Reading skills in young adolescents with a history of Specific Language Impairment: The role of early semantic capacity

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Abstract

This study assessed the reading skills of 19 Spanish-Catalan children with Specific Language Impairment (SLI) and 16 age-matched control children. Children with SLI have difficulties with oral language comprehension, which may affect later reading acquisition. We conducted a longitudinal study examining reading acquisition in these children between 8 and 12 years old and we relate this data with early oral language acquisition at 6 years old. Compared to the control group, the SLI group presented impaired decoding and comprehension skills at age 8, as evidenced by poor scores in all the assessed tasks. Nevertheless, only text comprehension abilities appeared to be impaired at age 12. Individual analyses confirmed the presence of comprehension deficits in most of the SLI children. Furthermore, early semantic verbal fluency at age 6 appeared to significantly predict the reading comprehension capacity of SLI participants at age 12. Our results emphasize the importance of semantic capacity at early stages of oral language development over the consolidation of reading acquisition at later stages.

Keywords: Specific Language Impairment; Reading comprehension; Word recognition; Reading accuracy; Reading speed

1. Introduction

Children with specific language impairment (SLI) present a language disorder that delays the mastery of language skills without presenting hearing loss or other developmental delays (see definition by the National Institute of Deafness and Other Communication Disorders from the U.S. National Institutes of Health). This disorder affects the reception and expression of spoken language capacities, respectively b16700 and b16710 in the International Classification of Functioning, Disability and Health. According to diagnostic criteria established by Stark and Tallal (1981), these children obtain scores in language tests <1.25 standard deviations or less although present a performance IQ of 85 or above. Recent episodes of otitis media, abnormalities in the structure or the oral motor skills, neurological damages or other social-psychological disabilities that could explain their impairment also need to be discarded.

SLI affects all language components but there are large individual differences due to the heterogeneity of the disorder. With regards to phonology, some of the most common characteristics are a lack of production of trisyllabic words, omission of unstressed initial syllables and final consonants, simplification of diphthongs, consonant cluster reduction and phoneme substitution (Aguilar-Mediavilla, Sanz-Torrent, & Serra-Raventos, 2002; Aguilar-Mediavilla & Serra-Raventós, 2006). Morphosyntax presents omission of function words and required arguments, errors in verb agreement and tense as well as limited syntactic structures with a deficit on the mean length utterance (Aguilar-Mediavilla, Sanz-Torrent, & Serra-Raventós, 2007; Sanz-Torrent, Aguilar-Mediavilla, Serrat, & Serra-Raventós, 2001; Serra-Raventós, Aguilar-Mediavilla, & Sanz-Torrent, 2002; Serrat et al., 2010). A semantic delay is evidenced by late acquisition of the first word (about 24 months) and occurrence of the lexical explosion (24/36 months). Small vocabulary, use of circumlocutions, common words or wildcards, frequent pauses, repetitions and interjections are also present, pointing out the lexical shortage of these children (Guo, Tomblin, & Samelson, 2008). Finally, pragmatics is affected too, with a lack of initiative to start conversations, passive participation, and improper use of turn taking (Leonard, 1998).

During primary school, both typically developing and SLI children are expected to acquire the fundamental skill of reading. Through reading we are able to decipher a text and understand the message it transmits, an essential ability during schooling, as most of academic knowledge is transmitted and worked by means of written language. Literacy depends on the reader's capacity to transform written symbols into words and full sentences. Nevertheless, being able to decode words, and even paragraphs, accurately is not enough: we need to comprehend what we read and create a mental representation of the information presented in the text. The Simple View of Reading, a model of the process of reading acquisition proposed by Hoover and Gough (1990), focuses on the distinction of these two processes, decoding and comprehension, as the basic components of reading.

