

## **Effectiveness of the computerized tool EPI.com to enhance comprehension and expression in students aged 3 to 6**

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### Abstract

The acquisition of comprehension and expression abilities is a key issue in learning processes, particularly due to the difficulties students may come across. The computerized tool EPI.com is based on an adaptation of Hypertext to Early Childhood Education, aiming at an improvement in lexical, semantic and syntactic processes. This piece of work aims at analyzing the effectiveness of EPI.com in improving psycholinguistic and verbal aspects in a global way and depending on age. A total of 155 students (aged 3-6) participated, divided into an Experimental Group (EG; 93 students who worked with EPI.com) and a Control Group (CG; 62 students who followed the traditional methodology). They were all evaluated by means of the Illinois Test of Psycholinguistic Abilities and the Peabody test. Results show the effectiveness of the strategy used with the EG, with statistically significant scores in psycholinguistic factors if compared to those in the CG. Three-year olds were those obtaining greater benefits. It is concluded in this study that EPI.com is effective in the improvement of psycholinguistic abilities in the sample used

*Keywords:* Comprehension, expression, intervention, hypertext, early childhood.

### Resumen

En el proceso de aprendizaje resulta clave la adquisición de habilidades de comprensión y expresión, sobre todo, dadas las dificultades de los estudiantes. La estrategia informatizada EPI.com se basa en la adaptación del Hipertexto a Educación Infantil con el fin de mejorar los procesos léxicos, semánticos y sintácticos. En este trabajo se plantea como objetivo analizar la eficacia de EPI.com en la mejora de aspectos psicolingüísticos y verbales de forma global y en función de la edad. Participaron 155 estudiantes (3-6 años) clasificados en Grupo Experimental (GE; 93 estudiantes que trabajaron con EPI.com) y Grupo Control (GC; 62 estudiantes que siguieron la metodología habitual). Todos ellos fueron evaluados con el Test de Illinois de Habilidades Psicolingüísticas y el test Peabody. Los resultados muestran la eficacia de la estrategia en el GE con puntuaciones estadísticamente significativas en los aspectos psicolingüísticos frente al GC. Son los estudiantes de 3 años quienes obtienen un mayor beneficio. Se concluyó la eficacia de EPI.com sobre la mejora de los aspectos psicolingüísticos con la muestra utilizada.

*Palabras clave:* comprensión, expresión, intervención, hipertexto, infantil.

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## Introduction

The acquisition of Reading comprehension and writing skills is a key factor in learning processes and one many students show difficulties in (Gutiérrez, 2016; Ripoll & Aguado, 2014). For instance, reports on the assessment of reading comprehension such as the PISA report (Program for International Student Assessment; Organisation for Economic Co-operation and Development OECD, 2014) or the PIRILS report (International Association for the evaluation of educational achievement; IEA, 2011) show the relevance of reading difficulties among Spanish students. In the first of those reports, the 25,313 students assessed scored 488, which is significantly below the average for the 34 participant nations. Besides, the PIRILS report also shows that the 8,580 participant year 4 Spanish students Rank lower than average in the study, with a score of 513. All in all, the results obtained in the above mentioned studies highlight that, in this key area for learning, a large number of students have difficulties, using inefficient and ineffective strategies (Watson, Gable, Gear, & Hughes, 2012). Axpe, Acosta and Moreno (2012) point out that the acquisition or development of general language skills, both expressive and comprehension, is one of the abilities that evidently correlate with learning to read. Those authors also emphasize that it is highly important for students to master increasingly longer and more complex morphosyntactic structures, a wider vocabulary and the sound system of Spanish.

In this sense, difficulties in reading are often related to psycholinguistic aspects (Axpe et al., 2012). Hence, those difficulties relate to the lack of a specific vocabulary (*lexical reading processes*; Ramus, Marshall, Rosen, & van der Lely, 2013), to the structure of texts, whose grammar may be complex (*syntactic processes*; Carretti & Motta, 2014), or to adequately relating concepts or ideas allowing to reach the actual meaning (semantic processes; Rapp, van den Broek, McMaster, Kendeau, & Espin, 2007). All in all, these comprehension skills problems or deficiencies do not necessarily derive from difficulties in decoding written words alone.

