The movement deficit in SLI: trace deletion or thematic role transfer impairment?

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Children with Specific Language Impairment have difficulties understanding relative clauses, difficulties that have been ascribed to a deficit in phrasal movement. The current study explores the nature of this deficit in movement, and specifically whether it is related to a deficit in the construction of traces, or whether traces are constructed, and the deficit is related to a failure to transfer thematic roles via chains. This question was assessed using reading-aloud of noun-verb homographs that are incorporated in object relative sentences, and their correct reading critically hinges on the correct processing of the object relative sentence. We used a property of Hebrew orthography, the underrepresentation of vowels, that makes the reading of homographs dependent on the sentence. The rationale behind the study was that readers who cannot process or represent traces of movement, are expected to fail in identifying the syntactic role of such homographs when they are incorporated after the trace position in movement-derived sentences, and therefore fail to read them. Nine school-age Hebrew-speaking children with SLI, and nine participants without language impairment read aloud and paraphrased such sentences. The children with SLI read the homographs after the trace correctly but failed to interpret the object relative sentences. They interpreted well the sentences that were not derived by movement. The study indicates that traces of movement are created in SLI but the assignment of thematic roles via chains is impaired.

1. Introduction

Phrasal movement was originally suggested as a theoretical construct, internal to linguistic theory. The current study uses this construct to better understand the syntactic impairments in children with Specific Language Impairment (SLI[1]) as well as to assess the psychological reality of the components of syntactic movement. Within, for example,

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[1] Several subgroups can be identified within the general definition of SLI. The current study focused on one specific subgroup – children with syntactic deficit. Throughout the paper when we write "SLI" we refer to this subgroup of SLI with a syntactic deficit.

the Government and Binding framework (Chomsky, 1981, 1982), syntactic movement is taken to include two related components - a trace at the position from which the element has moved, and a process of thematic role assignment via a chain between the antecedent and the trace.

Is this division between trace and thematic role assignment psychologically real? Can these two parts of syntactic movement be selectively impaired, and if so, is it possible to discern which of them is impaired in syntactic impairment?

The current study explores these questions through the study of the syntactic impairment of children with SLI. Somewhat similarly to individuals with agrammatic aphasia, children with SLI with syntactic impairment experience difficulties in the comprehension of non-canonical sentences that are derived by phrasal movement. They can understand simple active sentences, subject relatives and subject questions, but fail to understand reversible verbal passives (Adams, 1990; Bishop, 1979; van der Lely & Harris, 1990), object relatives (Adams, 1990; Friedmann & Novogrodsky, 2003; Stavrakaki, 2001), referential object questions (Ebbels & van der Lely, 2001; Friedmann & Novogrodsky, 2003) and topicalization structures in English (van der Lely & Harris, 1990).

Though some researchers agree that the deficit in these sentential structures is related to a deficit in movement (Ebbels & van der Lely, 2001; van der Lely & Harris, 1990), the exact nature of the deficit is still an open question. What exactly is impaired when phrasal movement is impaired? Two logical possibilities are either to ascribe the deficit to an impairment in the construction or identification of the trace, or to an impairment that is related to the thematic role assignment via chain.

An example for the first account is the Trace Deletion Hypothesis that was suggested for the deficit in agrammatic comprehension (Grodzinsky, 1995, 2000). Individuals with agrammatism fail to understand reversible sentences that are derived by movement and according to Grodzinsky this happens because in agrammatism the trace is deleted from the syntactic representation. This, in turn, impairs the assignment of thematic roles to

noun phrases that moved from their original sentential position. When the order of the arguments remains canonical, non-syntactic strategies (that assign an agent role to the first NP, for example) can lead to correct interpretation. However, when the object moves to a position before the subject, and the sentence is semantically reversible, comprehension fails.

The current study suggests data that indicate that the deficit in movement in SLI is different in nature from the one in agrammatism. In SLI, we would like to argue, the trace is not deleted, but thematic role assignment is impaired. In order to test the comprehension of movement-derived sentences and to detect the underpinnings of the deficit in comprehension, a special task was created. This task included reading of object relative sentences that included noun-verb homographic heterophones. The correct reading of this homograph crucially depends on the syntactic structure that is assigned to the sentence by the reader.

