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Intervention in reading processes in pupils with Specific Language Impairment (SLI)

Víctor M. Acosta Rodríguez, Gustavo M. Ramírez Santana, Nayarit del Valle Hernández and Laura de Castro Bermúdez
Universidad de La Laguna

Abstract

Background: Children with Specific Language Impairment (SLI) encounter significant difficulties in learning to read. The aim of this research was to determine the efficacy of an intervention program on reading processes (letter identification, lexical processes, syntactic processes and semantic processes) in children with SLI. **Method:** The sample consisted of a total of 34 pupils diagnosed with SLI and 34 children with typical language development. For the selection of the sample, the CELF-3 test, the Peabody test, the Hearing Association and Visual Association subtests of the ITPA and the K-BIT Intelligence test were used. The intervention program consisted of 144 sessions of 40 minutes each, in which oral language activities were combined with other activities related to the automation of basic reading processes and reading sentences and texts. **Results:** Significant gains were also made in the group of children with SLI versus controls in lexical, syntactic, and semantic reading processes. **Conclusions:** A combined program of both oral language and reading skills improves reading achievement in pupils with SLI.

Keywords: reading, assessment, intervention programs, specific language impairment.

Resumen

Intervención en procesos lectores en alumnado con Trastorno Específico del Lenguaje (TEL). **Antecedentes:** los niños con Trastorno Específico del Lenguaje (TEL) tienen importantes dificultades para el aprendizaje de la lectura. El objetivo de esta investigación ha sido comprobar la eficacia de un programa de intervención sobre los procesos lectores (identificación de letras, procesos léxicos, procesos gramaticales y procesos semánticos) en niños con TEL. **Método:** la muestra estuvo compuesta por un total de 34 alumnos diagnosticados con TEL y 34 niños con un desarrollo típico del lenguaje. Para la selección de la muestra se utilizaron los tests CELF-3, Peabody, las subpruebas de Asociación Auditiva y de Asociación Visual del ITPA y el Test de Inteligencia K-BIT. El programa de intervención constó de 144 sesiones, de 40 minutos de duración cada una, en el que se combinaron actividades de lenguaje oral con otras destinadas a la automatización de procesos lectores básicos y de lectura de frases y textos. **Resultados:** los niños con TEL obtuvieron ganancias significativas frente a los controles en los procesos lectores léxicos, sintácticos y semánticos. **Conclusiones:** un programa combinado de lenguaje oral y lectura mejora el rendimiento lector en alumnado con TEL.

Palabras clave: lectura, evaluación, programas de intervención, trastorno específico del lenguaje.

During the early stages of education, reading is a fundamental objective for all pupils. However, there are risk groups who suffer serious difficulties for effective learning. These include children with Specific Language Impairment (SLI), who are characterized by having a considerable delay in their language development, despite the absence of neurological, sensory or non-verbal intelligence deficits (Leonard, 2014). Many studies have found reading problems in these pupils (Catts, Fey, Tomblin, & Zhang, 2002). In fact, oral language problems have a negative impact on reading, especially when phonological disturbances appear together with related lexical-semantic, morphosyntactic, and narrative aspects (Coloma et al., 2012).

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Corresponding author: Víctor M. Acosta Rodríguez
Facultad de Ciencias de la Salud
Universidad de La Laguna
38350 Santa Cruz de Tenerife (Spain)
e-mail: vacosta@ull.es

Research data confirm that reading problems in SLI are mixed (Bishop & Snowling, 2004), that is, the causes should be sought in the interaction of decoding and comprehension skills. First, a close relationship has been established between reading and phonological processing skills. In this sense, it was found that phonological representations constitute an area of weakness in children with SLI, although not to the degree of severity reached in other disorders such as dyslexia (Claessen & Leitao, 2012). Second, other components have been linked to reading difficulties in these children, and more specifically with respect to their lexical-semantic, grammatical and narrative deficits, that cause severe problems of reading comprehension (Ramus, Marshall, Rosen, & van der Lely, 2013). Further, longitudinal studies confirm that differences between children with SLI and their peers increase over time (Flax et al., 2003).

