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Effect of verb argument structure on picture naming in children with and without specific language impairment (SLI)

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Abstract

Background—This study investigated verb argument structure effects in children with specific language impairment (SLI).

Aims—A picture-naming paradigm was used to compare the response times and naming accuracy for nouns and verbs with differing argument structure between Spanish-speaking children with and without language impairment.

Methods & Procedures—Twenty-four children with SLI (ages 5;3–8;2 [years;months]), 24 age-matched controls (ages 5;3–8;2), 24 MLU-w controls (ages 3;3–7;1 years), and 31 adults participated in a picture-naming study.

Outcomes & Results—The results show all groups produced more correct responses and were faster for nouns than all verbs together. As regards verb type accuracy, there were no differences between groups in naming one-argument verbs. However, for both two- and three-argument verbs, children with SLI were less accurate than adults and age-matched controls, but similar to the MLU-matched controls. For verb type latency, children with SLI were slower than both the age-matched controls and adults for one- and two-argument verbs, while no differences were found in three-argument verbs. No differences were found between children with SLI and MLU-matched controls for any verb type.

Conclusions & Implications—It has been shown that the naming of verbs is delayed in Spanish children with SLI. It is suggested that children with SLI may have problems encoding semantic representations.

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Keywords

language development; specific language impairment; picture naming; verbs and argument structure

Introduction

Verbs are fundamentally different from nouns. Nouns can refer to objects that have a constant shape and form across time. Verbs, on the other hand, refer to states, actions or processes that can vary across both time and space. Verbs are also more complex than nouns semantically and syntactically, since verbs specify the number and type of possible nominal arguments in different thematic roles. Verb argument structure can specify one, two, or three nominal arguments in roles such as agent, theme, recipient, goal or experiencer. For example, the verb 'to *give*' specifies a first argument in the agent role, a second argument in the recipient role and a third argument in the theme role, as in the sentence 'John gave his mother a flower.' The specification of *verb argument structure* serves as an important interface between lexis, syntax and semantics (e.g. Grimshaw 2005, Jackendoff 2002, Levin and Rappaport 1995)

Several studies have examined the effects of argument number on verb processing in adults. In particular, verb production becomes more difficult for participants with Broca's aphasia as the number of arguments entailed by the verb's representation increases (Kemmerer and Tranel 2000, Kim and Thompson 2000, 2004, Thompson *et al.* 1997, Jonkers 2000, Jonkers and Bastiaanse 1996, 1998, De Bleser and Kauschke 2003, Kiss 2000, Luzzatti *et al.* 2002, Moreover, some studies have found increasing processing times related with representational complexity (the increasing number of verb arguments). Some reading time data suggest that the speed of reading verbs aloud is a function of its argument structure or semantic complexity (e.g. Gennari and Poeppel 2003, McElree *et al.* 2001). Likewise, some studies have found effects of verb argument complexity (e.g. Shapiro and Levine 1990, Shapiro *et al.* 1987, 1989) such that the more alternative argument structures associated with a verb, the harder that verb was to process (Shapiro *et al.* 1987).

Specific language impairment (SLI) is an impairment characterized by developmental delays in verbal abilities without accompanying non-verbal cognitive deficits (Bishop 1997, Leonard 1998). The speech of children with SLI is characterized by a greater than normal misuse and omission of inflectional morphology. These difficulties have been widely demonstrated in English (e.g. Grela and Leonard 2000, Hadley and Rice 1996, Leonard 1995, Leonard *et al.* 1997, Rice and Wexler 1996, 1997, Rice *et al.* 1995) as well as in other languages such as Catalan and Spanish in which children with SLI omit verb markers (person, number and tense) and auxiliary verbs, and show mistakes with the use of infinitives (Sanz-Torrent *et al.* 2008b). Other studies suggest that children with SLI may also have particular problems with argument structure (de Jong 1999, Grela and Leonard 1997, Loeb and Leonard 1988, Schelletter *et al.* 1999). Several studies in English have shown that children with SLI omit obligatory arguments more often compared with age-matched controls (Fletcher 1991, Roberts *et al.* 1994) and make errors in a much wider variety of verbs compared with MLU-w-matched controls (King and Fletcher 1993). Children with SLI use significantly fewer argument types (Thordardottir and Weismer 2002) and omittedmore grammatical subject arguments in ditransitive sentences than in sentences with intransitive and transitive verbs (Grela 2003). In this sense, a recent study of Catalan and Spanish children with SLI (Sanz-Torrent *et al.* 2011) describes three experiments on verb argument structure using different methodologies: an observational study which uses a spontaneous-talk longitudinal sample, a sentence-naming task as a result of event video observation and an experimental sentence-naming task with static images that differ in the number of verb arguments. Although the specific results vary according to the methodology used, there was clear evidence that Catalan- and Spanish-speaking children with SLI have special difficulties in producing verbs with a highly complex argument structure, often omitting obligatory arguments.

Despite this apparent vulnerability of verb argument structure in SLI, only a few studies have yet compared object naming with action naming in children with SLI using a picture-naming task (Dockrell *et al.* 2001, Sheng and McGregor 2010a, 2010b). Moreover, to date no study has yet examined the possible effects of verbs that differ in the number of verb arguments on picture naming. Most previous picture naming studies carried out on children with SLI focus solely on object naming (Anderson 1965, Ceci 1983, Kail and Leonard 1986, Katz *et al.* 1992, Lahey and Edwards 1996, McGregor *et al*. 2002, Leonard *et al.* 1983, Wiig *et al*. 1982). These studies all showed slower naming speed and increased naming errors in comparison with age-matched controls. For example, Lahey and Edwards (1999) found significantly more semantic associate errors (e.g. ‘dust’ for ‘broom’), phonological errors (e.g. ‘pumplin’ for ‘pumkin’), and ‘don’t know’ errors in the children with SLI than in the age-matched controls. Only two studies have compared object and action naming in children with SLI (Dockrell *et al.* 2001, Sheng and McGregor 2010a). Dockrell *et al. (*2001) compared object and action naming in 31 children with word finding difficulties (WFDs), some of whom may have had SLI, mean age 7;1 years. They found that children with WFDs made proportionally more phonological errors on object naming and more unrelated and semantically nonspecific errors on action naming (e.g. *doing* for *sewing*, *moving* for *crawling*) than their age-matched controls. Sheng and McGregor (2010a) examined the accuracy, latency and errors of noun and verb naming in children with SLI, control age children (CA) and expressive vocabulary controls (EV). Results showed that children with SLI and EV controls demonstrated comparable naming latency and accuracy and both were slower and less accurate than CA group. Object naming was faster than action naming in all groups and children with SLI made proportionally fewer taxonomic errors (that comprises superordinate, coordinate and subordinate errors) and more omission errors when naming objects and fewer misperception errors when naming actions than CA group.

Previous studies have failed to take into account all the variables that determine speed and accuracy in lexical access during picture naming. Some of them have only controlled for frequency (e.g. Dockrell *et al.* 2003, Lahey and Edwards 1996, 1999, McGregor *et al*. 2002) or age appropriateness (McGregor *et al*. 2002). However, research has shown that naming is also heavily influenced by age of acquisition (Carroll and White 1973, Morrison *et al*. 1992) and imageability (Barry *et al*. 1997, Cuetos and Alija 2003, Cuetos *et al*. 1999, Ellis and Morrison 1998, Snodgrass and Yuditsky 1996).

Although there is a general consensus on the linguistic profile of SLI, there is considerable debate regarding the underlying cause or causes for these deficits. Regarding picture naming difficulties in SLI, there are, broadly speaking, two classes of explanations in the literature. On the one hand, some investigations attribute these difficulties to deficits or immaturities in semantic representations (Dockrell *et al.* 2001, Thordardottir and Weismer 2002, Sheng and McGregor 2010a, 2010b). This interpretation is based on the idea that the degree of knowledge represented in a child's semantic lexicon makes words more or less vulnerable to retrieval failure. Moreover, this limited semantic knowledge contributes to higher naming latency times and more naming errors. In this regard, Bjorklund (1987) argued that growth in the content and organization of semantic memory influences the ease with which information can be retrieved. He posited that lexical items that are encoded robustly in terms of semantic features and semantic relationships have lower activation thresholds during retrieval. Based on this idea, Kail and Leonard (1986) proposed the storage hypothesis to account for the naming problems of children with SLI. According to this hypothesis, representational storage deficits contribute to the retrieval problems of children with SLI. In this vein, McGregor *et al*. (2002) observed deficits in the performance of children with SLI in the three tasks of naming, drawing and defining. They attributed these deficits to limited semantic knowledge, noting that the most frequent type of naming errors were semantic errors (McGregor and Appel 2002). Analysing speech samples from 50 children with SLI, Thordardottir and Weismer (2002) found that children with SLI used significantly fewer argument types, argument structure types, and verb alternations than age-matched children with normal language (NL). Like McGregor *et al.* (2002), they suggested that these differences were not merely attributable to production limitations such as utterance length but can be due to an incomplete argument structure representation for verbs. More recently, a study of ERPs in children with SLI showed that they have weaker lexical–semantic representations of verbs and their selectional restrictions (Sabish *et al.* 2006) than do age-matched controls.

An alternative account attributes these deficits to processing limitations (Weismer *et al.* 1999, Leonard 1998, Miller *et al.* 2001, Montgomery 2000). These limitations can involve either slower processing (as seen in increased latency in picture naming) or reduced capacity (as reflected in reduced ability to deal with words/sentences of increased complexity). In support of this account, several studies have emphasized that children with SLI are slower in the amount of work that can be accomplished in a given unit of time. In particular, they are slower than typically developing children on simple picture naming tasks (Katz *et al.* 1992, Lahey and Edwards 1996, Leonard *et al.* 1983).

