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Is the movement deficit in syntactic SLI related to traces or to thematic role transfer? ☆

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Abstract

Children with Syntactic Specific Language Impairment (S-SLI) have difficulties understanding object relative clauses, which have been ascribed to a deficit in syntactic movement. The current study explores the nature of the deficit in movement, and specifically whether it is related to a deficit in the construction of syntactic structure and traces, or whether the structure is constructed correctly but the transfer of thematic roles from the trace is impaired. This question was addressed using reading aloud and paraphrasing of object relatives that included noun–verb heterophonic homographs after the trace. Because the correct reading of homographs as noun or verb critically hinges on the identification of their syntactic position, readers who cannot construct traces are expected to read homographs incorporated after the trace incorrectly. The participants were 15 Hebrew-speaking children aged 9.3 to 14.6 with S-SLI and 50 typically developing children. The children with S-SLI read the homographs after the trace correctly but failed to interpret the object relatives, making thematic role errors. The results suggest that in S-SLI, at least for school-aged children, syntactic structure and traces are created, but the assignment of thematic roles from the trace to the moved element is impaired, leading to a deficit in the comprehension of movement-derived sentences.

Keywords: SLI; Syntax; Movement; Hebrew; Reading; Agrammatism; Relative clauses

1. Introduction

Children with Syntactic Specific Language Impairment (S-SLI) encounter difficulties in understanding non-canonical sentences that are derived by movement of phrases (Ebbels & van der Lely, 2001; Friedmann & Novogrodsky, 2004; Stavrakaki, 2001; van der Lely & Harris, 1990). The aim of the current study was to learn more about the nature of the deficit in SLI that is related to movement: What exactly is impaired when movement is impaired?

The term SLI (Specific Language Impairment) refers to a heterogeneous group of children who show difficulties in different aspects of language: word finding, phonology, morphology, syntax, semantics, and pragmatics (e.g., Bishop, 1997; Bishop & Rosenbloom, 1987; Clahsen, 1989; Leonard, 1998; Rice & Wexler, 1995; van der Lely, 1996, 1997, 1998; van der Lely & Battell, 2003; van der Lely & Christian, 2000). Several studies reported that within this heterogeneous group, subgroups can be identified (Conti-Ramsden & Botting, 1999; Conti-Ramsden, Crutchley, & Botting, 1997; Rapin & Allen, 1983), and dissociations between various linguistic abilities have been reported. For example, Dockrell, Messer, and Murphy (2005) presented a group of SLI participants whose word finding is impaired but who have preserved syntactic abilities, and Friedmann and Novogrodsky (2004, 2006) reported a group of school-age children with SLI who have a syntactic deficit, but without lexical retrieval deficits and without

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phonological deficits, a group of children with lexical retrieval deficits with intact syntactic ability (LeSLI—Lexical SLI), and a group with a phonological deficit[1] (Pho-SLI, phonological SLI), without a deficit in syntax. The current study focuses on the characterization of the syntax of children with SLI who have a syntactic impairment. This group has been termed "Grammatical SLI" (G-SLI) or "Syntactic SLI" (S-SLI) (Friedmann & Novogrodsky, 2004; van der Lely, 1996; van der Lely & Christian, 2000; van der Lely & Harris, 1990).

Children with SLI who have a syntactic deficit show impaired comprehension of object relative clauses (Adams, 1990; Friedmann & Novogrodsky, 2004; pre-therapy performance in Levy & Friedmann, in press; Stavrakaki, 2001), referential object questions (pre-therapy performance in Ebbels & van der Lely, 2001; Friedmann & Novogrodsky, 2003), object topicalization in Hebrew (Friedmann & Novogrodsky, 2003), and topicalized prepositional phrases in English (van der Lely & Harris, 1990).[2] They also show a deficit in the comprehension of reversible verbal passives (Adams, 1990; Bishop, 1979; van der Lely & Harris, 1990), with better comprehension of adjectival passives compared to verbal passives (van der Lely, 1996). These impaired structures share a syntactic property: they are all derived by movement of a phrase that results in a non-canonical order of the arguments in the sentence.

Some researchers agree that the deficit in the comprehension of these sentential structures is related to a deficit in some aspect of movement (Ebbels & van der Lely, 2001; Friedmann & Novogrodsky, 2004; Stavrakaki, 2001; van der Lely, 1998, 2004, 2005; van der Lely & Harris, 1990; see also Bishop, 1979 for an earlier suggestion that the difficulty is in sentences in which the surface structure is different from the deep structure). Yet, the exact nature of the deficit is still an open question. What exactly is impaired when the comprehension of phrasal movement is impaired?

In every sentence, the verb identifies the roles of the participants in the event, and assigns thematic roles to its arguments. For example, the verb *build* assigns a thematic role of an Agent—the builder, and a Theme—the object that was built. Verbs generally assign the role of the Agent to the argument before them and the role of the Theme to the argument that follows them. However, some sentences, like the object relative in (1), include a different order, and the Theme precedes the verb and the Agent. In these sentences the Theme is taken to undergo syntactic movement to an earlier position in the sentence (Chomsky, 1981, 1995). Phrases that move get their thematic role from the verb via a chain of movement: the moved element leaves a trace (marked by t_1) at the position from which it has moved, the verb assigns the thematic role to the position of the trace, and the thematic role is transferred to the moved element from the trace via a chain of movement. Syntactic movement thus includes two related components—a trace at the position from which the element has moved, and a process of thematic role assignment via a chain constructed between the moved element and the trace (see example (1)).

(1) The hut$_1$ that Shlomit built t$_1$ is green

For example, sentence (1) is an object relative. It is called object relative because it includes movement of the object of the relative clause, in this case, *the hut*, to a position earlier in the sentence.[3] When the object *hut* moves, it leaves behind a trace in the embedded object position. Thus, to correctly understand a sentence that includes syntactic movement like (1), a structural node for the object of the verb *built* has to be created, and an empty element, a trace of movement, should be placed there. This is not enough, though. For the relation between the verb and its moved argument to be established, the thematic role should be assigned to the moved element via a chain (illustrated by the arrow in (1)). Impaired comprehension of movement can result from a deficit in either of these operations.

The current study will evaluate these possible sources of deficit that can result in a difficulty in understanding movement-derived sentences in S-SLI—an impairment in the

[1] These children had errors in repetition of phonologically complex words and non-words in the BLIP test (Friedmann, 2003a), errors in non-word judgment, and poor phonological awareness in tests of judgment of same-different opening or closing phonemes. They did not have articulation deficits, dysarthria, or apraxia for speech.

