lower than that for the Control Group (CG; n=31); whereas posttest data showed no between group differences. Contrast analysis showed that the EG gained a greater level of phonological awareness ability and AE over CG. Our results indicate that children's attention efficiency not only improved as they developed, but also increased by means of a PATP.

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INTRODUCTION

Research on beginning reading documents the positive effects of a phonological awareness training program (PATP) on word reading (e.g. Ehri et al.⁽¹⁾). However, there has been limited research on the effects of a PATP on other cognitive systems, such as visual attention efficiency. *Phonological awareness* (PA) is the ability to manipulate the phonological structures of words such as phonemes, syllables and rhyme. *Visual attention efficiency* refers to the control mechanism that allows children to sustain their attention during a task that requires to focus and to select the target stimuli among other distracter stimuli within a given time⁽²⁾. From the System Perspective, during children development, their cognitive, linguistic and affective functions process information in an interrelated way. This synergic processing that takes place around kindergarten will have an effect on literacy achievement during the subsequent school years. Linguistic functions such as vocabulary, grammar and phonological awareness help children to organize other behavioral functions such as attention and memory, which, in turn, support reading acquisition⁽³⁾. Thus, we hypothesized that a systematic PATP will not only have an effect on phonological awareness, but will also improve visual attention efficiency. Using a pretest-posttest comparison group design, this 20 weeks study examined the effects of a PATP on visual attention efficiency performance in first grade Spanish speaking children growing up in at risk conditions of social vulnerability.

In different languages, PA has been recognized as the main predictor of reading achievement (for a review see Ziegler and Goswami⁽⁴⁾). Consequently, researchers have developed different PATP for children attending the first two years at the elementary school level, and have evaluated their effects on children's later reading achievement. These studies demonstrated that PA ability can be developed with consequent positive effects on reading achievement⁽¹⁾. To a lesser extent, the PATP effects on executive functions—such as visual attention efficiency—have been assessed.

Some researchers have described and assessed the relationship between PA and attention from two different perspectives. On the one hand, for children to be able read, they must be attentive to the sounds of speech. A child must be auditorily aware of the segments of the speech segments to associate each grapheme to its corresponding sound. From this perspective, children's phonological problems emerge from inattentive behavior and from inhibitory control deficit of irrelevant stimuli, rather than from a linguistic skill difficulty. This view is supported by a study in which data of phonological processing and reading, as well as teacher ratings of child behavior, was collected from children from kindergarten to 2nd grade (N=132). The analysis of the relationships among the variables indicated that inattentiveness negatively affected the acquisition of PA skills⁽⁵⁾. On the other hand, it has been reported that children with ADHD without learning disabilities do not present PA difficulties. Gómez et al.⁽⁶⁾ examined PA skills in Spanish speaking children with ADHD without learning difficulties aged 7 to 11. The sample was classified into three groups: an ADHD combined type (ADHD/+H), an

ADHD inattentive type (ADHD/-H), and one control group. Since differences between ADHD and control children on PA tasks scores were not found, the authors concluded that children with ADHD without learning disabilities performed similarly to controls on PA tasks. These results indicate that inattentiveness—without learning disabilities— would not interfere in children's PA acquisition. Additional evidence of absence of PA deficits in children with ADHD comes from Willcut et al.⁽⁷⁾ who showed that ADHD with reading disabilities was associated with an inhibition deficit and was not significantly associated with a deficit in PA.

We believe that the System Perspective favors the assumption that the development of PA abilities, throughout a systematic training in children growing up in at risk conditions of social vulnerability, will favor other cognitive functions, such as attention efficiency (AE). Under this view, Dickinson et al.⁽³⁾ explain that literacy develops as a consequence of linguistic, cognitive and affective functions that, working together, lead to a more mature coordinated processing system that influence children cognitive, linguistic, and behavioral outcomes. Thus, we sustain that as children develop linguistic skills, like vocabulary, grammar, discourse, and PA, other cognitive and behavioral functions such as attention efficiency reach higher levels of organization. During the performance of both, PA and visual AE tasks, children must be aware of every stimulus that they are processing. To accurately perform these two tasks independently, the stimulus must enter consciousness. From the System's viewpoint, we believe that by executing PA tasks, the organization processes that make a visual-stimulus conscious by accelerating the visual search task within a given time will be favored. Thus, we hypothesized that AE performance varies with PA instruction.