The aim of this paper is to analyse how increasing the number of verb arguments affects picture naming by Spanish-speaking children with SLI. In view of the potential importance of the different variables that determine speed and accuracy in lexical access during picture naming, we controlled the stimuli in the current study for the lexical variables of frequency, age appropriateness, age of acquisition, number of syllables, and imageability. The subjects included adults and children with and without SLI. We hypothesized that adults would have mature, complex semantic representations of verbs, whereas normally developing children would have simpler argument structure representations, and children with SLI would have poorer semantic representations and simpler argument structure representations.

The picture-naming task requires not only linguistic processing but also visual and semantic interpretation. However, young children are excellent readers of pictures, and so picture naming seems to be a suitable research tool for exploring children's semantic representations and lexical organization (Masterson *et al.* 2008). Moreover, the picture-naming task provides a way of evaluating the role of representational deficits, while keeping sentence processing limitations constant. Because this task only requires lexical access and not full sentence production, it can provide a more direct measure of the ways in which representational robustness facilitates retrieval. The better the representation, the shorter the naming time will be. In this task, it is possible that latencies would increase for verbs with more complex argument structures. However, such increases would then be attributable to representational factors and not sentence processing factors.

The incomplete semantic representations approach predicts that naming delays and errors in children with SLI depend not so much on the number of arguments of the verb, but rather on the precision of the semantic representation that these children have for each particular verb. As a result, high-frequency and high-familiarity verbs would be named faster and more accurately, regardless of the number of arguments they have. Furthermore, if children with SLI have poor semantic representations for verbs, they should produce more 'don't know' responses in naming (e.g. Freid-Oken 1984, German 1982, McGregor 1997, McGregor and Waxman 1998), and should make more mistakes. Moreover, the mistakes they make should be primarily semantic (e.g. 'key' for 'door', 'playpen' for 'crib'), as previous studies have shown (e.g. German 1982, Lahey and Edwards 1999, McGregor 1997). Conversely, the processing limitations approach predicts that naming delays and errors will increase primarily as the number of arguments increases.

Method

Participants

All participants were native Spanish speakers[1] and had normal or corrected-to-normal vision. Four groups took part in this study. The first group consisted of 31 adult students or junior faculty (22 boys, 19 girls) with ages ranging from 18;2 to 35;6 years. The second group consisted of 24 children (17 boys, seven girls) with SLI, with ages ranging from 5;3 to 8;2 years. The third group consisted of 24 children matched by age to the children with SLI (17 boys, seven girls), ranging from 5;3 to 8;2 years. The fourth group consisted of 24 children (17 boys, seven girls) matched on mean length of utterance by words (MLU-w) to the children with SLI, ranging from 3;3 to 7;1 years. Adult participants and the parents of child participants gave their written informed consent for their participation in this study.

[1]This study was carried out in Catalonia where it is very difficult to separate monolingual and bilingual children. In Catalonia both Spanish and Catalan are official languages, and both languages are typologically similar, leading to the fact that residents' proficiency in both languages is nearly native-like. For a review of Catalan and Spanish bilingualism and SLI, see Sanz-Torrent *et al.* (2008a).

The children with SLI were selected according to standard criteria for diagnosing SLI (Leonard 1998, Stark and Tallal 1981, Watkins 1994). Specifically, children with SLI were tested to assess their non-verbal intelligence and level of language development. Tests included the Wechsler Intelligence Scale for Children (WISC-R; Spanish version; Wechsler *et al.* 1993) or the Kaufman Brief Intelligence Test (KBIT; Kaufman and Kaufman 2004). Every child with SLI obtained a nonverbal IQ standard score above 85. Language ability was assessed by language profiles following the Spanish protocol for evaluation of language delay (AREL; Pérez and Serra 1998), the Spanish version of the Peabody Picture Vocabulary Test III (PPVT-III; Dunn *et al.* 2006), and the ELI child language scale (Saborit and Julián 2005) for children younger than 6 years. The ELI scale includes several subtests for phonetics, lexical reception, lexical production and pragmatics. Children with SLI had scores of at least a −1.25 SD below the mean, both on the Peabody III and the ELI. Language profiles based on transcripts of spontaneous conversations provided further information about the characteristics of the language production of the children. These analyses showed that these children had a delay of at least 1 year (Bishop 1997) in language production, based on MLU-w values. All the children selected for the study had been diagnosed with SLI by speech and language therapists from school educational psychology services and were receiving language intervention. Children were excluded if they had difficulty hearing pure tones in normal frequency ranges, neurological dysfunction, oral or motor dysfunction, or impaired social functioning.

The age-matched control group was equivalent in age (same year and ±2 months) and mother tongue (Spanish) to their counterparts in the SLI group. Teachers were asked if the control subjects' language development was normal for their age. Children were not selected if they had a history of speech therapy or psychological therapy. Moreover, teachers were asked to select children with normal academic performance. All of the children selected came from state schools in Catalonia and Valencia. With respect to the MLU-w control group, each child in the study group was paired with another child according to their linguistic level, measured from the MLU in words (±0.6 words), sex and mother tongue. In addition, non-verbal intelligence and language ability was assessed in all children selected in both the age-control and MLU groups using the same tests and protocols applied to children in the SLI group. A summary of the descriptive data for the three groups of children is presented in table 1.

Stimuli

Stimuli included 18 nouns and 18 verbs (six one-argument, six two-argument and six three-argument verbs). The experimental nouns and verbs are given in table A1 in appendix A. To maximize the homogeneity of the verbs' semantic structure, we choose verbs with the same thematic roles in each type. One-argument verbs only had the role of agent, two argument verbs had the roles of agent and theme and three-argument events had the roles of agent, theme and recipient.

Target words were also assessed for: (1) frequency in the LEXESP corpus (Sebastián *et al.* 2000) of written Spanish; (2) age of acquisition in the Serra-Solé corpus (Serra *et al.* 2000) using the CLAN program FREQ from the CHILDES project (MacWhinney 2000); and (3) imageability from published rating norms (Valle-Arroyo 1999). Syllable number also was controlled so that the target nouns and verbs both had mean syllable lengths of 2.17. The mean syllable length was also 2.17 for each level of argument structure. As seen in table 2, nouns did not differ from verbs in any way except for Imageability. As expected, nouns were rated as more imageable than verbs (e.g. Gillette *et al.* 1999, for a similar effect in English). As can be seen in table 3, the three verb groups did not differ significantly with respect to any of the properties, including imageability, although there was a marginally significant uncorrected pairwise comparison found between one- and two-argument verbs [$t(10) = 2.07$, p=0.07]. Although the number of stimuli in each set of verb types was relatively small (six), this has been the case in other studies investigating verb argument structure (e.g. Den Ouden *et al.* 2009), due to stimulus selection requirements.

Each of the 18 nouns and 18 verbs were paired with a clip art picture depicting the object or action. Each image consisted of a picture located in the centre of a quadrant on the screen. The background was white and the lines of the quadrant black (figure 1). Although there were some verbs, particularly some those in three-verb argument group that could be either transitive or ditransitive, we depicted the verbs in the particular argument structure form selected. For example, the verb '*tirar*' ['to throw'] could be transitive ('*Lucía tira una pelota*' ['Lucía throws a ball']) or ditransitive ('*Lucía tira una pelota al perro*' ['Lucía throws a ball to the dog']). All the images obtained high levels of name agreement from eight language experts in the Department of Basic Psychology, University of Barcelona. Moreover, in order to determine how well the images depicted the intended object or action, a separate group of 32 adults rated the appropriateness of each word for the corresponding picture. This was done for each item by showing the picture with the word printed next to it (in singular form for nouns and in the infinitive form for verbs). Participants then answered the following question 'On a scale from 1 to 7 how good is this as a one-word name for this picture?' As expected, nouns were better labels for pictures than verbs (table 2, Label appropriateness). Crucially, however, label appropriateness did not differ significantly between the three verb classes (table 3).

Procedure

Participants were tested individually in a quiet room where they were seated approximately 22-inch in front of a 17-inch TFT monitor. Stimuli were presented on the screen, which was set to 1024 × 768 pixels. Participants were instructed: 'You'll see some drawings that represent either objects or actions. You have to say in only one word their name as fast as possible!' There were four practice trials before the experimental task (one noun and three verbs: one-, two- and three-argument verbs) to acquaint participants with the flow of events. Before beginning the experiment proper, we made sure that participants understood that they had to use just one word to name the picture. We repeated practice trials until they correctly named four practice pictures in sequence. The test images were presented in two blocks counterbalanced across participants containing eighteen images each (nine nouns and nine verbs, three for every argument complexity). Moreover, the order of presentation of the pictures in each block was randomized anew for each subject. All the participants were given both blocks. At the start of each trial, participants saw a crosshair for 1000 ms. Then the target image was displayed and remained during 6000 ms. A digital voice recorder with a tie-clip microphone was used for voice recording.