[2] Right-branching subject relatives and subject questions pose less comprehension difficulties to children with S-SLI compared to object relatives and object questions (Deevy & Leonard, 2004; Friedmann & Novogrodsky, 2003, 2004; Stavrakaki, 2001), although they are also derived by phrasal movement. The reason might be that whereas object relatives (such as "*I saw the grandmother that the girl drew_*") include a non-canonical word order in that the theme of the action precedes the agent of the action, in subject relatives ("*I saw the grandmother that _drew the girl*") the order of the agent and the theme is canonical, allowing for the interpretation of the sentence using a non-syntactic strategy (see Grodzinsky, 1990; Friedmann & Novogrodsky, 2004). Another explanation might be that the transfer of a thematic role to a moved argument over another argument of the verb (of the same type) is impaired in S-SLI, causing a deficit in object relatives, where the theme moves across the agent, but not in subject relatives, where the assignment of thematic role to the agent does not cross any other argument of the verb.

[3] According to some theories (for example, Chomsky, 1986, 1995), the detailed syntactic mechanism that derives relative clauses is the following: an empty operator or the relativizer *who* or *which* moves from within the embedded sentence, from subject or object position, to the specifier position of CP, where it is co-indexed with the head of the relative clause. In addition, some recent accounts suggest that what is left behind is not a trace but rather a deleted copy (Chomsky, 2000, 2001; Hornstein & Nunes, 2002; Nunes, 2001). According to a different analysis for relatives, it is the relative head itself that moves from within the embedded clause to CP and subsequently to the relative head position above CP (Kayne, 1994; Vergnaud, 1974; see Sauerland, 2000 for a discussion of the two analyses). Because all these analyses share the core assumption that in relative clauses there is movement, and a thematic role has to be transferred to the moved element, the differences between these theories will not be relevant to the discussion here.

construction of the syntactic structure of the object relative clause and the identification of the trace position, or a deficit in the assignment of thematic roles via chain to the moved element. For this aim, a special task was created. This task used the fact that in reading noun–verb heterophonic homographs, (i.e., words that are written the same but sound differently, like *tears*), the correct reading requires the analysis of the syntactic position of the homograph. For example, in sentence (2), the word *tears* appears as the object, and is therefore read as a noun, whereas in sentence (3), it appears as the verb, and therefore read as a verb.

(2) I saw the *tears* in the little boy's eyes.
(3) The little boy *tears* the gift wrap.

We used this phenomenon and tested reading aloud of object relative sentences that included noun–verb heterophonic homographs immediately after the trace position. In object relatives, like in simple sentences, the correct reading of the homograph depends on the syntactic structure that the reader assigns to the sentence. Crucially, the correct reading of the homograph and the comprehension of the structure require the construction of a trace as the object of the embedded verb and the identification of the homograph as the main verb. In order to read correctly the homograph *tears* in sentence (4), for example, the reader has to understand that the object of *saw* is *the puppy*, or actually its trace, and therefore *tears* cannot be the object of *saw*, and is rather the main verb. Another relevant example from English is given in (5). In this example the words after the homograph do not expose the meaning of the homograph. The correct reading of the heterophonic homograph *objects* (with the correct stress position) requires the understanding of the sentence, and specifically, the construction of a trace as the object of the embedded verb *pushed*, and the identification of the homograph *objects* as the main verb.

(4) The puppy$_1$ [that the little boy saw t_1] *tears* the gift wrap.
(5) The woman$_1$ [that the demonstrator pushed t_1] *objects* to the prime minister.

The Hebrew orthography usually does not represent vowels, and some consonant letters are also ambiguous. This creates numerous heterophonic homographs, many of them representing different grammatical categories like nouns and verbs. Because many of these homographs are known to young children, they can be used in a study of children's comprehension.

For example, the written word ALH (עלה) can be read, because of the underrepresentation of vowels in Hebrew, either as a verb /*ala*/, climbed, or as a noun /*ale*/, leaf. In Hebrew, like in other languages, the correct reading of heterophonic homographs depends on the identification of their syntactic role. An example of a Hebrew sentence we used is given in (6). In this sentence, the main verb is the homograph ALH, and it is located right after the position of the trace.

(6) Ha-madrix$_1$ she-ha-yeled ra'a t_1 ALH al ha-har
The-guide$_1$ that-the-boy saw t_1 *climbed* on the-mountain
The guide that the boy saw climbed the mountain.
(7) The guide that the boy saw *a leaf* on the mountain.

The rationale behind this task is that if the reader identifies the trace, she should know that the trace is the argument of the embedded verb and thus a correct reading of the verb is expected. However, if the reader cannot construct a trace at the required position, the embedded verb *saw* would appear to be lacking an argument. This might lead to an incorrect reading of the homograph as the object of the embedded verb. In this case, the written sentence (6) will be read as in (7), *saw a leaf*.[4]

The crucial point here is that even the assumption of an empty category at the correct structural position (manifested in the correct reading of the homograph) does not guarantee the correct interpretation of the sentence. If there are difficulties in the assignment of thematic roles to the displaced NP, the interpretation of the sentence might still be flawed (for example, understanding sentence (6) as if the guide saw the boy). Or, in processing terms (see for example Nicol & Swinney, 1989; Zurif, Swinney, Prather, Solomon, & Bushell, 1993), the correct antecedent (the moved element, in the above example, *the guide*) may not be activated at the trace. These difficulties in assignment of thematic roles can be identified by asking the reader to paraphrase the sentence.

Thus, oral reading of the homograph immediately after the trace position might serve as a sensitive indicator for the construction of the syntactic position of the object and the assumption of an empty category in this position. Paraphrasing of the sentence might be a litmus for whether or not the thematic roles were correctly assigned to the moved element.

If the difficulties in the comprehension of object relatives in children with S-SLI are due to inability to construct the trace, poor performance in the reading task is expected, with a tendency to read the homographic verb as the object noun. But if the difficulties are due to a deficit in thematic role assignment to moved elements, with unimpaired trace identification, correct reading of the homograph is expected, accompanied with difficulties in the assignment of

[4] Although *prima facie* these sentences look complex and include some kind of ambiguity and in these respects resemble garden path sentences, they are not garden path sentences: In garden path sentences there is temporary ambiguity that gets resolved at a certain later point in the sentence where a syntactic reanalysis takes place. Unlike them, in the sentences we used in the current study an intact syntactic parser should identify the moved NP when the "that" is met, and therefore look for a position to assume a trace, without the need for syntactic reanalysis.

thematic roles in the paraphrasing task. Thus, the comparison of performance in reading and in paraphrasing can shed light on the component of syntactic movement that is impaired in S-SLI.