Decoding depends on different processes, from the identification of individual or full sequences of letters, to the transformation into their corresponding phonemes, also including access to relevant lexical entries. Following the U. S. National Reading Panel (2000), this component involves three domains of reading: phonemic awareness, phonics and fluency. The knowledge that words are made up of smaller sound units and that this units can be represented by the letters of the alphabet, hence, has a prominent role during decoding, and phonological processing abilities have been established frequently as a good predictor of later reading outcomes (Aguilar-Mediavilla, Buil-Legaz, Pérez-Castelló, Rigo-Carratalá, & Adrover-Roig, 2014; Melby-Lervåg & Lervåg, 2011). Reading comprehension, on the other hand, focuses on the interpretation of activated semantic information and reflects a complex set of skills involving several cognitive processes that are common to both oral and written language modalities (Hoover & Gough, 1990). According to the U. S. National Reading Panel (2000), this capacity involves word fluency, enhanced vocabulary skills and text comprehension abilities.

The relationship between SLI and reading acquisition has been thoroughly researched over the last few years. Some studies even consider SLI and dyslexia as different stages in a continuum of language impairment (Farquharson, Centanni, Franzluebbers, & Hogan, 2014; Bishop & Snowling, 2004). However, the nature of the exact relation between SLI and reading impairment is still unclear, as different studies have obtained conflicting results regarding the simultaneous appearance of these two deficits. In a recent review, Ricketts (2011) summarizes previous evidence regarding the association between SLI and reading difficulties. For example, various studies have been conducted with children with SLI, who displayed an impaired performance on decoding and comprehension tasks compared with age-matched controls (Snowling, Bishop, & Stothard, 2000; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). Catts et al. (2002) conducted similar studies, in this case with a large sample of 117 children with a preschool diagnosis of SLI. They found reading impairment in the majority of their participants, showing deficits in both word recognition and reading comprehension. However, almost 40% of their sample appeared to present unimpaired decoding and comprehension capacities. Differences in the presence of reading deficits associated with SLI may be due to the improvement of language skills of some of the children during schooling, which consequently would improve reading abilities. However, the apparent lack of impairment could also be interpreted as illusory recovery (Scarborough & Dobrich, 1990) in which case these children could experience some difficulties in reading in their adolescence and adulthood when literacy demands become more specialized. Furthermore, discrepant findings exist, not only regarding the presence of literacy impairments, but also in relation to the developmental time course of reading abilities in SLI children (St. Clair, Durkin, Conti-Ramsden, & Pickles, 2010).

Discrepancies between studies might be related to the heterogeneity of the language profiles associated to SLI. In line with the general framework posed by the Simple View of Reading, Bishop and Snowling (2004) suggest that reading abilities of children with SLI might be directly influenced by their strengths and weaknesses across phonological and supra-phonological domains (i.e. semantics, grammar…) of oral language. Thus, whereas the former would influence written word recognition deficits, the latter would be related to reading comprehension impairments.

Other sources of discrepancy between studies of literacy acquisition in children with SLI might be related to the specific characteristics of the languages studied, including morphological or syntactic complexity as well as the degree of transparency of the orthographic systems studied. Orthographic transparency, which is known to affect the ease of reading acquisition (Caravolas et al., 2012), refers to the degree of direct correspondence between graphemes and phonemes in a language. Thus, results obtained in very deep languages like English (Bishop & Snowling, 2004), might not be extrapolable to more transparent orthographic systems like Dutch (Vandewalle, Boets, Ghesquière, & Zink, 2012), Italian (Brizzolara et al., 2011) or Catalan (Aguilar-Mediavilla et al., 2014).

Our study aims to compare the evolution of the reading abilities of children with a history of SLI and children with typical development in the context of a transparent language such as Catalan. We present the results of the second phase of a longitudinal study that started with the diagnosis of our participants at age 6. Our new data explores the evolution of their reading capacities between ages 8 and 12, a period during which children complete their last four years of primary education, acquiring and consolidating their reading abilities, and laying the foundations for most of future learning. We expect our SLI participants to have improved their reading capacities although some impairment might still be evident in comparison to the control group specially in the, more demanding, comprehension subprocess. Moreover, we expect early oral language abilities to predict their reading success at these later stages of literacy acquisition.