Speech coding

Voice recordings were transcribed and then categorized as correct or incorrect. Answers were only considered as correct if children used a single word to name the picture. Using a digital sound editor, we calculated latencies as the time from the start of the presentation of the target image display to the onset of naming. Latencies were only calculated for correct responses. The time spent in false starts and pre-response vocalizations (e.g. ‘eeh’, ‘mm’) was excluded, so that the response was considered to begin with the word that actually named the picture. Synonyms were coded as correct responses. To assess which words were synonyms to the targets, we consulted three Spanish dictionaries of synonyms (Corripio 1995, Gili Gaya 1991, Sainz 1993). We accepted those nouns that at least two of these dictionaries includes as a synonym of the target noun. For verbs, we included as synonyms the verbs that meet the synonymy criterion and that had same number of verb arguments in the same thematic roles as the target verb (for example, we accepted ‘*tirar*’ for ‘*lanzar*’ [‘throw’ for ‘launch’]. For errors, we selected 12 mutually exclusive categories following an adapted version of the classification scheme used by Druks *et al.* (2006) and Rodríguez-Ferreiro *et al.* (2009). Examples of each error type are given in table 4. Semantically related errors were classified as coordinate, superordinate, subordinate, or associative errors. Coordinate errors named an object or action sharing the same category as the pictured concept, at the same level of specification. Superordinate errors named the categories to which pictured concepts belonged. Subordinate errors named an object or action sharing the same category but at a more detailed level of specification compared with the pictured concept. As Rodríguez-Ferreiro *et al.* (2009) note, the hierarchical organization of action concepts is not as clear as in the object concepts’ domain (Morris and Murphy 1990), so the separation between subordinate/superordinate and coordinate errors in the action naming task should be approached with caution. Errors semantically related to the target but belonging to a different semantic category were classed as associative errors. We categorized those responses naming objects or actions that were visually similar but otherwise semantically unrelated to the target object or action as visual errors. When the participant named an object or action that appeared in the picture but was different from the target concept, the error was categorized as a misinterpretation. In addition to semantic or visual errors, we distinguished phrases or sentences, class, formal and unrelated errors as well as perseverations and null responses. Phrases or sentences were categorized according to whether or not they contained the target word. Errors were categorized as class errors if the errors named a concept semantically related to the target concept but belonging to a different grammatical class. We classified as formal errors those responses sharing more than 50% of their phonemes with the target word. Perseverations consisted of repetitions of a previous response. Unrelated errors did not present an identifiable relationship between error and target under any of the above-mentioned categories. Null responses were counted where participants refused to make a response or did not make an intelligible response.

The response types (correct or incorrect) and error types were first coded by a research assistant and later recoded by the first author. Disagreements between the assistant and the first author were resolved by agreement between the first and the second author.

Results

Naming accuracy

Figure 2 presents the percentage of correct responses of every group for nouns, all verbs together, and separately for one-, two- and three-argument verbs. An ANOVA with the factors of word category (noun, all verbs together) and group showed a significant main effect for word category [$F_{(1,99)}$ = 215,418; $p < 0.01$, $\varepsilon^{2 =}$ 0.685] and group [$F_{(3,99)}$ = 26,257; $p < 0.01$, $\varepsilon^2 = 0.443$]. The interaction between word category and group was also significant [$F_{(3,99)}$ = 9881; $p < 0.01$, $\varepsilon^2 = 0.230$]. All of groups produced more correct responses for nouns than verbs. Paired comparisons with Bonferroni correction showed that children with SLI were significantly less accurate than adults and the age-matched control group, but equal to the MLU-matched group. Adults were more accurate than children with SLI and MLU controls but no differences were found between adults and the age-matched controls. Finally, the age-matched control group was as accurate as adults, but more accurate than the MLU-matched group and the children with SLI.

An ANOVA with the factors of verb argument number (one, two, three) and group showed significant main effects for argument number [$F_{(2,98)}$ = 33,311; $p < 0.01$, $\varepsilon^2 = 0.405$] and group [$F_{(3,99)}$ = 20,535; $p < 0.01$, $\varepsilon^2 = 0.384$]. The interaction between argument number and group was also significant [$F_{(6,196)}$ = 5714; $p < 0.01$, $\varepsilon^2 = 0.149$]. There were differences in correct responses between one- and two-argument verbs [$t(102)$ = 6467; $p <$ 0.01] and between one- and three-argument verbs [$t(102)$ = 5605; $p < 0.01$] but not between two- and three-argument verbs. Paired comparisons with Bonferroni correction showed that children with SLI were not different from the MLU-matched children. In contrast, the age-matched control group was not different from the adults. The SLI and MLU control groups were less accurate than the adults and the age-matched controls. Children with SLI named one-argument verbs significantly better than two- [$t(23)$ = 6309; $p < 0.01$] and three-argument verbs [$t(23)$ = 6012; $p < 0.01$], but no differences were found between two- and three-argument verbs. The MLU-matched group showed the same pattern [V1–V2, $t(23)$ = 5592; $p < 0.01$ and V1–V3, $t(23)$ = 3715; $p < 0.01$], whereas the age-matched control group were more accurate in naming one-argument compared with two-argument verbs [$t(23)$ = 3323; $p < 0.01$]. Finally, no naming accuracy differences between argument numbers were found in adults. The comparison of the groups of the sample according to the number of arguments did not show differences in the percentage of accuracy of naming one-argument verbs between groups. However, for both two- and three-argument verbs, children with SLI were less accurate than adults and age-matched controls but similar to the MLU-matched controls.

In sum, all of groups produced more correct responses for nouns than all verbs together. Children with SLI were significantly less accurate than adults and the age-matched controls, but not different from the MLU-matched controls. In contrast, the age-matched controls were not different from the adults. Children with SLI named one-argument verbs significantly better than two- and three-argument verbs, but no differences were found between two- and three-argument verbs. The MLU-matched controls showed the same pattern, whereas the age-matched controls only showed differences in naming accuracy between one- and two-argument verbs. No differences involving argument number were found in adults. Finally, there were no differences between groups in the percentage of accuracy of naming one-argument verbs. However, for both two- and three-argument verbs, children with SLI were less accurate than adults and age-matched controls, but similar to the MLU-matched controls.

Error types

Table 5 presents the percentages of the different types of errors of every group for nouns and all verbs together. We used the Mann–Whitney *U*-test reported as *z*-scores that were corrected for ties. For nouns, children with SLI differed from adults in the percentage of all errors ($z = -3.96$, $p < 0.01$) and in the errors in which they changed the target noun for a sentence or phrase with a target ($z = -2.34$, $p < 0.05$) and null responses ($z = -3.91$, $p < 0.01$). Children with SLI made significantly more errors ($z = -2.79$, $p < 0.01$), sentences or phrases with target ($z = -2.07$, $p < 0.05$) and null responses ($z = -2.62$, $p < 0.05$) than age-matched controls and no differences with the MLU-matched controls were found.

As regards verbs, children with SLI differed significantly from the adults in the total percentage of errors ($z = -5.56$, $p < 0.01$), sentences or phrases with target ($z = -4.08$, $p < 0.01$), sentence or phrase without target ($z = -3.21$, $p < 0.01$), null responses ($z = -3.30$, $p < 0.01$), perseverations ($z = -2.01$, $p < 0.05$), unrelated errors ($z = -2.24$, $p < 0.05$) and class-crossing errors ($z = -2.38$, $p < 0.05$). Children with SLI made significantly more errors ($z = -4.52$, $p < 0.01$) and produced more sentences or phrases with target ($z = -3.48$, $p < 0.01$) and without target ($z = -2.08$, $p < 0.05$) with respect to age-matched controls. Again, no differences with the MLU-matched controls were found.

Table 6 presents the percentages of the different types of error of every group for one-, two- and three-argument verbs. The results with one-argument verbs, showed that children with SLI produced more sentences or phrases with target ($z = -3.34$, $p < 0.05$) and null responses ($z = -2.64$, $p < 0.01$) than adults. Children with SLI only differed from the age-matched controls in the percentage of sentences or phrases with target ($z = -2.20$, $p < 0.05$) and no differences were found in comparison with the MLU-matched controls. For two-argument verbs, children differed significantly in the percentage of total errors ($z = -5.78$, $p < 0.01$), sentences or phrases with target ($z = -4.27$, $p < 0.01$) and without target ($z = -2.09$, $p < 0.05$), null responses ($z = -2.91$, $p < 0.01$) and class-crossing errors ($z = -3.33$, $p < 0.01$) from adults. With respect to the age-matched controls, they only differed in the percentage of total errors ($z = -4.51$, $p < 0.01$), sentences or phrases with target ($z = -3.13$, $p < 0.01$) and class-crossing errors ($z = -2.12$, $p < 0.05$) but no differences were found in comparison with the MLU-matched controls. In three-argument verbs, children with SLI differed significantly in the percentage of total errors ($z = -5.36$, $p < 0.01$), sentences or phrases with target ($z = -3.21$, $p < 0.01$) and without target ($z = -2.98$, $p < 0.01$), null responses ($z = -2.99$, $p < 0.01$) and class-crossing errors ($z = -3.16$, $p < 0.01$) from adults. With respect to the age-matched controls, they only showed differences in the percentage of total errors ($z = -4.74$,

$p < 0.01$), sentences or phrases with target ($z = -3.19$, $p < 0.01$) and without target ($z = -2.13$, $p < 0.05$). Finally, children with SLI made more subordinate errors ($z = -2.59$, $p < 0.05$) than the MLU-matched controls.

In sum, the main differences between children with SLI and the age-matched controls was in regard to the total percentage of errors ($p < 0.01$) and the null responses ($p < 0.05$) in naming nouns. For verbs, the differences were also in regard to the total percentage of errors ($p < 0.01$). It is remarkable that, despite having been instructed to name in only one word the pictures, the children with SLI use more sentences or phrases to name both nouns and verbs than the control age children. These errors were constant across verbs types. Finally, only small differences were found between children with SLI and the MLU-matched controls (only in subordinate errors in verbs).

Naming latency

Figure 3 presents the mean response latencies of every group for nouns, all verbs together and separately for one-, two- and three-argument verbs. ANOVAs were carried out on the factors of word category (noun, all verbs together) and group (adults, control age, MLU-w controls and SLI). There were significant main effects for word category $F_{(1,96)} = 108{,}445$; $p < 0.01$; $\varepsilon^2 = 0.530$ and group $F_{(3,96)} = 24{,}699$; $p < 0.01$; $\varepsilon^2 = 0.426$. All of groups produced nouns faster than verbs. Using paired comparisons (Student–Newman–Keuls) with Bonferroni correction, the group effect was found to be significant between the adults and the other three groups showing that adults were significantly faster than the other groups. No differences were found between the three groups of children. There was no significant interaction between group and word category.