Comprehension abilities are strongly related to expression abilities (Berninger & Abbott, 2010). Authors like Carreti and Mota (2014) point out that comprehension predicts quality of expression. Abbot, Berninger and Fayol's metaanalysis (2010) shows that comprehension has an effect on composition among children in school years 2 to 6. Carreti and Mota (2014) also indicate that, just like comprehension, expression is a complex activity requiring cognitive abilities such as planning, transcription and revision and does not only imply producing ideas, but also organizing them in a way that is coherent and consistent with the objectives to be transmitted.

Bearing all this in mind, students showing comprehension and expression difficulties form a largely heterogeneous group with different profiles, degrees and levels (Watson et al., 2012). Aiming at alleviating these difficulties, authors have tried to find out which are the most adequate working methodologies in specific intervention (Gutiérrez, 2016; Ponce, López, & Mayer, 2012). These reading comprehension difficulties do not decrease with the repetitive reading technique (Pressley, 2006), although the Spanish educational system puts special emphasis on coding and decoding abilities and on fluency. Ripoll and Aguado (2014) highlight that, in languages with systems like the Spanish one, reading comprehension skills. Authors like Swanson, Howard and Sáez (2006) highlight that students require training in how to use strategies, thus benefitting from explicit instruction methodologies.

According to Ponce et al. (2012), a strategy is an action or a sequence of systematic steps taken in order to obtain key information from a text in order to ease its comprehension and later expression. In order to reach these objectives, students must have a good knowledge of how the strategies work and when to implement those.

In order to establish a specific teaching methodology, different authors highlight some of the main components in strategies used when learning to read (De Corte, Verschaffel, & Van de Ven, 2001; Mayer, 2008). For example, De Corte et al. (2001) point at four main strategies: activating prior knowledge, clarifying difficult words, making a schematic representation of the text, and formulating the main idea. Reading comprehension strategies may also, according to Mayer (2008), be grouped into levels relating to the cognitive processes backing them up. The SOI (Selection, Organization, Integration) model by Mayer (2008) suggests that comprehension strategies must comprise three cognitive processes: selecting information, which requires attention being paid to relevant content; organizing or constructing a coherent structure; and integrating information and previous knowledge. In order to reach those three cognitive processes it is necessary to implement explicit instruction strategies allowing students to acquire the ability. An aspect these two models have in common is the relevance of representation structures (Álvarez & González-Castro, 2012; Álvarez & Soler, 2005). These structures allow for the development of the three types of processing that are relevant to comprehension and expression: lexical processing (main concepts are highlighted and defined in the structure of representation, which allows for an increase in vocabulary), syntactic processing (grammatical structure is established through an adequate representation that tries to ease the expression and composition of relevant information) and semantic processing (propositions are coherently related and integrated in order to enhance their being understood, comprehended and, hence, expressed).

Aiming at establishing a coherent representation structure addressed at working on reading comprehension through the three processing types, Álvarez and Soler (2005) develop the so-called Hypertext strategy. Hypertext is based on neoconnectionist learning theories (Cobos, 2005) and on Ausubel's significant learning. Ausubel, Novak and Hanesian, (1978) describe significant learning as that by which students relate new information to the one they already may have, readjusting and rebuilding knowledge throughout the process. Based on these theories, hypertexts are organizers of knowledge or web-like conceptual representations whose parts or structural nodes relate to each other through significant links. (Álvarez & Soler, 2005). This strategy is aimed at older students (its implementation is normally started in year 3, though students gain autonomy in its usage from Secondary Education onward), as this is the moment when the highly conceptual load of the curriculum calls for information comprehension and representation abilities. However, authors like Gil and Vicent (2009) and Gutiérrez (2016) highlight the importance of intervention strategies from early school years in order to reduce possible risks of later developing difficulties that are more specific. To this aim, an adaptation of Hypertext for Early Years and the first stage in Primary Education was developed, through a software tool called EPI.com which was devised in order to stimulate psycholinguistic abilities relating to lexical, syntactic and semantic processing (the key areas in comprehension and expression processes).