2. Methods

2.1. Participants

The participants in this investigation were recruited in 2007 as part of a longitudinal study that compared SLI children and a group of age-matched controls at ages 6 and 8 (Aguilar-Mediavilla et al., 2014). Children in the SLI group were selected from all schools in the Balearic Islands by asking for children showing language problems without having a history of cognitive, auditory, social or neurological damages. Our group assessed their oral language profiles with the standardized test PLON-R: Navarra Oral Language Test Revised (PLON-R: Prueba del Lenguaje Oral de Navarra Revisada; Aguinaga, Armentia, Fraile, Olangua, & Uriz, 2004) and also their Non-verbal IQ (Wechsler, 2009). The PLON-R test includes, among others, picture naming and sentence repetition tasks, as well as spontaneous verbal expression and comprehension subtests, allowing us to assess phonology, morphosyntax, lexicon and pragmatics. Neurological, social and emotional data were obtained from speech therapists at school. We also requested their records related to audition to the Balearic Ministry of Health in order to rule out hearing problems. This institution conducts an Otoacoustic Emissions (OAE) analysis to all children in Majorca and an audiometric test to those children that fail the OAE. The initial sample for the present study consisted of 19 children aged between 11;4 and 12;2, nine males, who fulfilled the established criteria for diagnosing children with SLI (Stark & Tallal, 1981; Tomblin, Smith, et al., 1997; Tomblin, Records, et al., 1997). Specifically, these children scored above 85 in the non-verbal IQ scale on the Weschler Preschool and Primary Scale of Intelligence (WPPSI-III), assessed in Spanish, and obtained scores of at least -1.25 SD below the mean in the overall test score. Sensory, psychiatric, neurological or social disorders were also discarded. The control group comprised children of similar characteristics to those of the SLI participants but with no language problems, selected amongst their classmates. Due to unavailability at the time of the second assessment, the sample was reduced to 16 participants, ten males. Children in the SLI and control groups were matched for age, gender, IQ, dominant language, socioeconomic status and parental involvement in children's education (all $ps>.05$), but differed in their PLON scores ($p < .001$). The participants were all simultaneous Spanish–Catalan bilinguals, and their language of instruction at school was Catalan. A summary of the participants' sociodemographic characteristics is presented in table 1.

2.2. Procedure

Information regarding early oral competence of our participants had been gathered through the Spanish adaptation by Aguilar-Alonso and Moreno-González (2012) of the NEPSY test (Developmental Neuropsychological Assessment; Korkman, Kirk, and Kemp, 1998) at age 6 (see Aguilar-Mediavilla et al., 2014, for a detailed explanation). In the previous phase of the study, the NEPSY phonological processing and semantic fluency subtests significantly predicted reading capacity at age 8. The phonological processing subtest consists of a word segment recognition task based on syllabic and supra-syllabic units. The semantic fluency task is a part of a word generation subtest based on a semantic category (e.g. animals).

Their reading abilities were assessed for the first time at age 8 and then again at age 12 by means of a Catalan adaptation of the PROLEC test (Assessment Battery for Reading Processes; PROLEC: Batería de Evaluación de los Procesos Lectores; Cuetos, Rodríguez, & Ruano, 1998), the most used literacy test in our context for children in primary education (ages 6 to 12). At the time of the second assessment, we also introduced measures of reading speed for some of the tasks as included in the revised version of the test PROLEC-R (Cuetos, Rodríguez, Ruano, & Arribas, 2007 The PROLEC test comprises eight subtests that vary in their reliability estimates (see Cronbach's α values below), making some of them poor predictors:

Letters (α =. 51): in this subtest participants are asked to name 18 letters (i.e., "t", "r", "ç") as fast as they can. Time stops when the child has finished naming the last letter. The aim of this task is to verify that the child knows the letters and their pronunciation and evaluate the degree of automaticity in recognition.

Same-different (α =. 75): in this task a list with a sequence of 20 written word or non-word pairs is presented and the children have to decide whether the letter sequences are the same or different (e.g. "mercat-mercat"; "margue-marge"). There were 10 pairs of words and 10 pairs of non-words. This task is also timed and aims to assess sublexical processing abilities.