A review of the research on reading intervention shows that interventions combining phonological training with reading improve skills in poor readers. However, there is less empirical evidence of the effectiveness of intervention in children with SLI

with respect to difficulties in grammatical and semantic processes. In this case, it is important to train receptive and expressive language skills to improve reading comprehension. Bowyer-Crane et al. (2008) studied the effectiveness of two training programs for improving reading skills in children with SLI. The first combined phonological awareness activities with reading books, while the second focused on helping improve oral language skills, that is, vocabulary, inferencing, expressive language and listening skills. The first program led to improved letter identification and phonological awareness, while the second optimized lexical and grammatical skills. Currently, most intervention programs combine stimulation of phonological awareness and reading skills with oral language training (Hulme & Snowling, 2011; Clarke, Truelove, Hulme, & Snowling, 2014).

The above considerations were taken into account when designing the present study for Spanish-speaking children with SLI. Specifically, the main objective was to improve reading processes of children with SLI by an intervention program.

Method

Participants

The sample consisted of 68 primary school children, divided into two groups. An experimental or SLI group (SG) was composed of 34 children diagnosed with specific language impairment (28 males, *mean* age: 8.01, *range*: 5.68-11.53, *SD*: 1.55 years). To make up the control group (CG), 34 children with typical language development were chosen from among the classmates of the children with SLI in order to homogenize the sample as much as possible by eliminating variables such as the school context, teacher, methodology or peer group. These pupils had no language problems and followed schooling within the usual parameters (28 males, *mean* age: 7.95 years, *range*: 5.72-11.43, *SD* = 1.59).

The normality of the age variable was verified by the Kolmogorov-Smirnov test ($z = 1.022$, $df = 68$, $p = .247$). To verify that the groups were well matched in this variable, a hypothesis test was performed. A t-test showed no significant difference between the groups; also, the effect size was small, $t(64) = 1.25$, $p = .879$; Cohen's $d = .04$; Levene's $F(1, 66) = .04$, $p = .853$.

Instruments

Instruments for the selection and evaluation of the sample. First, participants were subjected to certain exclusion criteria related to SLI present in the literature: namely, the pupils' school histories were examined to determine whether major problems existed, especially with respect to their hearing and orofacial motor skills. Then, the three tests set forth below were administered. The results of this process are set out in Table 1.

CELF-3. Starting with the test most used internationally for the study of this disorder, the CELF-3 (Semel, Wiig, & Secord, 2003). This is a language assessment test with scales for Spanish speakers in the United States, with Cronbach's alpha between .74 and .91. It evaluates the processes of language comprehension and expression in general, by means of tasks involving the structuring and formulation of sentences, concepts and directions, structure and kinds of words, and remembering prayers. The results in this test, expressed in standard deviations below the mean, were crucial. However, given that some researchers point to the need to use two or more measures of language, the Peabody test (Dunn, Padilla, Lugo, & Dunn, 1986) was also used, as well as two subtests of the Illinois Test of Psycholinguistic Abilities (ITPA; Kirk, McCarthy, & Kirk, 2005).

PEABODY. The Peabody test, focused on vocabulary, can be administered between 2.6 and 16 years of age, with a reliability of $\alpha = .93$. The child must choose from among four images the one corresponding to the word given by the evaluator, and the vocabulary used consists of names of objects, situations, professions and animals, actions and attributes. The SLI group results, expressed as standard deviations below the mean, were also very low for this test.

ITPA. Finally, we administered the Visual and Hearing Association subtests of the ITPA (Cronbach's alpha between .75 and .91) to check the degree of knowledge of conceptual relationships (semantic psycholinguistic processes); results showed a mean psycholinguistic age far below the chronological age.

Kaufman's Brief Intelligence Test (K-BIT; Kaufman & Kaufman, 2000). Furthermore, it was found that the children with SLI had a non-verbal IQ equal to or higher than the score of 85; for this, the K-BIT Intelligence Test was used. This test was chosen because it uses non-verbal forms ($\alpha = .98$).

Instruments for evaluating reading processes. Reading processes were studied using the PROLEC-R (Cuetos, Rodríguez, Ruano, & Arribas, 2009). This consists of two tests for each of the processes involved in reading, except semantic processes, which consists of three tests. The first two tests – the names or sounds of letters test and the same-different test – are intended to examine the processes of letter identification; the next two tests, which entail reading words and nonwords, are used to assess lexical or visual word recognition processes; syntactic processes are evaluated by means of tests of grammatical structures and punctuation marks; and finally, semantic processes are studied by testing sentence comprehension, text comprehension and listening (oral comprehension). Reliability is established by means of a Cronbach's alpha coefficient between .48 and .74.