On the other hand, as Sung, Chang and Huang (2008) point out, difficulties in implementing the reading strategies at school may be lessened through Technology (computers, tablet PCs, digital boards, etc.). Authors point at various advantages

obtained through the introduction of computers and computerized systems when teaching to read. First, those systems may provide immediate individual feedback based on learning conditions. Second, computer-aided learning allows students to monitor their own learning pace. Third, through the different representations, motivation is reinforced. In their study with 130 year 6 students, Sung et al. (2008) observe that students significantly improve in the usage of efficient reading comprehension strategies through the implementation of a strategic program based on Mayer's SOI. As for Early Years, no studies have been found that analyze the effectiveness of computer-based strategies on comprehension and expression, something understandable due to the difficulties in assessing those aspects at such early ages. Besides, only quite recently did computers reach classrooms in most Western countries, after which incorporating Technologies to schools and classrooms has been among the aims of educational systems. However, and despite the fact that digital boards are not yet habitual resources in everyday classes, some studies show that using these new technologies allows for an improvement in teaching and learning processes (Lazakidou & Retalis, 2010). All in all, as authors like Burin, Coccimiglio, González and Bulla (2016) point out, it is not without criticism that the efficiency of new technologies is being viewed. For example, Purvis, Aspden, Bannister and Helm (2011) stress that in order for new technologies to be really effective in teaching and learning processes they must bear in mind learning theories and those guidelines and activities that are required in order to fully back educational processes up.

Bearing in mind how beneficial programs implemented through new technologies are and how necessary interventions addressed at early school years are, the present study aims at analyzing the efficiency of EPI.com in the improvement of psycholinguistic and verbal processes. To this aim, apart from globally considering improvements in children aged 3 to 6, differences concerning three age groups (three, four and five-year-olds) are also considered, since EPI.com includes different functions according to developmental moment.

## Method

### *Participants*

Participants in this investigation are a total of 155 children, aged 3-6 ( $M = 4.185$ ,  $SD = 0.824$ ), 80 girls and 75 boys attending 4 schools in the Principality of Asturias (Spain). The sample is obtained by means of an intentional procedure and convenience sampling. Assigning the schools to one of the experimental conditions was done at random: Experimental Group ( $n = 93$ ; follows the EPI.com intervention) and Control Group ( $n = 62$ ; follows traditional methodology). The final sample comprises 6 classes at 2 schools having only one class per year as part of the EG and 6 classes at 2 schools having only one class per year as part of the CG.

Aiming at analysis of profiles according to students' age, the sample is classified into three age groups: Group 1 (65 students, 33 boys y 32 girls aged between 3 and 3 years 11 months), Group 2 (55 students, 27 boys y 28 girls aged between 4 and 4 years 11 months), Group 3 (35 students 10 boys y 15 girls aged between 5 and 5 years 11 months).

No statistically relevant differences according to age were found among participants in the analysis  $F(1, 153) = 0.548$ ,  $p = .460$ ,  $\eta_p^2 = .004$ ; nor the IQ  $F(1, 153)$

= 0.074,  $p = .786$ ,  $\eta_p^2 = .000$  between both functions (EG y CG); neither were significant differences found according to sex in the selected sample  $\chi^2(1) = 0.161$ ,  $p = .688$ .

### *Instruments*

*The PEABODY picture vocabulary test* (Dunn, Dunn, & Arribas 2010) is aimed at adults and children aged 2.5 and up. It takes 10/20 minutes to assess verbal aspects through the test. To this aim it contains 192 flashcards showing four pictures each. The child must indicate which of the images best represents the meaning of a given word. In the original version of the test, Cronbach's alpha shows values near .90, ranging from .80 to .99, with even/odd correlation values between .89 and .99 and test/retest reliability between .91 and .94.

