

LEXICAL CHARACTERISTICS OF VERBS IN SCHOOL-AGE CHILDREN  
WITH SPECIFIC LANGUAGE IMPAIRMENT

BY

NAAMA KENAN

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**ABSTRACT****LEXICAL CHARACTERISTICS OF VERBS IN SCHOOL-AGE CHILDREN  
WITH SPECIFIC LANGUAGE IMPAIRMENT**

By

Naama Kenan

Advisor: Professor Richard G. Schwartz

Many of the language deficits exhibited by children with specific language impairment (SLI) can be described as “verb-related”. The purpose of the current study was to investigate the lexical properties of verbs in the language of children with and without SLI. Three planned experiments targeted this issue with different experimental tasks. The participants were 16 children with SLI (ages 8;5-12;6), and 16 age-matched typically language developing (TLD) children. A group of 16 adults (ages 18-21) have also participated in Experiment 3.

In Experiment 1, the production of sentences for specific verbs, in relation to the number and type of arguments and complements, was analyzed. Children with SLI were found to produce more errors and they responded with more “*don't know*” (DK) responses, as compared with their TLD peers.

In Experiment 2, a grammaticality judgment task assessed the children’s sensitivity to specific types of sentential complements that certain verbs select. Children with SLI were found to produce more judgment errors and to produce more errors when they attempted to correct ungrammatical sentences, as compared with their TLD peers.

In Experiment 3, verb activation during on-line sentence comprehension was targeted. The goal was to determine which structural characteristics of verbs affect the

time it takes children with SLI, children with TLD, and adult listeners, to activate verbs from the mental lexicon. Three variables were examined: (a) the number of arguments, (b) the number of structural options, and (c) the thematic structure. An online pitch change method was employed. Analysis of reaction times revealed that the number of structural options was the crucial factor that affected verb processing. It created complexity effects for all three groups of participants. Children with SLI were affected by the lexical characteristics of verbs in the same way as the two control groups.

These results show a dissociation between the normally appearing verb activation mechanism of children with SLI, and their difficulty in translating this implicit knowledge into explicit linguistic knowledge required for performing a variety of production and comprehension tasks. An individual perspective showed, however, that not all children with SLI were impaired on the non-online measures.

## DEDICATION

I dedicate this dissertation to my beloved family: to my husband, Ronen, and to my three daughters: Lior, Reut, and Ofir. Ronen was the first person to suggest that I should pursue a PhD degree. Through the years, he has been my closest supporter, counselor, and advocate. He allowed me to work endless days and nights, by taking on many familial responsibilities. Ronen, I could not have done it without you. I love and thank you with all my heart. My daughters supported me by being patient and understanding and by growing up in a reality where Mom was always busy with her studies. Lior, Reut, and Ofir, you are the most important treasures in my life. I love you very much and I feel proud of the kind of people you have become.

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## Introduction

Children with specific language impairment (SLI) show a significant limitation in language ability, despite their normal hearing, age-appropriate scores on nonverbal tests of intelligence, intact neurological status, and no evidence of autism or other behavioral disorders.

Many of the deficits exhibited by children with SLI can be described as “verb-related”. Lexical-semantic, morphological, and syntactic verb limitations have been found. The properties of verbs make them a more complex lexical class for acquisition and use, compared to nouns. Verbs are conceptually and semantically more complex than nouns, since they encode relational, rather than referential terms (Gentner, 1978, 1982). Verbs are harder to learn due to the perceptual nature of actions, which are transient, variable, and may involve more than one perspective (Tomasello & Kruger, 1992). In addition, verbs are the core element of the sentence, and require specific attention to the syntactic environments in which they can be used (Pinker, 1989). These properties of verbs affect their acquisition for typically-language-developing (TLD) children and for children with SLI, who demonstrate extraordinary difficulties in verb production and comprehension. Specific impairment patterns, however, vary in relation to stage of acquisition and typological characteristics of the target language.

The specific properties of verbs determine their representation in the mental lexicon. In addition to their meaning, sounds, and grammatical class, verbs must be represented according to their structural properties. Current linguistic theories emphasize two representational systems: syntactic subcategorization, and argument structure. Syntactic subcategorization specifies which types of complements are selected by any

particular verb. Argument structure describes verbs in terms of their arguments = the participants in the event or action to which the verb refers, including their thematic roles. The importance of these verb-centered structural properties is emphasized in various theories of sentence processing, in which predicates and their theta roles serve as the major organizing element for sentence construction during both production and comprehension (Grimshaw, 1990; Haegeman, 1994; Reinhart, 2000). Some of the lexical and grammatical difficulties associated with SLI may be related to limitations in the knowledge of the structural characteristics of verbs.

### Theoretical Accounts of SLI

The theoretical accounts that attempt to explain the source of the impairment in SLI remain controversial (see Leonard, 1998, for a review of the accounts of SLI). In general, most theories of SLI can be categorized as processing accounts, which attribute SLI to a limitation in general processing capacity or to specific processing mechanisms, or as linguistic accounts, which attribute SLI to a deficit in linguistic representation.

Processing theories postulate that children with SLI have difficulty processing the information that is needed for language acquisition. Thus, language itself is not viewed as the problem. Instead, limitations in various processing mechanisms may significantly affect the child's ability to access language from the input and to use it with facility after it has been acquired. The determining factor, according to these theories, is the amount of material that has to be integrated and stored, and the time available for completing these operations, rather than the particular type of material (Leonard, Ellis Weismer, Miller, Francis, Tomblin, & Kail, 2007). Processing capacity of children with SLI has been investigated from two perspectives. The structural perspective focuses on short-term

memory capacity. Children with SLI demonstrate limitations in phonological short-term memory (e.g., Dollaghan & Campbell, 1998; Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000). The functional perspective focuses on speed of processing. Children with SLI respond more slowly than age-matched peers on a variety of linguistic and non-linguistic tasks (e.g., Lahey, Edwards, & Munson, 2001; Miller, Kail, Leonard, & Tomblin, 2001; Montgomery, 2000, 2002, 2005).

Linguistic accounts of SLI assume that grammatical weaknesses are the result of incomplete knowledge of particular rules, principles, or constraints. These theories differ in the specific type of knowledge that children are assumed to be lacking, but to date most focus on morphosyntactic limitations. Most theoretical explanations do not point to problems in the interface between semantics and syntax. However, existing data in the literature on SLI provide enough evidence that some deficits in production and comprehension can be analyzed and explained in terms of the structural characteristics of verbs. A comprehensive study that focused on argument structure in Dutch-speaking children with SLI revealed a weakness in argument structure, and proposed that this area should be incorporated into theories of SLI (de Jong, 1999).

Some studies documented a greater frequency of structural errors in sentence production patterns of children with SLI. However, de Jong suggested that argument structure weakness is best described not in terms of grammaticality, but rather in terms of complexity. Children with SLI commit occasional argument-structure errors, but their weakness is demonstrated by their tendency to use verbs with less complex argument structure. The findings of de Jong (1999) pointed to the number of arguments, the type of complements, and the multiple options for argument structures as complexity variables

that affect language production. The thematic structure of verbs was proposed as an additional complexity variable (Grela & Leonard, 1997; 2000). More data regarding verb complexity effects can be found in on-line verb processing studies of adults. The number of argument structure options affects verb activation time during sentence comprehension (Shapiro, Brookins, Gordon, & Nagel, 1991; Shapiro, Gordon, Hack, & Killackey, 1993; Shapiro & Levine, 1990; Shapiro, Zurif, & Grimshaw, 1987; Shapiro, Zurif, & Grimshaw, 1989).

An important theoretical issue pertains to the categorization of children with SLI into subgroups (e.g. Conti-Ramsden & Botting, 1999; Conti-Ramsden, Crutchley, & Botting, 1997). Researchers of either theoretical camp as well as clinicians who treat children with SLI agree that the term SLI refers to a heterogeneous group of children, who may differ significantly from one another in terms of their impaired language domain/s (word finding, phonology, morphology, syntax, semantics, and pragmatics). Recent studies provide increasing evidence that SLI may affect one particular language domain. Friedmann & Novogrodsky (2004; 2006a; 2007) reported a group of school-age children with SLI who have a syntactic deficit, without lexical retrieval or phonological deficits ("Syntactic SLI" (S-SLI), see also van der Lely, 1996; van der Lely & Christian, 2000; & van der Lely & Harris, 1990), a group of children with lexical retrieval deficits with intact syntactic ability ("Lexical SLI" (Le-SLI), see also Dockrell, Messer, & Murphy, 2005), and a group with a phonological deficit ("Phonological SLI" (Pho-SLI)). These findings suggest a modular organization within the language module, in which the different components of language function independently and may be selectively impaired. With regards to the lexical characteristics of verbs, an interesting question

concerns the relation between the function of children with SLI in this area and their function in the areas of syntax and semantics. These findings also point to the importance of defining the profile of children with SLI who serve as research subjects, and to the significance of adopting an individual perspective which should be incorporated into data analysis.

### Verb Deficits in SLI

A limited lexicon is one of the hallmarks of SLI. This deficit appears to affect verbs more than nouns. For example, preschool children with SLI have lower verb diversity as compared with age- or language-matched TLD children (Conti-Ramsden & Jones, 1997; Davidson, 2002; Fletcher & Peters, 1984; Jones & Conti-Ramsden, 1997; Rice & Bode, 1993; Watkins, Rice, & Moltz, 1993). Other studies, however, found comparable diversity, but only with younger, language-matched controls (de Jong, 1999; Grela and Leonard, 1997; Kelly, 1997; Kelly & Rice, 1994; Thordardottir & Ellis Weismer, 2002). Children with SLI use fewer tokens of the verbs they know (Jones & Conti-Ramsden, 1997; Thordardottir & Ellis Weismer, 2001, 2002). Even when children with SLI use or comprehend particular lexical items, they do not always show a complete mastery of these words (McGregor & Leonard, 1995). Children with SLI use more GAP than specific verbs (Davidson, 2002; De Jong, 1999; Rice & Bode 1993), but others did not provide evidence that the reliance on GAP verbs is a unique strategy of children with SLI (Conti-Ramsden & Jones, 1997; Kelly, 1997; Thordardottir & Ellis Weismer, 2001, 2002; Watkins et al., 1993). Children with SLI also have a higher rate of semantically incorrect use of verbs as compared with controls (Davidson, 2002; De Jong, 1999; Rice & Bode, 1993). Finally, children with SLI experience a particular difficulty in the

acquisition of new verbs, as compared with nouns (Fletcher & Peters, 1984; Oetting, 1999; Oetting, Rice, & Swank, 1995; Rice, Oetting, Marquis, Bode, & Pae 1994).

Despite some inconsistent findings, children with SLI appear to have an overall verb deficiency. Most explanations focused on the semantic, morphological, syntactic, and pragmatic characteristics of verbs that make them a complex lexical category for acquisition. However, children with SLI may also be impaired in their representation and access to the structural information for verbs, including syntactic subcategorizations and argument structure.

A number of investigations have examined argument structure in the language of children with SLI. The production of obligatory arguments was the focus of several studies. Rice & Bode (1993) found evidence for verb- and object-omission in language samples of three SLI subjects. However, there was a low incidence of errors and no control group. Davidson (2002) found an overall higher frequency of omission of obligatory sentence constituents (including subject, verb, and object) in productions of Hebrew-speaking children with SLI, as compared with both age-matched and language-matched controls, and Grela and Leonard (1997) found higher frequency of subject omission in productions of their SLI subjects as compared with language-matched controls. An earlier investigation, however, did not find differences in the frequency of object omission, which was low for children with and without SLI (King & Fletcher, 1993), but the children with SLI omitted obligatory direct objects of a greater variety of lexical verbs than their language-matched controls. This was also true in samples of Dutch-speaking children with SLI (de Jong, 1999). These omissions are limited in their

frequency, and some may reflect the influence of discourse, which makes them pragmatically acceptable.

A somewhat different approach to argument structure errors in production focused on subject and auxiliary verb omission in relation to lexical characteristics such as thematic roles and the number of arguments (Grela & Leonard 1997, 2000). Children with SLI and language-matched peers were more likely to include subject arguments in sentences with intransitive verbs (e.g. “*he is walking*”) than in sentences with transitive verbs (e.g. “*he ate the tiger*”) or ditransitive verbs (e.g. “*she gave the book to Bill*”). Children with SLI omitted subjects more frequently than control subjects when ditransitive verbs were present. Both groups of children tended to omit auxiliary “be” forms more frequently when attempting to produce sentences with ditransitive verbs compared to sentences that included intransitive (unergative) and transitive verbs.

Grela and Leonard also examined these production data in terms of the Unaccusativity Hypothesis (Perlmutter, 1978; Perlmutter & Postal, 1984). According to this hypothesis, there are two classes of intransitive verbs: unaccusatives and unergatives. Semantically, they differ in the thematic role of their subject, which is an agent for unergatives, and a theme or a patient for unaccusatives. Syntactically, the single argument of unaccusatives is a direct object. Thus, although superficially, the sentences “*the leaf fell*” and “*the bird chirped*” both have NP-V word order, the first involves NP movement from object to subject position while in the other the NP is base-generated in the subject position. Results revealed clear group differences. Children with SLI omitted the sentence subject significantly more often when they attempted to produce sentences containing unaccusative verbs, as compared with unergative verbs. The effect of thematic

structure was not found in productions of the language-matched controls. This finding was attributed to difficulty with the movement operation required for the use of unaccusatives or to the difficulty assigning a thematic role to the subject position, because this case represents an incongruence of thematic role assignment and case marking. Thus, lexical characteristics of verbs affect production patterns of sentences by both TLD and SLI children. Generally, more arguments elicit more errors, and unaccusative verbs elicit more errors than unergative verbs. These effects distinguished the productions of children with SLI from productions of their language-matched controls for the most part, and appear to be complexity-related.

There is further evidence of overall correct, but less sophisticated use of verbs by children with SLI as compared with TLD controls (de Jong, 1999; King, 1994; Thordardottir & Ellis Weismer, 2002). Thordardottir and Ellis Weismer (2002), for example, found that children with SLI had a significantly lower repertoire of argument types (thematic roles) and argument structure types (in terms of the number of arguments) as compared with age-matched and language-matched controls. Children with SLI tended not to include the beneficiary argument for ditransitive verbs, thus reducing a potential three-place argument structure to a two-place one. In addition, four-place argument structures were used exclusively by the TLD children. Similar production patterns were obtained in an investigation of Dutch-speaking children with SLI (de Jong, 1999). These children used more verbs intransitively, and fewer verbs with more than one internal argument (especially with NP-PP complements), as compared with language-matched controls. However, the group differences in this last study fell short of statistical significance, except for a sub-group of five individually matched pairs. Thus, group

variability and small numbers led to the non-significant findings. The main limitation of these studies is their method, which involves determining the presence or absence of certain structures in spontaneous productions. When the target structures are not found, there is no way of telling whether the subjects experience a real difficulty in using them, or simply did not have a chance to use them. Nevertheless, these studies did point to an area of weakness for school age children with SLI; they tended to avoid the use of verbs with more complex argument structures (i.e., more arguments) and their sentence productions contained a narrower range of thematic roles.

The production of argument structure by children with SLI was also studied in relation to argument structure alternations. When children acquire the structural properties of verbs, they have to learn that certain verbs may alternate between two different argument structures. One challenge is to distinguish between verbs that can alternate and verbs that cannot. This topic has been investigated extensively in typical language development (Bowerman, 1974; Braine, Brody, Fisch, & Weisberger, 1990; Lord, 1979; Pinker, 1989). Using both alternatives for the same verb requires that both structures are lexically represented. Studies that focused on the ability of children with SLI to use such alternations provided mixed results. Examinations of causative and locative alternations (King, Schelletter, Sinka, Fletcher, & Ingham, 1995; Loeb, Pye, Richardson & Redmond, 1998) revealed no differences between English-speaking children with SLI and children with TLD. However, de Jong (1999) did find that Dutch-speaking children with SLI used fewer inchoative-causative-, locative-, and dative-alternations as compared with their TLD controls. In a sentence elicitation procedure, children with SLI produced both alternants of the same verb less often, and preferred the

shorter alternative in comparison with their language-matched controls. Such results are compatible with the findings that productions of children with SLI are mostly correct but less varied, in terms of the full range of argument structures that are possible for various verbs. They point to a possible extraordinary difficulty of children with SLI in acquiring and using the multiple structural options available for the same verb.

The reviewed findings provide initial evidence that the structural characteristics of verbs play an important role in the verb use of children with SLI. Specifically, a verb's number of arguments, its thematic structure, and its multiple options for argument structures, are all important variables that affect production patterns. However, existing data are limited in a number of ways. Most studies focused on production patterns, but to learn about the status of structural representations in SLI, comprehension processing are needed. The majority of findings are derived from language samples. Samples provide a good indication of what children prefer to use, rather than what children can use. To determine the effects of various structural variables on sentence processing, more experimental data are needed, in which such variables can be manipulated and controlled. Most studies have been conducted with English-speaking children which limits generalizability to other languages. Finally, although there is evidence that impaired production patterns in SLI can be attributed to complexity variables related to the lexical representation of verbs, no studies have examined the initial, more automatic stage of lexical access.

#### Verb Effects in Adult Sentence Processing

On-line methods are believed to reflect details of the ongoing comprehension process. They are less prone to conscious reflection and capture the more automatic, fast-

acting aspects of language processing. Previous studies of verb processing have employed the Cross-Modal Lexical Decision (CMLD) paradigm. This paradigm involves a standard assumption of dual cognitive tasks competing for the same limited resources. The two competing tasks are typically presented to subjects through two different modalities: auditory and visual. As aspects of sentence processing increase in complexity, processing capacity for the secondary (visual) task decreases. Thus, verbs for which the lexical representation is more complex should take longer to access and consequently, result in longer reaction times (RTs) to the visual probe.

On-line verb processing has been examined in neurologically-intact (NI) adults and in adults with aphasia. A number of studies have examined whether the amount of structural information in verb entries affects sentence processing. When the parser encounters a verb, it momentarily activates all possible structural arrangements for that verb. Thus, measuring processing load at the immediate vicinity of the verb should reflect the amount of lexical information that is activated with that verb.

In a series of studies, Shapiro and his colleagues demonstrated that the number of argument structure possibilities is the crucial factor that directly affects verb processing. In their first study, Shapiro et al. (1987) examined the effects of the number of possible argument structures, the number of possible strict subcategorizations, and the number of arguments. Verbs with more argument structure options elicited longer RTs to the visual probes than verbs with fewer options for argument structures.