2. Method

2.1. Participants

The participants were 65 monolingual Hebrew-speaking children: 15 school-age children with S-SLI and 50 children with unimpaired language development.

S-SLI group: The 15 participants in the S-SLI group were 11 boys and 4 girls, in 4th to 8th grade, aged 9.3 to 14.6 years (mean age 11.7 years, SD = 1.8 years). All of them were attending regular classes in regular schools. They were diagnosed as children with SLI prior to the study, using clinical tests, administered by speech-language pathologists and educational specialists, based on reading comprehension assessment and non-standardized tests that are used in the clinics. There are no standard or norm-reference language assessment tests in Hebrew for children with SLI above 6th grade yet, and for children up to 6th grade there is only one norm-reference test that assesses only lexical-semantic abilities (MAASE, Rom & Morag, 1999). Thus, to assess whether they have a language impairment and to identify the linguistic abilities that are impaired, we thoroughly assessed their syntactic abilities as well as lexical-semantic, and phonological abilities using tests we developed, and compared their performance to the performance of control groups of at least 50 children without reports of language or reading impair- ment.

Their lexical-semantic retrieval and comprehension were tested using the MAASE test, which tests lexical-semantic abilities, and the SHEMESH test of naming 100 object pictures (Biran & Friedmann, 2005). Participants up to 7th grade were tested using the MAASE, participants from 6th grade was tested using the SHEMESH. The performance of all but one of the participants on the MAASE was within the normal range (within one SD from the mean of their age). All the participants who undertook the SHEMESH test performed similarly to the control group. Phonological abilities were assessed using repetition tests of phonologically complex words and non-words (BLIP, Friedmann, 2003a) which all but two of the participants performed not different from a control group. The detailed profile of their non-verbal and non-syntactic abilities is given in Appendix A, and a detailed presentation of their performance on the syntactic tests follows in this section. Their performance indicated that all of them had a syntactic deficit, and were therefore diagnosed with syntactic SLI (S-SLI). Most of them had a selective S-SLI, without lexical or phonological deficits. One of them had, in addition to S-SLI, also lexical retrieval difficulties, and two had a phonological impairment in addition to the syntactic deficit.

All the participants met all the exclusionary criteria for SLI (Leonard, 1998). They had no hearing impairment and no recent episodes of otitis media, no abnormalities of oral structure or problems in oral function; they showed no evidence of obvious neurological impairment or impaired neurological development; they had no symptoms of impaired reciprocal social interaction or restriction of activities that are typical of autism or PDD. Their non-verbal intellectual functioning was within the age-appropriate level, as indicated by the Wechsler Intelligence Scale for Children (WISC-R95, Hebrew adaptation, Cahan, 1998) or by their score on the Raven's Matrices (within 1 SD from the average of their age range).

This study assesses the comprehension of object relatives in a new way, and therefore it was necessary to establish, using more classical methods, that the participants had a deficit in the comprehension of sentences derived by phrasal movement. For this aim, we used three syntactic tasks of auditory comprehension, and included in the study only children who had poor performance in at least two of the three tasks.[5] The tasks were: (a) a binary task of matching a picture to a relative clause, in which each participant heard 40 right branching subject- and object relative sentences and was asked to choose the picture matching the sentence between two pictures—the matching one and a reversed roles one, (b) a task of comprehension questions, in which each participant heard 90 center-embedded or right-branching subject and object relatives and answered comprehension questions about the thematic roles in the relative clauses; (c) question-picture matching task, in which each participant heard 40 subject- and object referential Wh-questions, and were asked to choose the picture that answered the question, between two pictures, again one matching and one that included reversed roles. Poor performance on object relatives or object questions in each task was defined as performance rate that was more than one SD below the average performance of a control group of 50 participants in fourth grade (mean age 9.7, SD = 4.5 months).[6]

The comprehension of the S-SLI participants, as measured by the three tasks, was severely compromised. They performed poorly on the object relative sentences and on object Wh questions. In the sentence-picture matching task, they had an average comprehension of 73.0% of the object relatives (SD = 18.4), whereas children with unimpaired language perform 85% correct on this task at age 6.0 (see Friedmann & Novogrodsky, 2004), and 95% correct at fourth grade (SD = 6%). The performance of the children with S-SLI on the object relatives was in marked contrast to subject relatives, where they were 96.3% correct (SD = 4.8%), which indicates that they understood the task and the pictures correctly. In the comprehension questions

[5] Ten potential SLI participants were excluded on the basis of good performance on the syntactic measures: 6 had only LeSLI (lexical SLI), 3 had dyslexia but no SLI, and one had pragmatic SLI without syntactic difficulties.

[6] A different control group than the one that participated in the current study in the homograph reading task.

task on object relatives they performed 73.8% correct (SD = 19.7%), whereas the control group, who were in fourth grade, performed 91% correct (SD = 11%). In the question-picture matching task, they performed 73.5% correct (SD = 14.2%) on referential object questions, and the fourth graders in the control group were 87% correct (see Friedmann & Novogrodsky, 2003; Novogrodsky & Friedmann, 2002). The differences between the SLI group and the control performance were statistically significant for each of the three tests ($p < .006$).

Control group: The participants in the control group for the current study were 50 typically developing children, 25 were in fourth grade (mean age = 9.8, SD = 0.5), and 25 were in sixth grade (mean age = 11.8, SD = 0.5). They had no language or hearing disorders. This group was selected to provide information regarding the normal development of reading and comprehension of object relative clauses in Hebrew.[7]

2.2. Material

The test included 24 sentences with main verbs that were heterophonic homographs of nouns. Half were relative clauses, and half were control sentences. The relative clauses were center-embedded object relatives with the relativizer "*she-*", which is obligatory in Hebrew relative clauses (it is the only relativizer in Hebrew, and it is also used as the embedding marker for sentential complements). The homographic verbs appeared in the relative clauses immediately after the trace. Example (8) shows an object relative clause with the homograph *MDBR*, which can be read either as a verb *medaber* "talks", or as the noun *midbar* "desert". The control sentences were length-matched simple sentences without movement that included the same homographic verb (9).

(8) ha-shofet$_1$ she-ha-ish ciyer t_1 **medaber** b-a-televizia
The-judge$_1$ that-the-man drew t_1 talks in-the-television
The judge that the man drew is talking on TV.

(9) ha-talmid ha-xadash b-a-kita **medaber** be-zman ha-she'urim
The-student the-new in-the-class talks in-time the-lessons
The new student in class talks during the lessons.