The Illinois Test of Psycholinguistic abilities ITPA (Ballesteros & Cordero, 2011; Kirk, McCarthy, & Kirk, 1986) aims at assessing psycholinguistic functions. It allows a three-dimensional study of psycholinguistic profiles: communication channels, psycholinguistic processes and levels of organization. (1) Communication channels are the routes through which communication contents flow. The ITPA incorporates auditory-vocal and visual-motor channels; (2) There are three main psychological processes involved in the acquisition and use of language: receptive, expressive and associative. The receptive process evaluates the aptitude required to recognize and/or understand what is seen or heard (*visual and auditory comprehension*); the expressive process evaluates the abilities needed to express ideas or respond verbally or through gesture (*verbal and motor expression*); and the associative process includes internal manipulation of perceptions, concepts and linguistic symbols (*visual and auditory association*). (3) Levels of organization may be automatic (*grammatical and auditory integration, sequential auditory memory and sequential visual-motor memory*) and representative (the sum of the three psycholinguistic processes). All in all, the test provides information concerning 11 variables: auditory comprehension, visual comprehension, auditory association, visual association, verbal expression, motor expression, grammatical integration, visual integration, auditory integration, sequential auditory memory and sequential visual-motor memory. These variables are related to the three types of processing, which, though interdependent, are linked to association and expression at the lexical level, to comprehension at the lexical level and to integration at the syntactic level.

The original version of the test has a reliability index between .74 and .90, with a construct validity of .97 for the representative level and .99 for the automatic level. In this study, and with the sample used, the scores in the pretest are .973 for Cronbach  $\alpha$ , .972 in the posttest, with McDonald  $\omega$  of .993 y .992 for each (McDonald, 1999). In this sense, if any of the items were omitted, the improvement would represent an insubstantial variance, not less than .923. The value of the Average Variance Extracted obtained for the ITPA is .970, exceeding the recommended minimum (.70). On the other hand, the Composite reliability (CR) obtain values from .872 to .969, above the acceptable minimum (.50)

*Intervention tool: EPI.com*

The program *EPI.com* is a computerized tool deriving from an adaptation for pre-primary and primary education of the program *Hypertexto* (González-Pienda et al., 2008). This tool aims at stimulating information processing through the stimulation of psycholinguistic abilities relating to lexical, semantic and syntactic processing. Processing is understood as a weblike set of structures that are internally and externally related in such a way that any content will be more easily remembered if the interacting connectors are activated (González-Pienda et al., 2008). Understanding will not exclusively depend on how information is interpreted or constructed, but also on the way it is selected, related and transmitted, both verbally and in written form. Hence the importance of working on comprehension-expression processes as a single block, making students participate actively in translating, interpreting and extrapolating what is being learnt. To do this, a transformation of linear messages into interrelated web-like structures, hypertext-like, is required.

This transformation is produced and stimulated with *EPI.com* by integrating three fundamental aspects for comprehension: the representation, organization and integration of information. Those three aspects develop at the same time when using the *EPI.com* strategy. The representation of information starts with simple messages presented through images (iconic representation), images associated to words (combined representation) and words (symbolic representation). Those three ways of presenting content depend on the students' competence (e.g. students aged 3-4 work with iconic representation, those aged 5-6 work with combined representation and those older than 6 work with symbolic representation). Information is organized into hypertextual structures using three types of processing networks present in the three types of representation: (network 1-1, one "bolo" on each hypertext branch; network 1-2, one "bolo" on the left branch and two on the right branch; network 1-3, one "bolo" on the left branch and three on the right branch). The integration of information is eventually reached through the reversibility of the process, in which, starting with the hypertext, the student produces the linear text again, thus facilitating expression processes. The tool always follows this sequence (iconic, combined and symbolic), so that students initially learn how to relate concepts with no need to introduce lexical processing, which is more demanding in terms of cognitive effort. This enables students to learn how to organize and relate information before reading, which will result in a solid and stable basis for the development of the fundamental processes in reading, that are lexical, semantic and syntactic processes.