The effect of argument structure complexity was replicated in several later studies (Shapiro et al., 1989; Shapiro & Levine, 1990; Shapiro et al., 1991; Shapiro et al., 1993). This effect was found even when subjects listened to sentences that were structurally

biased towards one particular argument structure (Shapiro et al., 1989), regardless of sentence type (Shapiro et al., 1993), and only at the vicinity of the verb (Shapiro & Levine 1990). When the visual probe was presented to subjects a few syllables downstream from the verb, the argument structure complexity effect was no longer present.

One study, however, challenged these findings. Aherns & Swinney (1995) suggested that the relevant complexity metric was not the number of internal argument structures for a verb, but instead, the number of actual thematic roles (*participant roles*) that are associated with the central sense of the verb. They examined argument structure complexity by comparing verbs with two thematic roles and one possible argument structure to verbs with two thematic roles and three possible argument structures. Participant role complexity was examined by comparing verbs with two possible argument structure and one participant role to verbs with two possible argument structures and three participant roles. Sentences containing verbs with three-participant-roles induced significantly longer RTs to the visual probe than sentences containing verbs with one-participant role. There was no evidence for a relation between the number of argument structures and increase in processing load.

Verb processing during on-line sentence comprehension has also been examined in adults with aphasia. Like children with SLI, individuals with aphasia have verb-related semantic, syntactic, and morphological difficulties in production and comprehension. Adults with agrammatic Broca's aphasia exhibited a normal pattern of activation, reflecting the same verb effects as NI listeners (Shapiro & Levine, 1990). A fluent aphasic group did not exhibit this pattern of activation. The same results were obtained

even when more complex sentences were used. Shapiro et al. (1993) found that accessing argument structure information appears normal for agrammatic Broca's patients even when they listen to sentences containing trace-antecedent relations, which they cannot normally interpret. The Wernicke's aphasic patients were not sensitive to the thematic properties of verbs in any of the sentence types. Verb argument structure activation appears to be independent from the subsequent integration of this information for the ultimate comprehension of the sentence.

In summary, on-line studies of verb processing in NI adults suggest that the lexical characteristics of verbs are significant for sentence processing. The number of argument structure possibilities was found in several different studies to be the crucial factor affecting verb activation time, although the number of participant roles inherent in the central sense of the verb was also found to be a potential complexity factor. Different aphasic patients were found to be selectively impaired with regards to the activation of the lexical information for verbs. Thus, the mechanism of activating verbs from the lexicon appears to be independent from other operations required for correct sentence comprehension.

#### Sentence Comprehension and Argument Structure in SLI

Several recent investigations have focused on syntax comprehension. A consistent finding is that children with SLI have a significant difficulty comprehending a variety of sentence structures that are derived by movement of a phrase that results in a non-canonical order of the arguments (Friedmann & Novogrodsky, 2003, 2004; Stavrakaki, 2001; van der Lely & Harris, 1990). For example, Friedmann & Novogrodsky (2004) found that children with S-SLI had significant difficulty comprehending object-relatives.

These authors proposed that in addition to a problem in phrasal movement, the non-canonical order of arguments in object relatives created a problem in thematic role assignment for the moved element, which forced the SLI subjects to resort to a guessing strategy. Two later studies (Friedmann & Novogrodsky, 2006b; Friedmann, Gvion, & Novogrodsky, 2006) further explored the object relative comprehension deficits in children with S-SLI. These studies employed two tasks. In the first, children read aloud object relative sentences that included noun-verb heterophonic homographs (words that are written the same way but that can be read with two different pronunciations depending on whether they serve as a noun or a verb) after the trace. This assessed the children's abilities to construct the syntactic structure of the sentences. The second task required the children to paraphrase object relatives. This assessed the ability of subjects to transfer the correct thematic roles from the trace to the moved element, and consequently, to comprehend these sentences correctly. Children with SLI were able to read the homographs correctly, but they failed to interpret the object relatives, as expressed in various thematic role errors. Although the representation of thematic roles was not specifically targeted in this study, these findings show that the correct use of thematic roles is affected by the syntax of the sentence. Despite an ability to construct the correct syntactic structure with the trace in the correct position, children with S-SLI have a deficit in the integration of lexical knowledge with the required syntactic operation, resulting in thematic role errors and failure to comprehend object relatives.

The lexical representation of argument structure may indeed be intact in SLI, within the context of a significant impairment in syntactic comprehension. A syntactic treatment study examined one child with S-SLI (12;2) who had significant difficulties in

the comprehension and production of structures containing syntactic movement and canonical order violation (Levy & Friedmann, in press). His sensitivity to argument structure was intact, as demonstrated by his unimpaired performance on a sentence production task. He was explicitly taught syntactic rules. The therapy program began with an explanation of verb argument structure and the Theta Criterion, to make his apparent implicit knowledge explicit, so it could be used as an anchor for further comprehension of sentences with movement. The treatment included identifying the verb and its arguments, at first in simple SVO sentences, then in semantically irreversible sentences that contain movement, and finally, in semantically reversible sentences that contain movement. He improved in all syntactic structures compared to baseline. Thus, the use of intact sensitivity to verb argument structure contributed to the treatment of syntactic impairments,

In summary, studies of sentence comprehension in children with S-SLI suggest that the two processes required for sentence comprehension, the construction of syntactic structures containing movement and the assignment of thematic roles to moved elements, are independent. In addition, the representation of argument structure appears to be independent from the construction of structures derived by movement, and from the ability to assign thematic roles to arguments that are arranged in non canonical order. Intact argument structure representations may be used to facilitate an improvement in sentence comprehension. Thus, it is important to consider the interaction between lexical representation and syntax, and to clearly separate the effect of syntactic operations from the representation and use of argument structure. The subjects in these studies were specifically defined as S-SLI, based on a thorough assessment of their linguistic

functions. Focusing on a specific subgroup of SLI may potentially reduce the inconsistency and mixed patterns of results that are often reported in the literature on SLI.

### SLI Research in Hebrew

The current study was conducted on Hebrew-speaking children with SLI. Like children with SLI who speak other languages, they show the familiar pattern of delayed and slow lexical development, and late emergence of grammar. Their language is characterized by phonological and pragmatic deficits as well (Dromi, Leonard, & Blass, 2001). Two major research approaches can be found in the literature. One group of researchers focused on the specific typological characteristics of Hebrew in order to determine their effects on the language impairment profile. As a Semitic language, Hebrew has a rich, verb-related, morphological system. Inflectional morphology on the verb specifies features of tense, finiteness, and agreement. Interestingly, Hebrew-speaking children with SLI do not demonstrate particular difficulty in mastering the variety of inflections that are required for verb use in Hebrew (Dromi, Leonard, Adam, & Zadoneisky-Erlich, 1999; Dromi et al., 2001; Dromi, Leonard, & Shteiman, 1993; Leonard & Dromi, 1994; Leonard, Dromi, Adam, & Zadoneisky-Erlich, 2000; Rom & Leonard, 1990).

The second research approach has not focused on the characteristics of Hebrew. Instead, production or comprehension processes were analyzed in order to characterize impairment patterns. Using the Hebrew Index of Productive Syntax (IPSyn), Davidson (2002) found that the SLI children produced grammatical errors in a significantly higher rate than their age-matched controls. In comparison with language-matched controls, the SLI group differed in the frequency of: (1) major sentence constituent omissions, (2)

deviant semantic use of words, and (3) addition of extra, unnecessary words or morphemes. These errors reflect an extraordinary difficulty with the use of verbs and with the expression of argument structure.

Syntactic comprehension was the focus of several recent investigations that were described in the section on sentence comprehension and argument structure (Friedmann & Novogrodsky, 2004; Friedmann & Novogrodsky 2006b; Friedmann, Gvion, & Novogrodsky, 2006; Levy and Friedmann, in press). As described, their findings were consistent with findings from other languages, showing that children with S-SLI have extraordinary difficulty comprehending syntactic structures that are derived by movement and that contain non-canonical order of arguments. In these studies the specific features of Hebrew were used in the task design (e.g. the under-specification of vowels in the Hebrew writing system which creates a variety of homographs, see Friedmann & Novogrodsky 2006b; and Friedmann, Gvion, & Novogrodsky, 2006). In summary, studies that targeted syntactic production (Davidson, 2002) and syntactic comprehension (Friedmann & Novogrodsky, 2004; Friedmann & Novogrodsky, 2006b; Friedmann, Gvion, & Novogrodsky, 2006; & Levy & Friedmann, (in press)) demonstrated that syntax represents a main area of impairment for Hebrew-speaking children with SLI.

The current study targeted Hebrew verbs (see Berman, 1985, for a description of the Hebrew verb system). Tense and agreement inflections were considered during the construction of stimuli for the online experiment (see the Method section of Experiment 3). An important feature of Hebrew verbs is their system of patterns (*binyanim* = plural for *binyan* = a verb pattern). All Hebrew verbs are combined from two morphemes: a tri-consonantal root, and a *binyan*. The *binyan* is a morpho-phonological template, combined

of various suffixes and vowels. The *binyanim* are represented as a combination of upper-case letters such as "KTL" (representing the root) and lower case letters (representing the suffixes or vowels of the template). There are seven different *binyanim* for verbs in Hebrew, but only five are normally used by preschool and school-age children: *KaTaL*, *niKTaL*, *KiTeL*, *hiKTiL*, & *hitKaTeL*. The *binyanim* are associated with particular semantic notions (i.e. causality, reflexivity, reciprocity, etc.), and with particular argument structures, but the system as a whole is only partially regular. In the online experiment of the current study (Experiment 3), two types of analyses have compared between different verb categories that can be found within the same *binyan*. Verbs in *binyan hiKTiL* that can be used within a single, causative structure were compared with verbs that can be used within two, causative and unaccusative structures. In addition, unergative verbs in *hitKaTeL* were compared with unaccusative verbs from the same *binyan*. An attempt was made to control the effect of *binyan* complexity for the two other analyses that were conducted in the online experiment, by having the different *binyanim* equally or near-equally represented in the verb categories that were compared.

#### Summary and Rationale

Current linguistic accounts of SLI do not focus on the structural representation of verbs as a major impairment area. The present study will attempt to determine whether this type of linguistic knowledge is impaired in SLI. In addition, a suggestion was made that this area is impaired in SLI not in terms of grammaticality, but rather in terms of complexity (de Jong, 1999). There is a need to look at this area from both grammaticality and complexity perspectives. The use of a variety of tasks, including sentence production, grammaticality judgment, ungrammaticality correction, and online verb processing,

provides an opportunity for a comprehensive examination of this area and for the analysis of performance patterns according to grammaticality and complexity aspects.

The documented heterogeneity of SLI is receiving a new, more specific definition, as recent investigations provide increasing evidence for selective impairments. In particular, children who exhibit syntactic limitations without lexical-semantic deficits are distinguished from children who exhibit mostly lexical-semantic deficits and no syntactic difficulties. These findings raise the importance of defining the specific SLI subjects used in research. In addition, it emphasizes the modular nature of the cognitive system, in which particular functions may be impaired while others remain intact. The current study adopts this view by analyzing performance patterns in terms of associations and dissociations between specific types of linguistic operations.

Findings from studies on the lexical-verb deficits of children with SLI are somewhat inconsistent due to methodological concerns. First, most studies do not define the particular impairment profile of their subjects. It is possible that the heterogeneity of subjects in these studies created a mixed pattern of results. In addition, most data were gathered from English-speaking children through the use of language samples. There is a need to use experimental, structured tasks, and look at the performance of children with SLI in a language with different characteristics, in order to shed additional light on the verb deficits associated with SLI. The present study employed four different experimental tasks, in which both production and comprehension of children with SLI were examined. The subjects were Hebrew speakers.

Despite a certain degree of inconsistency, existing findings from SLI provide enough evidence for an overall deficiency, and they justify further investigation.

Recorded deficits include: reduced verb lexicon, higher frequency of grammatical errors related to argument structure in sentence production, and limited and less sophisticated production of argument structures, expressed in the avoidance of complex argument structures and infrequent production of multiple structural options that are available for certain verbs. In the present study, grammaticality was addressed with two production tasks: production of sentences for given verbs, and production of corrections for ungrammatical sentences. The grammatical errors produced by the children with and without SLI on both tasks were counted and analyzed. In addition, the sentence production task provided a certain lexical measure of the participants' familiarity with specific, selected verbs, as expressed in the number of "don't know" (DK) responses. A grammaticality judgment task has also been employed, in order to examine the sensitivity of children with SLI to the specific sentential complements of verbs. The verbs used in this task represented a more complex category, both semantically and syntactically. Semantically, most of the verbs used in this task can be defined as *cognitive* (i.e. *believe, suspect, regret*) or *information-transfer* (i.e. *confirm, claim, promise*), in addition to a few modal verbs (i.e. *can, may, dare*) and aspectual verbs (i.e. *begin, continue, finish*). Syntactically, these verbs select multiple options for sentential complements. It should be interesting to examine whether the documented limitation that children with SLI were found to have in their spontaneous use of such verbs is extended to a difficulty in judging the grammaticality of sentences that contain them. Finally, the complexity issue was addressed by focusing on three structural characteristics that have been found to affect performance patterns of children with SLI: the number of arguments, the number of

structural options, and thematic structure, and analyzing their effects on sentence processing by using an online method.

Online studies of verb processing in adults have shown that the lexical characteristics of verbs affect sentence processing, but there is some disagreement about the particular lexical property which is most significant during verb activation: the number of argument structure options, or the number of participant roles. In the present study, an online experiment was designed to specifically determine which, out of three lexical characteristics, affect verb activation time. Selected verbs were arranged in three different complexity hierarchies. The first complexity hierarchy focused on the number of arguments. To avoid possible confusion between arguments and participant roles, only verbs for which these two representational concepts were conflated, were used. Thus, verbs with one obligatory argument/thematic role, verbs with two obligatory arguments/thematic roles, and verbs with three arguments/thematic roles, were compared.

The second complexity hierarchy focused on the number of argument structure options, as defined by Shapiro et al. (Shapiro et al., 1987; Shapiro et al., 1989; Shapiro et al., 1991; Shapiro et al., 1993; Shapiro & Levine, 1990). However, the present study proposed a somewhat different definition for the actual variable being tested. The three types of sentential complements (propositions, interrogatives, and exclamations) represent different semantic types within the same syntactic category (S). However, treating the different types of sentential complements from a semantic perspective only provides an incomplete description of their characteristics. In fact, propositions (P) clauses are very different syntactically from exclamations (E) and interrogatives (Q). Proposition clauses in Hebrew require the use of the complementizer *she* (that) in C<sup>0</sup>.

Interrogatives and exclamations require control over question constructions, which involve a syntactic movement into spec-CP. In addition, infinitival complements constitute an additional semantic and syntactic category. The use of infinitival constructions requires the acquisition of control properties of PRO (a phonetically-empty element that serves the function of the clause's subject). Thus, finding that verbs with more options for different sentential complements exert more processing effort on listeners than verbs with less sentential complements may reflect the burden of their different syntactic operations, rather than the burden of their semantic differences. In any case, rather than following the linguistic definitions of “strict subcategorizations” and “argument structures”, I decided to simply compare between verbs that have a different number of structural options. I treat the different types of sentential complements separately, in accordance with the argument structure definition of semantic types. By calling them “structural options” I acknowledge the fact that they are different syntactically as well. I also treat the option for an infinitival complement separately. Since these complements convey the meaning of an action, I classify them as “A”.

As an example, the Hebrew verb *lamad* (learn) has 7 different structural options according to my definition. It selects 6 different types of phrasal and sentential complements, in addition to an option of being used with no complements:

1. *Hu lamad* (He studied). [ \_ ] = no complement.
2. *Hu lamad et ha-nose* (He learned the subject). [ \_ NP]
3. *Hu lamad al dinosaurim* (He learned about dinosaurs). [ \_ PP]
4. *Hu lamad she-hem metu* (He learned that they died) [ \_ P]
5. *Hu lamad eifo hem xayu* (He learned where they lived) [ \_ Q]

6. *Hu lamad kama ze meanyen* (He learned how interesting this is). [\_ E]
7. *Hu lamad lirkav al ofanaim* (He learned to ride a bicycle). [\_ A]

Finally, the third complexity hierarchy targeted two categories of verbs with a different thematic structure. Unaccusative verbs were compared with unergative verbs. Reviewed findings (Grela & Leonard, 1997), in which unaccusative verbs were found to elicit more production errors for children with SLI, raised a question about whether the complexity effect of this variable extends to the very initial stage of verb activation during online sentence comprehension.

The study of verb effects during on-line sentence processing raises new possibilities for studying child language in both unimpaired and impaired populations. The use of on-line methods with children has been quite limited so far. These techniques have the potential of revealing complexity effects that may not be detected with other methods, and they can be used for comparing the performance of children with and without SLI. When young children are involved, the task is naturally changed. For example, several studies have used pictures instead of written words as their visual probes. Children were instructed to make a lexical decision such as whether the object in the picture is animate or not, or whether it is edible or not (Love & Swinney, 1997; McKee, Nicol & McDaniel, 1993; Roberts, Marinis, Felser, & Clahsen, 2007; Swinney, Shapiro, & Love, 1998). Recently, a new method for the study of on-line sentence processing has been successfully used with English-speaking adults. Violet and Shapiro (2005) have developed a *pitch change method*, in which the detection of a pitch change occurring over one target lexical item within a sentence served as a measure of learning about the particular time at which role filler information (also known as *thematic fit*)

becomes available to the human parser. Their findings strongly supported the usefulness of the pitch change method for studying aspects of on-line sentence comprehension. This new method is particularly appealing for research with children. The task is challenging enough on the one hand, but simple and easy to explain on the other hand. Consequently, this task was used in the present study for the purpose of detecting verb complexity effects.

Sentence comprehension studies in SLI suggest that the relation between the structural characteristics of verbs and syntax should be carefully evaluated. Syntactic structures in general, and structures derived by movement in particular, were found to affect the ability of subjects to assign correct thematic roles to arguments of verbs. Any research that targets sentence comprehension should distinguish between the representation of arguments and thematic roles and the use of these representations for the purpose of sentence comprehension. There is evidence that even when representations are intact, the use of this knowledge may be impaired at later stages of sentence processing.

#### Research Questions and Predictions

The main theoretical question addressed by the present study concerns the status of the lexical representation of verbs in the language of children with SLI: Is it impaired or intact? The specific goal was to determine whether Hebrew-speaking children with SLI are affected by the structural characteristics of verbs in the same way as TLD children. Three experiments were planned to address this question. The use of three different methodologies allowed for a comprehensive and detailed look at different aspects of this lexical knowledge.