Non-word reading (α =. 68): this subtest consists of a list of 40 pseudowords for the participant to read aloud as fast as possible. It is also intended to provide information regarding the phonological reading capacities.

Word reading (α =. 81): this is also a timed subtest, in which the child is asked to read aloud 40 words. The use of real-word stimuli provides information regarding decoding and lexical abilities.

Grammatical structures (α =. 67): the participant is asked to select which of four given pictures corresponds to a written sentence (e.g. "El conill està saltant per sobre el gat" / The rabbit is jumping over the cat). This subscale includes 16 sentences, four of each of the following categories: active voice, passive voice, relative clauses and focus in complement clauses. The task focuses on the understanding of appropriate word order and syntactic-grammatical relations between words.

Punctuation marks (α =. 90): this subtest consists of a full text presented for the participant to read aloud as fast as possible. The experimenter assesses whether the participant observes the punctuation marks.

Sentence comprehension (α =. 57): in the task the participant is asked to perform given written instructions (e.g. "Draw a tree with three apples") or decide which of four drawings corresponds to a given written sentence (e.g. "The blue ball is inside the box"). This subtest consists of 16 items and is aimed to assess comprehension at the sentence-level.

Texts comprehension (α =. 76): the children are asked to read four short stories (two narrative and two expository texts). Then, they are presented with four questions for each of them in order to state their degree of reading comprehension.

All the children were evaluated at their schools and were tested individually by examiners who were trained by the principal investigator. Examiners were not aware whether the children belonged to the SLI or control groups.

3. Results

A summary of each group's raw scores on each task is presented in table 2. Children in the control group obtained numerically higher scores than children with a history of SLI on all tasks except for the same-different test at age 12. We conducted a MANOVA analysis with group (between participants) and age (within participants) as independent variables and the scores on the eight PROLEC tasks as dependent variables. We observed significant effects of age (Pillai's trace: $F(8, 26) = 334.554$, $p < .001$). Within-subject tests yielded significant differences in all the tasks for this variable (*ps* < .001). Differences between groups, on the other hand, were obtained in four of the eight tasks: letters ($F(1, 33) = 8.777$, $p = .006$), punctuation marks ($F(1, 33) = 4.647$, $p = .038$), words ($F(1, 33) = 4.243$, $p = .047$) and texts ($F(1, 33) = 10.916$, $p = .002$). The interaction between age and group yielded no significant results (Pillai's trace: $F(8, 26) = 1.910$, $p = .102$).

Planned T-tests showed significant within-groups differences, age 8 vs. age 12, in all the tasks in both the SLI and control groups (*p*s<.005). Regarding the between-groups comparisons, significant differences were observed in several PROLEC tasks at age 8: letters ($t(28.07) = 2.57$, $p = .016$), same-different ($t(22.86) = 3.16$, $p = .004$), grammatical structures ($t(33) = 2.28$, $p = .029$), punctuation marks ($t(33) = 2.24$, $p = .032$) and texts ($t(33) = 3.09$, $p = .004$). In contrast, only the texts reading tasks showed significant differences at age 12 ($t(26.88) = 2.28$, $p = .030$). A summary of these results is presented in table 2.

Another MANOVA analysis was conducted in order to compare the reading times (i.e. speed values) of the SLI and control groups in each task at age 12 –these measures were taken only at 12 years old– (Pillai's trace: $F(5, 29) = 1.451$, $p = .236$). No significant differences appeared in any of the tasks (all *ps* >.2).

Given the great heterogeneity in the language profile of children with SLI (Leonard, 2014a, 2014b) we decided to complement our study conducting individual analyses of the reading abilities of our participants at 12 years old. In order to better analyze their linguistic profiles, we grouped reading tasks in two categories according to their main goal in the test. On the one hand, letter identification, same-different, word reading and non-word reading subtests were considered as decoding (i.e. word recognition) tasks. On the other hand, the grammatical structures, punctuation marks, sentence comprehension and text comprehension subtests were considered comprehension tasks. The presence of a reading deficit in any of the tasks was established according to the standardized scales provided by PROLEC-R. Four of the participants in the SLI group presented impaired scores in at least one of the tasks in the decoding and in the comprehension subdomains, whereas other ten participants showed deficit in comprehension tasks only. In contrast, only one of the children in the SLI group presented reading deficits restricted to the word recognition subdomain. Four children did not present any reading problem. The incidence of reading deficiencies was even more apparent in the analysis of reading speeds. According to standardized scales, 17 out of 19 SLI participants presented slow reading in at least one of the timed tasks.