Attention improves as children develop and by means of systematic direct instruction (e.g.⁽⁸⁾). Ison et al.⁽⁸⁾ examined the effects of an AE training program on children aged 7 to 12 with attentional deficit. The results showed that both the experimental and the control groups significantly increased their AE performance during the posttest assessment. Thus, the results confirmed the effect of time on AE.

Although there is evidence that linguistic based intervention programs have positive effects on reading acquisition, reports about these program effects on attention efficiency have been limited. Stevens et al.⁽⁹⁾ assessed if a program designed to improve linguistic abilities, might influence neural substrates of selective auditory attention shown to be deficient in language impaired children. The trained group showed a larger increase in auditory selective attention and measures of receptive language than those of the control group. Kerns et al.⁽¹⁰⁾ assessed the effects of a direct intervention program for improving attention on children diagnosed with attention deficit hyperactivity disorder. The intervention included to complete visual and auditory tasks. Consistent with the system perspective, the authors found that the experimental group did significantly better on non-trained measures of attention. Thus, we predicted that visual AE will vary according to time and training effects.

METHODS

To assess the impact of our PATP on children's AE performance, we employed a pretest-posttest quasi experimental comparison group design. Pretest and posttest measures of children's PA and AE were obtained.

Participants

The sample consisted of 61 children (*Mean Age* = 76 months, *SD* = 6.8) from an urban marginal public elementary school in Mendoza, Argentina. The school selection met the following criteria: **a)** neither grapheme nor phonemic training was introduced in the kindergarten class until the children attended the first grade; and **b)** the children who attended this school develop in at risk conditions of social vulnerability (high rates of unemployment, restricted social networks of support, precarious living conditions) and are exposed to middle/low levels of home literacy (the average of school attendance years of adults aged 25 and over, living with the child, were less than 9).

The subjects were Spanish speaking children with no known history of neurological, inattentive behavior, or hearing disorders and had not learned to read. Data collection started at the beginning of the academic year and lasted a month. Whereas the experimental group received the PATP ($n = 30$; *Mean Age* = 6.3 years, *SD* = 4.9), the control group ($n = 31$; *Mean Age* = 6.4 years, *SD* = 4.7) received a shorter alternative program to control the Hawthorne effect.

Materials

We obtained one measure of children's general cognitive ability and pretest and posttest measures of children's phonological awareness ability and visual attention efficiency.

General cognitive ability

We administered two subtests of the Wechsler Preschool and Primary Scale of Intelligence (WIPPSI): the vocabulary and block design. The means for the experimental group was 94.8 (*SD* = 10.2) and for the control group was 92 (*SD* = 12).

Phonological awareness skills

To obtain an overall measure of PA we: a) obtained measures of the following tasks: Phoneme blending, phoneme segmentation, initial phoneme identity, and phoneme isolation; b) converted each raw score for every task into a 0-10 scale value; c) added all the normalized values; and d) converted the added value into a scale 0-10. In the **Woodcock-Muñoz Sound Blending Subtest**⁽¹¹⁾, the subject listens to a series of syllables or phonemes and then is asked to blend the sounds into a word. From a total of 33 items that compose this task, we only took into account the scores obtained by the children in the last 20 items because the first 13 items require the child to blend syllables into words. The maximum score was 13. This task has a median internal consistency reliability of 0.86 in ages 5 to 19. The **Manrique-Gramigna Phoneme Segmentation Task**⁽¹²⁾ requires breaking the word into its sounds by positioning

a marker for each sound; for example, "How many sounds in "más" (3: /m/ /a/ /s/). The task has 42 stimuli that are presented randomly from each of three following conditions: 14 single phoneme words, 14 two phoneme words, and 14 three phoneme words. The maximum score was 42. The **Initial Phoneme Identity Task**⁽¹²⁾, requires the subject to identify which of the drawings located in the lower part of the chart starts with the same sound as the drawing located in the upper part of the chart. This task is composed of 10 items each, and each item consists of three drawings presented on a chart (one in the upper part and two in the lower part of the chart). The maximum score was 10. It has an internal consistency reliability of 0.75. The **Jimenez Ortiz Phoneme Isolation Task**⁽¹³⁾ requires recognizing within a series of five drawings, one that starts with the sound given by the experimenter; e.g., "What word starts with the sound /o/?" It has an internal consistency reliability of 0.52. For every phonemic awareness task administered, 1 point was given for each correct answer.