Experiment 1 targeted sentence production. Do children with SLI commit more errors related to the number and type of arguments and complements, when they produce sentences for specific verbs as compared with age-matched TLD children? A secondary goal of this experiment was to examine the subjects' familiarity with verbs that were selected as stimuli for Experiment 3. The verbs were presented to children by the experimenter, one verb at a time. The children were asked to produce a sentence for each verb. Previous findings regarding structural errors in spontaneous productions were not consistent in terms of finding clear group differences between children with and without SLI. Finding a significantly greater number of such errors in productions of the SLI participants in this task will provide support for the proposal that SLI involves grammaticality impairment in using the structural requirements for specific verbs. In addition, a greater number of "don't know" responses among the SLI participants will support a verb lexical deficit.

Experiment 2 targeted the meta-linguistic knowledge regarding sentential complements. Are children with SLI sensitive to the specific types of sentential complements that are selected by particular verbs in the same way as TLD children? This question was addressed with two related tasks that focused on judgment and production. In the judgment task children had to judge the grammaticality of sentences in which the verb was followed by either a complement it selects, or by a complement it does not select. This task reflects a meta-linguistic awareness to this aspect of sentences, and it does not involve the burden of language production. However, when a sentence was judged as ungrammatical, the participant was asked to produce a correction for it. This task can be considered more challenging, as it requires the production of a grammatical

sentence, based on to the exposure to an ungrammatical stimulus. It is hypothesized that sensitivity to this lexical characteristic may be an area of difficulty for children with SLI. Thus, performance patterns in which the children with SLI commit more errors in the two parts of this task (judging grammaticality of sentences and correcting the ungrammatical ones) were expected. The accuracy rate of the SLI group was expected to be lower as compared with the TLD group on both measures.

Experiment 3 targeted the very initial and automatic stage of lexical activation during sentence comprehension. Which structural characteristics of verbs create complexity effects during on-line sentence comprehension for children with and without SLI and for NI adults? This question was addressed with an on-line pitch change method. The experiment was structured to examine the effects of the three lexical characteristics that have been found by previous studies as significant for both lexical access and for correct sentence production: (1) the number of arguments, (2) the number of structural options, and (3) the thematic structure of verbs. These three variables were analyzed within a complexity hierarchy perspective in order to determine the effect of each one of them on the time it takes listeners to activate verbs from their lexicons. The performance of children with SLI was compared to the performance of age-matched controls, to determine whether the language impairment can be attributed to this initial stage of processing. In addition, performance patterns of both groups of children were compared to performance of NI adults, who represented the normative, mature performance of native speakers on this task. Predicted patterns of RTs were based on previous findings, according to which all three variables have the potential of affecting processing load of listeners. Thus, finding longer RTs to the pitch change when subjects listen to sentences

containing the more complex verbs as compared with verbs that are less complex should reflect the effects of these variables on on-line sentence processing. The above predictions applied to the normative, unimpaired performance of NI adults. The performance of the TLD children was generally expected to be similar, with any difference attributable to maturation and experience. Because the verbs selected were familiar to the children (as demonstrated by Experiment 1), the same pattern of results with perhaps somewhat slower overall RTs was expected for the TLD group. The main research question concerned the performance of the SLI group in relation to their age-matched controls. If SLI involves impairment to the representations of or in the access to the structural characteristics of verbs, then children with SLI are expected to exhibit sensitivity to such complexity effects that differs from their TLD peers. Their sensitivity could differ in several ways: (1) children with SLI could be unaffected by complexity effects at all. A more like outcome was that children with SLI would be more affected by complexity than the TLD peers. A final possibility was that children with SLI would exhibit the same complexity effects but would do so within the context of overall slower RTs.

## **Experiment 1**

### Method

The main goal of this experiment was to compare the production of sentences by children with SLI and their age-matched peers, in relation to the number and type of arguments and complements of verbs. A secondary goal of this experiment was to determine whether the particular verbs that were chosen to serve as stimuli for the online experiment (Experiment 3) were familiar to the subjects.

### Participants

Thirty-two subjects participated in the study, constituting two groups. The experimental group consisted of 16 children with SLI, 9 males and 7 females, who ranged in age from 8;5 to 12;6 years. The control group consisted of 16 Typically-Language-Developing (TLD) children, 8 males and 8 females, who ranged in age from 9;2 to 12;4. An attempt was made to pair-match the two groups of children for chronological age (the difference in months for 12 pairs was between 0-5 months, the difference in months for two additional pairs was 8-9 months), grade (9 pairs were from the same grade and 7 additional pairs were one grade different), gender (for 11 pairs), socio-economic status, and overall group means for non-verbal intelligence (score on the Raven Matrices Test). Table 1 summarizes the characteristics for the two groups of children.

Table 1  
Subject Characteristics for SLI &d TLD Groups

SLI Group					TLD Group				
Child	Gend.	Age	Grade	Raven	Child	Gend.	Age	Grade	Raven
1	M	8;5	3	103	17	M	9;2	3	112
2	F	9;0	3	94	18	M	9;2	4	116
3	M	9;0	4	111	19	M	9;2	5	112
4	M	9;2	3	105	20	M	9;2	3	104
5	F	9;2	3	121	21	M	9;3	4	114
6	M	9;6	4	86	22	F	9;11	4	115
7	F	9;9	4	100	23	F	10;2	5	118
8	F	9;10	5	96	24	F	10;2	5	118
9	F	10;0	5	108	25	F	10;1	5	121
10	M	10;2	5	120	26	F	10;5	4	101
11	M	10;2	5	127	27	M	10;6	5	113
12	M	10;10	5	103	28	F	10;7	5	93
13	F	11;0	5	113	29	F	11;8	6	101
14	F	11;7	5	108	30	F	11;9	6	102
15	M	11;7	6	99	31	M	12;0	6	112
16	M	12;6	6	87	32	M	12;4	6	112
<b>Average</b>				<b>105.06</b>	<b>Average</b>				<b>110.25</b>
<b>SD</b>				<b>11.66</b>	<b>SD</b>				<b>7.75</b>

Note. Children are presented according to matched pairs, from youngest to oldest.  
 Gend. = gender.

The SLI children were recruited by approaching local psychologists, school advisors, special-ed teachers, and speech-language pathologists. After they were given

information about the study, these professionals referred parents of potential SLI subjects to the researcher. The TLD children were recruited by fliers posted in public places within the experimenter's home town. Parents of children subjects filled out a language background questionnaire to eliminate children with histories of neurological impairment, gross motor, emotional, or other medical problems (see Appendix A). All children participants passed a hearing screening (20dB HL at 500, 1000, 2000, & 4000 Hz). One child who did not pass the hearing screening was excluded from the study. Adult participants reported no known history of hearing, language, or learning disabilities. All participants in this study came from typical upper-middle class Israeli homes, and gave their consent for participation in the study.

Prior to the beginning of the experiment, all children underwent a complete speech and language evaluation using a variety of clinical tests. Children were categorized as SLI or TLD based on the results of this evaluation. Children whose scores deviated from the norms on at least two of the tests were assigned to the SLI group. All other children were assigned to the TLD group. Two children were eventually excluded from the study because they presented with mixed results and their language status was undetermined.

The diagnostic battery focused on syntactic, phonological, and lexical-semantic aspects of language. The syntactic testing (see Table 2) included: (1) the BABMI-ZTI Comprehension of Relatives Test, which examines children's comprehension of subject- and object-relatives using a sentence-picture matching task (Friedmann & Novogrodsky, 2002, 2004; Friedmann & Shapiro, 2003), (2) the BAMBI-SINUN Sentence Repetition Test, which examines the ability of children to repeat sentences with various syntactic

structures, including verb movement, various types of complements and adjuncts, passive sentences, OSV structures, and object relatives (Friedmann & Novogrodsky, 2002), and (3) the BAMBI-ADIF Production of Relatives Test, which examines children's ability to respond to questions by using relative clauses (Friedmann & Novogrodsky, 2002; Novogrodsky & Friedmann, 2006) The phonological testing (see Table 3) included: (a) the BLIP-Repetition Test, which examines the ability of children to correctly repeat real and nonsense words with various phonological structures (Friedmann, 2003), and (b) the BLIP-Judgment Test, which examines the sensitivity of children to the phonotactic rules of Hebrew by making plausibility judgment for minimal pairs of nonsense words (Friedmann, 2003). The lexical-semantic testing (see Table 3) included: (1) the auditory associations sub-test of the ITPA, which examines the ability of children to make semantic analogies (Kirk, McCarthy, & Kirk, 1971), (2) the MAASE Lexical-Semantic Test, which examines expressive semantics, using tasks such as naming items to a given category, finding similarities and differences between two objects, explaining the two meanings of homonyms, and describing various objects (Rom & Morag, 1999), and (3) the SHEMESH Naming Test, which examines the ability of children to name 100 objects presented in pictures (Biran & Friedmann, 2004, 2005). The number of semantic errors that were produced by children when attempting to repeat sentences on the BAMBI-SINUN test was also included in the lexical-semantic analysis as an additional measure of semantic function.

The ITPA & MAASE tests provide age-reference scores to which the performance of individual children can be compared. However, no standard or age-equivalent scores are currently available for the BAMBI battery, the BLIP battery, and

for the SHEMESH test, despite their extensive use with children from a variety of age groups for research purposes. In order to determine whether children were impaired on these tests I used the modified t-test (Crawford, Garthwaite, & Howell, 2004; Crawford & Howell, 1998), which is specifically designed for comparing an individual's test scores against norms derived from relatively small samples of control groups. The scores of every SLI subject on each of the tasks were compared to the mean of the control group. Scores that were found to be significantly different were taken to indicate impaired performance (see shaded scores in Tables 2 and 3). For all analyses, an alpha level (two-tail) of .05 was used. Finally, the Raven Matrices Test (Raven, Court, & Raven, 1977, 1995) was used to screen out children with cognitive limitations. Only children whose scores fell within one SD of the mean for their age were included in the study.

At the end of the diagnostic process, an overall intra-linguistic profile was compiled for the SLI subjects (see Table 4). The various measures that were used to assess each language domain were counted, as an indication of severity. As can be seen, individual children vary in their overall profile and in the degree of severity by which each domain is affected. Out of the 16 SLI participants, 15 were found to be impaired on at least one syntactic test, 11 were found impaired on at least one phonological test, and 15 were found to be impaired on at least one lexical-semantic measure. Thus, the SLI group consisted of children's whose language impairment was not specific to one language domain. In fact, 10 participants were found to be impaired on all three domains (with varying degrees of severity), 5 subjects were impaired on two language domains, and only one child showed a selective impairment in syntax.

Table 2

Results of Diagnostic Syntactic Tests for SLI & TLD Subjects

Test	BAMBI-ZTI		BAMBI-SINUN			BAMBI-ADIF	Child Category
	No. of Correct Res. on Object Relatives (total = 20 items)	No. of Errors + Hesitations (total = 60 items)	No. of Structural Errors (total = 28 items)	No. of Correct Res. (total = 28 items)	No. of Correct Res. on R, P, T (total = 13 items)	No. of Correct Res. on Object Relatives (total = 60 items)	
9	16	9	2	<b>24</b>	<b>11</b>	6	SLI
14	19	5	1	26	12	3	SLI
8	18	<b>17</b>	<b>3</b>	<b>23</b>	<b>11</b>	<b>0</b>	SLI
10	16	7	<b>5</b>	<b>20</b>	<b>7</b>	<b>4</b>	SLI
6	20	8	<b>4</b>	<b>19</b>	<b>7</b>	<b>5</b>	SLI
16	18	<b>10</b>	2	<b>25</b>	<b>11</b>	<b>0</b>	SLI
11	17	5	<b>3</b>	<b>23</b>	<b>9</b>	6	SLI
15	<b>15</b>	<b>11</b>	<b>3</b>	<b>24</b>	10	6	SLI
3	20	1	<b>11</b>	<b>14</b>	<b>5</b>	<b>0</b>	SLI
13	<b>15</b>	5	<b>5</b>	<b>18</b>	<b>8</b>	<b>2</b>	SLI
4	16	4	<b>4</b>	<b>20</b>	<b>8</b>	<b>2</b>	SLI
12	19	3	1	<b>23</b>	12	6	SLI
7	17	8	2	<b>24</b>	<b>9</b>	<b>4</b>	SLI
2	<b>11</b>	<b>13</b>	<b>13</b>	<b>10</b>	<b>2</b>	<b>5</b>	SLI
5	<b>14</b>	<b>12</b>	2	<b>19</b>	<b>7</b>	6	SLI
1	<b>12</b>	<b>12</b>	<b>5</b>	<b>20</b>	<b>9</b>	<b>2</b>	SLI
<b>Mean</b>	16.44	8.13	4.13	20.75	8.63	3.38	
<b>SD</b>	2.63	4.24	3.36	4.23	2.68	2.47	

Table 2 Cont.

Test	BAMBI-ZTI		BAMBI-SINUN			BAMBI-ADIF	Child Category
	No. of Correct Res. on Object Relatives (total = 20 items)	No. of Errors + Hesitations (total = 60 items)	No. of Structural Errors (total = 28 items)	No. of Correct Res. (total = 28 items)	No. of Correct Res. on R, P, T (total = 13 items)	No. of Correct Res. on Object Relatives (total = 60 items)	
28	20	2	2	26	12	6	<b>TLD</b>
25	20	3	0	27	12	6	<b>TLD</b>
24	20	5	1	27	12	6	<b>TLD</b>
23	20	1	0	28	13	6	<b>TLD</b>
19	20	1	0	27	12	6	<b>TLD</b>
30	20	9	0	27	12	6	<b>TLD</b>
18	20	3	0	28	13	6	<b>TLD</b>
21	19	3	<b>3</b>	<b>25</b>	12	6	<b>TLD</b>
29	20	1	1	26	12	<b>5</b>	<b>TLD</b>
20	17	7	1	26	13	<b>5</b>	<b>TLD</b>
32	18	5	0	27	12	6	<b>TLD</b>
31	17	5	0	28	13	6	<b>TLD</b>
27	20	2	0	28	13	6	<b>TLD</b>
22	20	5	0	28	13	6	<b>TLD</b>
26	18	4	0	27	12	6	<b>TLD</b>
17	15	7	0	27	12	6	<b>TLD</b>
<b>Mean</b>	19.00	3.94	0.50	27.00	12.38	5.88	
<b>SD</b>	1.55	2.38	0.89	0.89	0.50	0.34	
<b>Crawf. Sig. score</b>	15 (t = 2.50, p = .02)	10 (t = 2.47, p = .02)	3 (t = 2.72, p = .02)	25 (t = 2.18, p = .05)	11 (t = 2.68, p = .02)	5 (t = 2.51, p = .02)	

Note. Scores which are significantly different from the scores of the control group (Crawford et al., 2004; Crawford & Howell, 1998) are highlighted. R = sentences with relatives, P = passive sentences, T = sentences with topicalization.

Table 3

Results of Phonological and Lexical-Semantic Tests for SLI and TLD Groups

Test	Phonological Testing		Lexical-Semantic Testing				Child Category
	BLIP-Rep. No. of Correct Responses (total = 26 items)	BLIP-Jud. No. Of Correct Responses (total = 19 items)	ITPA	MAASE	SHEMESH Percentage of Immediate Responses	No. of Semantic Errors on BAMBI-Rep.	
9	26	18	W/N	W/N	<b>90%</b>	1	<b>SLI</b>
14	25	14	W/N	W/N	<b>88%</b>	1	<b>SLI</b>
8	<b>21</b>	13	W/N	W/N	91%	2	<b>SLI</b>
10	24	13	<b>B/N</b>	<b>B/N</b>	<b>83%</b>	2	<b>SLI</b>
6	24	<b>12</b>	<b>B/N</b>	<b>B/N</b>	<b>90%</b>	5	<b>SLI</b>
16	<b>22</b>	14	<b>B/N</b>	<b>B/N</b>	91%	1	<b>SLI</b>
11	24	<b>8</b>	W/N	<b>B/N</b>	94%	2	<b>SLI</b>
15	25	15	W/N	W/N	97%	1	<b>SLI</b>
3	<b>21</b>	14	W/N	W/N	<b>90%</b>	3	<b>SLI</b>
13	<b>22</b>	14	<b>B/N</b>	<b>B/N</b>	<b>90%</b>	5	<b>SLI</b>
4	24	16	<b>B/N</b>	W/N	<b>89%</b>	4	<b>SLI</b>
12	<b>22</b>	<b>11</b>	W/N	W/N	<b>89%</b>	4	<b>SLI</b>
7	<b>22</b>	14	W/N	W/N	<b>89%</b>	2	<b>SLI</b>
2	<b>18</b>	<b>9</b>	<b>B/N</b>	<b>B/N</b>	<b>89%</b>	5	<b>SLI</b>
5	<b>23</b>	14	<b>B/N</b>	<b>B/N</b>	<b>86%</b>	7	<b>SLI</b>
1	<b>18</b>	14	W/N	<b>B/N</b>	91%	3	<b>SLI</b>
<b>Mean</b>	22.56	13.31			90%	2.88	
<b>SD</b>	2.31	2.44			3.00	1.83	

Table 3 Cont.

Test	Phonological Testing		Lexical-Semantic Testing				Child Category
	BLIP-Rep. No. of Correct Responses (total = 26 items)	BLIP-Jud. No. Of Correct Responses (total = 19 items)	ITPA	MAASE	SHEMESH Percentage of Immediate Responses	No. of Semantic Errors on BAMBI-Rep.	
25	25	19	W/N	W/N	96%	1	<b>TLD</b>
30	24	17	W/N	W/N	91%	0	<b>TLD</b>
24	26	17	W/N	W/N	99%	0	<b>TLD</b>
26	26	13	W/N	W/N	95%	1	<b>TLD</b>
22	24	17	W/N	W/N	94%	0	<b>TLD</b>
32	26	16	W/N	W/N	96%	1	<b>TLD</b>
27	26	17	W/N	W/N	98%	0	<b>TLD</b>
31	26	15	W/N	W/N	99%	0	<b>TLD</b>
19	26	15	W/N	W/N	92%	1	<b>TLD</b>
29	26	19	W/N	W/N	99%	1	<b>TLD</b>
20	26	14	W/N	W/N	93%	1	<b>TLD</b>
28	25	17	W/N	W/N	94%	0	<b>TLD</b>
23	25	15	W/N	W/N	99%	0	<b>TLD</b>
18	26	17	W/N	W/N	96%	0	<b>TLD</b>
21	24	14	W/N	W/N	97%	0	<b>TLD</b>
17	25	17	W/N	W/N	97%	1	<b>TLD</b>
<b>Mean</b>	25.44	16.19			95.9%	0.47	
<b>SD</b>	0.81	1.72			2.60	0.52	
<b>Crawf. sig. score</b>	23 ( $t = 2.92, p = .01$ )	12 ( $t = 2.36, p = .03$ )			90% ( $t = 2.20, p = .04$ )	2 ( $t = 2.85, p = .01$ )	

Note. Scores which are significantly different from the scores of the control group (Crawford et al., 2004; Crawford & Howell, 1998) are highlighted. W/N = within 1 SD of the age-equivalent score, B/N = below 1 SD of the age-equivalent score.