Procedure

The study used a quasi-experimental design of repeated measures with a pretest-posttest control group (cross design with non-equivalent control group). The intervention program was the independent variable and reading processes – that is, identification of letters and lexical, syntactic, and semantic processes – constituted the dependent variables.

Table 1
Test results for diagnostic evaluation

Tests	SG		CG	
	M	SD	M	SD
CELF Expressive. SD	-1.4	.9	1.5	.9
CELF Receptive. SD	-1.2	.6	1.1	.7
PEABODY. SD	-1.5	1.2	.3	.9
ITPA. Hearing Assoc. PA	3.9	2.3	7.7	2.0
ITPA. Visual Assoc. PA	5.4	2.3	6.6	1.7
K-BIT. Non-verbal IQ	102.2	9.0	114.9	12.3

Note: SG: Pupils with SLI; CG: Control group; PA: Psycholinguistic age; SD: Standard deviation; IQ: Intelligence quotient.

Participants selection. An initial screening was performed in all schools in the Island of Tenerife, in collaboration with teams of educational psychologists, who were asked to identify all pupils with potential features of SLI, that is, those with problems with one or more components of language expression and/or comprehension, especially morphosyntax and semantics, or who had spent several years with unresolved language difficulties. A total of 65 pupils were identified, who were then given a comprehensive evaluation protocol to confirm the diagnosis, consisting of various standardized tests. Thirty-one pupils were found to present only a simple language delay, that is, a slight time lag with phonological problems but no lexical-semantic or morphosyntactic disturbances. The final sample consisted of pupils from different socioeconomic backgrounds, attending both public and private schools, and from both rural and metropolitan areas. Finally, parents/guardians were asked to give their consent to the child's participation in the study by signing the corresponding informed consent.

The intervention program. The chronological age control group received no intervention of any sort; the SLI group received an intervention program during the 2012-13 and 2013-14 school years, with an overall duration of 18 months. A total of 144 sessions lasting 40 minutes each were conducted with a twice-

Table 2
Components, activities, materials, and procedures of the intervention program

Components	Activities	Materials	Procedures
Narrative	• Reading the story *The three hungry mice* without and with icons • Retelling the story • Inventing a story with help • Generating own stories, without adult assistance	• Comic strips showing the story • Icons representing the basic categories of the narrative structure • Cards and pictograms • Sticks for generating stories	• Offering of models; using questions at different levels of complexity, multiple opportunities to respond • Recast, expansions, extensions and vertical structure • Graphic organizers
Morphosyntax	• Completing sentences • Crossing out the incorrect words in sentences • Sorting sentences • Ordering and verbalizing patterned sequences of actions with drawing • Placing phrases in their respective speech bubbles • Sorting phrases aided by a card • Using support graphics to associate a phrase with a drawing	• *Comics para Hablar* (Monfort & Juárez, 1988) • *Comprender el lenguaje haciendo ejercicios* (Aguado, Cruz, & Domezáin, 2003) • *Logo-kit 1* (Monfort, Juárez, & Monfort, 2008)	• The recast as an immediate response to what is produced by the child, but modifying one of the elements of the sentence or mode • Modeling • Descriptions and reviews of objects • Imitations • Building a story through drawings
Identifying letters and lexical processes	• Phonological awareness • Naming: colors, drawing and numbers • Reading words and nonwords	• *Programa ALE* (González & Cuetos, 2008)	• The processes are contextualized through characters that guide all activities
Reading	• *Level 1*. Explanation of the unit theme (e.g., transportation) -Vocabulary work - Sentence construction - Guessing concepts from definitions - Phonological awareness - Phoneme-grapheme association *Level 2*. Again, explanation of the unit theme (e.g., transportation) -Vocabulary: medium frequency words (boat, submarine, etc.) and action phrases - Conversation - Introduction of verbs (to fly, to travel, etc.) - Phonological awareness - Phoneme-grapheme association - Games with letters - Fast reading of letters - Reading syllables and words *Level 3*. Again, explanation of the unit theme - Vocabulary: low frequency words (ballooning, paragliding, etc.) - Expand the semantic field with related terms - Phonological awareness - Reading: different fonts, reading paragraphs, phoneme-grapheme and orthographic representations of word conversion (reading fluency) - Reading games with letters and words - Reading sentences and text	• *Leer en un clic* (García de Castro & Cuetos, 2012).	• Each level has its own mascot to motivate the child. Level 1: Dompi the elephant; Level 2: Petra the bear; Level 3: Ara and Bruna • The characters will guide the various activities

weekly frequency; the aim of these sessions was to promote pupils' reading and oral language skills. The work was always done in the morning in the speech therapy classroom of each participating school, and was administered by a total of 18 speech/language therapists.