An example of such sentence is given in (1). In this sentence, the main verb, which is located right after the position of the trace, is a homograph. The written word GZR (גזר), because of the underrepresentation of vowels in Hebrew orthography, can be read either as a verb /*gazar*/, cut-past-3rd-masc, or as a noun /*gezer*/, carrot. The correct reading depends on the context. In a sentence like (1), it functions as a verb.

    (1)   *ha-baxur$_1$ she-ha-yeled ahav t$_1$ GZR itonim yeshanim.*
           The-guy$_1$ that-the-boy liked t$_1$ *cut/carrot* newspapers old.
           "The guy$_1$ that the boy liked cut old newspapers."

The rationale behind this task is that if the reader cannot construct a trace at the required position, the embedded verb 'liked' would appear to be lacking an argument. This might lead to an incorrect reading of the homographic verb as a noun, as the argument of the embedded verb. In this case, (1) will be read "*ahav gezer*" ("liked carrot"). On the other hand, if the trace is not deleted, the reader should know that the trace is the argument of the embedded verb and thus a correct reading of the verb is expected.

The crucial point here is that even assumption of a trace at the correct position (manifesting in correct reading of the homographic verb) does not guarantee the correct interpretation of the sentence. If there are difficulties in the assignment of thematic roles via chain, the interpretation of the sentence might still be flawed. Or, in processing terms (see for example Nicol & Swinney, 1989; Zurif, Swinney, Prather, Solomon & Bushell, 1993), the correct antecedent is not activated at the trace. These difficulties can be identified by asking the reader to paraphrase the sentence.

If the difficulties in the comprehension of object relatives in children with SLI are due to trace deletion, poor performance in the reading task is expected, with tendency to read the homographic verb as a noun. But if the difficulties are due to thematic role assignment deficit, with unimpaired trace identification, correct reading of the homograph is expected, accompanied by difficulties in the paraphrasing task. Thus, dissociation between good performance in reading and poor performance in paraphrasing will support the discrimination between these two components of syntactic movement.

2. Method

2.1 Participants

Eighteen monolingual Hebrew-speaking children participated in the study: nine school-age children with Specific Language Impairment (SLI) and nine children with normal language development, matched to the SLI group.

SLI group: The participants in the SLI group were 5 boys and 4 girls, aged 9;7 to 12;11 years (mean age 11;5 years, *SD* = 1;3 years). They were diagnosed as children with SLI prior to the study, through standard clinical tests, done by speech-language pathologists, and based on additional information supplied by educational specialists who work with them. All of them were attending regular classes in regular schools. Eight of the nine children participated also in a binary sentence-picture matching task in which they heard subject- and object- relative sentences and were asked to choose the picture matching the sentence from the matching picture and a picture with reversed roles (Friedmann & Novogrodsky, 2003; Novogrodsky & Friedmann, 2002). Another girl was tested by

means of a different test that included questions about the agent of subject- and object-relative sentences. All nine children had difficulty understanding who did what to whom in the object relative sentences, and preformed poorly on the object relative sentences (mean = 78%) compared to subject relatives (mean = 91%), and compared to children with unimpaired language (who perform 85% on object relatives at age 6;0 and at ceiling at age 7;0).

Control group: The participants in the control group were 5 boys and 4 girls with unimpaired language, aged 9;7 to 12;11 years (mean age 11;4 years, *SD* = 1;2 years). Each was matched to one of the participants in the SLI group. This group was selected in order to provide information regarding normal development of reading and comprehension of relative clauses in Hebrew.

2.2 Material

The test included 20 sentences. Ten were center-embedded object relatives with main verbs that were homographic-heterophoneous with nouns. These homographic verbs appeared right after the trace of the relative clause. In (2), the word *orez* (written AORZ אורז) can be read either with a ultimate stress *oréz*, as a verb "packs", or with penultimate stress, as the noun *órez*, "rice". (Hebrew orthography does not mark stress.) The other ten were control sentences that included the same homographic verb in a sentence that was comparable in length but did not include a relative clause (3).