Table 4

Summary of Impaired Language Domains for Children with SLI

<b>Child</b>	<b>Syntax</b> <b>3 tests:</b> <b>BAMBI-ZTI,</b> <b>BAMBI-</b> <b>SINUN, &amp;</b> <b>BAMBI-ADIF</b>	<b>Phonology</b> <b>2 tests: BLIP-</b> <b>REP &amp; BLIP-</b> <b>JUDG</b>	<b>Lexicon</b> <b>4 tests: ITPA,</b> <b>SHEMESH,</b> <b>MA'ASE, &amp;</b> <b>semantic errors</b> <b>on BAMBI-</b> <b>SINUN</b>
1	3	1	2
16	2	1	2
13	3	1	4
8	3	1	1
10	2	0	4
4	2	0	3
2	3	2	4
9	1	0	1
6	2	1	4
15	2	0	0
3	1	1	2
7	2	1	2
5	2	1	4
12	0	2	2
14	1	0	1
11	1	1	2

Note. The numbers represent the number of tests in each of the language domains (syntax, phonology, and lexicon) on which performance of the child was found to be impaired. For BAMBI-ZTI & BAMBI-SINUN an impaired performance on at least one measure (excluding the number of correct responses on BAMBI-SINUN which reflects semantic errors as well) was taken to indicate impairment.

## Materials

The verbs used in this experiment were taken from the stimuli selected for Experiment 3. There were 10 ditransitive verbs, 10 verbs in *hiKTiL* with causative and unaccusative structures, 10 verbs with sentential complements that have two-three structural options, 10 verbs with sentential complements that have five-seven structural options, 9 unaccusative verbs, and 2 unergative verbs. The total number of verbs was 51, and their complete list is provided in Appendix B.

## Procedure and Analysis

The experimenter asked each child to make up a sentence with each of the verbs. *Don't know* (DK) responses and productions with errors were counted and analyzed. Errors were categorized as missing argument, incorrect complement, semantic errors, and *others* (morphological errors, incomplete sentences, etc.).

## Results

### Group Analysis

The data were the number of errors in productions and the number of DK responses. Numbers and percentages of both measures for SLI and TLD groups are provided in Table 5. The unaccusative/causative category yielded the most DK responses for both groups: 30% of responses by the SLI group and 8% of responses by the TLD group. Four verbs elicited the highest number of DK responses (7-13 of the SLI children). Consequently, these verbs were not included in Experiment 3. The next two categories of verbs that elicited DK responses were verbs with 2-3 structural options, and ditransitive verbs. This was found for the two groups of participants. Overall DK responses ranged from 1%-30% for the SLI group and 0%-8% for the TLD group. Data were analyzed for

between-group effects, using a Mann-Whitney test. For all analyses, an alpha level of .05 was used. The SLI children gave more of DK responses across all verb categories as compared with the TLD group ( $U = 38, p < .01$ ).

The range of errors was 0%-12% for the SLI group and 0%-5% for the TLD group. Once again, the SLI group made more errors overall ( $U = 190, p = .02$ ) and across verb categories as compared with the TLD group. The three verb categories with the highest number of errors were identical for the two groups, and included the ditransitive, the causative/unaccusative, and the two-three structural options verbs. This finding from a structured task is consistent with previous findings that children with SLI exhibit more errors in spontaneous language than their age-matched peers.

Table 5  
Numbers and Percentages of *Don't Know* (DK) Responses and Errors on the Sentence Production Task for SLI and TLD Groups

	<b>Ditrans.</b> <b>(10 verbs)</b>	<b>Unaccus.</b> <b>/Caus.</b> <b>(10 verbs)</b>	<b>2-3 Opts</b> <b>(10 verbs)</b>	<b>5-7 Opts</b> <b>(10 verbs)</b>	<b>Unacc.</b> <b>(9 verbs)</b>	<b>Unerg.</b> <b>(2 verbs)</b>	<b>Total</b>
<b>SLI</b>							
DK	9 (6%)	48 (30%)	13 (8 %)	2 (1%)	3 (2%)	8 (25%)	83 (10%)
Errors	19 (12%)	13 (8 %)	16(10%)	5 (3%)	5 (3%)	0 (0%)	58 (7%)
<b>TLD</b>							
DK	1 (<1%)	13 (8%)	4 (2%)	0 (0%)	0 (0%)	0 (0%)	18 (2%)
Errors	6 (4%)	5 (3%)	8 (5%)	1 (<1%)	1 (<1%)	0 (0%)	21 (2%)

Note. Percentages are calculated out of the total number of productions for each of the verb categories tested within each of the groups: Ditrans. = ditransitive, Unaccus./Caus = verbs in *hiKTiL* with unaccusative and causative structures, 2-3 Opts. = verbs with 2-3 structural options, 5-7 Opts. = verbs with 5-7 structural options, Unacc. = unaccusative, & Unerg. = unergative. DK = *don't know*.

A summary of error types for SLI and TLD groups is presented in Tables 6 and 7. As can be seen, most of the errors produced by children with SLI (24 errors) reflected a missing argument. The second to the largest category of errors among children with SLI was incorrect argument, in which the arguments used by the children were not appropriate for the verb, and the third largest category of errors in their productions involved an incorrect complement. Most of the few errors produced by the TLD group involved a missing argument (11 errors), but five out of these errors were produced by the same child. Thus, when types of errors are analyzed, it can be seen that they reflect a

difficulty with using the correct arguments and complements for verbs for the purpose of sentence construction.

Table 6

Summary of Error Types in Productions of Children with SLI

<b>Child</b>	<b>Missing Argument</b>	<b>Incorrect Comple- ment</b>	<b>Incorrect Argument</b>	<b>Other Errors</b>	<b>Total</b>
9	2	0	0	0	2
14	3	1	0	0	4
8	1	0	1	0	2
10	0	0	0	0	0
6	0	0	0	0	0
16	1	0	2	0	3
11	2	1	1	0	4
15	2	1	1	0	4
3	5	0	1	2	8
13	1	3	2	1	7
4	2	2	3	1	8
12	1	0	1	0	2
7	0	1	1	0	2
2	2	1	2	2	7
5	1	0	0	0	1
1	1	2	1	0	4
<b>Total</b>	<b>24</b>	<b>12</b>	<b>16</b>	<b>6</b>	<b>58</b>

Table 7

Summary of Error Types in Productions of TLD Children

<b>Child</b>	<b>Missing Argument</b>	<b>Incorrect Comple- ment</b>	<b>Incorrect Argument</b>	<b>Other Errors</b>	<b>Total</b>
<b>29</b>	0	1	0	0	1
<b>27</b>	0	1	1	0	2
<b>26</b>	0	1	1	1	3
<b>22</b>	5	1	0	1	7
<b>18</b>	1	0	0	0	1
<b>23</b>	1	0	0	0	1
<b>21</b>	1	0	0	0	1
<b>32</b>	1	0	0	0	1
<b>17</b>	2	0	0	0	2
<b>20</b>	0	0	1	0	1
<b>31</b>	0	0	0	1	1
<b>25</b>	0	0	0	0	0
<b>30</b>	0	0	0	0	0
<b>24</b>	0	0	0	0	0
<b>28</b>	0	0	0	0	0
<b>19</b>	0	0	0	0	0
<b>Total</b>	<b>11</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>21</b>

Individual Analysis

The data from the production task were analyzed individually. The modified t-test (Crawford et al., 2004; Crawford & Howell, 1998) was used to determine whose result was significantly different than the mean of the control group. The two-tail cut-off score for the overall number of DK responses and for the overall number of production errors was 6. Table 8 summarizes the results of individual children with SLI on this task. Scores that were significantly different than the mean of the control group are shaded. As can be seen, three children with SLI were impaired on both measures (2, 3, & 4), four children

with SLI were found to be impaired on one of the measures (1, 5, 7, & 13), and nine children with SLI were not impaired on either measure (7, 8, 9, 10, 11, 12, 14, 15, & 16).

Table 8

Number of Errors and Number of *Don't Know* (DK) Responses on Sentence Production Task for Individual Children with SLI and TLD Children

SLI Subject	Overall Number of Production Errors	Overall Number of DK Responses	TLD Subject	Overall Number of Production Errors	Overall Number of DK Responses
9	1	5	28	0	2
14	4	2	25	0	0
8	2	2	24	0	1
10	0	0	23	1	1
6	0	2	19	0	0
16	3	2	30	0	0
11	0	3	18	1	1
15	4	4	21	1	0
3	7	9	29	1	3
13	7	2	20	1	2
4	8	8	32	1	0
12	2	5	27	2	0
7	2	8	31	1	0
2	7	8	26	3	4
5	2	10	22	7	6
1	4	13	17	2	0

Note. All scores that were significantly different than the mean of the TLD control group (Crawford et al., 2004, Crawford & Howell, 1998) are shaded. DK = *Don't Know*.

The number of errors was found to be significantly higher than the mean of the control group for 4 children with SLI, and 12 children actually showed normal production

patterns. The number of DK responses was found to be significantly higher than the mean of the control group for 6 children with SLI, and 10 children showed normal response patterns. It is also important to note, that one TLD child exhibited a significantly higher number of production errors and of DK responses. Her performance elevated the mean of the control group.

### Discussion

Results of the sentence production task revealed group differences between children with SLI and their age-matched peers. The overall higher number of DK responses of children with SLI as compared with TLD children is in agreement with findings about a deficient verb lexicon in SLI (Conti-Ramsden & Jones, 1997; Davidson, 2002; Fletcher & Peters, 1984; Jones & Conti-Ramsden, 1997; Rice & Bode, 1993; Watkins, Rice, & Moltz, 1993). The results are naturally limited to the 51 verbs that were selected for this experiment, but the group difference was statistically significant. The meaning of DK responses, however, should be treated with some caution. Several different interpretations are possible. DK responses may indeed reflect a total lack of familiarity with the relevant verbs, but they may also convey a partial, incomplete knowledge, or a simple avoidance of the production task. It is important to note, that the verbs used in this task were the verbs used in the online experiment (Experiment 3). During the online experiment, our participants were asked to respond to various comprehension questions regarding details of the target sentences. As will be discussed later, the SLI participants were found to produce more errors on this task than the TLD and the Adult groups. This finding from a comprehension task supports the proposal that the SLI participants were not completely familiar with the target verbs.

The overall higher number of errors related to the number and type of arguments and complements of verbs, produced by children with SLI as compared with TLD children, is consistent with previous findings that documented a greater number of errors in their spontaneous sentences (Grela & Leonard, 1997, 2000; Rice & Bode, 1993). In the present study, errors occurred in a structured, experimental task, reflecting a grammaticality difficulty with using the correct structural characteristics for specific verbs. The analysis of error types further supports this proposal, as the errors reflect a difficulty in using the correct number and type of arguments and complements. However, it should be acknowledged that production tasks may be difficult for children with SLI who have lexical, retrieval impairment. It is possible that such production errors reflect a difficulty with retrieving the correct arguments for specific verbs.

The important finding revealed by the individual analysis is that not all children with SLI express a difficulty with the knowledge of specific verbs and with their use within sentences. Although seven children with SLI expressed a difficulty on one of the measures, nine children performed much like the control group on this task. These results show the heterogeneity among children with SLI, in terms of the specific measures with which this difficulty was found to be expressed. The performance of individual participants was further analyzed in Experiments 2 & 3. Interestingly, the three children who were found to be impaired on both measures in this experiment (2, 3, & 4) were among the four children who were found to be impaired on the two measures used in Experiment 2. They can probably be considered as the most severely impaired in this area, among the SLI participants. Individual analyses will be discussed later from an overall perspective on individual impairment profiles.

## Experiment 2

### Method

The goal of this experiment was to examine the children's sensitivity to the specific types of sentential complements that verbs select. A grammaticality judgment task was employed.

### Participants

The same two groups of children subjects described for Experiment 1 participated in this experiment.

### Materials

The verbs that were used in this experiment select specific types of clausal complements, in addition to phrasal ones. For example, some verbs select only propositions (P), such as *he'emin* (believe): *hu he'emin she-hi tavo* (He believed that she will come); others select only interrogatives (Q), such as *sha'al* (ask): *hu sha'al eifo hi* (He asked where she was); still others select only infinitives (A), such as *hitxil* (begin): *hu hitxil lalexet* (He began to walk). Thirty five lexical verbs that select specific phrasal and clausal complements were used. Each verb was presented to subjects within two types of sentences: (1) grammatical sentences in which the verb was followed by a complement it selects, and (2) ungrammatical sentences in which the verb was followed by a complement it does not select. For example, the verb *he'emin* (believed) was used with an interrogative clause, as in *\* hu he'emin lama hi tavo* (\* He believed why she will come), the verb *sha'al* (ask) was used with a propositional clause, as in *\* hu sha'al she-hi tavo* (\* He asked that she will come), and the verb *hitxil* (begin) was used with a propositional clause, such as in *\* hu hitxil she-hi tavo* (\* He began that she would come).

Each type of clausal complement (P, Q, and A) was used to create between 11-13 ungrammatical sentences. There were 35 grammatical and 35 ungrammatical sentences, for a total of 70 sentences. Grammatical and ungrammatical sentences were mixed and their order of presentation was randomized. The complete list of sentences is presented in Appendix C.

### Procedure

The sentences were read to the children by the experimenter. The children were told that some sentences are *correct* in their structure and can be used in Hebrew, whereas others may be *incorrect* structurally and can not be used in Hebrew. They were given a few examples of *correct* and *incorrect* sentences. The experimenter emphasized that *correct* and *incorrect* were not related to the content of the sentences, but only to the order and type of words used in them. The children were also asked to correct the sentences that they judged as ungrammatical. There were five practice trials before presenting the target sentences.

### Data Analysis

Responses of children to the sentences were recorded as *correct* (judging grammatical sentences as grammatical and judging ungrammatical sentences as ungrammatical) or *incorrect* (judging ungrammatical sentences as grammatical and judging grammatical sentences as ungrammatical). *Correct* and *incorrect* responses were summarized for the SLI and the TLD groups. Next, the corrections that children provided for the ungrammatical sentences were analyzed as *correct* (without any type of errors), or *incorrect* (with any type of errors). The errors within the corrections were further analyzed into the following categories: a missing argument, an incorrect complement,

semantic errors, and *others* (morphological errors, incomplete sentences, etc.). Finally, an individual analysis was conducted in order to learn about the function of individual subjects with SLI.

### Results

The data for this task were the percentages of total judgment errors, further divided into percentages of judging ungrammatical sentences as grammatical (*UG as G*) and percentages of judging grammatical sentences as ungrammatical (*G as UG*), and the percentages of correction errors. The numbers of errors, means and standard deviations for the TLD and SLI groups are presented in Table 9. Mean numbers of errors on three judgment measures are presented according to groups in Figure 1. All data were analyzed for between-group effects, using a Mann-Whitney test. For all analyses, an alpha level of .05 was used.

Table 9

Sums, Means (numbers & percentages), and SDs (numbers & percentages) of Judgment Errors and Correction Errors for SLI and TLD Groups

	<i>UG as G</i>	<i>G as UG</i>	<b>Total Judgment Errors</b>	<b>Total Correction Errors</b>
<b>SLI</b>				
<b>Sum</b>	109 (out of 560)	14 (out of 560)	123 (out of 1120)	34 (out of 456)
<b>Mean</b>	6.81 (19.46%)	0.88 (2.50%)	7.69 (10.98%)	2.13 (7.72%)
<b>SD</b>	3.17 (9.00%)	1.09 (3.00%)	3.57 (5.00%)	1.59 (6.00%)
<b>TLD</b>				
<b>Sum</b>	41 (out of 560)	1 (out of 560)	42 (out of 1120)	11 (out of 520)
<b>Mean</b>	2.56 (7.32%)	0.06 (0.18%)	2.63 (3.75%)	0.69 (2.12%)
<b>SD</b>	1.79 (5.11%)	0.25 (0.71%)	1.78 (2.55%)	0.79 (2.48%)

Note. Percentages of judgment errors were calculated out of the total number of grammatical or ungrammatical sentences presented to each of the groups. Percentage of correction errors were calculated out the total number of corrections that were produced by each group. *UG as G* = judging ungrammatical sentences as grammatical, *G as UG* = judging grammatical sentences as ungrammatical.

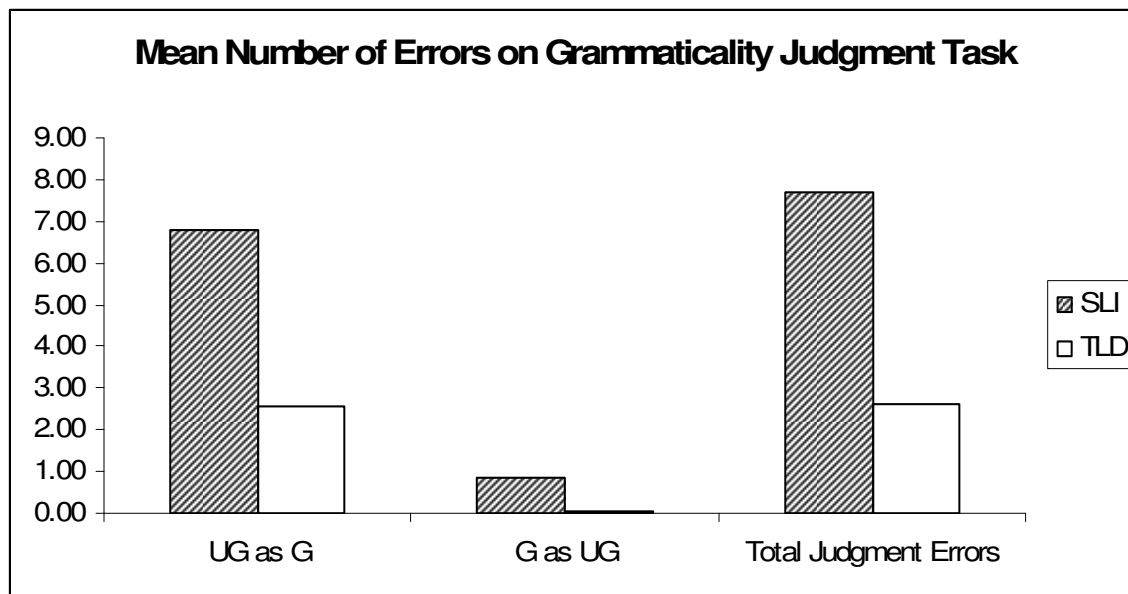


Figure 1. Mean number of errors on grammaticality judgment task, for ungrammatical sentences judged as grammatical (*UG as G*), grammatical sentences judged as ungrammatical (*G as UG*), and total judgment errors, for SLI & TLD groups.