A series of joint seminars and workshops (involving the research group and speech therapists) were held to establish the objectives, content, and procedures for the intervention and select the materials required. Once the speech therapists had been fully familiarized with the program, they began its implementation, with regular monitoring conducted by means of direct observation via video recordings. Subsequently, these recordings were analyzed in joint seminars in order to resolve the difficulties encountered and assess the achievements made, thereby ensuring the reliability of the intervention. In this regard, it was found that the intervention was indeed conducted according to plan throughout the course of the program, with the different speech therapists involved following the same guidelines.

The aim of the intervention was to stimulate oral language skills and basic reading processes. For the first objective, a series of oral storytelling activities were designed using fictional stories in order to improve flow, production, and comprehension of oral language. Along with this, other activities were also carried out aimed at optimizing the participants' knowledge, comprehension, and production of different syntactic structures.

For the second objective, the *ALE program* (González & Cuetos, 2008) was used in order to automate the processes of preparation for reading (phonological awareness and naming speed) and recognizing letters, syllables, words and nonwords (lexical processes). The rest of the work involved implementing the method *Leer en un clic* (García de Castro & Cuetos, 2012). This method offers a number of phonological awareness activities, where each grapheme is formed from a drawing that has the shape of the grapheme and that starts with that sound, so that the relationship is no longer arbitrary. It also contains a large number of activities to contribute to increasing pupils' vocabulary. The work plan is organized into three levels. In our case, we started at Level 1, as the levels do not correspond to chronological age but to reading levels, determined using the PROLEC-R (Cuetos et al., 2009), as discussed above. The three levels deal with the same semantic units and letters, the main difference being the number of words and pictures used, as well as the use of written texts that increase in complexity as one moves up the levels. A guide for therapists (Suárez & Cuetos, 2013: 5) gives a detailed explanation of the procedures to be followed:

Key aspects of learning to read are covered: vocabulary and fluency in lexical access, phonological awareness, grapheme-phoneme rules, and orthographic representations of words. Finally, depending on the level, pupils will then begin with reading letters, syllables, words, sentences or texts. A different letter drawing is created for each semantic field; for example, for the transport unit, a drawing of an airplane ("avión") is transformed into the letter "a".

Table 2 shows the different components of the intervention program.

Data analysis

To evaluate the effects of the intervention program on the dependent variables (PROLEC factors), that is, *Identification of letters*, *Lexical processes*, *Syntactic processes*, and *Semantic processes*, a descriptive analysis and multivariate analysis of covariance (MANCOVA) were run for each. Further, univariate analyses of covariance (ANCOVA) were performed for each component (PROLEC major indices) of these dependent variables: Identification of letters (*letter names*, *same-different*), Lexical processes (*reading words*, *reading nonwords*), Syntactic processes (*grammatical structures*, *punctuation marks*), and Semantic processes (*sentence comprehension*, *text comprehension*, *oral comprehension*). Also, *age* was used as a covariate in all analyses.

First, the MANCOVA and ANCOVAs were performed with pretest scores. Second, the MANCOVA and ANCOVA were performed with posttest scores, adding the pretest score as a second covariate. Finally, MANCOVA and ANCOVA were performed with pretest-posttest differences. For each variable, in the pretest, posttest, and pretest-posttest differences, effect size was also calculated. Statistical analyses were performed using SPSS for MAC, v. 21.0.

Results

Analysis Pretest

First, the descriptive analysis was run of the pretest scores of both groups (see Table 3), with a MANCOVA for each dependent variable (see Table 4) and an ANCOVA with each component of the dependent variables (see Table 5).

The pretest MANCOVA for *Identification of letters* showed significant differences and a large effect size. Results of the pretest ANCOVAs indicated that before the intervention, the differences between the groups were statistically significant and effect sizes were large in both components of this dependent variable.