The relative clauses were constructed so that the homograph in its incorrect, noun reading, would be a semantically and syntactically appropriate complement to the embedded verb. For this aim we chose embedded verbs that could take the noun homographs as their object. The fact that the homograph did not include a determiner could also not be used as a cue for it being a verb, because in Hebrew indefinite nouns appear without a determiner, and there were also no morphological cues that could identify the homograph as a verb or a noun. To prevent reliance on semantic and world knowledge cues in the interpretation of the sentences, the relative clauses were semantically reversible, namely, the subject and the object of the embedded verb could semantically serve both as the agent and as the theme. For example, in (8) it is possible both for the judge to like the man and for the man to like the judge, and therefore the comprehension cannot be based solely on the semantics of the lexical items, and has to rely on syntax.

We chose only homographs for which the verb and the noun meanings were different enough to permit reliable judgment of which meaning was selected in the speakers' paraphrases (like *tear*, *presents*, and *objects* in English). The homographs were simple and frequent words that are known to school age children both for their verb and for their noun meaning. After the administration of the test we asked the children what the meaning of half of the target words were, and all the children knew both meanings.

Also, to rule out an alternative explanation that the correct reading of the homograph is due to a higher frequency of the verb meaning, we chose homographs that were either biased towards the incorrect (noun) meaning or that were judged to have similar frequency for the noun and verb meanings.[8] We determined the dominant meaning according to 50 Hebrew-speaking adults without language impairment and 50 Hebrew-speaking children in 4th–7th grade without language impairment. The 50 adults (aged 18–55) judged the relative frequency of the noun and the verb meanings of the homographs. They were asked to determine for each homograph whether the verb or the noun meaning is more frequent or whether the two meanings have a similar frequency. Using a definition of ambiguity bias according to which the difference between the number of judges who preferred the noun meaning and the number of judges who preferred the verb meaning was at least 25% (13) of the judges,

[7] We chose to compare the 4th to 8th grade S-SLI group to two groups of unimpaired children at 4th and 6th grade, because choosing a language-matched group would either lead us to the same control groups we included in the study anyway, or to a very young group that cannot read yet. Given that language involves many different abilities, the term language-matching is not at all trivial and surely does not have a single denotation. Let us consider three possible language-matching criteria: lexicon or phonology matching, matching on a general syntactic measure, and matching on object relative comprehension ability. The chronological-age matched group was actually also language-age matched with respect to lexicon and phonology. The children with S-SLI who were included in the study showed significant differences between different linguistic abilities—whereas their syntax was impaired, the lexical abilities and the phonological abilities of most of them were average for their age. A comparison on a *general measure of syntax* would also yield a chronological-age matched group, because the participants with SLI had no tense or agreement errors, and their ability to produce embedded sentences (without movement) was normal, so in these respects they were also language-matched to the chronological age matched group. We are left with comparing them to children who still show poor performance on the comprehension of object relatives, but then we reach children who are 4 to 5 years old, who obviously cannot perform the reading test. Because of these considerations, we chose the two control groups that participated in the current study.

[8] A pilot study we conducted before this study indicated that the children with S-SLI read the homographs in the relative clauses correctly, and we therefore made the reading task harder, by using only homographs for which the correct reading could not be due to bias toward the verb meaning, namely those that are biased toward the incorrect noun reading and those that are unbiased.

there were eight words biased towards the (incorrect) noun reading, and four which were unbiased. Using Onifer and Swinney's (1981) stricter criterion for primary meaning, of a meaning preferred by at least 75% of the judges, only one homograph was biased toward the noun reading, and the rest were equi-biased.

In addition, 50 children in 4th–7th grade were given a list of the homographs as single words and were asked to read them aloud. For each child we noted which homographs were read as nouns and which were read as verbs. The results were similar to the results of the adults, and even more strongly biased towards the noun reading. Ten of the homographs were strongly biased towards the noun reading (more than 75% of the children read them as nouns), and two homographs were biased towards the noun but less strongly (69–74% of the children read them as nouns).

The test sentences were divided into two blocks; one block was administered in each of two sessions. Each block included 12 sentences: six relative clauses and six control sentences, the control for the other six homographs. The second block included the control sentences for the six target sentences in the first block, and six relative clauses whose control sentences appeared in the first block. Thus, each homograph appeared only once in each block.

2.3. Procedure

The participants were asked to read the sentences aloud, and then explain them in their own words. A syntactically simple practice sentence was given prior to the test, and using this sentence as an example, the meaning of "explain the sentence in your own words" was discussed with the participants. Feedback was given for the participant's paraphrase of this sentence, and when it was necessary further explanations and simple practice sentences were given until each participant understood the task. The experimental sentences were presented one by one. The participants read each sentence aloud and then paraphrased it as accurately as possible. To reduce demands on memory, each written sentence remained in front of the participant until s/he finished reading and paraphrasing that sentence. No time limit was set. The experimenter did not give the participants any feedback as to their success or failure in the test items, only general encouragement. If the paraphrase was unclear to the experimenter, a direct question was asked. For example, if the child said in the paraphrase of sentence (8) "He talks on TV", we asked "Who talks?". The second block of the test was administered between 1 week and 2 weeks after the first, to prevent effects of memory of the parallel sentences with the same homographs.

3. Results

The main findings were that the participants with S-SLI read the homographs much like the controls, but were significantly poorer in paraphrasing the object relative clauses. Hence, the results of reading aloud and the performance in paraphrasing will be presented separately.

3.1. Reading aloud

When we compared the reading aloud of the two age subgroups of the control group, we found that the rate of reading errors in the younger control group was significantly higher than that of the older control group, $t(48) = 2.41$, $p = .02$, $d = 0.70$. We therefore divided the SLI group accordingly, into two age groups, a younger group with 7 children in 4th and 5th grade, and an older group of 8 children in 6th grade and on. In the SLI group too, the participants in the younger group made more errors of reading the homograph verb as a noun than the participants in the older group, $t(13) = 2.47$, $p = .03$, $d = 1.37$.

A two-way ANOVA of the performance in reading aloud of the two age groups and the two language groups (SLI/control) also showed a main effect for age, $F(1, 64) = 4.94$, $p = .03$, $\eta_p^2 = 0.08$. There was no main effect of language group, $F(1, 64) = 2.49$, $p = .12$, and no age X group interaction, $F(1, 64) = 0.01$, $p = .97$, indicating that whereas chronological age had an effect on homograph reading in object relatives, the SLI groups did not differ from the unimpaired groups.

Although most of the homographs were biased toward the incorrect, noun reading, the children in all groups read the verb correctly as a verb most of the time, with a homograph reading error rate below 10%.

Importantly, the SLI and the control groups did *not* differ in the rate of reading errors when each subgroup of children with SLI was compared to its age-matched control group. The young SLI group and the young control group had an average of 9.5% and 7% errors of reading the homograph as a noun respectively, $t(30) = 0.94$, $p = .36$; the older SLI group and the older control group had 5% and 2.5% such errors respectively, $t(31) = 1.40$, $p = .17$.