### Grammaticality Judgments

Most judgment errors, as expected, involved judging ungrammatical sentences as grammatical. Both groups committed only a few errors of judging grammatical sentences as ungrammatical. A Mann-Whitney test revealed that the SLI children performed more poorly on all of the judgment measures: for "UG as G" ( $U = 28, p < .01$ ), for "G as UG" ( $U = 62.5, p < .05$ ), and for the total judgment errors ( $U = 20.5, p < .01$ ). Thus, as predicted, children with SLI committed significantly more errors when judging sentence grammaticality in terms of the specific sentential complements that verbs select.

### Corrections

As can be seen in Table 9, the overall percentage of correction errors was low for both TLD and SLI groups. A Mann-Whitney test revealed that children with SLI committed significantly more correction errors than their age-matched peers ( $U = 49, p < .01$ ). Most of the correction errors (22 out of 34 for SLI and 7 out of 11 for TLD) included the use of a wrong complement. In these cases, the children attempted to correct the content of the embedded clause, without changing the unacceptable complement that was presented to them by the experimenter (see Table 10). For example, the ungrammatical sentence: \* *ha-more hit'anyen she-ha-yeladim lo higi'u* (The teacher was interested that the children haven't arrived), in which a P complement was used for a verb that selects only PP and Q complements, was "corrected" to: \* *ha-more hit'anyen she-ha-yeladim me'axarim* (The teacher was interested that the children were late), in which the same type of P complement was used. Remaining errors reflected incorrect arguments, in which the arguments used by the children were not appropriate for the verb. For example, the ungrammatical sentence: \* *ha-na'ar ha-gvo'a iyem al Udi lama hu yaxtof lo et ha-kova* (The tall guy threatened Udi why he would snatch his hat) was "corrected" to: \* *Udi iyem al danit she-hi-gonevet lo et ha-kadur* (Udi threatened Danit that she is stealing the ball from him). The remaining errors included morphological errors, fall starts, or *don't know* responses.

Table 10

Types of Errors Produced by Children with SLI and TLD in Corrections

	<b>Incorrect Complement</b>	<b>Incorrect Argument</b>	<b>Other Errors</b>	<b>Missing Argument</b>	<b>Total</b>
<b>SLI</b>	22	4	7	1	<b>34</b>
<b>TLD</b>	7	2	2	0	<b>11</b>

Individual Analysis

The grammaticality judgments were also examined for individual children. The modified t-test (Crawford et al., 2004; Crawford & Howell, 1998) was used to determine whose result was significantly different than the mean of the control group. The two-tail "cut-off" score for the overall number of judgment errors was 7, and for the overall percentage of correction errors it was 8%. Table 11 summarizes the results of individual children with SLI on this task.

As can be seen in Table 11, the overall number of judgment errors produced by 10 of the children with SLI was significantly higher than the mean number of judgment errors of the TLD group. The mean percentage of correction errors produced by seven children with SLI was significantly higher than the mean percentage of correction errors of the TLD group. Five children were found to be impaired on both measures, in a statistically significant way. Interestingly, three of these children were the participants who were identified as the most severely impaired on the sentence production task used in Experiment 1 (2, 3, & 4). Thus, despite the differences in their number of errors, most

children with SLI exhibited a clear difficulty with at least one of the tasks used in this experiment. Four children with SLI performed like the control group.

Table 11

Number of Judgment Errors and Correction Errors for Individual SLI and TLD Subjects

<b>SLI Subject</b>	<b>Overall Number of Judgment Errors</b>	<b>Mean Percentage of Correction Errors</b>	<b>TLD Subject</b>	<b>Overall Number of Judgment Errors</b>	<b>Mean Percentage of Correction Errors</b>
9	4	6%	28	1	0%
14	5	17%	25	0	0%
8	7	0%	24	2	3%
10	6	10%	23	1	3%
6	8	11%	19	0	6%
16	7	3%	30	2	3%
11	2	3%	18	6	0%
15	4	3%	21	5	7%
3	15	14%	29	3	0%
13	11	8%	20	2	0%
4	7	10%	32	2	3%
12	6	7%	27	4	0%
7	7	3%	31	5	6%
2	14	24%	26	3	0%
5	9	0%	22	4	0%
1	11	4%	17	2	3%

Note. All scores that were significantly different than the mean of the TLD control group (Crawford et al., 2004; Crawford & Howell, 1998) are shaded.

## Discussion

The findings of the grammaticality judgment task revealed that school-age children with SLI have an extraordinary difficulty with judging the grammaticality of sentences in terms of the correct sentential complements for verbs. The prediction that this area may be impaired in SLI was supported by the group differences that were statistically significant for all the measures used.

As discussed earlier, the verbs used in this experiment may be considered more complex, both semantically and syntactically. They were found to be less frequently used as compared with less complex verbs, in various studies that looked at spontaneous productions of children with SLI (de Jong, 1999; King, 1994; Thordardottir & Ellis Weismer, 2002). The present study did not compare between verbs that take sentential complements and verbs that take phrasal complements. However, the documented difficulty in using these verbs spontaneously was extended to a difficulty in performing an experimental task of grammaticality judgment. This experimental task may be considered as meta-linguistic, because it requires the participants to think about and relate to the linguistic, grammatical status of sentences. However, the knowledge that was required in order to make these judgments is directly related to the lexical representation of the structural characteristics of verbs. The participants were not directed to pay attention to any specific type of linguistic rules, but they were generally directed to the syntactic aspect of the sentence rather than to its semantic aspect. Thus, findings that express a difficulty in this task show a problem with the knowledge of the structural characteristics of verbs that select multiple types of sentential complements.

The correction task further demonstrates the difficulty in this area. As a group, children with SLI produced significantly more errors than their TLD controls, when they attempted to correct the sentences which they earlier judged as ungrammatical. Thus, dissociation was expressed in the performance of children with SLI: even when they can determine that a sentence is ungrammatical, they often do not have the facility to provide a grammatical correction for that sentence. The higher number of errors produced by children with SLI as compared with TLD children in their correction sentences is consistent with the findings of the production task used in Experiment 1. Both production tasks elicited a higher number of grammatical errors on the part of the SLI participants.

The individual analysis revealed that most SLI participants demonstrated some difficulty with the judgment and/or with the correction tasks. The heterogeneity of the group was revealed by the number of errors produced on both tasks, which varied among individual children. In addition, four children were not found to be impaired on either measure of this task. Finally, the same three children were found to be most severely impaired on the tasks of both experiments 1 and 2.

## Experiment 3

### Method

The goal of this experiment was to determine which structural characteristics of verbs create complexity effects for listeners in verb activation during on-line sentence comprehension. Based on previous findings, three variables were examined: (a) the number of arguments – verbs with more arguments should take longer to activate than verbs with less arguments, (b) the number of structural options – verbs with more structural options should take longer to activate than verbs with less structural options, and (c) the thematic structure – unaccusative verbs should take longer to activate than unergative verbs. In addition, I wanted to determine whether children with SLI differ from TLD children and NI adults in the way by which they are affected by these complexity variables.

### Participants

Forty eight subjects participated in this experiment constituting three groups. The same two groups of children subjects described for Experiments 1 & 2 participated in this experiment. An additional control group consisted of 16 adult monolingual speakers of Hebrew, 11 females and 5 males, who ranged in age from 18-21 years. Adults were recruited by fliers posted in public places within the experimenter's home town.

### Materials

Verbs. To examine the effect of the number of arguments, three categories of verbs were compared: (1) verbs with one argument, such as: *shar* (sing), *baxa* (cry), and *xiyex* (smile), (2) verbs with two arguments, such as: *shavar* (break), *hipil* (drop), and *kimet* (wrinkle), and (3) verbs with three arguments, such as: *sam* (put), *hixnis* (insert),

and *mile* (fill). There were 10 lexical verbs in each of the categories, for a total of 30 target verbs. An attempt was made to control other aspects of the lexical representation as much as possible. All verbs had an agent subject; one-argument verbs were unergative, two-argument verbs were transitive, and three-argument verbs were ditransitive. In addition, two-argument verbs subcategorized for Noun Phrase (NP), and three-argument verbs subcategorized for NP followed by Prepositional Phrase (PP). Finally, to control for possible effects of multiple structural options all chosen verbs could be used within a single structure.

To examine the effect of the number of structural options, four categories of verbs were selected for two comparisons. Two categories of verbs from *binyan hiKTiL* were compared: (1) verbs that can be used within a single, causative structure, such as *hetis* (fly an airplane), *hoshiv* (make someone sit down), and *hirdim* (put someone to sleep), and (2) verbs that can be used within either a causative or unaccusative structures, such as *hivrik* (shine/make something shine), *hexshix* (become dark/make something dark), and *hishmin* (become fat/cause someone to become fat). These stimuli were selected to determine whether verbs that can be used within two different structures take longer to activate than verbs which can be used within a single structure. There were 10 lexical verbs in each of the categories, for a total of 20 verbs. It is important to note, that in this case the thematic structure of the verbs and the number of arguments are confounded with the number of structural options. Thus, finding longer reaction times to the causative/unaccusative verbs as compared with the causative verbs may reflect the burden of their additional structural option and also of their specific thematic types.

In addition, two categories of verbs that take clausal complements in addition to phrasal ones were compared: (1) verbs that could be used within two to three different structures, such as the verb *badak* (check), which selects: NP, as in: *hu badak et ha-bxina* (he checked the exam), P, as in: *hu badak she-hi higi'a* (he checked that she arrived), and Q, as in: *hu badak lama hi lo higi'a* (he checked why she did not arrive), and (2) verbs that could be used within five to seven different structures, such as the verb *lamad* (learn), see sentence examples for this verb at the end of the literature review). There were 10 lexical verbs in each of the categories, for a total of 20 target verbs. Most of the verbs chosen for this analysis had two arguments. There were a couple of verbs that required three arguments, and these were equally represented in the two groups.

To examine the effect of thematic structure two categories of verbs were compared: (1) unergative verbs, such as *hitkofef* (bend over) and *hishtolel* (act wild), and (2) unaccusative verbs, such as *hitmotet* (collapse) and *hitkamet* (wrinkle). These two types of verbs can be found within several different *binyanim* in Hebrew, but only *hitKaTeL* hosts a relatively large number of verbs from both types. Thus, using verbs in the *hitKaTeL* pattern eliminates possible effects of *binyan* complexity. In addition, all of the verbs chosen for this analysis can be used within a single structure. There were seven unergative verbs, out of which three were used in two different sentences, nine unaccusative verbs, out of which one was used in two different sentences. Thus, there were 16 experimental verbs that were used for this analysis.

Stimulus validation. Six students in linguistics were asked to judge the verbs selected. For the ditransitive verbs, a list of verbs that require three arguments was created. The verbs were placed in sentences with two or three arguments and the judges

provided grammaticality judgments. Only those verbs that were judged by at least five out of the six judges as requiring three arguments (ditransitive) were included. For the verbs in *binyan hiKTiL* that can be used in causative and unaccusative structures or only in a causative structure, the judgments provided were the basis on which the verbs were assigned to one of these groups. For verbs with sentential complements in Experiments 1 and 2 judges were given a list of all possible complements, and they were asked to mark each complement that they believed could be selected by each of the verbs. Judgments were tallied, and the complements that were selected by at least 5 out of the 6 judges for any given verb were considered to be complements of that verb. The thematic type of verbs (unaccusative vs. unergative) was determined by unanimous judgments. Other verbs were not used.

In the absence of frequency of occurrence data for verbs in Hebrew I asked 39 native speakers to judge the frequency of the verbs in spoken Hebrew, on a scale of 1-7, where 7 meant very frequent and 1 meant very rare. Judgments were averaged and analyzed using ANOVA (for comparing the means for the three verb categories used in the analysis of the number of arguments) and t-test (for all other verb categories). There was no significant difference between the mean frequency judgments for verbs with one-argument, verbs with two-arguments, and verbs with three arguments ( $F(2,27) = 0.11, p = .90$ ). There was no significant difference between the mean frequency judgments for verbs in *hiKTiL* with one structural option and verbs in *hiKTiL* with two structural options ( $t(1,14) = 1.71, p$  (two tail) = .11). There was no significant difference between the mean frequency judgments for unaccusative and unergative verbs ( $t(1,14) = 1.80, p$  (two tail) = .09). A significant difference was found between the mean frequency

judgments of verbs with sentential complements that have 2-3 structural options and verbs that have 5-7 structural options ( $t(1,18) = 3.43, p = .02$ ). Verbs with sentential complements that have 5-7 structural options were judged to be more frequent (mean = 6.13) than verbs with 2-3 structural options (mean = 4.565). This finding will be discussed further in the Results section.

Sentences. The total number of experimental verbs for the on-line experiment was 90 (9 categories x 10 verbs per category). All verbs were inserted into sentences. All pitch changes were created on adverbs placed after the verb (a structure which is grammatical in Hebrew regardless of verb type). The structure of experimental sentences was as follows: subject-verb-adverb-complements/adjuncts. In order to match between sentences created with verbs taken from different categories on as many aspects as possible, verbs were arranged in groups of three (for the number of arguments or two (for the number of structural options and thematic structure), with each triad/pair consisting of one verb from each group, followed by the same adverb. The adverbs following the verbs related either to the manner of action, such as *be-kalut* (easily), *be-simxa* (happily), or *be-sheket* (quietly), or to the time of the action, such as *ba-boker* (in the morning), or *be-shabat* (on Saturday). I intentionally varied the types of adverbs used in order to eliminate the subjects' ability to predict the pitch changes. In addition, the number of syllables of verbs in each triad/pair was also matched. All verbs were past tense and single with half male and half female forms. Finally, I wanted to ensure that subjects were used to the speaker's normal pitch prior to encountering the pitch change. Thus, in order to lengthen the amount of speech that subjects were exposed to prior to the verb, I padded subject heads with PPs, as in: *ha-yeled im ha-kova ha-gadol* (The boy with the

large hat). The number of syllables within the subject phrase was matched within each of the triads/pairs, as well as the stress pattern of the words (stressed and unstressed syllables).

Fifty-six filler sentences were created. The filler sentences had various structures and differed from that of the experimental sentences. The pitch change location in the fillers varied. Experimental and filler sentences were mixed and randomized. In addition, 48 yes/no comprehension questions were used to ensure attention to the sentences. For example, the experimental sentence: *The dog with the shiny fur barked wildly at the kids in the yard*, was followed by the question: "Did the dog bark wildly at the children?" The questions were presented before filler sentences rather than experimental sentences, to avoid any effects on the processing of the experimental sentences. Finally, two sets of 17 practice sentences with varying structures and with pitch changes placed at different points were created.

The 194 sentences, fillers, and comprehension questions were divided into two separate sessions, with each session consisting of two segments (48/49 sentences per segment) in addition to a practice segment. Children took a brief break in between these sets. The complete list of sentences for Experiment 1 is provided in Appendix E.

### Pitch Changes

The adverb pitch changes were created using the Audacity Sound Editing Software, four algorithms were chosen (Violett & Shapiro, 2005) that lowered the pitch (-20%, -25%, -30%, and -35%). The four different levels of pitch change were equally divided between the adverbs, which were presented in a random order. This was intended to minimize predictability of a single pitch change.

### Procedure

The method used in this experiment was the pitch change method (Violett and Shapiro, 2005) in which subjects indicate by a button press (“yes”) when they hear a change in pitch. The Tempo reaction time software program (version 2.0.0) was used to run this experiment, with a computer and a button box. Participant responses to the experimental pitch change probes and to the comprehension questions were recorded by the computer via the button box. Participants were told to listen to sentences for comprehension and for a word in each sentence with a pitch change. The stimuli were presented to subjects through speakers in a sound-proof room. Following the presentation of the pitch change, target participants had 2000 ms in which to respond. Responses recorded later than 2000 were coded as errors. Participants were encouraged to respond as quickly as possible to the change, and encouragement for rapid, accurate responses was provided randomly throughout the experiment. They were told that if they pressed the button by mistake, but then heard a pitch change later in the sentence they should press the button again. Participants were also told that every couple of sentences they would be asked a comprehension question about the previous sentence and they should press the “yes” or “no” button to respond.

The two parts of this experiment were administered to subjects within two separate 50-minute sessions. Each one of these experimental sessions began with a practice trial that included 12 sentences with pitch changes and 5 comprehension questions. Next, the two segments of each part were separated by a "break", during which one half of the production task (Experiment 1) and one half of the judgment task (Experiment 2) were administered. By the end of the experimental sessions, each child

participant received a bookstore coupon of 50 NIS (New Israeli Shekels), for his/her participation in the study.

## Results

### Data Reduction

The original data set consisted of 4320 responses (90 verbs x 48 subjects). Responses were first analyzed for accuracy and any false positives were eliminated. Any response coded as "0" (the response button was not pressed within 2000 ms), less than 200 ms, or over 1000 ms, was eliminated. Verbs for which there were more than 12 non-responses across the three groups of subjects were excluded from the data set. In addition, four verbs from *binyan hiKTiL* that elicited a high number of "don't know" responses on the part of the SLI children in the sentence production task (Experiment 1) were excluded from analysis. I ended up eliminating responses to 10 of the verbs: one verb from the analysis of the number of arguments (one-argument verb), five verbs from the analysis of the number of options in *binyan hiKTiL* (one verb with one structural option and four verbs with two structural options), and four verbs from the analysis of thematic structure (two unaccusative and two unergative verbs). Thus, after eliminating responses to these verbs (10 verbs x 48 subjects = 480 responses) and all additional "off" responses (a total of 391 responses) I ended up having a data set of 3449 responses for analysis. Generally, overall accuracy of responses was high (80%) and enabled statistical analysis for complexity and group effects.