Finally, we also carried out different regression analyses in order to explore the possible influence of the degree of oral language development of the SLI participants at age 6 over reading capacity, including both precision and speed, at age 12. Following the analysis logic applied in the individual analyses, we added up the scores of the decoding and comprehension tasks of each participant separately, in order to obtain compound global scores corresponding to these two reading subprocesses. Accordingly, we grouped reading speed values in one general score. For each global score we performed a regression analysis with a model including the two predictor variables. Our analyses failed to observe any significant influences of early oral language capacities over global decoding (R2 = .012) or speed (R2 = .039) scores. Nevertheless, we obtained significant effects of early oral competence over late reading comprehension (R2 = .333). More specifically, semantic fluency at age 6 significantly predicted global comprehension at age 12 (phonological processing: β= .250, p= .240; semantic fluency: β= .509, p= .024).

4. Discussion

We conducted a longitudinal study that examined the evolution of literacy acquisition in children with a history of SLI during the four last years of primary education, ages 8 to 12, as well as the relationship between their early oral language ability and later reading competence. In line with previous results (St. Clair, Durkin, Conti-Ramsden, & Pickles, 2010), reading abilities of the participants in the control and SLI groups showed a similar progression rate, with both groups producing better results in all reading tasks at age 12 compared to 8. The comparison between the two groups, however, showed that control participants obtained higher scores in all reading tasks at the first time of assessment, with significant differences between groups at the letters, same-different, grammatical structures, punctuation marks and texts comprehension tasks. At age 12, in contrast, differences between groups appeared only in the text comprehension task. The results of our study, conducted in the context of a fairly orthographically transparent language such as Catalan, outline a course of literacy acquisition of SLI children that starts with widespread reading deficits affecting both decoding and comprehension competences, age 8, and are restricted to the comprehension subdomain at later stages, age 12. This pattern of results was confirmed at the level of individual analyses. The study of reading performance at age 12 showed that 79% of our SLI participants presented some kind of reading impairment, with most of them, 14 out of 15, showing a reading comprehension deficit with or without associated decoding impairments. Furthermore, the individual analyses also showed 17 out of 19 SLI participants to present slow reading. Overall, our data reveals a pattern of SLI-reading deficit co-occurrence slightly higher than in previous studies. For instance, Snowling et al. (2000) detected a substantial impairment in reading competence in 65% of their participants, whereas Catts et al., (2002) found a large percentage of children with SLI (approximately 40% of the sample) to present unimpaired reading.

Interestingly, our SLI participants presented a decrease in their reading deficit at later stages of literacy acquisition, showing a significant impairment only in relation to comprehension. This observation is consistent with results obtained by Botting, Simkin, & Conti-Ramsden, (2006), who pointed out the stronger association of SLI with late reading deficits in the comprehension, compared to the word recognition, domain. Along with the results of our individual analyses, this observation is also in line with predictions outlined by Snowling et al. (2000), who proposed that SLI children would present word recognition impairments early in the development of reading abilities, while reading comprehension deficits would be more apparent at later stages of literacy acquisition. Specifically, the deficit observed in our results is restricted to text comprehension. However, the poor reliability estimates of the sentence comprehension task used in this study prevents us from ruling out the possible existence of an impairment also at the sentence level. Further studies with more reliable measures should be conducted to determine the exact dimension of this impairment.