An ANOVA with the factors of group and verb type (one, two or three arguments) revealed significant main effects for verb type [$F_{(2,84)} = 39{,}808$; $p < 0.01$; $\varepsilon^{2\,=}$ 0.487] and group [$F_{(3,85)} = 14{,}49$; $p < 0.01$; $\varepsilon^2 = 0.338$], as well as a significant interaction between group and verb type [$F_{(6,168)} = 2{,}193$; $p < 0.02$; $\varepsilon^2 = 0.073$]. One-argument verbs were significantly faster than two- and three-argument verbs [V1 versus V2, $t(90) = 6.513$; $p < 0.01$ and V1 versus V3, $t(91) = 7.762$; $p < 0.01$]. We found this pattern for all groups except the SLI. That group only showed significant differences between one- and two-argument verbs [$t(16)=2.602$; $p <0.02$]. Paired comparisons with Bonferroni correction showed that SLI children were significantly slower than adults and the age-matched controls, but were not different from the MLU-matched group.

For one-argument verbs, children with SLI were slower than adults and age-matched controls, but similar to MLU controls. The age-matched controls were slower than adults, faster than children with SLI, but similar to MLU-matched controls. MLU-matched controls were similar to age-matched controls and children with SLI, but slower than adults. The adults were faster than all three groups of children. For two-argument verbs, children with SLI were slower than adults and the age-matched controls, but comparable to the MLU-matched controls. The age-matched controls did not differ from the adults or the MLU-matched controls, but were faster than the children with SLI. The MLU-matched controls were similar to children with SLI and the age-matched controls, but slower than the adults. The adults were faster than the children with SLI and the MLU-matched controls, but comparable to the age-matched controls. Finally, for three-argument verbs we found that all three of the child groups spent a similar time in naming those verbs, but all of them were slower than adults.

In sum, the results showed that all of groups produced nouns faster than verbs. Adults were faster than the three groups of children, which did not differ from each other. As regards verb types, one-argument verbs were significantly faster than two- and three-argument verbs, but no differences were found between two- and three-argument verbs. Children with SLI were significantly slower than adults and the age-matched controls, but were not different from the MLU-matched controls. All the groups named one-argument verbs significantly faster than two- and three-argument verbs except the SLI group that only showed significant differences between one- and two-argument verbs. Adults were faster than the other groups for all the verb types, except for two-argument verbs for which the age controls did not differ from the adult group. Children with SLI were slower than both the age-matched controls and adults for one- and two-argument verbs while no differences were found in three-argument verbs. No differences were found between children with SLI and MLU-matched controls for any verb type.

Discussion

The purpose of this study was to investigate argument structure effects in children with SLI. To do this we used a picture-naming paradigm to compare the response times and naming accuracy for nouns and verbs with different numbers of arguments for children with SLI, age-matched controls, MLU-matched controls and adults. Naming latency showed that verbs require more time to process than nouns and that production becomes more difficult as the number of arguments entailed within the verb's representation increases (between one and more arguments, but not between two and three arguments). This effect was found in all the groups.

With respect to accuracy, all the groups were better at naming nouns than verbs. Children with SLI were significantly less accurate in naming both nouns and verbs than adults and age controls but no differences were found with respect to the MLU-matched control group. Moreover, children with SLI and the MLU-matched controls showed differences in correct responses between one- and two-argument verbs and between one- and three-argument verbs but not between two- and three-argument verbs. The age-matched control group only showed differences in naming accuracy between one- and two-argument verbs and no differences involving argument number were found in adults.

These results suggest that argument complexity leads to mistakes in naming. However, when the language knowledge is well established (in adults and age-matched controls), the impact of argument complexity on errors disappears. This suggests that linguistic experience leads to the establishment of robust semantic representations. Adults, who have a large amount of linguistic experience, performed the task very well and age-matched controls were more accurate than children with SLI and MLU-w controls. Children with SLI performed in a similar way to younger MLU-matched control children.

With regard to error types, we found that children with SLI made a greater percentage of total errors than adults and age-matched controls both for nouns and verbs. However, the differences in each specific error type were not as we expected. Previous studies in picture naming of nouns have found that children with SLI produce more 'don't know' responses (e.g. Freid-Oken 1984, German 1982, McGregor 1997, McGregor and Waxman 1998) and semantic mistakes (e.g. German 1982, Lahey and Edwards 1999, McGregor 1997). However, the results showed that children with SLI mostly made errors by producing sentences, rather than single-word responses. Only for naming objects did children with SLI show more null responses than the age-matched controls. Again, we found no differences between children with SLI and the MLU-matched control group. Discrepancies between the results and previous results in error types may be related to the age of the children, stimulus variables, or the definition and categorization of errors. Finally, we note that the fact that participants were instructed to name depicted objects or actions that were presented in a random order explains the high number of class-crossing errors found for all groups of the sample. These errors are frequent in studies based on object and action naming (e.g. Masterson *et al.* 2008, Rodríguez-Ferreiro *et al.* 2009).

The results for naming latency paralleled those for accuracy. First, nouns were named faster than verbs. This finding has also been widely reported for adults (e.g. Caramazza and Hillis 1991, Hillis and Caramazza 1995, Shapiro and Caramazza 2003) and for young children (e.g. Masterson *et al.* 2008). The current study showed this same pattern for older children with SLI. Several other studies have also found that nouns are processed more quickly than verbs (e.g. Sereno 1999, Tyler *et al.* 2001, Dietrich *et al.* 2001), but this effect can disappear if imageability is balanced (Chiarello *et al.* 2002, but see Kauschke and Stenneken 2008). Therefore, the differences between nouns and verbs may be attributable to imageability and the degree to which the word was a good label for the target picture. Nouns tend to generate more imageable information than verbs, allowing for speeded processing in a task of naming a visual referent.

In contrast to previous research, we did not find differences in noun naming latency between children with SLI and their controls. Several studies using the picture-naming task have shown that children with SLI have slower latencies for nouns than do age-matched controls (Anderson 1965, Ceci 1983, Kail and Leonard 1986, Katz *et al.* 1992, Lahey and Edwards 1996, Leonard *et al.* 1983, Wiig *et al*. 1982). Most of the previous studies only controlled stimuli for high noun frequency and did not take into account other variables that determine speed and accuracy in lexical access during picture naming. Initially, it seemed that this could explain the fact that we did not find differences, given that we controlled stimuli for frequency, age of acquisition, imageability and syllable length. However, a recent study by Sheng and McGregor (2010a) that controlled all these variables found that children with SLI had comparable naming latency to expressive vocabulary controls (EV), but remained slower and less accurate than CA group. These authors suggested that the SLI children's vocabulary was limited or that they might have difficulties in lexical–semantic organization. In this light, the findings could be explained by the fact that the stimuli were so frequent that they produced a ceiling effect that eliminated potential differences. The fact that children with SLI named the nouns correctly nearly 90% of the time adds further support to this hypothesis.

For verbs, more complex argument structures took longer to be processed. All the groups named one-argument verbs significantly faster than two- and three-argument verbs but they did not show differences between two- and three-argument verbs. Children with SLI only showed significant differences between one-and two-argument verbs. Moreover, children with SLI showed significant differences in latency in comparison with both adults and age-matched controls but not in comparison with MLU-matched controls. Also, the difference of latency times between children with SLI and age-matched controls for two-argument verbs (682.21 ms) was nearly double that for one-argument verbs (382.21 ms). This shows that children with SLI were slower for all verbs but especially for more complex verbs, just as the processing limitations account predicted. However, the lack of differences with respect to MLU-matched controls suggests that this slowness may be due to poorer semantic representations in verbs. In this regard, children with SLI seem to have semantic representations of verbs similar to those of younger children.

One surprising finding was that children with SLI named three-argument verbs faster than two-argument verbs. However, because the level of naming accuracy for both of these verb types was so low (about 30%), these latency differences should be interpreted cautiously. In this regard, it is important to note that, in all the groups other than the SLI group, no differences were found in latency time for naming two- and three-argument verbs. All of the three-argument verbs that we selected for the study can accept both two- and three-argument structures. Moreover, for these verbs, the three-argument ditransitive alternation is less frequent than the two-argument transitive one. Therefore, it could be that, despite being depicted in three-argument form, people would activate the most frequent alternation (the transitive). Speakers spend the first 300 ms of processing trying to understand the action (Griffin and Bock 2000). So it could be that in order to produce only the verb, rather than a full sentence, participants only activated the most frequent argument structure alternation with the results that no differences were found between the two types of verbs. This interpretation may explain previous studies in picture naming in which no differences were found between two- and three-argument verbs, even when the picture constrained the interpretation (Shapiro and Levine 1990, Thompson *et al.* 1997, Kim and Thompson 2000).

One of the main findings of this study was that children with SLI did not show differences from the MLU-matched controls in accuracy or latencies. This suggests that children with SLI have semantic representations like those of younger children. Moreover, the lack of differences found between children with SLI and the MLU-matched group suggests a pattern of delay, rather than deviance. Therefore, argument structure seems to be relatively equally affected as language overall, at least in terms of naming speed and accuracy.

The results obtained in this research have important implications for clinical intervention. The fact that children with SLI have smaller verb lexicons or impoverished semantic representations of some verbs could be one of the variables influencing sentence comprehension and production of these children. It may well be that the difficulties that children with SLI have in understanding and forming sentences stem from representational problems in the semantics of the verbs in those sentences. On one hand, in language comprehension, several processing models have supported the importance of lexical constraints for anticipating and activating incoming information (e.g. Altmann and Steedman 1988, MacDonald *et al.* 1994). Moreover, several studies have demonstrated that verb argument structure and other aspects of the combinatory lexical knowledge play an important role in guiding sentence comprehension (e.g. Bolan *et al.* 1990, Ferreira and McClure 1997, Garnsey *et al.* 1997, Konieczny *et al.* 1997, Trueswell *et al.* 1993, 1994). On the other hand, in language production, the semantics of a verb plays a crucial role because the activation of a verb lemma also implies the retrieval of other information necessary for sentence production. In this sense, information regarding argument structure will help children produce a sentence that contains all the obligatory constituents for that particular verb in that particular context. If children do not have a complete knowledge of the semantics of the verb, they may produce a variety of errors involving omission of obligatory arguments and substitution of correct arguments (Bowerman and Brown 2007, Gropen *et al.* 1991). Thus, language intervention should focus on providing a greater number of experiences with verbs in different contexts and with alternations of different argument structures. Such instruction could help children enrich the degree of knowledge represented in their semantic lexicon and improve their language comprehension and production. In this regard, Ebbels *et al.* (2007) considered whether syntactic–semantic and semantic therapies could improve the use of verb argument structure in pupils with persistent SLI. The results showed that pupils receiving the syntactic–semantic and semantic therapies made significant progress, which was maintained at follow-up and generalized to control verbs. Both therapies improved linking of arguments to syntax, and the syntactic–semantic therapy tended to increase use of optional arguments. Pupils receiving the control therapy made no progress.