The pretest MANCOVA for *Lexical processes* showed significant differences and a large effect size. Results of the pretest ANCOVAs indicated significant differences in the two components, and the effect sizes were large.

The pretest MANCOVA for *Syntactic processes* showed significant differences and a large effect size. Results of the pretest ANCOVAs showed statistically significant differences between groups and the effect sizes were large in both components.

The pretest MANCOVA for *Semantic processes* showed significant differences and a large effect size. Results of the pretest ANCOVAs showed statistically significant differences between the groups in all three components and all effect sizes were large.

Analysis Posttest

Subsequently, the analyses with posttest scores of the dependent variables were made, adding the pretest score as a second covariate. The results are presented in Tables 3, 4 and 5.

The posttest MANCOVA for *Identification of letters* showed no significant difference and a moderate effect size. Results of the posttest ANCOVAs indicated that differences between groups were not obtained for any component of this dependent variable, and both effect sizes were moderate.

The posttest MANCOVA for *Lexical processes* showed no significant difference and a moderate effect size. None of the posttest ANCOVAs for the components of this variable indicated significant differences, and both effect sizes were small or moderate.

Table 3
Descriptives of principal indexes of PROLEC-R in the pretest, posttest and pretest-posttest differences for each group

Components of the dependent variables	Pretest				Posttest				Post-Pre			
	SG		CG		SG		CG		SG		CG	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Letter names	41.6	40.6	117.6	46.4	96.5	44.3	165.2	44.7	60.1	41.6	49.8	38.4
Same-different	12.3	8.8	21.8	8.1	23.1	11.5	35.6	15.1	12.1	10.0	14.2	10.7
Reading words	32.3	34.1	83.0	49.0	69.6	39.6	115.0	48.7	40.1	29.4	28.3	34.1
Reading nonwords	22.0	21.7	47.6	21.6	44.0	22.2	58.3	17.6	24.1	15.7	10.7	12.6
Grammatical structures	6.9	4.7	13.2	2.6	11.4	3.5	15.5	1.3	5.1	4.4	2.3	2.5
Puntuation marks	4.0	5.7	15.8	13.4	9.5	7.1	19.3	6.8	5.8	6.0	2.6	15.7
Sentence comprehension	8.7	5.7	15.3	1.3	12.8	4.4	15.9	.4	4.6	6.0	.5	1.3
Text comprehension	3.7	3.9	11.1	3.7	8.3	3.9	13.0	2.4	5.2	3.3	1.9	3.0
Oral comprehension	.9	1.1	4.3	2.2	2.2	1.8	5.8	2.0	1.5	1.6	1.4	2.2

Notes: SG: Pupil group with SLI (n = 34); CG: Control group (n = 34).

Table 4
Results of the multivariate analysis of covariances for each dependent variable between experimental and control groups.

Dependent variables	Pre			Post			Post-Pre		
	F	p	ηp^2	F	p	ηp^2	F	p	ηp^2
Identification of letters	28.6	.001	.48	1.7	.18	.07	.5	.610	.02
Lexical processes	13.0	.001	.30	2.4	.11	.09	4.9	.011	.16
Syntactic processes	28.7	.001	.49	3.8	.03	.13	3.4	.041	.12
Semantic processes	46.3	.001	.70	1.5	.22	.09	5.5	.002	.24

Table 5
Results of the univariate analysis of covariances each component of the dependent variables between experimental and control groups.

Components of the dependent variables	Pre			Post			Post-Pre		
	F	p	ηp^2	F	p	ηp^2	F	p	ηp^2
Identification of letters									
Letter names	57.0	.001	.48	3.9	.055	.07	.4	.513	.01
Same-different	27.8	.001	.31	1.0	.322	.02	.4	.536	.01
Lexical processes									
Reading words	25.1	.001	.29	.1	.709	.00	.8	.371	.02
Reading nonwords	24.7	.001	.29	1.7	.197	.03	8.7	.005	.14
Syntactic processes									
Grammatical structures	46.6	.001	.43	7.2	.010	.12	6.2	.016	.11
Punctuation marks	21.9	.001	.26	16.0	.001	.24	.9	.336	.02
Semantic processes									
Sentence comprehension	48.5	.001	.44	2.0	.161	.04	7.9	.007	.13
Text comprehension	81.5	.001	.57	.7	.392	.01	12.0	.001	.18
Oral comprehension	84.6	.001	.58	8.2	.006	.14	.0	.993	.00

The posttest MANCOVA for *Syntactic processes* showed significant differences and a moderate-large effect size. Results of the posttest ANCOVAs showed statistically significant differences between groups in both components, and both effect sizes were moderate-large or large.