(2) *ha-oreax$_1$ she-ha-ish   sone t$_1$ **orez** et ha-mizvadot.*
     The-guest$_1$ that-the-man hates *t$_1$* packs acc the-suitcases
     The guest that the man hates packs the suitcases.

(3) *ha-tayar im ha-ben ha-xamud   **orez** et ha-mizvadot.*
     The-tourist with the-son the-cute packs acc the-suitcases
     The tourist with the cute son packs the suitcases.

The verb and the noun meanings of each homograph were different enough so that it would be possible for the experimenter to understand which meaning the participant chose in the paraphrasing task. The test sentences were divided into two blocks, with each block including ten sentences: five with relative clauses and five control sentences (the control for the other five homographs). The second block included the control sentences for the five target sentences in the first part, and five relative clauses whose control sentences appeared in the first block.

2.3 Procedure

The participants were asked to read the sentences and to explain them in their own words. A practice sentence was given prior to the test, and using this sentence as an example, the meaning of "your own words" was discussed with the participants and further explanations were given when necessary. Then the experimental sentences were presented one by one. The participants read each sentence aloud and then paraphrased it as accurately as possible. Each written sentence remained in front of the participants until they finished reading and paraphrasing it, namely, paraphrasing was performed when the sentence was still in front of the participant. No time limit was set. Only general encouragement was given but feedback was not contingent upon the success of the participant. If the paraphrase was not clear, a direct question was asked (for example, if the child said in the paraphrase of Sentence 2 "He packed the suitcase", we asked "Who packed?"). The second block of the test was administered at least one week after the first, to prevent effects of memory of the parallel sentences with the same homographs.

3. Results

The performances in reading aloud and in paraphrasing were analyzed separately.

3.1 Reading aloud:

On the reading task both SLI and control groups read the homographs well and there were only few errors of reading the target word as noun instead of verb.

As can be seen in Table 1, although the SLI group made more errors than the control group, the number of errors is relatively small.

Table 1

Number of times the homograph was erroneously read as a noun, out of the total number

of sentences, *SD* in parentheses

	Object relative	Control sentences
SLI group	11/90 (1.09)	0/90 (0)
Control group	3/90 (0.7)	0/90 (0)

3.2 Paraphrasing:

However, when the performance on the *paraphrasing task* was analyzed, the SLI and the control groups differed significantly. As seen in Table 2, while the control group performed well both on the relative sentences (91%) and the control sentences (98%), the performance of the SLI group was significantly lower on the relative clauses (66%) while they showed good comprehension of the control sentences (97%).

Table 2

Mean percentage correct in paraphrasing, *SD* in parentheses

	Object relative	Control sentences
SLI group	66% (14%)	97% (7%)
Control group	91% (0.08%)	98% (0.04%)

The difference in performance between the relative clause and the control sentence was significantly larger in the SLI group than in the control group, as can be seen in the significant interaction between sentence type (object relative versus simple sentence) and group (SLI versus control) ($F(1,16) = 23.97$, $p = .0001$). Namely, center-embedded object relative sentences were more difficult than simple sentences for both groups, but the difficulty in this structure was significantly larger for the SLI group.

A qualitative analysis of the paraphrasing demonstrates that the SLI group had more difficulties in thematic role assignment than the control group. For both groups the main type of error was thematic role assignment errors, but while the control group made only 11 such errors, the participants with SLI made 43 errors in thematic roles.

The two most frequent errors related to thematic roles were reversals of the thematic roles in the embedded clause (4a), and errors that took the subject of the relative clause to be the agent of the matrix verb (4b). Additional errors included assigning the same thematic role to both NPs, such as taking both NPs to be the agents of the same verb (5a), no theme for the embedded verb, and neglect of the main verb (5b), and errors that related to the matrix subject as bundled to the subject of the relative clause, assigning both of them a single thematic role (6). In some cases only one type of error appeared while in others more than one did. Errors (4)-(6) were produced after the participant read the sentence aloud correctly, showing that even though the structure may have been constructed well, the interpretation and assignment of thematic roles failed.