Future research should continue to explore the hypotheses that children with SLI have smaller verb lexicons or impoverished semantic representations of verbs that their age-matched controls and their influence in sentence comprehension and production.

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References

Altmann G, Steedman M. Interaction with context during human sentence processing. Cognition. 1988; 30:191–238. [PubMed: 3215002]

Anderson J. Initiatory delay in congenital aphasoid conditions. Celebral Palsy Journal. 1965; 26:9–12.

Barry C, Morrison M, Ellis A. Naming the Snodgrass and Varderwart pictures: effects of age of acquisition, frequency and name agreement. Quarterly Journal of Experimental Psychology. 1997; 50A:560–585.

Bishop, D. Uncommon Understanding. London: Psychology Press; 1997.

Bjorklund DF. How age changes in knowledge base contribute to the development of children's memory: an interpretive review. Developmental Review. 1987; 7:93–130.

Bolan J, Tanenhaus M, Garnsey S. Evidence for the immediate use of verb control information in sentence processing. Journal of Memory and Language. 1990; 29:413–432.

Bowerman, M.; Brown, P. Crosslinguistic Perspectives on Argument Structure: Implications for Learnability. Hillsdale, NJ: Lawrence Erlbaum; 2007.

Caramazza A, Hillis A. Lexical organisation of nouns and verbs in the brain. Nature. 1991; 349:788–790. [PubMed: 2000148]

Carroll JB, White MN. Word frequency and age of acquisition as determiners of picture-naming latency. Quarterly Journal of Experimental Psychology. 1973; 25:85–95.

Ceci S. Automatic and purposive semantic processing characteristics of normal and language learning-disabled children. Developmental Psychology. 1983; 19:427–439.

Chiarello C, Liu S, Shears C, Kacinik N. Differential asymmetries for recognizing nouns and verbs: where are they? Neuropsychology. 2002; 16(1):35–48. [PubMed: 11853355]

Corripio, F. Gran diccionario de sinónimos. Barcelona: Ediciones B; 1995.

Cuetos F, Alija M. Normative data and naming times for action pictures. Behavior Research Methods, Instruments and Computers. 2003; 35:168–177.

Cuetos F, Ellis AW, Álvarez B. Naming times for the Snodgrass and Vanderwart pictures in Spanish. Behavior Research Methods, Instruments and Computers. 1999; 31:650– 658.

De Bleser R, Kauschke C. Acquisition and loss of nouns and verbs: parallel or divergent patterns. Journal of Neurolinguistics. 2003; 16:213–229.

De Jong, J. Specific Language Impairment in Dutch: Inflectional Morphology and Argument Structure. Enxchede: Print Partners Ipskamp; 1999.

Den Ouden D, Fix S, Parrish TB, Thompson CK. Argument structure effects in action verb naming in static and dynamic conditions. Journal of Neurolinguistics. 2009; 22:196–215. [PubMed: 20160850]

Dietrich D, Waller C, Johannes S, Wieringa BM, Emrich HM, Münte TF. Differential effects of emotional content on event-related potentials in word recognition memory. Neuropsychobiology. 2001; 43:96–101. [PubMed: 11174053]

Dockrell JE, Messer D, George R. Patterns of naming objects and actions in children with word finding difficulties. Language and Cognitive Processes. 2001; 16:261–286.

Dockrell JE, Messer D, George R, Ralli A. Beyond naming patterns in children with WFDs—definitions for nouns and verbs. Journal of Neurolinguistics. 2003; 16:191–211.

Druks J, Masterson J, Kopelman M, Clare L, Rose A, Rai G. Is action naming better preserved (than object naming) in Alzheimer's disease and why should we ask? Brain and Language. 2006; 98:332–340. [PubMed: 16843522]

Dunn, L.; Dunn, LM.; Arribas, D. PPVT-III Peabody, Test de Vocabulario en Imágenes. Madrid: TEA Ediciones; 2006.

Ebbels SH, van der Lely HKJ, Dockrell JE. Intervention for verb argument structure in children with persistent SLI: a randomized control trial. Journal of Speech Language and Hearing Research. 2007; 50:1330–1349.

Ellis AW, Morrison CM. Real age-of-acquisition effects in lexical retrieval. Journal of Experimental Psychology: Learning, Memory, and Cognition. 1998; 24:515–523.

Ferreira F, McClure K. Parsing of garden-path sentences with reciprocal verbs. Language and Cognitive Processes. 1997; 12:273–306.

Fletcher, P. Evidence from syntax for language impairment. In: Miller, C., editor. Research on Child Language Disorders. Austin, TX: PRO-ED; 1991. p. 167-187.

Freid-Oken, M. Unpublished doctoral dissertation. Boston University; Boston, MA: 1984. The development of word finding abilities in language deficient children.

Garnsey S, Pearlmutter N, Myers E, Lotocky M. The contributions of verb bias and plausibility to the comprehension of temporarily ambiguous sentences. Journal of Memory and Language. 1997; 37:58–93.

Gennari S, Poeppel D. Processing correlates of lexical semantic complexity. Cognition. 2003; 89:B27–B41. [PubMed: 12893127]

German D. Word-findings substitutions in children with learning disabilities. Language, Speech, and Hearing Services in Schools. 1982; 13:223–230.

Gili Gaya, S. Diccionario de sinónimos. Barcelona: VOX; 1991.

Gillette J, Gleitman H, Gleitman L, Lederer A. Human simulations of vocabulary learning. Cognition. 1999; 73:135–176. [PubMed: 10580161]

Grela BC, Leonard LB. The use of subject arguments by children with specific language impairment. Clinical Linguistics and Phonetics. 1997; 11:443–453.

Grela BC, Leonard LB. The influence of argument-structure complexity on the use of auxiliary verbs by children with SLI. Journal of Speech, Language and Hearing Research. 2000; 43:1115–1125.

Grela BG. The omission of subject arguments in children with specific language impairment. Clinical Linguistics and Phonetics. 2003; 17(2):153–169. [PubMed: 12762209]

Griffin Z, Bock K. What the eyes say about speaking. Psychological Science. 2000; 11:274–279. [PubMed: 11273384]

Grimshaw, J. Semantic structure and semantic content in lexical representation. In: Grimshaw, J., editor. Words and Structure. Stanford, CA: CSLI; 2005. p. 75-89.

Gropen, J.; Pinker, S.; Hollander, M.; Goldberg, R. Affectedness and direct objects: The role of lexical semantics in the acquisition of verb argument structure. In: Levin, B.; Pinker, S., editors. Lexical and Conceptual Semantics. Oxford: Blackwell; 1991. p. 153-195.

Hadley P, Rice M. Emergent uses of BE and DO: evidence from children with specific language impairment. Language Acquisition. 1996; 5:209–243.

Hillis AE, Caramazza A. The representation of grammatical categories of words in the brain. Journal of Cognitive Neuroscience. 1995; 7:396–340. [PubMed: 23961868]

Jackendoff, R. Foundations of Language: Brain, Meaning, Grammar, Evolution. Oxford: Oxford University Press; 2002.

Jonkers, R. Verb-finding problems in Broca's aphasics. In: Bastiaanse, R.; Grodzinsky, Y., editors. Grammatical Disorders in Aphasia: A Neurolinguistic Perspective. London: Whurr; 2000. p. 105-122.

Jonkers R, Bastiaanse R. The influence of instrumentality and transitivity on action naming in Broca's and anomic aphasia. Brain and Language. 1996; 55:33–39.

Jonkers R, Bastiaanse R. How selective are selective word class deficits? Two case studies of action and object naming. Aphasiology. 1998; 12:193–206.

Kail, R.; Leonard, LB. Word-Finding Abilities in Language-Impaired Children. Rockville, MD: American Speech-Language-Hearing Association; 1986. Monographs No. 25

Katz W, Curtiss S, Tallal P. Rapid automatized naming and gesture by normal and language impaired children. Brain and Language. 1992; 43:623–641. [PubMed: 1483194]

Kaufman, AS.; Kaufman, NL. KBIT: Kaufman Brief Intelligence Test (KBIT, Spanish Version). Madrid: TEA; 2004.

Kauschke C, Stenneken P. Differences in noun and verb processing in lexical decision cannot be attributed to word form and morphological complexity alone. Journal of Psycholinguistic Research. 2008; 37:443–452. [PubMed: 18452060]

Kemmerer D, Tranel D. Verb retrieval in brain-damaged subjects: 1. Analysis of stimulus, lexical, and conceptual factors. Brain and Language. 2000; 73:347–392. [PubMed: 10860561]

Kim M, Thompson CK. Patterns of comprehension and production of nouns and verbs in agrammatism: implications for lexical organization. Brain and Language. 2000; 74:1–25. [PubMed: 10924214]

Kim M, Thompson CK. Verb deficits in Alzheimer's disease and agrammatism: implications for lexical organization. Brain and Language. 2004; 88:1–20. [PubMed: 14698726]

King G, Fletcher P. Grammatical problems in schoolage children with specific language impairment. Clinical Linguistics and Phonetics. 1993; 7:339–352.