An item analysis using Grubbs Test for Detecting Outliers (Grubbs, 1969) indicated that the errors were normally distributed between items, and there was no specific homograph or sentence that yielded an outlying rate of errors. There were not more errors of reading the homograph as a noun in the homographs biased toward the noun reading compared to the unbiased ones. In fact, the item which was most biased toward a noun was read correctly by all participants.

The homographs in the control sentences were read correctly by both the control group and SLI group (except for one incorrect reading of one homograph by an SLI participant). The number of reading errors in words *other* than the homographs in both language groups occurred in a similar rate in the two sentence types. In the S-SLI group there were six errors in reading words other than the homograph in the relative clauses and 12 in the control sentences, $t(14) = 1.16$, $p = .27$; In the control group there were six errors in reading words other than the homograph in the relative clauses and nine in the control sentences, $t(49) = 0.83$, $p = .41$.

Most of the noun-to-verb errors in reading the homographs resulted in an incorrect paraphrase, or in a failure to understand the sentence as in example (10). This characterized all of the reading errors of the young SLI group, and all but one of the older SLI errors. The control group had wrong paraphrases after the incorrect reading of the homograph in two thirds of the cases. In the minority of cases, a third of the cases for the control groups and one case for the SLI group, they paraphrased the sentence correctly although they read it incorrectly.

(10) Target: The guide$_1$ that the boy saw t_1 *climbed* the mountain
Incorrectly read: The guide that the boy saw *a leaf* the mountain
Paraphrase: The boy saw a guide but what is leaf? I don't understand.

Thus, within each age group, the children with S-SLI read the homographs similarly to the control participants, and all the groups read the homographs correctly in at least 90% of the relative clauses.

3.2. Paraphrasing

Unlike the reading errors, the paraphrasing task yielded important differences between the S-SLI and the control group, as can be seen in Fig. 1.

The control group had relatively few paraphrasing errors, and the younger and older control groups did not differ significantly in the rate of paraphrasing errors, which was $M = 7\%$ for the fourth graders and $M = 9\%$ for the sixth graders, $t(48) = 0.89$, $p = .38$. In the SLI group too, there was no significant difference between the two age groups, 36.0% errors for SLI children in 4th and 5th grade, and 33.3% for SLI children in 6th grade and older, $t(13) = 0.27$, $p = .79$, and no correlation between age and paraphrasing error rate in the SLI group, $r = 0.31$, $p = .26$. The data of the two control groups were therefore lumped together and compared to the SLI group.

The crucial difference between the SLI group and the control group lied in the rate of paraphrasing errors. The participants in the SLI group made an average of 34.6% paraphrasing errors out of the sentences that they read correctly, whereas the control group made only such errors in only 8.0% of the sentences they read correctly. The SLI group had significantly more paraphrasing errors compared to the control group, $t(63) = 7.76$, $p < .0001$, with a large effect size (Cohen, 1988), $d = 2.32$.

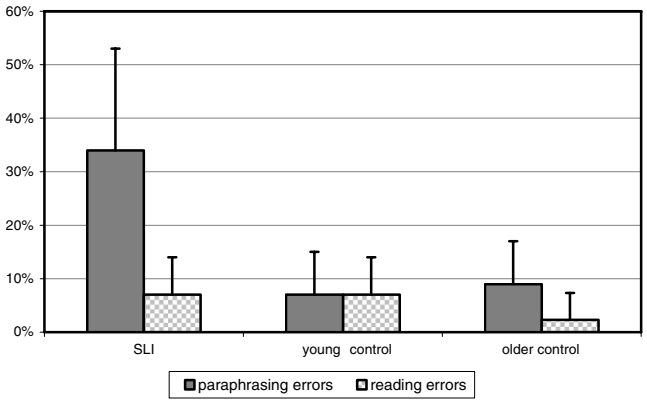

Fig. 1. Reading and paraphrasing errors in the object relative clauses (percentage of errors and SD).

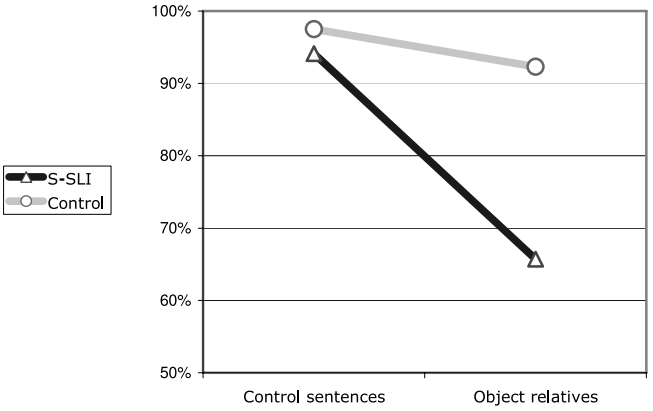

Fig. 2. The difference in performance between relative clauses and the control sentences in the paraphrase task, percentage of correct paraphrasing.

An analysis of variance of sentence type (object relatives versus simple sentences) and group (S-SLI versus control) showed that the object relative sentences were more difficult than simple sentences, as indicated by the main effect for sentence type, $F(1,63) = 106.36$, $p < .0001$, $\eta_p^2 = .63$, and that the general performance was poorer for the SLI than for the control group, $F(1,63) = 58.38$, $p < .0001$, $\eta_p^2 = .48$. Importantly, a significant interaction was found between sentence type and group, $F(1,63) = 40.74$, $p < .0001$, $\eta_p^2 = .40$, indicating that the difference in performance between the object relative clauses and the control sentences was larger in the S-SLI group than in the control group, see Fig. 2.

The distribution of the paraphrasing errors in the SLI group is presented in Table 2. These included various thematic role assignment errors, of the following types: reversal of thematic roles in the relative clause (11a), ascribing the predicate of the main clause to the subject of the relative clause (12), a mix of thematic role reversal in the relative clause and ascribing the main verb to the argument of the relative clause (11b), ascribing the main verb to the argument of the relative clause while ignoring the subject of the main clause, or not assigning it a role (13), and deletion of the relativizer "that/who" that changed the array of the thematic roles in the sentences (11c).[9]

[9] Although the production of relative clauses of the participants with SLI was impaired, the thematic role errors in paraphrasing could not be ascribed to the production difficulty. This is because most of their paraphrases did not include relative clauses at all, and they do not have thematic role errors in the production of simple sentences. Most of the paraphrases that indicated a thematic role error were simple sentences, coordinated sentences and sentential complements, and only 4 of these responses were object relatives. It is also worth noting in this regard that the same participants made thematic role reversals also in a sentence-picture-matching task, which is a comprehension task that does not include expressive language at all.