The program comprises 90 activities aimed at developing semantic processing (reading comprehension), syntactic processing (written expression) and, finally, lexical processing (routes to read), that is, maturity in instrumental abilities. To this aim, the starting point is a linear message in which every element must be placed in the hypertext web (the title in the rectangle, contents in the "bolos" and pictograms at the links -these links are always the same, to define: *is, is for, is part of*; and to expand: *has, is for, is in-*). Having finished the hypertext, it must be transformed back into a linear message, in order to facilitate the reversibility of the process. The contents chosen for the activities must relate to those in the official curriculum for the students' age group. Thus, the proposal was synthesized: 5 blocks (body and food, family, transport, animals and seasons) with six tasks each (e.g. animals: cat, hen, cow, sheep, lion and bird).

These different types of combination (blocks, tasks, ages, representations) resulted in a 9-level structure, with 10 activities per level.

### *Procedure*

The study is conducted in accordance with the Declaration of Helsinki by the World Medical Association (Williams, 2008). To start with, written permission from school principals, and consent by parents/guardians is requested by sending letters describing the computerized tool (EPI.com) to be used. Then, pre-test information is gathered for approximately 60 minutes per student (participation is voluntary on the part of students and confidentiality of the data is guaranteed at all times). Pre-test and post-test assessment was carried out by two specialists collaborating with the research group, who were previously trained in *handling* the tests for an hour. After pre-test evaluation, the tool starts being used in the EG. A specialist visits each school three times a week for three months, with 45-minute sessions during which the intervention took place in presence of the class tutor. A three-step protocol is followed in implementing the tool: (1) the specialist presents the computerized tool to the students using a digital board and showing the images and pictograms present in the iconic representation, examples are set and the children can do some practice with the strategy; (2) all the children, individually and at the same time, complete two hypertexts on the computer under the specialist's supervision; (3) hypertexts are sequentially produced on the digital board so that all the students can do the process (revision on the board) throughout the three-month period. Later on, as students improve in using the tool, the specialist introduces combined representation with the three corresponding activities associated to each type of web (1-1, 1-2 y 1-3). The intervention comes to supplement the traditional methodology, especially because the strategy does not mean to replace traditional teaching, but only be a supplement to allow for a better comprehension and expression on the part of the students.

At the same time, the teachers in the CG follow the traditional methodology, based on the competences set by the authorities for this educational stage. Specifically, activity worksheets are used that include tasks such as identifying sizes, identifying letters, colouring or tracing or pasting on images relating to topics such as means of transport or seasons, copying from a picture, etc. The classroom teacher does the activities together with the students and guides individual work. A specialist visits the class once a week in order to know and register the activities carried out by the teacher, making sure the work dynamics is the same in both schools in the GC. At the end of the intervention, post-test assessment was carried out in both groups.

### *Data analysis*

Due to the objectives set for this study, Univariate (ANOVA) and Multivariate (MANOVA) Analyses of Variance were carried out, together with statistic descriptive analyses. First, differences between the Experimental Group (EG) and the Control Group (CG) were analyzed in terms of variables such as age, school year and sex. Differences are not statistically significant, so these variables were not included as covariate in the analyses following. The criterion used in interpreting effect sizes is that in the well-known work by Cohen (1988) which establishes that an effect is small when

$\eta^2 = .01$  ( $d = 0.20$ ), medium when  $\eta^2 = .059$  ( $d = 0.50$ ) and large if  $\eta^2 = .138$  ( $d = 0.80$ ).

## Results

Table 1 below shows the statistical descriptions of the variables included in the study. Prior to analysis of differences, variables were checked for a normal distribution. According to the criterion presented by Finney and Di Stefano (2006), by which scores between 2 and -2 in asymmetry and 7 and -7 in kurtosis correspond to sufficiently normal distribution, we may conclude that all the variables included in the study show a normal distribution.