Kiss, K. Effect of verb complexity on agrammatic aphasics' sentence production. In: Bastiaanse, R.; Grodzinsky, Y., editors. Grammatical Disorders in Aphasia: A Neurolinguistic Perspective. London: Whurr; 2000. p. 152-170.

Konieczny L, Hemforth B, Scheepers C, Strube G. The role of lexical heads in parsing: evidence from German. Language and Cognitive Processes. 1997; 12:307–348.

Lahey M, Edwards J. Why do children with specific language impairment name pictures more slowly than their peers? Journal of Speech, Language, and Hearing Research. 1996; 39:1081–1098.

Lahey M, Edwards J. Naming errors of children with specific language impairment. Journal of Speech, Language, and Hearing Research. 1999; 42:195–205.

Leonard L. Functional categories in the grammars of children with specific language impairment. Journal of Speech and Hearing Research. 1995; 38:1270–1283. [PubMed: 8747820]

Leonard, L. Specific Language Impairment. London: MIT Press; 1998.

Leonard L, Eyer J, Bedore L, Grela B. Three accounts of the grammatical morpheme difficulties of English-speaking children with specific language impairment. Journal of Speech and Hearing Research. 1997; 40:741–753.

Leonard L, Nippold M, Kail R, Hale C. Picture naming in language-impaired children. Journal of Speech and Hearing Research. 1983; 26:609–615. [PubMed: 6668948]

Levin, B.; Rappaport, HM. Unaccusativity: At the Syntax–Lexical Semantics Interface. Cambridge, MA: MIT Press; 1995.

Loeb D, Leonard L. Specific language impairment and parameter theory. Clinical Linguistics and Phonetics. 1988; 2:317–327.

Luzzatti C, Raggi R, Zonca G, Pistarini C, Contardi A, Pinna GD. Verb–noun double dissociation in aphasic lexical impairments: the role of word frequency and imageability. Brain and Language. 2002; 81(1–3):432–444. [PubMed: 12081411]

MacDonald M, Pearlmutter N, Seidenberg M. Lexical nature of syntactic ambiguity resolution. Psychological Review. 1994; 101:676–703. [PubMed: 7984711]

MacWhinney, B. The CHILDES Project: Tools for Analyzing Talk. Hillsdale, NJ: Lawrence Erlbaum; 2000.

Masterson J, Druks J, Gallienne D. Object and action picture naming in three and five year old children. Child Language. 2008; 35:373–402.

McElree B, Traxler MJ, Pickering MJ, Seely RE, Jackendoff R. Reading time evidence for enriched composition. Cognition. 2001; 78:B17–B25. [PubMed: 11062325]

McGregor KK. The nature of word-findings errors of preschoolers with and without word-finding deficits. Journal of Speech and Hearing Research. 1997; 40:1232–1244.

McGregor KK, Appel A. On the relation between mental representation and naming in a child with specific language impairment. Clinical Linguistics and Phonetics. 2002; 16:1–20. [PubMed: 11913029]

McGregor KK, Newman RM, Reilly RM, Capone N. Semantic representation and naming in children with specific language impairment. Journal of Speech, Language, and Hearing Research. 2002; 45:998–1014.

McGregor KK, Waxman SR. Object naming at multiple hierarchical levels: a comparison of preeschoolers with and without word-findings deficits. Journal of Child Language. 1998; 25:419–430. [PubMed: 9770914]

Miller C, Kail R, Leonard L, Tomblin B. Speed of processing in children with specific language impairment. Journal of Speech, Language, and Hearing Research. 2001; 44(2):416–433.

Montgomery J. Verbal working memory and sentence comprehension in children with specific language impairment. Journal of Speech, Language, and Hearing Research. 2000; 43(2):293–308.

Morris MW, Murphy GL. Converging operations on a basic level in event taxonomies. Memory and Cognition. 1990; 18:407–418. [PubMed: 2381319]

Morrison C, Ellis AW, Quinlan PT. Age of acquisition, not word frequency, affects object naming, not object recognition. Memory and Cognition. 1992; 20:705–714. [PubMed: 1435273]

Pérez, E.; Serra, M. AREL. Análisis del retraso del lenguaje. Barcelona: Ariel; 1998.

Rice M, Wexler K. Toward tense as a clinical marker of a specific language impairment in English speaking children. Journal of Speech, Language and Hearing Research. 1996; 39:1239–1257.

Rice, M.; Wexler, K. Highly Specified and Long-term Grammatical Deficits Appear in Children with Language Impairments. Cambridge, MA: Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology; 1997.

Rice M, Wexler K, Cleave P. Specific language impairment as a period of extended optional infinitives. Journal of Speech and Hearing Research. 1995; 38:850–863. [PubMed: 7474978]

Roberts, J.; Rescorla, L.; Borneman, A. Morphosyntactic characteristics of early language errors: an examination of specific expressive language delay. Poster presented at the 'Symposium on Research in Child Language Disorders'; Madison, WI, USA: University of Wisconsin; 1994.

Rodríguez-Ferreiro J, Davies R, GonzÁlez-Nosti M, Barbón A, Cuetos F. Name agreement, frequency and age of acquisition, but no grammatical class, affect object and action naming in Spanish speaking participants with Alzheimer's disease. Journal of Neurolinguistics. 2009; 22:37–54.

Sabish B, Hahne A, Glass E, von Suchodoletz W, Friederici A. Lexical–semantic processes in children with specific language impairment. Neuroreport. 2006; 17:1511–1514. [PubMed: 16957599]

Saborit, C.; Julián, JP. ELI—L'Avaluació del Llenguatge Infantil. Castelló de la Plana; Universitat Jaume I: 2005.

Sainz, FC. Diccionario español de sinónimos y antónimos (. Madrid; Aguilar: 1993.

Sanz-Torrent M, Andreu L, Badia I, Sidera F. Argument omissions in preschool Catalan and Spanish-speaking children with SLI. Infancia y Aprendizaje. 2011; 34:49–66.

Sanz-Torrent, M.; Badia, I.; Serra, M. Contributions from the bilingual specific language impairment in Catalan and Spanish to the understanding of the normal and pathological language acquisition. In: Pérez-Vidal, C.; Juan-Garau, M.; Bel, A., editors. A Portrait of the Young in the New Multilingual Spain. Clevedon: Multilingual Matters; 2008a. p. 135-158.

Sanz-Torrent M, Serrat E, Andreu L, Serra M. Verb morphology in Catalan and Spanish in children with specific language impairment: a developmental study. Clinical Linguistics and Phonetics. 2008b; 22:459–474. [PubMed: 18484285]

Schelletter, C.; Sinka, I.; Fletcher, P.; Ingham, R. English speaking SLI children's use of locative/contact and causative alternations. In: Garman, M.; Letts, C.; Richards, B.; Schelletter, C.; Edwards, S., editors. Issues in Normal and Disordered Child Language: From Phonology to Narrative. Reading: University of Reading; 1999. p. 106-117.Special Issue of The New Bulmershe Papers

Sebastián, N.; Martí, MA.; Carreiras, M.; Cuetos, F. LEXESP. Léxico informatizado del español. Barcelona: Edicions Universitat de Barcelona; 2000.

Sereno JA. Hemispheric differences in grammatical class. Brain and Language. 1999; 70:13–28. [PubMed: 10534370]

Serra, M.; Serrat, E.; Solé, R.; Bel, A.; Aparici, M. La adquisición del lenguaje. Barcelona: Ariel; 2000.

Shapiro K, Caramazza A. Grammatical processing of nouns and verbs in left frontal cortex? Neuropsychologia. 2003; 41:1189–1198. [PubMed: 12753958]

Shapiro LP, Levine BA. Verb processing during sentence comprehension in aphasia. Brain and Language. 1990; 38:21–47. [PubMed: 2302544]

Shapiro LP, Zurif E, Grimshaw J. Sentence processing and the mental representation of verbs. Cognition. 1987; 27:219–246. [PubMed: 3691026]

Shapiro LP, Zurif E, Grimshaw J. Verb processing during sentence comprehension—contextual impenetrability. Journal of Psycholinguistic Research. 1989; 18:223–243. [PubMed: 2738859]

Sheng L, McGregor K. Object and action naming in children with specific language impairment. Journal of Speech, Language and Hearing Research. 2010a; 53:1704–1719.

Sheng L, McGregor K. Lexical–semantic organization in children with specific language impairment. Journal of Speech, Language and Hearing Research. 2010b; 53:146–159.

Snodgrass JG, Yuditsky T. Naming times for the Snodgrass and Vanderwart pictures. Behavior Research Methods, Instruments, and Computers. 1996; 28:516–536.

Stark RE, Tallal P. Selection of children with specific language deficits. Journal of Speech and Hearing Disorders. 1981; 46:114–122. [PubMed: 7253588]

Thompson C, Lange K, Schneider S, Shapiro L. Agrammatic and non-brain-damaged subjects' verb and verb argument structure production. Aphasiology. 1997; 11:473–490.

Thordardottir E, Weismer SE. Verb argument structure weakness in specific language impairment in relation to age and utterance length. Clinical Linguistics and Phonetics. 2002; 16(4):233–250. [PubMed: 12148158]

Trueswell J, Tanenhaus M, Garnsey S. Semantic influences of parsing—use of thematic role information in syntactic ambiguity resolution. Journal of Memory and Language. 1994; 33:285–318.

Trueswell J, Tanenhaus M, Kello C. Verbspecific constraint in sentence processing—separating effects of lexical preference from garden-paths. Journal of Experimental Psychology—Learning Memory and Cognition. 1993; 19:528–553.

Tyler LK, Russel R, Fadili J, Moss HE. The neural representations of nouns and verbs: PET studies. Brain. 2001; 124:1619–1634. [PubMed: 11459753]

Valle-Arroyo, F. Normas de Imaginabilidad. Oviedo: Universidad de Oviedo, Servicio de Publicaciones; 1999.