(11) Target sentence: ha-baxur she-ha-yeled ahav gazar itonim yeshanim
The-guy that-the-boy loved cut old newspapers
a. Interpretation: ha-baxur she-ohev et ha-yeled gazar itonim
The guy that-loves acc the-boy cut newspapers
The guy that loves the boy cut newspapers.
b. Interpretation: ha-yeled gazar itonim yeshanim, biglal ze ha-baxur ahav oto
The-boy cut newspapers old, for this the-guy loved him
The boy cut old newspapers, that's why the guy liked him.
c. Interpretation: ha-yeled ha-tinok ahav ligzor itonim yeshanim
The-boy the-baby liked to-cut newspapers old
The baby boy liked to cut old newspapers.

(12) Target sentence: ha-ganenet she-ha-yalda baxara mexaberet sipurim
The-kindergarten-teacher that-the-girl chose composes stories.
Interpretation: ha-yalda she-baxra ba-ganenet mexaberet sipurim
the-girl that-chose in-the-kindergarten-teacher writes stories.
The girl that chose the kindergarten-teacher writes stories.

(13) Target sentence: ha-gur she-ha-yeled roce oxel marak of
The-puppy that-the-boy wants eats chicken-soup
Interpretation: ha-kelev she-nolad katan... ha-yeled roce leexol marak 'of veha... lo kol kax hevanti et ha-kesher shel ha-gur
The-puppy that-was-born little...the-boy wants to-eat chicken-soup and the...not so understood the relation of the-puppy
The puppy that was born little, the boy wants to eat chicken soup and the... I didn't quite understood the relation of the puppy.

(14) Target sentence: ha-shofet$_1$ she-ha-ish ciyer t_1 **medaber** b-a-televizia
The-judge$_1$ that-the-man drew t_1 talks in-the-television
The judge that the man drew is talking on TV.
a. Main clause paraphrase: The judge is talking on TV.
b. Sentence repetition: The judge that the man drew is talking on TV.

The paraphrasing performance of the SLI participants in this task, measured by the number of relative clauses they did not make paraphrasing errors on, correlated with their performance in the task of comprehension questions about center-embedded and right-branching object relatives (described in Section 2.1), $r = .42$, $p = .058$.

Another type of response, which occurred in a similar rate in the two language groups, was incomplete paraphrases. The incomplete paraphrases did not include a paraphrasing error, but were either just a paraphrase of the main clause, which ignored the relative clause as in example (14a), or a verbatim repetition of the written sentence, as in example (14b).

As shown in Table 1, these responses appeared in a similar rate in the SLI group and in the control group, 10.8% and 9.3%, respectively, for the sum of the two types of incomplete paraphrases, $t(63) = 0.11$, $p = .91$. The younger groups made more such incomplete paraphrases than the older control groups, a difference which was marginally significant for the control groups, 15.2% and 3.3% respectively, $t(48) = 2.03$, $p = .048$, $d = 0.59$, and did not reach significance for the SLI groups, 15.4% and 6.7% respectively, $t(13) = 1.62$, $p = .065$.

After the second session, we asked each participant to describe which test sentences were most difficult for her/him to paraphrase. Here, too, the replies of the children in the SLI group differed from that of the children in the control group. The children in the SLI group said that the object relative clauses were the most difficult sentences because they were harder to understand. In marked

Table 1
Percentage of each type of non-target paraphrase out of the correctly read relative clauses (SD)

	Paraphrasing errors	Incomplete paraphrases	
	Thematic role errors	Main clause paraphrasing	Repeating the written sentence
S-SLI	34.6 (19.4)	6.6 (9.5)	4.1 (7.7)
Control	8.0 (8.0)	4.9 (15.1)	3.9 (9.6)

Table 2
Types of theta role assignment errors in the relative clause paraphrases of the SLI group

Error type	% of paraphrasing errors
Theta role reversal in the relative clause	22%
Ascribing the predicate of the main clause to an argument in the relative clause	24%
Theta role reversal and ascribing the main predicate to an argument in the relative clause	35%
Ascribing the predicate of the main clause to an argument in the relative clause and not assigning a role to the main subject	6%
Deletion of the relativizer	14%

contrast, the children in the control group usually pointed to a simple sentence and said it was harder to paraphrase because it was not complex and therefore they could not paraphrase it by breaking it into clauses, but rather had to look for synonyms.

To summarize, the children in the SLI group read the homographs similarly to the control group, but their paraphrases showed poor comprehension of object relatives. The analysis of the errors that were made while paraphrasing, together with a relatively good reading aloud of the same sentences supports the idea that it is the incorrect assignment of thematic roles, rather than inability to construct the structure, that leads to the poor comprehension of object relative clauses in S-SLI.

4. Discussion

The results of the current experiment show that children with S-SLI have a deficit in the comprehension of object relative clauses. This is in keeping with previous results indicating a deficit in the comprehension of object relatives (Adams, 1990; Friedmann & Novogrodsky, 2004; Levy & Friedmann, in press; Stavrakaki, 2001) and supports the general claim that children with S-SLI have a deficit that is related to movement of phrases (Ebbels & van der Lely, 2001; Friedmann & Novogrodsky, 2004; van der Lely & Harris, 1990). The main thrust of the current study was to go beyond this generalization, and try to characterize the nature of the deficit in movement of phrases. The study was designed to decide between two possible sources for the deficit in movement: a deficit in forming the syntactic structure of the relative clause and the position of the trace, or a deficit in assigning thematic roles through the trace to the moved element with unimpaired construction of the trace position. The results suggest that the deficit in object relative clauses in S-SLI, at least in the school-ages tested, does not lie in the construction of the syntactic tree and the position of the trace, because the position of the trace was created, as evinced by the correct reading of the homograph. Importantly, the paraphrase revealed that this was not enough for the children with S-SLI to understand the sentences with the object relatives. Although they read the object relatives correctly, and constructed an empty category[10] at the correct structural position—as the object of the embedded verb, they failed to link the verbs to their arguments, leading to errors in the thematic roles assigned to the noun phrases in the sentences with respect to the two verbs in the sentence. These results thus suggest that the syntactic structure is usually constructed correctly by the age of 4th to 8th grade, and that the empty category is placed at the correct position; however, the children with S-SLI have problems connecting the thematic role assigned to the empty category with the correct NP and therefore the assignment of thematic is impaired. In the first part of the Discussion we discuss the results that indicate the unimpaired construction of the structure. Then we discuss the results regarding a deficit in assigning thematic roles.