**Table 1**  
Means and standard deviations for the pre-test and post-test variables in the PEABODY test and ITPA

	Pre-test		Post-test		F (1, 153)	$\eta_p^2$
	EG (n = 93) M(SD)	CG (n = 62) M(SD)	EG (n = 93) M(SD)	CG (n = 62) M(SD)		
Peabody	41.78(19.07)	40.59(17.68)	45.72(20.57)	39.77(17.59)	3.479	0.02
Auditory Comprehension	8.48(7.26)	8.37(8.49)	11.64(10.04)	8.08(8.49)	5.286*	0.03
Visual Comprehension	7.83(3.93)	7.35(4.27)	10.33(4.86)	6.88 (4.20)	20.75***	0.11
Visual Memory	2.05(2.32)	1.93(2.30)	3.54(3.18)	1.87 (2.41)	12.45***	0.07
Auditory Association	7.81(4.44)	7.38(5.07)	10.48(5.33)	6.77(4.77)	19.52***	0.11
Auditory Memory	3.95(1.96)	3.77(2.19)	5.50(3.140)	3.62(2.15)	16.84***	0.09
Visual Association	5.67(4.96)	5.30(5.40)	9.24(6.754)	4.95(5.18)	17.98***	0.10
Visual Integration	13.47(4.73)	12.87(5.47)	17.66(7.19)	12.48(5.43)	23.28***	0.13
Verbal Expression	15.51(8.58)	14.58(9.18)	22.21(11.38)	13.83(8.86)	23.88***	0.13
Grammatical Integration	7.17(4.16)	6.83(4.59)	12.16(5.69)	6.06(4.60)	49.44***	0.24
Motor Expression	11.77(5.19)	11.06(5.80)	13.79(5.50)	10.91(5.95)	9.50**	0.05
Auditory Integration	6.30(4.39)	5.61(4.69)	8.01(5.21)	5.83(4.70)	6.96**	0.04

M, Mean; SD, Standard Deviation; EG, Experimental Group; CG, Control Group.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Differences in the pre-test were first analyzed, with no statistically significant results neither in the verbal aspects measured by means of the Peabody test  $F(1, 153) = 0.153$ ,  $p = .696$ ,  $\eta_p^2 = .001$  nor the psycholinguistic aspect measured using ITPA Wilks'  $\lambda = .967$ ,  $F(11, 143) = 0.442$ ,  $p = .935$ ,  $\eta_p^2 = .033$ . Due to the absence of significant differences, these variables are not regarded as covariate in later analyses.

As regards post-test scores, they do not show statistically significant differences between the EG and the CG in verbal aspects (Peabody)  $F(1, 153) = 3.479$ ,  $p = .064$ ,  $\eta_p^2 = .022$ , but they do in psycholinguistic aspects (ITPA) Wilks'  $\lambda = .454$ ,  $F(11, 143) = 15.640$ ,  $p \leq .001$ ,  $\eta_p^2 = .546$ . The analyses of inter-subject effects show that those differences are found in all the ITPA variables (auditory comprehension, visual comprehension, visual memory, auditory association, auditory integration, verbal expression, grammatical integration, motor expression and auditory integration), as shown in Table 1. On the other hand, the size of the effects proved small (-from lowest to highest-, auditory comprehension, auditory integration, motor expression), medium (visual association, visual comprehension, auditory association, visual memory), and even large (visual integration, verbal expression, grammatical integration). It is worth noting the grammatical integration variable, with a size of the effect of .24.



### *Age-based profiles*

This study also aims at testing the efficiency of the tool in three age groups: Group 1 (aged 3), Group 2 (aged 4), and Group 3 (aged 4). With regard to Group 1, differences between the GE ( $n = 38$ ) and the CG ( $n = 27$ ) are statistically significant Wilks'  $\lambda = .412$ ,  $F(12, 52) = 6.189$ ,  $p \leq .001$ ,  $\eta_p^2 = .588$ . The analyses show that those differences do not appear in the Peabody results, though they are present in all the variables in the ITPA (see Table 2), with medium-sized effects (-from smallest to largest-auditory integration, motor expression, auditory comprehension, visual comprehension and auditory memory) and large effects (auditory association, visual memory, visual association, verbal expression, visual integration and grammatical integration).