### Reaction Times

Mean reaction times (RTs) and standard deviations (SDs), in milliseconds, for correct responses, for each group, under each of the verb categories, are presented in

Table 12 and Figures 2-5. Figure 6 presents the overall means of RTs across all experimental conditions for the three groups of subjects.

RTs were analyzed using General Linear Model (GLM) ANOVAs with repeated measures tests, with Group (TLD, SLI, and Adults) serving as a between-subject variable and Number of Arguments (one, two, and three), Number of Structural Options for verbs in *hiKTiL* (one and two), Number of Structural Options for verbs with Sentential Complements (two-three options and five-seven options), and Thematic Structure (unaccusative and unergative verbs) serving as a within-subject-repeated-measure variable. For all analyses, an alpha level of 0.05 was used. Levene's Test for Equality of Variances was used to ensure that the error variance was not significantly different between the verb categories.

A t-test for correlated samples was conducted on RTs of each group separately, whenever a main effect of any of the lexical variables was found with the GLM test. Finally, an individual analysis was also conducted whenever main effects were found, using the modified *t* test. This type of analysis provided information about the performance of individual subjects in relation to the complexity effects found.

Table 12

Mean RTs and SDs (in milliseconds) for TLD, SLI, and Adult Groups, According to Verb Categories

Group	RT	Variable								
		No. of Arguments			No. of Struct. Opts – Verbs in <i>binyan hiKTiL</i>		No. of Struct. Opts – Verbs with Sentential Complements		Thematic Structure	
		1	2	3	1	2	2-3	5-7	Unac.	Uner.
TLD	Mean	366	385	376	371	423	350	372	382	351
	SD	51	42	69	57	64	46	53	52	44
SLI	Mean	390	398	378	400	430	364	385	380	380
	SD	70	60	48	55	96	72	42	64	54
Adults	Mean	354	343	349	352	364	323	346	329	340
	SD	56	46	64	57	51	58	55	58	54

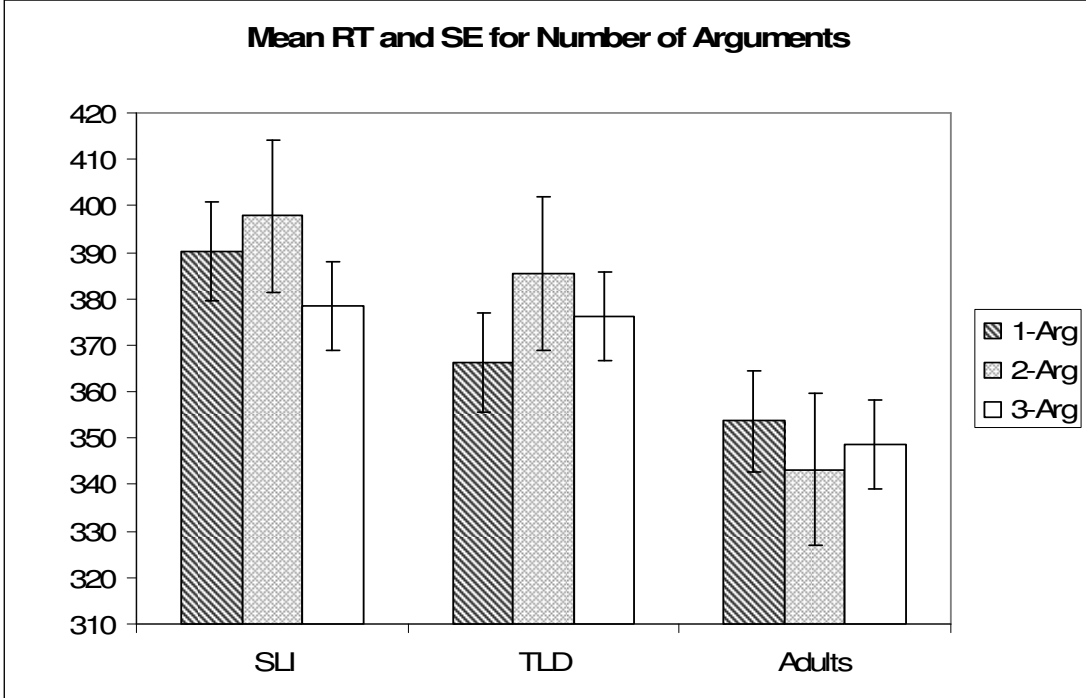


Figure 2. Mean group reaction times (RT) & SE for verbs with one, two, and three arguments

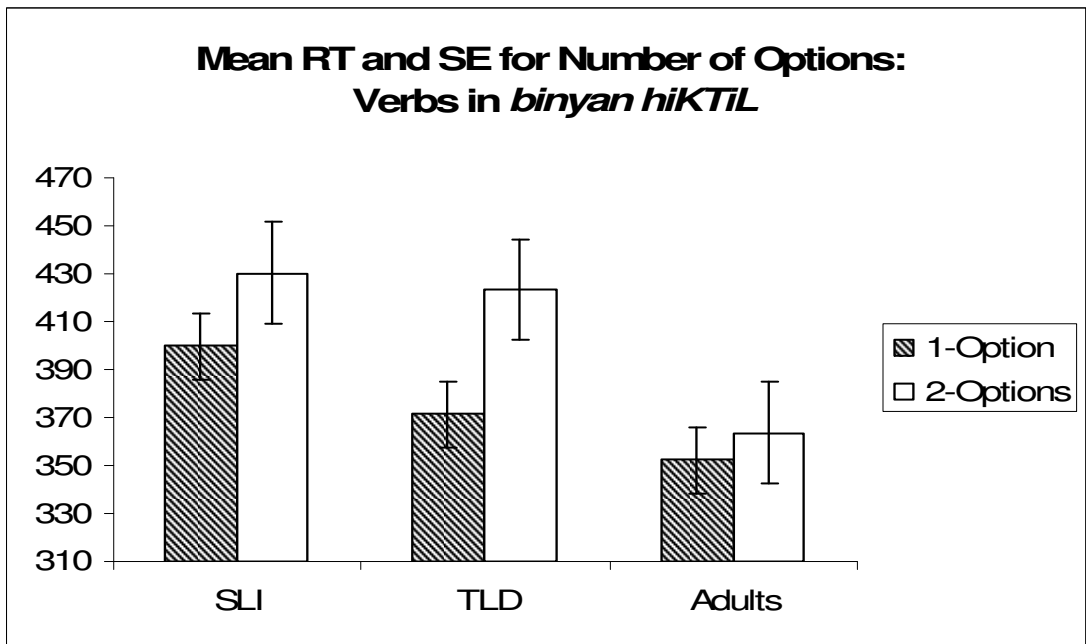


Figure 3. Mean Group Reaction Times (RT) & SE for verbs with one structural option and verbs with two structural options in *hiKTiL*

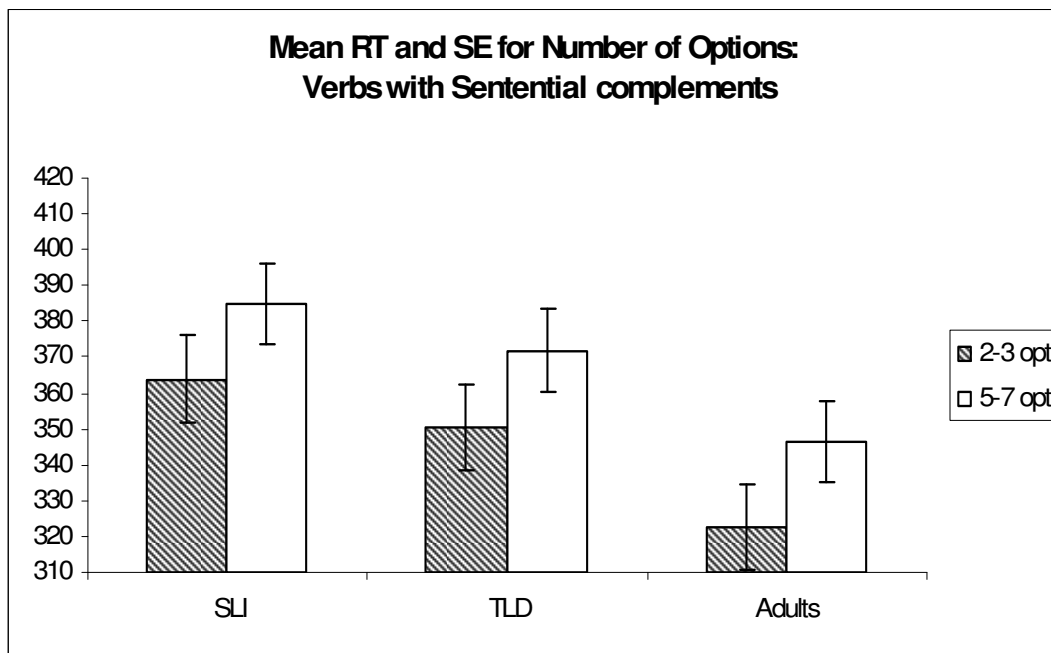


Figure 4. Mean group reaction times (RT) & SE for verbs with two-three structural options and verbs with five-seven structural options

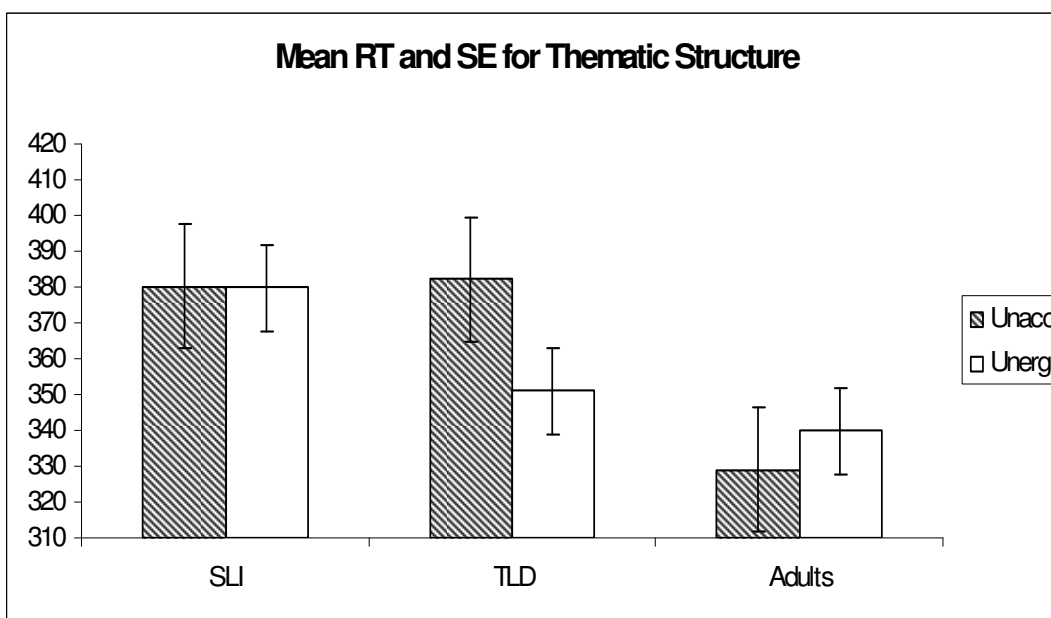


Figure 5. Mean group reaction times (RT) & SE for unaccusative and unergative verbs

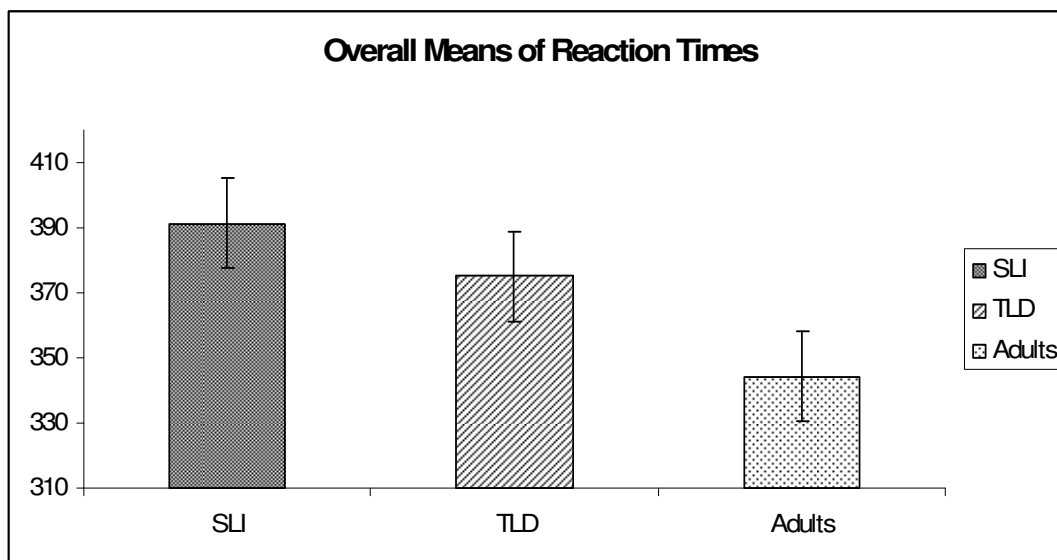


Figure 6. Mean group reaction times (RT) & SE across all verb categories

### Number of Arguments

Within-group analysis. No effect was found for the number of arguments ( $F(2,45) = 0.71, p = .49$ ), and there was no interaction between the number of arguments and group ( $F(8,45) = 1.28, p = .28$ ). As can be seen in Table 12 and in Figure 2, the pattern of results was mixed. This inconsistent pattern does not support the hypothesis that the number of arguments affects the time it takes listeners to access verbs from the lexicon in a consistent and predictable manner. This lexical characteristic does not have a complexity effect on the initial stage of sentence processing.

Between-group analysis. The between group effect was approaching significance ( $F(2,45) = 2.65, p = .08, \eta = 0.11$ ). The groups appeared to perform differently on their overall mean RTs, and I believe that only lack of statistical power due to the small samples prevented this effect from becoming significant. In Table 12 and Figures 2 & 6 the mean RTs of the SLI group were consistently the slowest, across all verb categories.

Mean RTs of the adults were consistently the fastest, and mean RTs of the TLD group were in between the mean RTs of the SLI and the Adults groups. This result is consistent with my prediction that children with SLI may be functioning in a context of overall slower responses.

Number of Structural Options: Verbs in *hiKTiL*

Within-group analysis. The mean RTs for the two groups of verbs from *binyan hiKTiL* differed, ( $F(1,45) = 11.97, p < .01, \eta = 0.20$ ), with RTs to the one-option verbs being faster than RTs to the two-option verbs. No effect was found for the interaction between the number of structural options and group ( $F(2,45) = 1.81, p = .18$ ). All three groups of subjects displayed the same pattern of longer RTs when listening to verbs with two structural options compared to those with one structural option (see Table 12 and Figure 3). This supports my hypothesis that the number of structural options affects verb activation time. The data were further analyzed to determine whether this effect was present in each group. The effect was significant for the TLD group ( $t(1,15) = 2.91, p$  (one tail)  $< .01$ ) and approached significance for the SLI group ( $t(1,15) = 1.53, p$  (one tail)  $= .07$ ) and for the Adult group ( $t(1,15) = 1.49, p$  (one tail)  $= .08$ ). The activation pattern was the same for all three groups.

Between-group analysis. The effect of Group was significant ( $F(2,45) = 4.27, p = .02, \eta = 0.16$ ). The same pattern found in the previous analysis was repeated: mean RTs of the SLI group were the slowest, mean RTs of the Adults were the fastest, and mean RTs of the TLD group were in between the mean RTs of the SLI and the Adults groups (see Table 12 and Figures 3 & 6). These findings support the prediction that children with

SLI will be affected by the same complexity variables as TLD children, but within a context of overall slower RTs.

#### Number of Structural Options: Verbs with Sentential Complements

Within-group analysis. The mean RTs for the two groups of verbs that select sentential complements differed, ( $F(1,45) = 11.93, p = .01, \eta = 0.21$ ), with RTs to verbs with 2-3 structural options being faster than RTs to verbs with 5-7 structural options. Effect of interaction between the number of structural options and group was not significant ( $F(2,45) = 0.16, p = .98$ ). Thus, as can be seen in Table 12 and Figure 4, all three groups displayed the same pattern of increased RTs when listening to verbs that have five-seven structural options as compared with verbs that have two-three structural options. This effect is strengthened by the finding that the 5-7 structural option verbs were judged as more frequent than the 2-3 structural option verbs (see Stimulus validation).

These results are consistent with the analysis of the number of structural options that was conducted with other verb categories (one- and two-structural options for verbs in *hiKTiL*). This documented complexity effect provides support for my hypothesis that the number of structural options affects processing time during on-line sentence comprehension.

The data were further analyzed with a t-test for correlated samples, in order to determine whether the effect of the number of structural options was significant for each group separately. I found significant main effects for the TLD group ( $t(1,15) = 1.86, p$  (one tail) = .04), for the SLI group ( $t(1,15) = 1.72, p$  (one tail) = .05) and for the Adults group ( $t(1,15) = 2.57, p$  (one tail) = .01). These results are consistent with the results of

the GLM test, and they support the hypothesis that this structural characteristic creates a complexity effect in the on-line verb processing of listeners. The effect was significant for all three groups of subjects. Thus, the SLI group exhibited the same activation pattern as the two control groups.

Between-group analysis. The effect of group approached significance ( $F(2,45) = 2.89$ ,  $p = .07$ ,  $\eta = 0.11$ ). The same pattern described earlier was found for the overall group means of RTs: the SLI group demonstrated the slowest overall responses, the Adults group demonstrated the fastest overall responses, and the TLD group demonstrated RTs that were in between the RTs of these two groups (see Table 12 and Figures 4 & 6). The difference did not reach statistical significant probably due to reduced power caused by small samples. This supports the prediction that children with SLI will be affected by the same complexity variables as TLD children, but within a context of overall slower RTs.

#### Thematic Structure

Within-group analysis. No effect was found for thematic structure ( $F(1,45) = 0.592$ ,  $p = .45$ ,  $\eta = 0.01$ ) and for the interaction between thematic structure and group ( $F(2,45) = 1.94$ ,  $p = .16$ ,  $\eta = 0.79$ ). As can be seen in Table 12 and Figure 5, the pattern of results was mixed, and it does not support my hypothesis that the thematic structure of verbs affects the time it takes listeners to access verbs from the lexicon.

Between-group analysis. The effect of group was significant ( $F(2,45) = 4.42$ ,  $p = .18$ ,  $\eta = 0.16$ ). As for all other analyses, it can be seen that the SLI group had the slowest overall responses, the Adults had the fastest responses, and the TLD group had RTs that were in between the RTs of these two groups (see Table 12 and Figures 5 & 6).