Attention efficiency

We administered the Magallanes Scale for Visual Attention⁽¹⁴⁾ to the class as a group. It requires the child to search and to cancel the target stimulus on a chart, among a series of visual distracter similar stimuli, within a given time—6 minutes. The target stimulus is posted on the upper part of the chart and consists of a human figure pictogram in which the right arm and leg are flexed. The chart is composed of 720 stimuli; 140 are target stimuli and 580 are distracters. Before the task begins, each participant is tested for basic target stimuli recognition. The participants are asked to search the target stimuli in a left to right, top to bottom order, and cross them out. To obtain an AE score, the sum of the total number of incorrect answers plus the number of omitted ones is subtracted from the total number of correct answers (Attention Efficiency Direct Score = CA – (IA + O)).

The phonological awareness training program

In every lesson our PATP include the following exercises: First, a phoneme segmentation activity: Is the program main activity. It requires the children to break two and three grapheme words by positioning a marker for every sound he/she pronounces. Second, a linguistic game to foster the awareness of rhyme, sound categorization, or sound blending. Third, a letter name knowledge activity that requires to select and hold up the letter corresponding to the sound that the teacher articulates aloud; to say aloud the first sound of the drawing, and to put the drawing inside a bag with the correct letter sign; and letter-sound bingo games. The program consisted of a total of 34 lessons of 30 minutes each and is imparted by the teacher to the class as a group⁽¹⁵⁾.

Procedures

Pretest measures of children's general cognitive ability, PA abilities were given to the children individually, and visual attention efficiency was given to the children as a group. Pretest assessment was administered by a researcher or well-trained graduate students in a quiet room at the school. After finishing the

pre-assessment stage, the PATP was imparted to the experimental group. The teacher received specific training on the lessons to be imparted each week. To control treatment fidelity, every lesson was supervised by the main author or by the trained student who registered the activities and verbal interactions. The PA program lasted three months. The control group received an alternative 5 lessons program focused on grammar development. Children receiving the alternative program manipulated the same visual material as the children that were receiving the PATP. The alternative program was developed to control the confounding variable which holds that the experimental group could improve its word recognition skills due to the impact of the visual stimuli. Based on the teacher's request, the alternative program focused on grammar development. Finally, posttest measures of PA; word reading and attention efficiency were gathered.

RESULTS

Hypothesis 1. To assess if phonemic awareness (PA) ability varies according to PA training (with and without) and time (pre-intervention and post-intervention), we used a general linear ANOVA model with repeated measures. A three factor partially nested design was applied. The model factors were time (A = pre and post), training (B= with and without), and subject (C = 61). Subject was nested within training and entered as a random variable. An alpha level of 0.05 was used as the criterion for all statistical tests. Time and training interactively affected PA $F(1, 49) = 3.9$, $MSE = 60$, $p = .05$. Pretest score mean from the EG ($M = 58$, $SE = 1.84$) did not differ from that of the CG ($M = 61$, $SE = 1.82$). Although the post-test score mean from the EG ($M = 75$, $SE = 1.84$) was larger than the post-test score mean of the CG ($M = 72$, $SE = 1.81$), $t(61) = 1.14$, $p = 0.2$ (two-tailed), this difference was not statistically significant to account for training effect $F(1, 49) = 0.12$, $MSE = 60$, $p = .07$. Thus, the interaction was significant by means of time $F(1, 61) = 41$, $MSE = 60$, $p < .0001$: posttest score means were significantly larger than pretest score means.

According to the previous result, we assessed whether the gain in PA was greater for the children who received the PATP than for children who did not. To assess this difference in PA gain, we contrasted the results of the differences between pre-and post-phonemic awareness score means for every group. To do this, we estimated the following contrast $L = (\mu_{11} - \mu_{21}) - (\mu_{12} - \mu_{22}) = (58-75) - (61-72)$. The estimated difference was of $L = -6$ and the estimated standard deviation was $s\{L\} = 2.8$. For a 95 percent confidence coefficient, we require $t(.05; 59) = 1.6$. Hence, the lower confidence limit is $6 - 1.6(2.8)$ and the desired confidence interval is: $L \geq 1.52$. We concluded, with a 95 percent confidence coefficient, that the gain in phonemic awareness performance was greater for children who received the PATP than for children who received the alternative program, the difference in the mean gain being at least 1.52.

Hypothesis 2. The second ANOVA assessed if attention efficiency performance varied according to PA training and time. The factors were time, training, and subject. Subject was nested within training and entered as a random variable (Table 1).