The relative clause sentences in this test were structured in such a way that only the construction of the trace at the correct position could lead to the correct reading of the homograph: the homograph was positioned right after the embedded verb, and if the trace was not constructed correctly, it would have been taken to be the object of the embedded verb. We even made the identification of the role of the homograph harder by making it a proper complement to the embedded verb, and by using homographs that are more familiar in their noun meaning. Nevertheless, the children with S-SLI (and the control participants) could use the syntactic structure to constrain the correct reading of the homograph, and read the homograph in the relative clauses correctly as a noun more than 90% of the time. The factors applying to reading these sentences could be depicted as comprised of two forces pulling in opposite directions. The syntactic structure directs the reading of the homograph to the correct direction, whereas lexical considerations, such as frequency of meaning and predicate argument structure of the embedded verb, which requires a theme, incline toward the incorrect, noun meaning.[11] Despite the syntactic deficit of the children with

[10] At this point it is impossible to determine whether the empty category that the children with S-SLI created was a trace (for which they had only one end of the chain, the trace end, but they did not know to which NP this chain should connect), or another type of empty category, a pro, which was sporadically co-indexed with one of the NPs in the sentence.

[11] There are indications that young children access both meanings of ambiguous words similarly to adults already at ages 4.8–5.6 years (Swinney & Prather, 1989).

S-SLI, and despite the fact that children their age preferred to read all the homographs as nouns when they appeared in isolation, the syntactic structure prevailed in these sentences. This indicates that the children with S-SLI were able to construct the syntactic structure of the sentence, and to assume the trace in the correct position.

These results, which show that the structure and the empty category are unimpaired, fit nicely with recent approaches to SLI. For example, Jakubowicz (2005) suggested that children with SLI do not have difficulties with respect to Agree or Merge (External or Internal Merge), according to her, they do not have a deficit in the basic operation of movement. van der Lely (1998, 2004; van der Lely & Battell 2003) clearly stated that movement is not absent in G-SLI. The results of the current study are in line with these approaches. Again, we find that the structure and the basic operation of movement is not absent, as indicated by the correct reading of the homograph. However, Jakubowicz and van der Lely, as well as our current results suggest that there is some aspect that makes certain movement-derived sentences difficult for children with SLI (according to Jakubowicz the problem is related to the iteration of Merge; van der Lely ascribes it to the lack of Economy 2 principle which forces movement). In the current study this aspect seemed to be the inability to transfer the thematic role to a moved element. Because SLI is a developmental disorder, these results also have interesting bearing on language development. They suggest that the syntactic structure can develop independently of the ability to transfer thematic roles in a chain of movement.

The developmental pattern could also be seen in the difference between the performance of children who were at 4th grade and the older children (sixth graders and above), in both the control and the SLI group. Although all the participants read the sentences relatively well, the younger participants made more reading errors than the older participants. This developmental pattern could be explained by the fact that the relative clauses used in the current study were center-embedded. This type of object relative clauses is acquired later than right-branching object relatives (Correa, 1995; de Villiers, Tager-Flusberg, Hakuta, & Cohen, 1979; Kidd & Bavin, 2002; Sheldon, 1974).[12]

The main finding of the study was that although the reading of the homographs was above 90% correct for all groups, it did not guarantee the correct comprehension of the object relative clauses in the SLI group. The paraphrasing showed that object relative sentences were more difficult than simple sentences for both language groups, but the difficulty in this structure was significantly larger for the SLI group. These findings suggest that although the participants read the sentences correctly, indicating a correct construction of the empty category at the trace position, they failed to understand who did what to whom in the sentence. The main support for this conclusion comes from the analysis of errors, and the differences between task-inappropriate responses and thematic role errors. The task-inappropriate responses in paraphrasing, such as repeating the written sentence and paraphrasing only the main clause, occurred at a similar frequency in the SLI and the control group. Similarly, reading errors (of words other than the homograph) distributed evenly between the relative clauses and the simple sentences. In marked contrast, errors of thematic roles in object relative paraphrases appeared at a significantly higher rate in the SLI group.

It seems that an empty category was created as the object of the embedded verb, but then the SLI participants did not know to which NP they should transfer the thematic role. In processing terms, it could be viewed as follows: during the normal on-line processing of movement-derived sentences like relative clauses, semantic reactivation of the antecedent takes place at the trace (Love & Swinney, 1996; Nicol & Swinney, 1989; Swinney, Ford, Frauenfelder, & Bresnan, 1988; Swinney, Zurif, & Nicol, 1989). The children with SLI could not activate the correct NP at the trace position, and therefore failed at assigning the antecedent its thematic role. Recent data from children with G-SLI corroborate this direction. Marinis and van der Lely (2004) used cross-modal lexical priming and found that English-speaking children with G-SLI were unable to reactivate the antecedent at the Wh-trace position. That is, even if they know where to place an empty category, they do not know where to relate it to and hence—they cannot transfer the thematic role correctly.

When this happened, and the S-SLI participants failed to transfer the thematic role to the moved element, they produced various paraphrases, all sharing the mis-assignment of thematic roles to the arguments. The error types demonstrated all the possible combinations of the two arguments and the roles assigned by the two verbs (the main verb and the embedded verb): the theme of the embedded verb received an interpretation of the agent of the embedded verb; the agent of the embedded verb received the role of the theme of the embedded verb; the embedded subject, which was the agent of the embedded verb received an interpretation of the agent of the main verb; and in some cases more than one of these errors occurred within the same paraphrase. The other error types were inability to assign a thematic role to the subject of the main clause, which was the theme of the embedded clause and had to receive its role via a chain of movement, and assignment of thematic roles while deleting the relativizer and treating the sentence as if it was a simple structure with

[12] This might have an interesting relation to the development of the neural substrates that relate to syntax: Broca's area is divided into two subparts: BA 44 and BA 45. Whereas BA45 matures at around age 5, the age of acquisition of right-branching relatives, BA 44 reaches the mature stage only much later, around age 11 (Amunts, Schleicher, Ditterich, & Zilles, 2003), possibly lending the neural support for the interpretation of center-embedded relatives (see Jülich Workshop Experts, 2006, group discussion, p. 278).

respect to theta assignment. In these two errors the paraphrase referred only to part of the information presented in the sentence, although the sentence was in front of the children when they paraphrased it. The fact that the errors were made even though the sentence was fully presented to the participants throughout the reading and paraphrasing task indicates that it was not memory that was responsible for the difficulties in comprehension.