(4)   Target sentence: הבחור שהילד אהב **גזר** עיתונים ישנים

           ha-baxur she-ha-yeled ahav gazar itonim yeshanim

           The-guy that-the-boy loved **cut** old newspapers

   a. Interpretation: yesh baxur… yesh yeled she-ha-baxur ahav

           There-is guy…there-is boy that-the-guy loved

            "There is a guy…there is a boy that the guy loved".

   b. Interpretation: ha-yeled gazar itonim yeshanim

             The-boy cut newspapers old

            "The boy cut old newspapers".

(5)   Target sentence: החתול שסבא איבד **נעל** מגפיים אדומים

           ha-xatul she-saba ibed na'al magafayim adumim

           The-cat that-grandfather lost **wore** red boots.

   a. Interpretation: saba ibed xatul aval haxatul ibed magafayim adumim

           Grandfather lost cat but the-cat lost boots red".

            "Grandfather lost a cat but the cat lost red boots".

b. Interpretation: saba ibed magafayim she-xatul lakax lo otam

Grandfather lost boots that-cat took to-him them

"Grandfather lost boots that a cat took from him".

(6)   Target sentence: הסוס שהספורטאי בחר **דרך** על הדשא

ha-sus she-ha-sporta'i baxar darax al hadeshe

The-horse that-the-sportsman chose **stepped** on the grass.

Interpretation: ha-sus hasporta'i … eh…. Hu baxar darax al ha-deshe

The-horse the-sportsman ….um…. he chose stepped on the-grass"

"The horse the sportsman ….um…. he chose stepped on the grass"

To summarize, the results show poor comprehension of object relative sentences with a relatively good reading aloud of the same sentences.

4. Discussion

The results of the current experiment show that children with SLI have a deficit in the comprehension of relative clauses. This supports previous claims that some children with SLI have a deficit that is related to movement of phrases (Bishop, 1979; Friedmann & Novogrodsky, 2003; Ebbels & van der Lely, 2001; van der Lely & Harris, 1990). However, this study was further aimed at deciding between two possible sources for the deficit in movement: is it the case that the trace of movement is not formed on the first place, or is the trace formed, but do thematic roles still fail to be transferred via the chain? The new findings in the current research suggest that the deficit in relative clauses in SLI does not lie in the construction of the trace, because the position of the trace was created, and therefore the homograph was read aloud correctly as a verb. However, the paraphrase revealed that this was not enough for the children to understand the sentences with the object relatives. Although they read the sentences correctly, they failed to understand who did what to whom in the sentence, failing to link the verbs to their arguments. When the trace was constructed but its role was unknown, thematic role errors occurred in the role of the antecedent, or in the roles that were related to the matrix verb that followed the trace. These results thus suggest a window for looking at the

underlying deficit that ends up manifesting as a deficit in the comprehension of movement-derived sentences. They suggest that the structure is usually constructed correctly, but the assignment of thematic roles is impaired, possibly the transfer of thematic roles via chains.

Another point that emerges from the current results relates to the difference in the underlying deficit between agrammatic aphasics and children with SLI. A recent study by Friedmann and Gvion (2003; Friedmann, 2003), which used a similar methodology of reading of object relative clauses that include a noun-verb homograph as the main verb, found that agrammatic aphasics *fail* to read these sentences and read the main verb as the object of the embedded verb, thus indicating that the trace was never constructed. (Naturally, they also failed in interpreting the sentence, with many errors related to the incorrect reading of the homograph.) Thus, although both children with SLI and agrammatic aphasics fail to understand object relative clauses, the different pattern of performance suggests that the impairment that underlies their deficit is different: children with SLI fail to assign the thematic roles via chains, and agrammatic aphasics cannot even construct the structure with the trace in the correct position.

The results of the current study support the idea of two different processes in the construction of relative clauses: trace construction and assignment of thematic roles via chains. While poor performance in tasks of sentence-picture matching can only indicate that one of these is impaired, a task such as the one used in the current study might suggest an initial direction to determine the basis of this deficit.

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