We found significant effects of time ($p < 0.000$) on Attention Efficiency: both groups showed posttest AE score means significantly

higher than pretest score means. The pairwise comparison analysis supported our hypothesis. Pretest measures showed that the AE score mean for the experimental group was significantly lower ($M = 26.00$, $SE = 2.33$) than that for the control group ($M = 38.32$, $SE = 2.99$), $t(61) = 3.7$, $p = .0004$ (two-tailed). However, after administering the PATP to the experimental group, posttest data showed no between group differences in AE, indicating that the experimental group ($M = 50$, $SE = 2.33$) had matched the control group in AE ($M = 56.64$, $SE = 2.32$), $t(61) = 2.0$, $p = .07$ (two-tailed).

Therefore, we assessed whether the amount of attention efficiency gain was greater for children receiving the PATP than for children who did not. To assess this difference, we contrasted the results of the differences between pre and post AE score means for every group as follows: $L = (\mu_{11} - \mu_{21}) - (\mu_{12} - \mu_{22}) = (25-50) - (38-56)$. The estimated difference was of $L = 6$ and the estimated standard deviation was $s\{L\} = 3.3$. For a 95 percent confidence coefficient, we require $t(.05; 59) = 1.6$. The lower confidence limit is $6 - 1.6(3.3)$ and the desired confidence interval is: $L \geq .72$. Thus, the gain in attention efficiency performance was greater for children who received the PATP than for children of the control group, the difference in the mean gain being at least .72 (Figure 1)

Table 1. Analysis of variance for attention efficiency scores

Source	N	Df	Dfden	Sum of Squares	F	P
Time (A)	1	1	59	13589.78	158.02***	<.000
Training (B)	1	1	59	998.38	11.60**	0.001
A X B	1	1	59	237.13	2.75	0.10
Subjects [Reading Level] & Random	61	59	59	9011.09	1.77	0.14

Caption: $p < .05$ ** $p < .01$ *** $p < .001$

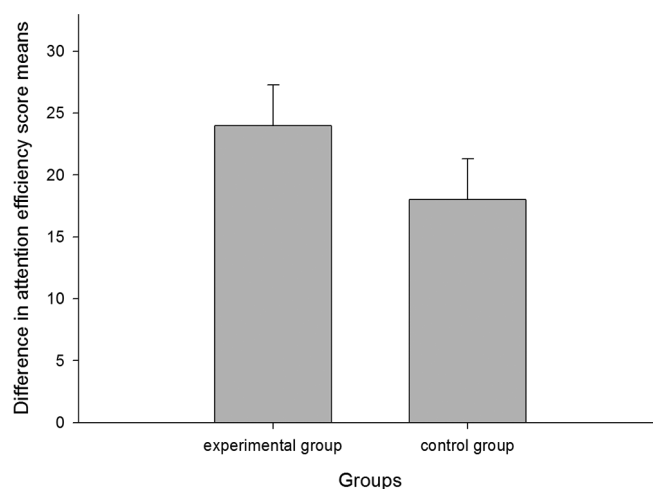


Figure 1. Attention efficiency main gain resulted from the contrast between pretest and posttest level means. $n = 30$ (experimental group), $n = 31$ (control group). $N = 61$

CONCLUSIONS

The results confirm that phonemic awareness training enhance such ability (cfr. ⁽¹⁾). The fact that participants were first graders, who received regular reading instruction while the phonemic awareness program was imparted, may account for the absence of the training program effects on phonemic awareness ability.

The findings indicate that children's attention efficiency not only improves during the first year of formal instruction, but also may increase by means of a structured phonological awareness training program. The significant improvement in children's attention efficiency system during the first two years of school instruction accounted for the absence of significant interaction effects between time and phonological awareness training. However, the effect of our PATP was significant enough to account for the differences found in AE gain after the training was imparted.

Consistent with the study of Stevens et al.⁽⁹⁾, our results show the positive effects of a phonological awareness training program on visual attention efficiency. Our findings indicate that because these two cognitive expressions—PA and visual attention efficiency—share similar cognitive mechanisms, children may improve their attention efficiency mechanisms by systematically strengthening their phonological awareness abilities.

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Author contributions

MAC developing the concept of visual attention efficiency; collecting data on the visual attention efficiency task, entering the visual attention efficiency data and assisting on the literature review process; MSI developing the concept of visual attention efficiency; obtaining and adapting the visual attention efficiency task; collaborating during the literature review process; MEP contributed: organizing the design; collecting pre and post measures of phonological awareness; delivering the phonological awareness intervention program; entering phonological awareness data; performing statistical analysis as well as writing and revising the manuscript.