Furthermore, we also aimed to investigate how early difficulties in oral language acquisition may influence the later development of reading capacities. In our previous study, (Aguilar-Mediavilla et al., 2014), we observed early phonological processing and semantic fluency capacities to influence global reading abilities at age 8. Our new data, gathered four years later, shows how the reading deficit, now mainly restricted to the comprehension subdomain, is only predicted by the early competence on the semantic fluency task. These results confirm the importance of semantic processes related to oral language over reading comprehension abilities, what supports the existence of common processes underlying both oral and written comprehension suggested by the SVR (Hoover & Gough, 1990). Additionally, our data confirm the conceptualization of the relation between SLI and dyslexia as directly dependent on the specific language profile of each child (Bishop and Snowling, 2004). Different oral language deficits associated to SLI seem to affect different subcomponents of reading capacity. During the first moments of literacy acquisition, diminished phonological and semantic abilities respectively influence decoding and comprehension capacities. Later on, after decoding skills have been strengthened through continuous training, the lack of semantic competence still affects reading comprehension.

A possible cause for the differences between rates of reading difficulties associated to SLI could be related to the bilingual nature of our sample. Previous studies have observed poorer oral language capacities in bilingual compared to monolingual children with SLI (Orgassa & Weerman, 2008; Westman et al., 2008). However, other studies have failed to observe differences between the oral abilities of bilingual and monolingual children with SLI (Rothweiler, Chilla and Clahsen, 2012;

Windsor, Kohnert, Lobitz, and Pham, 2010) so evidence regarding this possibility is still inconclusive. Unfortunately, our study does not allow us to ascertain whether the increased percentage of reading deficit in our sample is due to bilingualism. Future research comparing bilingual and monolingual children with SLI are needed to clarify this issue.

4.1. Conclusions

In sum, our data suggests that, although reading expertise of children with a history of SLI progresses with age, their reading achievement is affected by early limited language capacities. At later stages of literacy acquisition, this impairment is mainly present in the reading comprehension subdomain, and appears to affect word recognition to a lesser extent. Our results, hence, point out the relevance of prior oral language impairment in children with a history of SLI as a risk factor for the development of later reading difficulties. However, we have also found that the reading competence of children with a SLI diagnosis is very heterogeneous, and that not all children in this group show reading difficulties. Hence, the variability of language profiles presented by children with a history of SLI must be taken into account when their reading capacities are studied.

Conflict of interest

The authors report no conflicts of interest with the research described in this research article.

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Table 1. Sociodemographic characteristics of the sample

	Control (n=16)	**SLI (n=19)**
Males	10	9
Age T1	7;8	7;8
Age T2	11;8	11;8
Prefer Language Catalan	7	6
Prefer Language Spanish	9	13
High SES	1	1
Medium SES	11	13
Low SES	4	5
PLON-R at 5;6	10.31(1.82)	8.16(1.77)
Nonverbal IQ	107.5(10)	102.05(10.4)

Table 2. Summary of group's raw scores on each task and within group differences by age

		Between-groups differences SLI mean (SD)		Control mean (SD)		Within group differences	
		Age 8	Age 12	Age 8	Age 12	SLI	Control
PROLEC	max.						
Letters	20	13.58(1.54)*	19.32(1.0)	14.63(0.81)	19.81(0.40)	5.74 *	5.18*
Same-Different	20	11.11(0.99)*	19.42(0.61)	11.88(0.34)	19.31(1.40)	8.31*	7.43*
Words	40	13.11(3.45)	38.05(2.57)	14.38(1.02)	39.13(0.96)	24.94*	24.75*
Non-words	40	12.16(3.58)	35.74(3.63)	13.69(1.82)	37.38(2.25)	23.58*	23.69*
Grammatical Structures	16	7.74(2.96)*	13.26(2.28)	10.13(3.24)	13.75(1.44)	5.52*	3.62*
Punctuation marks	11	5.11(3.13)*	9.68(1.70)	7.31(2.60)	10.19(1.11)	4.57*	2.88*
Sentence Comprehension	16	9.21(2.86)	14.89(1.33)	10.69(1.58)	15.31(0.95)	5.68*	4.62*
Text Comprehension	16	5.05(3.52)*	11.58(3.45)*	8.75(3.53)	13.63(1.67)	6.53*	4.88*

* $p < .05$ in the comparison to its corresponding control group or in the within group comparison by age