Watkins, R. Specific language impairments in children: an introduction. In: Watkins, R.; Rice, ML., editors. Specific Language Impairments in Children. Baltimore, MD: Brookes; 1994. p. 1-15.

Wechsler, D.; Cordero, A.; de la Cruz, MV. Wechsler Intelligence Scale for Children, Revised (WISC-R, Spanish Version). Madrid: TEA Editions; 1993.

Weismer SE, Evans J, Hesketh L. An examination of verbal working memory capacity in children with specific language impairment. Journal of Speech, Language and Hearing Research. 1999; 42:1249–1260.

Wiig EH, Semel EM, Nystrom L. Comparison of rapid naming abilities in language-learning-disabled and academically achieving eight-year-olds. Language, Speech and Hearing Services in Schools. 1982; 13:11–23.

Appendix A

Table A1

Nouns and verbs used as stimuli in the experiment

Nouns	One-argument verbs	Two-argument verbs	Three-argument verbs
Árbol [tree]	*Bailar* [to dance]	*Abrir* [to pen]	*Atar* [to tie]
Avión [plane]	*Caer* [to fall]	*Coger* [to catch]	*Dar* [to give]
Cama [bed]	*Caminar* [to walk]	*Chupar* [to lick]	*Enseñar* [to teach]
Coche [car]	*Dormir* [to sleep]	*Llevar* [to carry]	*Regalar* [to give (a present)]
Flor [flower]	*Llorar* [to cry]	*Recoger* [to pick]	*Contar* [to tell]
Lámpara [lamp]	*Volar* [to fly]	*Tocar* [to play]	*Lanzar* [to throw]
Lápiz [pencil]			
Llave [key]			
Manzana [apple]			
Mesa [table]			
Muñeco [doll]			
Radio [radio]			
Reloj [clock]			
Silla [chair]			
Sofá [sofa]			

Nouns	One-argument verbs	Two-argument verbs	Three-argument verbs
Tarta [cake]			
Tomate [tomato]			
Vaso [glass]			

What this paper adds

What is already known on this subject?

SLI is an impairment characterized by developmental delays in verbal abilities without accompanying non-verbal cognitive deficits. Verbs have been proposed as an area of special difficulty for these children, because this group displays a substantial delay in the use and understanding of verbal morphology. These children omit obligatory arguments more often than age-matched controls. In comparison with MLU-matched controls, they make errors in a much wider variety of verbs and use significantly fewer argument types. Most of the previous studies of picture naming by children with SLI have focused solely on object naming. These studies all showed slower naming speed and increased naming errors in comparison with age-matched controls. The few studies that have compared object and action naming in children with SLI found that children with SLI were slower and less accurate in naming verbs than the CA group.

What this paper adds

This paper is the first to analyse the picture naming of nouns and verbs with different argument structure in children with typical language development and children with SLI. It was found that all the groups named nouns faster and more accurately than verbs. Moreover, when the number of verbal arguments increased, production became slower and less accurate (between one and more arguments, but not between two and three arguments) especially in the MLU-matched control children and the children with SLI. Although the naming of verbs is delayed in Spanish children with SLI, the lack of differences in this regard between the MLU-matched group and the SLI group suggests that there is no specific impairment in this area.

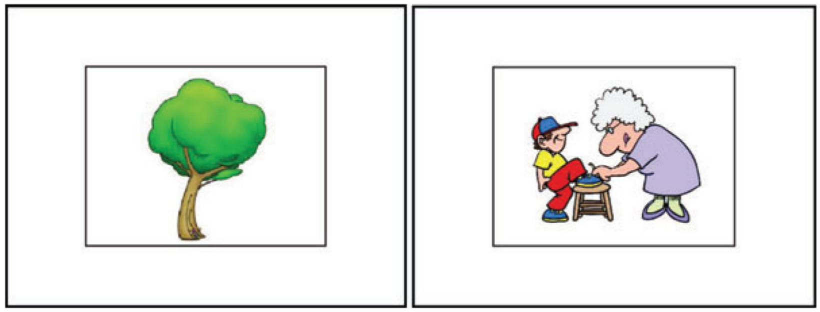

Figure 1.
Stimuli example: noun: *Árbol* [tree] and verb *Atar* [to tie].

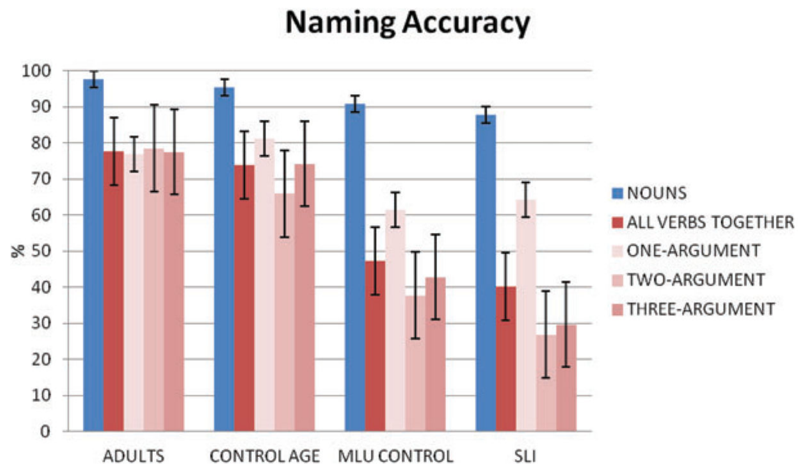

Figure 2.
Percentage of correct responses of nouns, all verbs together and separately intransitives, transitives and ditransitives.

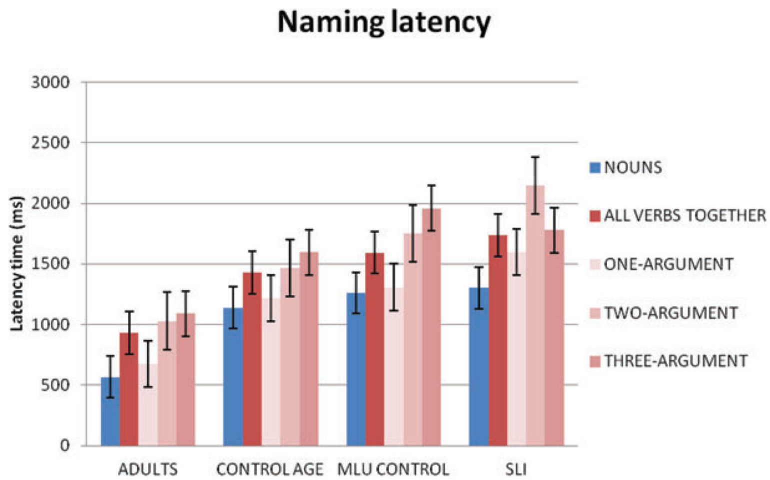

Figure 3.

Results in naming latencies: time from the beginning of the image display to the onset of naming (ms).

Table 1

Group age, cognitive measures and language performance

	Group			Pairwise
	SLI group	**Age controls Mean (SD)**	**MLUw controls**	
Age (years)	6.69 (0.90)	6.72 (0.92)	5.51 (1.05)	SLI = AC, SLI > MLU*, AC > MLU*
NVIQ	96.1 (7.9)	106.3 (6.0)	93.13 (9.32)	SLI = AC, SLI = MLU, AC = MLU
PPVT-III	89.58 (9.56)	112.07 (14.37)	92 (12.87)	SLI = AC, SLI = MLU, AC = MLU
ELI-Phonetics[a]	6.37 (4.27)	2.12 (2.23)	4.47 (3.87)	SLI > AC*, SLI = MLU, AC = MLU
ELI-Receptive vocabulary[a]	36.27 (18.84)	73.07 (17.97)	67.85 (26.13)	SLI = AC*, SLI = MLU, AC = MLU
ELI-Expressive vocabulary[a]	8.62 (1.8)	60.38 (15.06)	52.27 (28.84)	SLI < AC*, SLI < MLU*, AC = MLU
ELI-Pragmatics[a]	53.64 (25.99)	80.38 (15.60)	62.56 (14.34)	SLI < AC*, SLI = MLU, AC > MLU*
MLUw	3.95 (1.39)	6.86 (1.76)	3.97 (1.45)	SLI < AC*, SLI = MLU, AC > MLU*

Notes: Chronological age in years; NVIQ (Nonverbal Intelligence Quotient) in standard score (mean = 100; SD = 15); PPVT-III (Peabody Picture Vocabulary Test III. Spanish version) in standard score (mean = 100; SD = 15); ELI (Evaluación del Lenguaje Infantil); ELI-Phonetics in mean number of errors; ELI-Receptive vocabulary. ELI-Expressive vocabulary and ELI-Pragmatics in percentiles; MLU-w (Mean Length of Utterance by words).

[a]Values only calculated for children younger than 6 years old. Comparison were made by a two-tailed Mann–Whitney *U*-test.

*$p < 0.05$.