### Comprehension Analysis

Between-group analyses were conducted in order to compare the overall accuracy of responses to the comprehension questions that were presented to participants throughout the on-line task, between the three groups of subjects. Mean percentage of errors and standard deviations for comprehension questions according to groups are presented in Table 13 and Figure 6.

Seventeen questions related to sentences that varied in the number of arguments, 11 questions related to sentences that varied in number of structural options for verbs in *binyan hiKTiL*, 10 questions related to the number of structural options for verbs with sentential complements, and 10 questions that related to sentences that varied in thematic structure.

Table 13

Mean Percentages and Standard Deviations (SD) of Errors for Comprehension Questions

<b>Group</b>	<b>Percentage of Errors</b>	<b>No. of Arguments</b>	<b>No. of Str. Opts.: <i>hiKTiL</i></b>	<b>No. of Str. Opts: Sent. Comp.</b>	<b>Thematic Structure</b>	<b>Overall</b>
<b>TLD</b>	Mean	19.49%	13.64%	8.13%	11.88%	13.28%
	SD	6.70%	9.39%	9.81%	8.34%	9.39%
<b>SLI</b>	Mean	23.16%	18.18%	15.00%	18.75%	18.77%
	SD	6.95%	14.47%	15.92%	11.47%	12.71%
<b>Adults</b>	Mean	17.65%	7.39%	10.00%	13.13%	12.04%
	SD	5.26%	6.82%	10.95%	10.78%	9.42%

Note. The total number of answers for each group of subjects was 272 for the analysis of the number of arguments, 176 for the analysis of the number of structural options for verbs in *binyan hiKTiL*, and 160 for the analysis of the number of structural options for verbs with sentential complements and for the analysis of thematic structure. The total number of answers for each group was 768.

As can be seen in Table 13, participants from all three groups were able to answer most of these questions correctly, and the overall range of errors was between 7.39% and 23.16%. Thus, the original goal of this task was achieved: subjects were engaged in sentence comprehension during the on-line experiment. However, the overall means for the groups appeared different, and I decided to put it to a statistical test. An ANOVA was conducted with Group serving as a between-subject variable and Percentage of Errors serving as the dependent variable. Four separate ANOVAs were conducted on

comprehension data for each of the four analyses. Significant effect was found for the analysis of the Number of Structural Options for verbs in *hiKTiL* ( $F(2,45) = 4.10, p = .02$ ), and effect that was approaching significance was found for the analysis of the Number of Arguments ( $F(2,45) = 3.13, p = .05$ ). No effect was found for the other two analyses (for the Number of Structural Options for Verbs with Sentential Complements:  $F(2,47) = 1.29, p = .28$ , and for Thematic Structure:  $F(2,47) = 2.03, p = .14$ ), but I believe that this is due to low statistical power caused by the small samples. The SLI group showed a consistently greater number of errors as compared with the other two groups. This finding reflects another aspect of language impairment that distinguished the SLI group from the TLD group.

## Discussion

### Verb Complexity Effects

A main issue addressed by the on-line experiment was the potential complexity effect of three different lexical characteristics. In addition to the number of structural options, which affects sentence processing in adults, the experiment focused on the number of arguments and the thematic structure of verbs, because these variables affect production patterns of children with and without SLI (De Jong, 1999; Grela & Leonard, 1997, 2000; Thordardottir & Ellis Weismer, 2002). The number of structural options created a consistent and measurable complexity effect for adults, TLD children, and children with SLI. This effect was reflected in longer RTs of listeners to verbs from *binyan "hiKTiL"* that have two structural options (causative and unaccusative) as compared with verbs from the same *binyan* that have only one structural option (causative), and in longer RTs to verbs that select sentential complements with five-seven

structural options as compared with verbs that have only two-three structural options. This result is consistent with the results of Shapiro and his colleagues (Shapiro et al., 1987; Shapiro et al., 1991; Shapiro et al., 1993; Shapiro & Levine, 1990; Shapiro, et al. 1989), who investigated verb complexity effects in adults. The number of argument structure possibilities was the crucial lexical characteristic that consistently and predictably affected verb activation in adults. Although in the current study I used the term "structural options", acknowledging the syntactic difference between P (Propositions), Q (Interrogatives), E (Exclamations), and A (Action - infinitival) complements in addition to their obvious semantic differences, my results demonstrated the same effect. Recently, an fMRI study provided additional support for the significant effect of the number of subcategorization options on verb processing. Shetreet, Palti, Friedmann, & Hadar (2006) had 14 speakers of Hebrew perform a semantic decision task on auditory sentences. They found graded activations in the left-superior temporal gyrus and the left inferior frontal gyrus, which are considered to be linguistic areas, in correlation with the number of subcategorization options. These researchers concluded that the number of subcategorization options is indispensable in verb processing.

In addition to replicating earlier findings, the current study extends these results to a different language, to a different population of speakers, and to different structures. Previous on-line verb processing studies have focused on adult speakers of English. The current study provides a first look into this area with speakers of a typologically different language such as Hebrew. The unique characteristics of Hebrew were considered throughout the construction of the stimuli for the study; however, I did not expect them to create a difference in the results.

Previous studies have focused on adult listeners. The current study was conducted with two groups of 8;6-12;6 children. I found that in that age group the lexical activation is affected by the same variables as for mature, adult speakers. These findings provide important information regarding language development. They suggest that at the age range of the subjects (8;9-12;6) the lexicon already operates very similarly to adults with regards to verb activation.

Previous verb complexity effects were found only in relation to verbs that take sentential complements. In the present study two verb categories (from *binyan hiKTiL*) that do not take sentential complements were compared, and were found to create the same complexity effect. Thus, verbs that can be used within unaccusative (with no complement) and causative (with NP complement) structures elicit longer RTs than verbs that can be used within a causative structure only. This finding provides additional support to the idea that the crucial factor affecting the time it takes listeners to activate verbs from the lexicon is indeed the number of different structures, rather than the specific type of structures.

No complexity effect was found for the number of arguments. This result, once again, agrees with the findings of Shapiro et al. (1987), who specifically contrasted between the effects of the number of arguments and the number of argument structure possibilities, and found that only the number of argument structure possibilities affected reaction times of listeners. Ahrens and Swinney (1995), on the other hand, found that the number of participant roles inherent in the central sense of the verb affected on-line verb processing time. However, the number of participant roles is not always conflated with

the number of arguments. When obligatory arguments are concerned, the present study does not provide support for the proposal that their number affects verbs' activation time.

Finally, no complexity effect was found for thematic structure. This variable has not been tested directly with on-line verb processing methodologies, but it was found to affect production patterns of children with SLI (Grela & Leonard, 1997). I wanted to learn whether unaccusative verbs, whose use within grammatical sentences requires a syntactic movement, will be more complex in terms of lexical access, as compared with unergative verbs. The results of the current study did not provide support for this proposal.

Results of the current study should be considered in relation to the proposed representation of verbs in linguistic theory. Complexity effects in the RTs of listeners that reflect the number of structural options in the representations of verbs confirms their psychological reality. More specifically, our findings support linguistic proposals that postulate separate representations for different types of sentential complements (Grimshaw, 1990). Furthermore, previous studies compared verbs that select a different number of P, Q & E complements, but the present study suggests a separate representation for A complements (infinitival), which was counted as an additional structural option. As the listener hears a verb, an exhaustive activation of all structural options for that verb take place (Shapiro et al., 1987). The verb complexity effects revealed in the current study reflect that mechanism and extend support for its operation in children with and without SLI.

The current findings are consistent with previous reports of verb complexity effects during on-line sentence comprehension. They suggest that the number of

structural options determine the time it takes listeners to access verbs from the lexicon. The present results extend previous findings to Hebrew. In addition, complexity effects were found not just in adults' RTs of adults, but also in the RTs of school-age children. Children, with and without SLI, had RTs reflecting the same complexity effects.

### Children with SLI

The current study provides evidence that children with SLI are affected by the lexical properties of verbs in the same way as children without SLI. The complexity effect created by the number of structural options, which was found for the Adults and the TLD groups, was clear and significant in RTs of the SLI group as well. Moreover, as for the two control groups, the effect of this lexical characteristic was demonstrated by the SLI group in the two different types of analyses in which it was examined (verbs in *banyan hiKTiL* and verbs with sentential complements). This finding suggests that verb representation and access during on-line sentence comprehension is intact in SLI. It shows that the operation of their lexicon, at least in terms of retrieving the structural characteristics of verbs required for sentence processing, is normal acting.

Finding an activation pattern which appears normal for the SLI participants is consistent with the findings of Shapiro & Levine (1990) regarding the on-line verb processing of patients with Broca's aphasia. In that study a group of patients with Broca's aphasia exhibited a normal activation pattern, which reflected the same complexity effect of the number of argument structure possibilities that was found for NI listeners. In contrast, a group of patients with Wernicke's aphasia exhibited RTs that did not reflect this complexity effect. Shapiro & Levine concluded that verb access can be selectively impaired in different types of aphasia. A recent study (Biran & Friedmann, 2007)

provided support for this proposal. In this study, aphasic patients with syntactic impairments showed intact performance on a variety of non-online tasks that were planned to evaluate their knowledge of argument structure (verb completion within sentences, grammaticality judgment, & sentence production for specific verbs). In the present study, the SLI children were not further divided into sub-groups of SLI, such as lexical vs. syntactic. As can be seen in Table 4, the majority of the SLI subjects (14 out of 16) were found to be impaired on both areas. I do not ignore the heterogeneity of the experimental group, in terms of the severity of the language impairment and its individual manifestation profile; however, based on the group analyses I can say that as a group, children with SLI showed a normal pattern of lexical activation of verbs.

A clear and consistent group difference emerged when the data were viewed for overall speed of RTs. As can be seen in Figures 1-5, the RTs of the SLI group were the slowest, the RTs of the Adults group were the fastest, and the RTs of the TLD group were in between the RTs of the other two groups, and this finding was consistent across all verb categories. This group difference reached or approached statistical significance in all four analyses. When I predicted the results of the on-line experiment for the SLI subjects, I offered three different ways in which their performance could have been different. This finding is consistent with my final prediction, in which I proposed that even if children with SLI would exhibit the same complexity effects as TLD children, they may do so within a context of overall slower RTs. The meaning of this generalized slowness effect is yet to be determined. It could mean that the verb processing of children with SLI is overall slower than that of TLD children. Thus, it is possible that it takes children with SLI more time to access verbs as compared with TLD children. It could

mean, on the other hand, that these children were simply slower in responding to the pitch changes and in performing the actual button-pressing task. The present design does not let me separate between these two possible explanations. In any case, this finding is consistent with a considerable amount of data currently available regarding the slower performance of children with SLI as compared with age-matched children on a variety of cognitive tasks, including the more specific findings regarding slower RTs (e.g. Miller, Leonard, Kail, Zhang, Tomblin, & Fancis, 2006). The current study extends previous findings to the specific task used in the on-line experiment. Children with SLI in the present study displayed slower RTs of pressing a button in response to pitch changes while listening to aurally-presented sentences. This finding agrees with processing theories of SLI that focus on impaired processing mechanisms. Finally, in the current study it was found that TLD children were slower in their overall RTs than adults. This finding is consistent with the prediction, that any difference between the performance of the Adults and the TLD groups should be attributable to maturation and experience. It agrees with findings that show that over the course of development, RTs become faster, peaking in adolescence and young adulthood (Kail, 1991).

Another group difference emerged when responses of participants to the comprehension questions were analyzed. The SLI group exhibited the largest number of errors on these questions. This effect was statistically significant for one out of the 4 analyses conducted, but I believe this is due to lack of statistical power caused by overall small samples. Although a comprehension task was not specifically planned within the present research design, this result provides another expression of the impairment in SLI.

In summary, the automatic aspect of verb processing appears to function in a normal fashion for children with SLI. Clear differences were observed only with regards to their speed of processing, and in their responses to the comprehension questions.

### Individual Impairment Profiles

A summary of individual analyses that were conducted with four non-online experimental measures is provided in Table 14. As can be seen, when individual children with SLI are concerned, performance on the different measures varies, and the picture is one of unique and personal profiles.

Table 14

#### Summary of Individual Analyses on Experimental Tasks

SLI Subject	Judgment Errors	Corrections Errors	"DK" Responses	Production Errors
3	15	14%	9	7
4	7	10%	8	8
2	14	24%	8	7
13	11	8%	2	7
1	11	4%	13	4
6	8	11%	2	0
5	9	0%	10	2
7	7	3%	8	2
14	5	17%	2	4
8	7	0%	2	2
16	7	3%	2	3
10	6	10%	0	0
9	4	6%	5	1
15	4	3%	4	4
12	6	7%	5	2
11	2	3%	3	0

Note. Numbers that represent performance which was found to be different than the mean of the TLD group in a statistically significant way (Crawford et al., 2004, Crawford & Howell, 1998) are shaded.

Out of the 16 SLI participants, three were found to demonstrate impaired performance on all four experimental measures (2, 3, & 4), one child showed impaired performance on 3 measures (13), four showed impairment on 2 measures (1, 6, 5 & 7), four showed impairment on 1 measure (8, 10, 14, & 16), and four children did not show impairment across the measures (9, 11, 12, & 15). According to individual analyses, children with SLI vary in terms of whether or not they show a difficulty in using the structural characteristics of verbs. Although 12 participants in the present study showed impaired performance on at least one measure, four children with SLI performed like the control group of TLD children on all non-online measures used to assess this linguistic aspect. In addition, children with SLI who show impairment vary in terms of the number and type of measures with which this impairment is expressed.

Table 15 provides a description of the performance of each child with SLI on the various diagnostic tests and on the non-online experimental tasks. It can be seen, the relationship between syntactic and/or semantic impairment as identified by the diagnostic tests and impaired performance on experimental tasks is complex. As discussed earlier, most of the SLI participants were found to be impaired on both syntactic and semantic tests used in the diagnosis, and most of these children have showed impaired performance on at least one experimental measure. One child was found to be impaired only on syntax (15), and another child was found to be impaired only on lexical/semantics tests (12). Both these participants showed unimpaired performance on all experimental measures. Two additional children who were found to be impaired on both syntactic and lexical/semantic diagnostic tests showed unimpaired performance across all experimental

measures. This analysis shows that syntactic and or lexical impairment may or may not be accompanied by impairment in the use of the lexical characteristics of verbs.

Table 15

Summary of Individual Profiles on Diagnostic Tests and Experimental Tasks for Children with SLI

SLI Subject	Diagnostic Tests		Experimental Tasks
	Syntactic Impairment (out of 3 tests)	Lexical Impairment (out of 4 tests)	J-C-P Impairment (out of 4 measures)
9	1	1	0
14	1	1	1
8	3	1	1
10	2	4	1
6	2	4	2
16	2	2	1
11	1	2	0
15	2	0	0
3	1	2	4
13	3	4	3
4	2	3	4
12	0	2	0
7	2	2	1
2	3	4	4
5	2	4	2
1	3	2	2

Note. The numbers represent the number of tests/measures on which impaired performance has been identified. J = Judgment, C = Corrections, P = Production (including the number of errors and the number of DK responses).

## Overall Discussion

The purpose of the current study was to investigate the lexical characteristics of verbs in the language of children with and without SLI. Three planned experiments targeted this issue with three different experimental tasks. Experiment 3 focused on the initial stage of verb activation during on-line sentence comprehension. It examined how the structural characteristics that are inherent in verbs affect the time it takes children with SLI and their age-matched peers to activate verbs from the mental lexicon. Experiment 2 targeted the children's explicit, metalinguistic knowledge regarding verbs and their specific sentential complements, by using grammaticality judgment and correction tasks. Experiment 1 examined the production of sentences with various verb types, in relation to the number and type of arguments and complements.

The main goal of the present study was addressed by comparing the performance of a group of children with SLI to the performance of a group of age-matched TLD children, on several different linguistic tasks that require the use of the structural characteristics of verbs. In the online experiment, an additional control group of NI adults has also participated. Both group comparisons and individual analyses were used with the data.

The results of the online study (Experiment 3) suggest that the lexical representation of verbs in SLI is intact. As a group, the SLI participants showed sensitivity to the same complexity effects that were demonstrated by the two control groups, including age matched-TLD children and a group of adults. This sensitivity to complexity effects suggest that the structural characteristics, at least in terms of the number of structural options, is represented and accessed by children with SLI in a normal fashion. A group difference was found only in relation to the overall speed of

processing, but as discussed earlier, the true meaning of this finding is yet to be determined.

Sentence grammaticality judgment and sentence production reflect the ability of speakers to use the knowledge of the structural characteristics of verbs for the ultimate goal of sentence production and/or comprehension. Clear group differences were found in the ability of the subjects to judge the grammaticality of sentences. Children with SLI made significantly more errors on this task than their TLD peers. This task is rather challenging for children in general and for children with SLI in particular, as it requires working memory and attentional resources. The abilities of children with SLI to judge the grammaticality of sentences varying in verb characteristics provided an opportunity to distinguish between a general deficit in such judgments and a deficit specific to variations in complexity reflected in characteristics of verbs.

Significant group effects were also found for two production tasks: providing corrections for the ungrammatical sentences, and production of sentences for specific verbs. Thus, despite their normally appearing verb activation mechanism, some children with SLI have a difficulty in translating this implicit knowledge into explicit linguistic knowledge required for performing a variety of production and comprehension tasks.

A comparison of the results of Experiments 3 and 2 demonstrates the dissociation identified between the normally appearing verb activation and the impaired ability to use the same knowledge for the purpose of grammaticality judgments. The same category of verbs that was found to create the complexity effect in the on-line experiment was targeted in the grammaticality judgment experiment (verbs with sentential complements). Ten specific verbs (out of 30 used in the on-line experiment, and out of 35 used in the

grammaticality judgment task) were even used in both experiments. Thus, the same verbs were found to be accessed in a normal fashion and that created the normal complexity effect for children with SLI were difficult for them to judge, in terms of their specific types of sentential complements.

The two production tasks reflected yet another aspect of the impairment in the use of the structural characteristics of verbs by children with SLI. On both tasks, correcting ungrammatical sentences and producing sentences for specific verbs, the children with SLI committed a higher number of errors than the TLD children, and these differences were found to be statistically significant. Once again, when these results are compared with results of the on-line experiment a clear dissociation can be found. Despite exhibiting a normal pattern of verb activation, some children with SLI demonstrate a significant limitation with the ability to use this knowledge for the purpose of sentence production.