As for Group 2, differences between the GE ( $n = 32$ ) and the CG ( $n = 23$ ) are statistically significant Wilks'  $\lambda = .299$ ,  $F(12, 42) = 8.217$ ,  $p \leq .001$ ,  $\eta_p^2 = .701$ . The analyses show that those differences do not appear in the Peabody results nor in three ITPA variables (auditory comprehension, motor expression and auditory integration). Statistically significant differences appear in the rest of variables, with sizes of effect that are medium (-from smallest to largest- auditory memory, visual memory, visual comprehension, auditory association and visual association) and large (visual integration, verbal expression, grammatical integration).

Finally, in Group 3, differences between the GE ( $n = 12$ ) and the CG ( $n = 23$ ) are again statistically significant Wilks'  $\lambda = .205$ ,  $F(12, 22) = 7.094$ ,  $p \leq .001$ ,  $\eta_p^2 = .795$ . The analyses show none of those differences in the Peabody test nor in 4 of the ITPA variables (auditory comprehension, visual memory motor expression and auditory integration). The differences are statistically significant in the remaining variables, with sizes of effect that are medium (-from smallest to largest-, auditory memory and visual association) and large (auditory association, visual integration, visual comprehension, verbal expression and grammatical integration). As can be observed by considering the effects sizes, the variable with the largest explicative power is grammatical integration, with a large size of effect in all cases.

**Table 2**  
Means and standard deviations for the three age groups in the Peabody and ITPA variables

	Group 1				Group 2				Group 3			
	<i>EG M(SD)</i>	<i>CG M(SD)</i>	<i>F(1,63)</i>	$\eta_p^2$	<i>EGM(SD)</i>	<i>CG M(SD)</i>	<i>F(1,53)</i>	$\eta_p^2$	<i>EG M(SD)</i>	<i>CG M(SD)</i>	<i>F(1,33)</i>	$\eta_p^2$
Peabody	33.05(16.14)	28.25(11.93)	1.71	.026	48.21(17.68)	44.30 (15.63)	0.72	.013	63.17(16.93)	57.00(14.15)	1.16	.034
Auditory Comprehension	6.86(3.80)	4.37(2.78)	8.40**	.118	12.93(9.25)	10.30(9.45)	1.06	.020	17.73(13.99)	12.16(11.86)	1.38	.040
Visual Comprehension	8.15(4.22)	5.33(3.16)	8.63**	.121	10.03(4.28)	6.91(4.20)	7.19*	.119	14.34(4.25)	10.33(4.45)	6.78*	.171
Visual Memory	1.63(1.61)	0.48(0.93)	11.00**	.149	4.21(2.33)	2.69(2.36)	5.62*	.096	5.78(4.24)	3.41(3.20)	2.86	.080
Auditory Association	7.26(4.22)	4.03(3.44)	10.66**	.145	11.00(3.95)	7.82(4.28)	8.05**	.132	15.08(5.16)	10.91(4.71)	5.44*	.142
Auditory Memory	4.02(2.39)	2.40(1.64)	9.19**	.127	5.71(2.31)	4.34(1.84)	5.51*	.094	7.65(3.91)	5.00(2.37)	4.58*	.122
Visual Association	4.81(3.27)	2.03(2.48)	13.74***	.179	10.40(5.79)	6.13(5.10)	8.03**	.132	14.95(7.44)	9.25(6.22)	5.15*	.135
Visual Integration	13.05(3.75)	9.03(3.74)	18.08***	.223	19.59(6.03)	14.60(4.84)	10.71**	.168	22.60(8.59)	16.16(5.50)	5.51*	.143
Verbal Expression	13.28(6.32)	7.22(5.00)	17.18***	.214	25.50(8.28)	17.39(7.48)	13.88***	.208	32.39(10.81)	21.91(7.69)	8.86**	.212
Grammatical Integration	8.89(4.50)	3.29(3.11)	31.06***	.330	12.81(4.72)	7.73(3.79)	18.08***	.254	16.65(5.47)	9.08(5.58)	14.87**	.311
Motor Expression	10.02(4.14)	7.07(4.48)	7.47**	.106	15.15(4.41)	13.21(4.84)	2.38	.043	18.13(4.84)	15.16(5.95)	2.52	.071
Auditory Integration	5.44(4.06)	3.29(3.30)	5.14*	.075	8.93(4.62)	7.60(4.36)	1.15	.21	10.95(5.85)	8.16(5.50)	1.86	.053