The posttest MANCOVA for *Semantic processes* showed no significant difference and a moderate effect size. Statistically significant differences were only found between groups in the listening component (*oral comprehension*) with a large effect size. The other two components showed a small or moderate effect size.

Analysis Posttest-Pretest

Finally, the posttest-pretest differences were analyzed for each dependent variable, with the results presented in Tables 3, 4 and 5.

The post-pre MANCOVA for *Identification of letters* showed no significant differences and a small effect size. The results of the post-pre ANCOVAs indicated that no component of this dependent variable showed differences between groups, and both effect sizes were small.

The post-pre MANCOVA for *Lexical processes* showed significant differences and moderate-large effect size. Only the post-pre ANCOVAs for the *nonword reading* component indicated significant differences and moderate effect size. The other component showed a small effect size.

The post-pre MANCOVA for *Syntactic processes* showed significant differences and a moderate effect size. The results of the post-pre ANCOVAs showed statistically significant differences between the groups only in the *grammatical structures* component and a moderate effect size. The other component showed a small effect size.

The post-pre MANCOVA for *Semantic processes* showed significant differences and a large effect size. Statistically significant differences between groups were found in the *sentence comprehension* and *text comprehension* components, and both effect sizes were moderate-large. The other component showed a small effect size.

Discussion

According to the two-dimensional model proposed by Bishop and Snowling (2004), in which a close relationship is established between reading and language disorders, phonological deficits affect decoding skills, while deficits in other components of

language constitute risk factors for reading comprehension problems. In this sense, we should reflect on the first hypothesis of the present research. The results of the initial evaluation are worse in the SLI group than in the control group, with significant differences in all reading processes evaluated by the PROLEC-R (Cuetos et al., 2009). This corroborates the presence of mixed reading problems in the experimental group, with deficits that affect both decoding and comprehension, in line with data from other studies with Spanish-speaking children (Coloma et al., 2012).

The second hypothesis was linked to the effectiveness of the intervention program on the reading processes of children with SLI. The results obtained in our study are similar to those of authors like Hulme and Snowling (2011), whose proposals combined oral language activities and reading texts. More specifically, it should be noted that significant gains were observed in precisely those processes and tasks that are most vulnerable in these pupils. Thus, for example, they clearly improved their nonword reading. Much research has been done on the limitations that SLI places on the ability to store information in the phonological working memory, a fact that hinders phonological representations and consequently weakens acquisition of vocabulary, morphosyntax and reading fluency (Leonard, 2014). The activities aimed at optimizing grapheme-phoneme association, naming speed and reading words and nonwords in both the *ALE program* (González & Cuetos, 2008) and *Leer en un clic* (García de Castro & Cuetos, 2012) led to considerable improvements in reading achieved by the sublexical means.

Significant differences were also obtained in the syntactic processes, and more specifically in grammatical structures. Not surprisingly, the core of linguistic problems in SLI coincides with morphosyntactic problems (Washington, 2013); therefore, improving knowledge of the syntactic roles of the words that make up sentences and syntactic processing are important. In this sense, a decisive factor in the intervention program was the incorporation of activities linked to developing narrative and morphosyntax.

Finally, children in the SLI group made considerable gains in semantic processes, specifically in sentence and text comprehension, aspects that receive special attention in levels 2 and 3 of *Leer en un clic* (García de Castro & Cuetos, 2012). While it is important to understand different types of sentences, the linguistic profile of this disorder is such that improvement in text comprehension is considered more fundamental, as it indicates an ability to extract meaning from texts and integrate it into one's own knowledge. However, there was no major progress in listening (oral comprehension). The explanation for this finding could be related to the usual limitations faced by children with SLI in temporal-auditory speech processing, in the resources available in working memory, and in the management of inferences. In this sense, we would suggest incorporating into the program more attention to the teaching of vocabulary and improving working memory (López-Escribano, Elosúa Gómez-Veiga, & García-Madruga, 2013); the generation of inferences (Hulme & Snowling, 2011); and finally, the formulation of questions and greater use of figurative language (Clarke, Truelove, Hulme, & Snowling, 2014).

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