Table 2

Mean properties of nouns and verbs (SD) and (range). *F*-ratios reflect effect of syntactic category

	Nouns, N = 18	Verbs, N = 18	F-ratio test
Frequency	47.84 (49.46) (4.64–172.14)	44.75 (57.80) (1.79–249.11)	$F(1.34) = 0.024$. $p = 0.880$
Age of acquisition	22.89 (5.92) (18–30)	23.55 (5.38) (18–30)	$F(1.34) = 0.108$. $p = 0.746$
Imageability	6.29 (0.34) (5.77–7.00)	4.87 (1.18) (1.07–6.38)	$F(1.34) = 24.17$. $p < 0.001$
Label appropriateness	6.26 (0.67) (4.32–6.97)	4.37 (0.73) (3.35–5.93)	$F(1.34) = 63.08$. $p < 0.001$

Table 3

Mean properties of verb Classes (SD) and (range). *F*-ratios reflect effect of verb class

	One-argument, *N* = 6	Two-argument, *N* = 6	Three-argument, *N* = 6	*F*-ratio test
Frequency	41.52 (26.68) (17.14–84.82)	38.63 (35.04) (1.79–102.5)	54.11 (96.21) (4.46–249.11)	$F(2.15) = 0.065$. $p = 0.938$
Age of acquisition	21.33 (5.32) (18–30)	28.17 (3.60) (21–30)	21.17 (4.35) (18–29)	$F(2.15) = 3.706$ $p = 0.123$
Imageability	5.56 (0.65) (4.9–6.38)	4.12 (1.58) (1.07–5.42)	4.94 (0.74) (3.64–5.8)	$F(2.15) = 2.72$. $p = 0.10$
Label appropriateness	4.63 (0.92) (3.52–5.93)	4.18 (0.50) (3.35–4.68)	4.29 (0.83) (3.61–5.39)	$F(2.15) = 0.57$. $p = 0.58$

Table 4

Examples of the error categories

	Objects		Actions	
	Picture	**Error**	**Picture**	**Error**
Sentence or phrase with target	*casa* (house)	*llegar a casa* (arrive home)	*abrir* (to open)	*abrir la puerta* (open the door)
Sentence or phrase without target	*vaso* (glass)	*beber agua* (drink water)	*coger* (to catch)	*la niña salta* (the girl jumps)
Coordinate errors	*sofá* (sofa)	*silla* (chair)	*lanzar* (throw)	*coger* (to catch)
Superordinate errors	*sofá* (sofa)	*mueble* (furniture)	*chupar* (to suck)	*comer* (to eat)
Subordinate errors	*árbol* (tree)	*abeto* (fir)	*romper* (to break)	*coger* (to catch)
Associative errors	*reloj* (clock)	*hora* (hour)	*abrir* (to open)	*llamar* (to call)
Misinterpretation	*vaso* (glass)	*agua* (water)	*dar* (to give)	*beber* (to drink)
Visual errors	*muñeco* (doll)	*oso panda* (panda bear)	*llorar* (to cry)	*beber* (to drink)
Formal errors	*silla* (chair)	*mesilla* (side table)	–	–
Perseverations	*radio* (radio)	*reloj* (clock)	*caer* (to fall)	*volar* (to fly)
Unrelated errors	*radio* (radio)	*guitarra* (guitar)	*romper* (to break)	*pinchar* (to burst)
Class-crossing errors	*avión* (plane)	*volar* (to fly)	*llevar* (to lead)	*pastel* (cake)

Table 5

Percentage of error types for every group for nouns and all verbs together

	SLI	CA	MLU	Ad
Nouns				
Errors	12.27 (11.92)	4.63 (6.60)**	9.26 (11.56)	2.33 (3.71)**
Sentence or phrase with target	1.74 (5.83)	0.00 (0.00)*	0.36 (2.96)	0.00 (0.00)*
Sentence or phrase without target	0.18 (1.13)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Null responses	5.42 (9.27)	0.93 (3.54)*	3.47 (6.91)	0.00 (0.00)**
Coordinate errors	1.12 (2.30)	0.99 (2.11)	0.54 (1.88)	0.58 (1.67)
Superordinate errors	0.00 (0.00)	0.30 (1.13)	0.00 (0.00)	0.00 (0.00)
Subordinate errors	0.00 (0.00)	0.54 (1.57)	0.18 (1.13)	0.00 (0.00)
Associate errors	0.62 (1.88)	0.00 (0.00)	0.18 (1.13)	0.41 (1.39)
Misinterpretations	0.87 (2.11)	0.79 (1.88)	0.36 (1.57)	0.59 (1.67)
Circumlocutions	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Visual errors	0.32 (2.27)	0.00 (0.00)	1.09 (2.46)	0.35 (1.39)
Formal errors	0.38 (2.27)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Perseverations	0.39 (1.57)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Unrelated errors	0.35 (1.57)	0.00 (0.00)	1.63 (6.51)	0.00 (0.00)
Class-crossing errors	0.88 (2.11)	1.08 (3.54)	1.45 (7.97)	0.40 (1.39)
All verbs together				
Errors	59.80 (23.51)	26.56 (19.35)**	52.70 (29.14)	22.39 (11.83)**
Sentence or phrase with target	11.44 (11.88)	2.02 (5.11)**	8.51 (16.54)	1.22 (2.36)**
Sentence or phrase without target	4.30 (6.37)	1.04 (2.83)*	2.97 (4.59)	0.39 (2.11)**
Null responses	9.40 (16.17)	2.31 (3.80)	5.88 (10.90)	0.22 (1.06)**
Coordinate errors	3.08 (4.59)	1.80 (4.06)	1.98 (3.75)	1.97 (2.79)
Superordinate errors	1.56 (3.13)	1.32 (2.44)	1.25 (2.44)	3.34 (4.51)
Subordinate errors	00.00 (0.00)	0.00 (0.00)	1.58 (2.60)*	0.42 (1.47)
Associate errors	2.27 (4.18)	1.56 (3.58)	1.20 (2.44)	2.84 (3.98)
Misinterpretations	0.28 (1.20)	0.24 (1.20)	0.96 (2.83)	0.60 (1.77)
Circumlocutions	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Visual errors	0.49 (2.40)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Formal errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Perseverations	0.72 (1.99)	0.00 (0.00)	0.26 (1.20)	0.00 (0.00)*
Unrelated errors	1.67 (2.73)	0.83 (2.64)	1.02 (2.24)	0.39 (1.47)*
Class-crossing errors	24.59 (21.80)	15.10 (18.10)	27.07 (25.80)	11.01 (9.05)*

Note: Data are means of percentages. Standard deviations are shown in parentheses.

*Significance = $p < 0.05$;

**significance = $p < 0.01$.

Table 6

Percentage of error types for every group for one-, two- and three-argument verbs

	SLI	CA	MLU	Ad
One-argument verbs				
Errors	35.84 (31.07)	18.78 (25.21)*	38.54 (33.21)	23.11 (18.60)
Sentence or phrase with target	3.86 (11.26)	1.39 (6.80)	5.50 (13.61)	0.00 (0.00)*
Sentence or phrase without target	0.64 (3.40)	0.00 (0.00)	0.69 (3.40)	0.00 (0.00)
Null responses	6.25 (13.74)	0.00 (0.00)	2.78 (8.03)	0.00 (0.00)**
Coordinate errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Superordinate errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.54 (2.99)
Subordinate errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Associate errors	1.29 (4.70)	0.00 (0.00)	0.00 (0.00)	3.23 (6.69)
Misinterpretations	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Circumlocutions	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Visual errors	0.64 (3.40)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Formal errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Perseverations	0.64 (3.40)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Unrelated errors	1.29 (4.70)	0.00 (0.00)	0.69 (3.40)	0.00 (0.00)
Class-crossing errors	21.23 (23.98)	17.39 (24.32)	28.87 (29.18)	19.34 (17.79)
Two-argument verbs				
Errors	73.20 (25.50)	35.05 (23.53)**	62.29 (28.52)	21.49 (16.21)**
Sentence or phrase with target	13.11 (15.52)	2.18 (5.63)**	9.80 (19.61)	0.54 (2.99)**
Sentence or phrase without target	4.83 (10.40)	1.45 (4.70)	3.50 (8.48)	0.54 (2.99)*
Null responses	11.11 (23.40)	2.78 (6.34)	4.86 (12.51)	0.00 (0.00)**
Coordinate errors	3.45 (9.80)	2.91 (10.62)	2.80 (6.34)	2.15 (5.68)
Superordinate errors	1.38 (4.70)	1.45 (4.70)	1.40 (4.70)	3.23 (6.69)
Subordinate errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Associate errors	1.38 (4.70)	2.18 (5.63)	2.80 (6.34)	2.15 (5.68)
Misinterpretations	0.00 (0.00)	0.73 (3.40)	2.10 (5.63)	0.54 (2.99)
Circumlocutions	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Visual errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Formal errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Perseverations	0.69 (3.40)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Unrelated errors	2.07 (5.63)	0.00 (0.00)	0.00 (0.00)	0.54 (2.99)
Class-crossing errors	35.18 (28.37)	20.37 (22.87)*	35.03 (31.05)	11.80(11.54)**
Three-argument verbs				
Errors	70.36 (26.36)	25.86 (22.26)**	57.26 (34.55)	22.57 (19.56)**
Sentence or phrase with target	17.36 (19.84)	2.50 (6.76)**	10.24 (19.54)	3.13 (7.48)**
Sentence or phrase without target	7.44 (11.52)	1.67 (5.65)*	4.73 (10.63)	0.63 (3.60)**
Null responses	10.83 (10.63)	4.17 (8.30)	10 (10.69)	0.65 (3.59)**

	SLI	CA	MLU	Ad
Coordinate errors	5.79 (9.29)	2.50 (6.76)	3.15 (7.61)	3.76 (8.03)
Superordinate errors	3.31 (7.61)	2.50 (6.76)	2.36 (2.76)	6.26 (10.82)
Subordinate errors	0.00 (0.00)	0.00 (0.00)	4.73 (8.85)*	1.25 (4.99)
Associate errors	4.13 (4.30)	2.50 (6.76)	0.79 (4.08)	3.13 (7.48)
Misinterpretations	0.83 (4.08)	0.00 (0.00)	0.79 (4.08)	1.25 (4.99)
Circumlocutions	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Visual errors	0.83 (4.08)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Formal errors	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Perseverations	0.83 (4.08)	0.00 (0.00)	0.79 (4.08)	0.00 (0.00)
Unrelated errors	1.65 (5.65)	2.50 (8.97)	2.36 (6.76)	0.63 (3.59)
Class-crossing errors	17.35 (25.24)	7.53 (16.48)	17.32 (27.61)	1.88 (6.01)**

Note: Data are means of percentages. Standard deviations are shown in parentheses.

*Significance = $p < 0.05$;

**significance = $p < 0.01$.