M, Mean; SD, Standard Deviation; EG, Experimental Group; CG, Control Group.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

## Discussion

This paper aims at analyzing the effectiveness of the computerized tool EPI.com in improving psycholinguistic and verbal processes in 155 pre-school students. Results show a significant improvement in psycholinguistic aspects on the part of those using the tool. It may be concluded that the strategy EPI.com proves to be effective in interventions on those aspects, hence the importance of implementing interventions at early ages which lay the foundation for future learning. Besides, although the improvement in verbal aspects is not significant, the means observed show higher scores in the EG than in the CG.

Considering the age of participants in the research, detecting a positive evolution is particularly relevant. Authors like González-Valenzuela, Martín-Ruiz and Delgado-Río (2012) or Gutiérrez (2016) point at the relevance on early-age interventions. However, in pre-school education, students maturity levels is not sufficient at the instrumental level allowing for this type of interventions. Through an adaptation of Hypertext to Pre-School Education with the EPI.com program, an intervention is possible, which, in the sample used, shows an improvement in psycholinguistic processes. To be more precise, the interpretation of significance and the sizes of effect allows us to detect an improvement both in the variables relating to comprehension and in the students' expression (variables such as visual and auditory comprehension, grammatical integration, etc.).

Although similar investigations in pre-school education have not been found, these results are compatible with those in studies like the one by Sung et al. (2008), who observe positive results when dealing with reading comprehension in primary school children through a strategic program based on Mayer's SOI model. EPI.com is developed under the logic of Mayer's model, and, as the author claims (Mayer 2008), the process leading to significant learning depends both on the way the student processes information and on the material being presented. Thus, promoting learning depends both on improving the way students process information and on the way materials are presented. It is therefore relevant for the program to allow for adequate structures in which information is adapted by means of iconic representation to the student's level from age 3. Besides, simple content and wording are selected, which facilitate their structuring into processing networks from that age, progressively sequencing difficulty levels.

Results are also analyzed according to three age groups (3, 4, 5-year olds). The evolution observed proved more positive among the youngest students, since in that age group all the variables show a significant evolution. This may be linked to the way iconic information is presented, which, according to Barner, is the most appropriate for information processing during early childhood (Bruner, Goodnow, & Austin, 2001).

It's worth noting that, both in the analyses with the whole sample and in those by age groups, effect sizes are systematically larger in three variables: visual integration, verbal expression and grammatical integration, the last of which presents the largest effect size. These results point at a more positive evolution in semantic processing (variables such as visual comprehension) and also in syntactic processing (visual, grammatical... integration), as opposed to lexical processing. The lack of differences in verbal aspects (assessed by means of the Peabody Vocabulary Test), may be associated to a greater emphasis on these abilities on the part of the educational system, resulting in no significant differences between the control group and the experimental group.

It is finally necessary to highlight some limitations that should be addressed in future work. It must be stated that no advice from the corresponding Ethics Committee was sought. It is also worth noting that sample sizes by groups and age levels is limited, thus conditioning the generalization of the results obtained and the scope of the conclusions reached. Besides, the execution process is not analyzed and the effectiveness of the program is not compared to that of other computerized programs in order to check the benefit that using new technologies may bring by itself.

As for future lines of work, it might be convenient to include an evaluation of the process students perform when under the strategy. On the other hand, a Reading comprehension test for students aged 5-6, who have already started with the reading processes, should be included. Besides, since a pen-and-paper version of the strategy is also available, an analysis of the effectiveness of the program according to the format used (computerized or pen-and-paper) would provide a deeper insight into the effectiveness of the computerized strategy. Finally, it would be interesting to observe the benefits achieved when incorporating the tool, not only to the educational sphere, but to the family sphere too, as it might come to reinforce the acquisition of comprehension and expression abilities.

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Received date: 07-07-2016

Accepted date: 25-11-2016