The deficit in thematic roles that was reflected in the current task is similar to the difficulty evinced in other comprehension tasks such as sentence-picture matching. In sentence-picture matching tasks this deficit is manifested in that when the children with SLI hear object relatives and passive sentences they point to the picture that describes reversed thematic roles (Friedmann & Novogrodsky, 2004; van der Lely & Harris, 1990). This deficit might also be responsible for the difficulties in text comprehension, which are reported for school age children with SLI (Bishop & Adams, 1990; Botting & Conti-Ramsden, 2001; Conti-Ramsden, Botting, Simkin, & Knox, 2001), especially given the high frequency of Wh-movement structures in texts.

These results also go in the same vein with the way school-age children with S-SLI *produce* sentences that are derived by movement. In a recent study (Novogrodsky & Friedmann, 2006) we analyzed the way Hebrew-speaking children with S-SLI produce subject- and object relative clauses in two relative clause elicitation tasks. Eighteen school-age children with S-SLI participated in a task of reversible picture description (*This is the girl who the grandmother is kissing*) and in a task of preference production (*I prefer to be the boy who the teacher tests*). The main finding was that they had considerable difficulty in the production of relative clauses, especially of object relatives, but with a very specific pattern. They were able to produce the structure of a relative clause, including the embedding marker,[13] and did not produce ungrammatical sentences with a noun phrase at the trace position, but, importantly, they made thematic role reversals. The thematic role reversals occurred as producing a subject relative for an object relative, describing a situation that is the opposite of the picture presented (*This is the girl who is kissing the grandmother*), omitting one of the thematic roles, and using the wrong relative head (*I prefer to be the teacher who tests the boy*). This pattern is very similar to the one we found here for comprehension: preserved ability to construct the syntactic structure of object relative clauses, with impaired ability to assign thematic roles to the moved element.

Another point that emerges from the current results relates to the difference in the underlying deficit between individuals with acquired agrammatic aphasia and children with developmental syntactic disorder (S-SLI). In a study that used the same methodology of reading of object relative clauses that include a noun–verb homograph as the main verb (Friedmann, 2003b; Friedmann, Gvion, & Novogrodsky, 2006), we found that individuals with agrammatism *failed* to read these sentences and read the homograph main verb as the object of the embedded verb, thus indicating that the trace was never constructed. They also failed in interpreting the sentence, with errors related to the incorrect reading of the homograph, and many indications that they could not understand the construction of the embedding at all. This performance of the individuals with agrammatism is in marked contrast to the children with S-SLI who succeeded in reading the homograph. Thus, although both children with S-SLI and agrammatic aphasics fail to understand object relative clauses, their different patterns of performance in this reading task suggests that the nature of the impairment that underlies their deficit is different: children with S-SLI fail to assign the thematic roles to a displaced argument, whereas agrammatic aphasics cannot even construct the structure with the trace in the correct position, possibly because they cannot construct the high nodes of the syntactic tree that are required for Wh-movement and embedding (see Friedmann, 2001, 2005, 2006a, 2006b). This dissociation between the populations also points to the validity of the task. When the syntactic structure is impaired, it cannot be used for the correct reading of the homograph in object relatives, as is the case in agrammatism. This is however a different picture than the one that was witnessed in the current study of children with S-SLI.

The results of the current study support the notion of two different processes in the comprehension of relative clauses, one being the construction of the syntactic structure and the trace and the other is the assignment of thematic roles via chains. While poor performance in standard comprehension tasks can only indicate that movement is impaired, a task such as the one used in the current study might suggest an initial direction to determine which of these processes underlies the movement deficit in syntactic SLI. This study thus opens a window through which we can examine the underlying deficit that ends up manifesting itself in impaired comprehension of movement-derived sentences. The findings indicate that in syntactic SLI the syntactic structure is usually constructed correctly, but the assignment of thematic roles to the displaced constituent is impaired.

[13] Some other children with SLI reported in the literature (Håkansson & Hansson, 2000; Leonard, 1995; Schuele & Dykes, 2005; Schuele & Nicholls, 2000; Schuele & Tolbert, 2001) omit relative complementizers when they try to produce subject relative clauses. As discussed in Novogrodsky and Friedmann (2006), this can either be ascribed to their younger age—younger SLI children have a structural deficit and omit complementizers until age 6 or 7 but then stop omitting them, acquire the syntactic structure and remain with thematic role errors (as can be seen in the trend of fewer relative marker omissions in MM, Schuele & Nicholls, 2000). A different explanation might be that there is more than one subtype of S-SLI, one that involves only a deficit in the transfer or thematic roles to a moved element, and the other than involves a structural deficit, similar to individuals with agrammatism (Friedmann, 2005, 2006b; Friedmann & Grodzinsky, 1997).

Appendix A

Individual participant data—non-syntactic and non-verbal abilities[a]

Participant	Age (months)	Grade	Gender	IQ	Lexical-semantic		Phonology	
				W=WISC-R R=Raven	MAASE Score (norm: average ± SD for the grade and SES)[b]	SHEMESH (100 items) (ctrl=94, SD=2.4)	BLIP nonword repetition (25 items) (ctrl=21-25)	BLIP phonologically complex word repetition (29 items) (ctrl =28-29)
1	114	4	f	R 32/36 (27.25 ± 5.7)	34.5 (33.6 ± 6.3)	-	17	29
2	125	4	m	R 27/36 (27.25 ± 5.7)	42.2 (33.6 ± 6.3)	-	25	29
3	111	4	m	R 32/36 (27.25 ± 5.7)	31.5 (33.6 ± 6.3)	-	25	29
4	111	4	m	R 28/36 (27.25 ± 5.7)	33 (33.6 ± 6.3)	-	23	29
5	123	5	m	W 106	24.2 (33.8 ± 7.5)	-	24	29
6	140	5	m	W normal	35.7 (33.8 ± 7.5)	-	23	29
7	140	5	f		24 (30.4 ± 8.5)	-	21	29
8	134	6	m	R 40/60 (40.39 ± 9.12)	36 (36.4 ± 6.2)	-	25	29
9	144	6	m		37.5 (36.4 ± 6.2)	100	25	29
10	144	6	f	W 96	39 (36.4 ± 6.2)	97	22	29
11	153	7	f	W 124	45.7 (36.4 ± 6.2 6th grade norm)	100	25	29
12	148	7	m	W 94	39.25 (36.4 ± 6.2 6th grade norm)	100	25	29
13	166	8	m	W normal	Over age	97	25	29
14	166	8	m	R 36/48 in 5th grade (35.47±10.63)	Over age	94	25	29
15	174	8	m	W normal-high	Over age	96	17	29

[a] The highlighted cells indicate performance below the control performance.
[b] The MAASE test has norms only up to 6th grade.

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