Another dissociation emerged when the results of judgments and corrections are compared. The most frequent error in corrections of children with SLI involved repeating the same unacceptable complement which only a few seconds earlier was judged as ungrammatical. Thus, in some cases where children with SLI did show an ability to detect ungrammaticality caused by unacceptable complements, they were unable to replace the wrong complement and produce a correct sentence.

The most frequent category of errors produced by children with and without SLI in corrections was production of a wrong complement, and the most frequent category of errors in production of sentences for a given verb was a missing argument. The two additional categories of errors in the production of sentences task were incorrect

complements and incorrect arguments. Thus, there were no significant differences between the SLI and the TLD groups in terms of the types of errors produced. The difference, as discussed, was found in the overall number of such errors, which was significantly higher for the SLI group. Finding such structural errors that create ungrammaticality in production of sentences by children with SLI is consistent with findings from several studies that were discussed in the literature review (Davidson & Dromi, 2002; Grela & Leonard, 1997; Rice & Bode, 1993). Findings that did not document structural errors were based mostly on spontaneous language samples (De Jong, 1999; Thordardottir & Ellis Weismer, 2002). This is an example for difference in findings caused by the use of different participants or by the different methodologies. As discussed before, in their spontaneous use of language children tend to avoid words or structures that they do not have a complete mastery of. They will prefer to use language forms that are familiar and easy to use. This was exactly the conclusion of De Jong, who found that children with SLI used less complex and less varied argument structures in their spontaneous language. The structured task, in which children had to create sentences with specific verbs, revealed that even school-aged children with SLI commit errors that reflect a difficulty with expressing the structural properties of verbs. The source of these errors, however, remains unclear. These errors may reflect a problem with the knowledge and use of the structural characteristics of specific verbs, or it may reflect a generalized impairment in lexical retrieval. The first explanation may be correct for some children with SLI, and the second explanation may be correct for others.

In summary, the current study suggests that the representation of verbs and their access from the lexicon may be intact in SLI. However, a clear limitation was found in

the ability of children with SLI to use the structural characteristics of verbs. The impairment was expressed with three different experimental tasks, including grammaticality judgment, correction of ungrammatical sentences, and production of sentences. This is the general picture. However, the present results were analyzed from an individual-subject perspective as well. The findings of individual analyses are described next.

An individual perspective is important especially when a heterogeneous population such as children with SLI is concerned. It affords a more personal look at the profile of impairment for individual children. It also shows how the language impairment can be selectively expressed in some areas but not in others. The findings of the present study show that children with SLI vary in terms of whether or not they have impairment to the structural representation of verbs. Most children were found to be impaired on at least one measure, but four children did not exhibit impaired performance on any of the non-online measures. Variability was also found in terms of how the impairment was expressed. Children varied in terms of the specific measures on which their performance was found to be impaired, with unique and individual patterns.

The current study provides support for de Jong's proposal that impairment to the lexical representation of verbs should be incorporated into linguistic theories of SLI. However, de Jong distinguished between grammaticality and complexity. He suggested that the impairment is manifested mostly in complexity terms, because children with SLI use less varied and less complex argument structures. The present study did not examine the spontaneous language use of children with SLI. Instead, it examined the performance of these children on several different experimental tasks. The findings suggest that the

impairment can be viewed in terms of grammaticality as well. Children with SLI in the present study committed errors in judging grammaticality of sentences and in producing grammatical sentences. Interestingly, this impairment was found to be dissociated from the normal verb activation pattern demonstrated by the SLI subjects in the on-line experiment.

### Summary

Three research questions were targeted with three experiments. The first research question was: Do children with SLI commit more errors related to the number and type of arguments and complements, when they produce sentences for specific verbs as compared with age-matched TLD children? Results of the present study provide a positive answer to this question, at least for some of the children. A secondary goal of this experiment was to examine the participants' familiarity with verbs that were selected as stimuli for Experiment 3. The present study found a greater number of verbs that children with SLI were not familiar with, as compared with TLD subjects.

The second research question was: Are children with SLI sensitive to the specific types of sentential complements that are selected by particular verbs in the same way as TLD children? Results of the present study suggest that some children with SLI have difficulty with this type of structural knowledge. The SLI subjects committed significantly more judgment and correction errors as compared with age-matched TLD children.

The third question was: Which structural characteristics of verbs create complexity effects during on-line sentence comprehension for children with and without SLI and for NI adults? Results of the present study suggest that the number of structural

options is the lexical characteristic that affects the time it takes listeners to access verbs from their lexicon during sentence comprehension. Verbs with more structural options take longer to activate than verbs with less structural options. This complexity effect was demonstrated in two separate analyses (verbs in *binyan hiKTiL* and verbs with sentential complements), by NI adults, TLD children, and children with SLI. Thus, children with SLI exhibited the same complexity effects as the two control groups in their RTs. The only difference in performance of children with SLI as compared with their age-matched peers was found in their overall slower RTs.

Taken together, findings of the present study suggest that the lexical representation of verbs in children with SLI is stored and accessed in a normal fashion, except for a possibility of overall slower activation. However, when children with SLI are required to perform a variety of linguistic tasks that are based on this knowledge, some of them show a significant impairment, which is expressed in a greater frequency of errors as compared with age-matched children. In addition, the current findings show that impairment in the use of the lexical characteristics of verbs may come with or be separated from a lexical and/or syntactic impairment.

The present study has practical implication for diagnosis and treatment of children with SLI. The whole area of the structural characteristics of verbs is not regularly incorporated into diagnostic efforts and intervention plans. The current study suggests that it should. Children with SLI should be evaluated on various tasks that are specifically designed to assess their performance in relation to argument structure of verbs. As the individual analysis of the current study demonstrated, some children may be impaired in this area, and some may show intact performance. In any case, impaired argument

structure function should not be assumed based on the children's performance on syntactic and/or lexical-semantic tests, because the findings of the present study show that this area may be selectively impaired. When treatment of SLI is concerned, two different directions should be considered, in relation to results of evaluation. If argument structure function is found to be impaired, intervention plans should focus on directly improving this area. A recent study by Ebbels, van der Lely, & Dockrell (2007) reported that such "syntactic-semantic therapy" was effective for school-age children with SLI. Intact argument structure function, on the other hand, can be used in the treatment of syntactic and/or semantic impairments. Focusing on the number and type of arguments and on the specific types of complements that verbs require may facilitate a generalized improvement in the overall sentence production and comprehension skills of children with SLI. One study has looked into this proposal, by using explicit teaching of argument structure rules to a child with S-SLI, in order to improve his control over various movement-derived syntactic structures (Levy & Friedmann, in press). Levy and Friedmann reported encouraging results, but more therapy studies are required in order to develop efficient intervention methods.

Several important questions require further research. The present study focused on school-age children, at the age range of 8;5 to 12;6. Results of the online experiment are consistent with the proposal that at that age range the lexicon operates in the same manner as for adults. When exactly does it start operating this way? Additional studies should look at younger and narrower age ranges, in order to define developmental patterns for both children with and without SLI. Significant differences between children with SLI and TLD children may be found in a younger age.

Future research should extend the number and type of non-online tasks that are designed to assess the performance of children in relation to argument structure, and more verb categories should be incorporated into such tasks. For example, the production of verbs for given argument structures can be analyzed. To eliminate possible influence of lexical retrieval difficulties, a close set of verbs can be provided, from which participants can choose the appropriate verb. Various comprehension tasks can also be designed in order to compare between verbs that differ in their number and type of arguments and complements. In the present study, comprehension was only generally assessed during the online experiment. It was not analyzed in relation to different types of verbs and argument structures. Shapiro and Levine (1990) found that intact verb processing may accompany severe sentence comprehension problems in agrammatic aphasics. This area should be specifically assessed in relation to children with SLI. The production of multiple structural options for verbs by children with SLI should be investigated as well, in order to determine whether there is a difference between them. For example, the production of sentences with P, Q, and A complements should be compared, in order to determine whether specific types of complements create extraordinary difficulty.

Finally, the heterogeneity found in the performance of the SLI participants call for a closer look into the relationship between syntactic and/or semantic impairment and performance in terms of using the structural characteristics of verbs. Sub-groups of SLI should be targeted in order to study the relationship between syntax, semantics, and structural representations.

## Appendices

### Appendix A: Parent Questionnaire

Child's name \_\_\_\_\_ Today's Date \_\_\_\_\_

Date of birth \_\_\_\_\_ Age \_\_\_\_\_ Grade \_\_\_\_\_

Name of school \_\_\_\_\_ City \_\_\_\_\_

Home address \_\_\_\_\_ Home Tel. No. \_\_\_\_\_

Mother's name \_\_\_\_\_ Occupation \_\_\_\_\_ Cell phone \_\_\_\_\_

Father's name \_\_\_\_\_ Occupation \_\_\_\_\_ Cell phone \_\_\_\_\_

Brothers/Sisters & their ages \_\_\_\_\_

Primary language of the child \_\_\_\_\_

Other languages the child uses or is exposed to \_\_\_\_\_

Have you ever lived in a different country where a different language is spoken? \_\_\_\_\_

Child's birth place \_\_\_\_\_

Father's birth place \_\_\_\_\_ Mother's birth place \_\_\_\_\_

Are there any speech errors in the child's speech? If yes, please describe: \_\_\_\_\_

\_\_\_\_\_

Do you think your child has a language disorder? If yes, please describe: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

At what age did you first notice your child's language disorder? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Is there any history of the following in the family (check all that apply):

Speech/Language disorders \_\_\_\_\_ Hearing impairment \_\_\_\_\_

Learning disorders \_\_\_\_\_ Attention deficit disorders \_\_\_\_\_

Has your child ever been evaluated or worked with any of the following? (check all that apply and please explain):

ENT Doctor

---

Neurologist

---

Psychologist

---

Audiologist

---

Speech/Language Pathologist

---

Special Education Teacher

---

Do you think your child hears well?

---

When was the last time his/her hearing was tested?

---

Is your child wearing eye glasses?

---

Is your child left-handed or right-handed?

---

Please state the age at which the child reached each developmental milestone:

Walking \_\_\_\_\_ First words \_\_\_\_\_

Production of sentences \_\_\_\_\_ Fluent Reading \_\_\_\_\_

Is there any important medical information regarding your child's health? Please explain:

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---

In case your child visits a special education class, please answer the following questions:

At what age did your child enter this class?

---

What were the specific reasons for enrolling him/her in that class?

---

---

How many children are in that class?

---

Does he/she get any type of therapy?

---

How many times a week?

---

Is there any information you would like to share with us to help us understand your child better?

---

---

Appendix B: Stimuli for Experiment 1

**Verbs used in Production of Sentences Task**

**Ditransitive verbs:** *sam* (put), *natan* (give), *hixnix* (insert), *hifgish* (cause two people to meet), *hoshiv* (seat someone), *hotsi* (take out), *hikdish* (dedicate), *tseref* (join someone/something to something), *hish'in* (lean something against something), *hish'ir* (leave something/someone).

**Causative/Unaccusative verbs:** *he'edim* (become/make something red), *hilbin* (become/make something white), *hishxir* (become/make something black), *hixshix* (become/make something dark), *hivrik* (become/make something shine), *hemis* (defrost), *hizkin* (become/make someone old), *hixmir* (become/make something worse), *hishmin* (become/make something fat), *hixmitx* (become/make something sour).

**Verbs with 2-3 Structural options:** *xashad* (suspect), *badak* (check/examine), *hitxaret* (regret), *hit'anyen* (be interested in), *ixel* (wish), *gila* (find out), *hixkish* (deny), *xayav* (must), *nixesh* (guess), *tsarix* (need).

**Verbs with 5-7 Structural options:** *xashav* (think), *yada* (know), *hisbir* (explain), *hizkir* (remind), *ratsa* (want), *'amar* (say), *zaxar* (remember), *siper* (tell), *lamad* (learn), *gila* (discover).

**Unergative verbs:** *hit'no'e'a* (move), *hizdaxel* (crawl).

**Unaccusative verbs:** *hitmotet* (collapse), *hityabesh* (become dry), *hit'alef* (faint), *hitparek* (fall apart), *hitkalkel* (become out of order), *hitnape'ax* (become inflated), *hitstanen* (get a cold), *hitlaxlex* (become dirty), *hitkavets* (shrink).

Appendix C: Stimuli for Experiment 2

**Sentences for Grammaticality Judgment**

1. Dani **believed** that Mira went to Jerusalem. (Hebrew = *he'emin*)
  2. \* Michael **believed** if Mira left her purse at home. (Q instead of P or PP)
- 
1. The teacher **suspected** that Uri stole the car. (Hebrew = *xashad*)
  2. \* The manager **suspected** to take the money. (A instead of P or PP)
- 
1. Joel **regretted** that he fought with Moses. (Hebrew = *hitxaret*)
  2. \* Shmuel **regretted** how he made a chocolate cake. (Q instead of P or PP)
- 
1. El'ad **blamed** Uri that he forgot his bag in class. (Hebrew = *he'eshim*)
  2. \* Uri **blamed** Haim to leave the money in the drawer. (A instead of P or PP)
- 
1. Ziv **wished** his wife to do well on the exam. (Hebrew = *ixel*)
  2. \* Isaac **wished** Hava when she succeeded at work. (Q instead of P)
- 
1. Nir **claimed** that he rode his bike from Tel Aviv to Jerusalem. (Hebrew = *ta'an*)
  2. \* Josef **claimed** to walk to work every day. (A instead of P)
- 
1. The fireman **investigated** what caused the big fire. (Hebrew = *xakar*)
  2. \* The policeman **investigated** to cause the terrible accident. (A instead of Q or NP or PP)
- 
1. The manger **was interested** (in knowing) why Nurit is not prepared to work in the office. (Hebrew = *hit'anyen*)
  2. \* The teacher **was interested** that Lea does not want to go to school. (P instead of Q)
- 
1. David **found out** how one can go to Brazil. (Hebrew = *berer*)
  2. \* Gal **fund out** to get to Haifa by bus. (A instead of Q)
- 
1. Grandfather **can** take Rina to the zoo. (Hebrew = *yaxol*)
  2. \* Dudi **can** where he takes Rina. (Q instead of A)
- 
1. The driver **may** drop her on the bumpy road. (Hebrew = *alul*)
  2. \* The worker **may** how to drop Yael on the floor. (Q instead of A)
- 
1. Raz **is supposed** to replace the tire. (Hebrew = *amur*)
  2. \* Guy **is supposed** if he puts together the new lamp in the garden. (Q instead of A)
- 
1. The diligent student **is capable** of playing the piano for hours. (Hebrew = *mesugal*)

2. \* Joel **is capable** that he practices swimming every day. (P instead of A)
1. Mirit **dares** to jump into the swimming pool from the high diving board. (Hebrew = *me'iz*)
2. \* Dana **dares** that she rides a horse by herself. (P instead of A)
1. Mom **forced** Dani to go to school on Sunday morning. (Hebrew = *hixriax*)
2. \* Grandmother **forced** Matan that he went on a trip to the Kineret. (P instead of A)
1. Aunt Sarah **promised** to make kuskus in five minutes. (Hebrew = *hivti'ax*)
2. \* Ruti **promised** how to cook a vegetable soup. (Q instead of A)
1. The tour guide **confirmed** that the field trip will take place as scheduled. (Hebrew = *'isher*)
2. \* The teacher **confirmed** if the math test will take place on Monday. (Q instead of P or A)
1. Yig'al **felt** that he did not do well on the exam. (Hebrew = *hirgish*)
2. \* Rami **felt** to win the race. (A instead of P or Q or PP or NP)
1. The guard **threatened** Dani that he'll take his bag. (Hebrew = *iyem*)
2. \* The tall teenager **threatened** Uri why he snatched his hat. (Q instead of P or PP)
1. Daddy **requested (from)** Michal to turn on the light. (Hebrew = *bikesh*)
2. \* Yossi **requested (from)** Dana why she turned off the T.V. (Q instead of P or NP)
1. Orit's mother **must** know the whole truth. (Hebrew = *xayav*)
2. Roe'e's mother **must** how she reads all the books. (Q instead of A)
1. Daniel **saw** that the food for the party was prepared. (Hebrew = *ra'a*)
2. \* Ronen **saw** to decorate the classroom in preparation for the party. (A instead of P or Q or NP)
1. Yossi **informed** Mira that she was nominated to be the manager. (Hebrew = *hodi'a*)
2. \* The manager **informed** Micha'ela to manage the office. (A instead of P or Q or NP or PP)
1. Har'el **guessed** that the treasure was located in the orchard. (Hebrew = *nixesh*)
2. \* Barak **guessed** to find out Liat's secret. (A instead of P or Q)
1. Micha'el **checked** that the dough was ready for baking. (Hebrew = *badak*)
2. \* Uri **checked** to clean the house for Shabbat. (A instead of P or Q)

1. The teacher **explained** to the kids that he was sick last week. (Hebrew = *hisbir*)
  2. \* The guide **explained** to the kids to visit the Museum. (A instead of P or Q)
- 
1. David **disclosed** to Amir all the answers to the test questions. (Hebrew = *gila*)
  2. \* Dudi **disclosed** to Erez to think about the answer. (A instead of P or Q)
- 
1. The newsman **reported** about the battles in the north. (Hebrew = *dive'ax*)
  2. The newsman **reported** to get into the shelters. (A instead of P or Q or PP)
- 
1. Tal **began** counting the candles on the cake. (Hebrew = *hitxil*)
  2. Amit **began** that she put the plates in the cupboard. (P instead of A)
- 
1. She **continued** to climb the high mountain. (Hebrew = *himshix*)
  2. Zipora **continued** that she toured the Galilee on her own. (P instead of A or NP or PP)
- 
1. He **wondered** why she was late for the meeting. (Hebrew = *taha*)
  2. The soldier **wondered** that she drove her car to the wedding. (P instead of Q)
- 
1. Moses **was forced** to finish the work. (Hebrew = *ne'elats*)
  2. Shaul **was forced** that he finished the repairs at home. (P instead of A)
- 
1. Idan **was asked** to leave the classroom. (Hebrew = *hitbakesh*)
  2. Ro'ee **was asked** that he go to the library. (P instead of A)
- 
1. Meir **finished** writing the paper for school. (Hebrew = *siyem*)
  2. Issac **finished** that he ate the corn. (P instead of A or NP)
- 
1. Nira **must** study for the exam. (Hebrew = *muxrax*)
  2. Ari'e'la **must** that she took a shower before the party. (P instead of A or NP)

Appendix D: Stimuli for Experiment 3

**Sentences used in the On-line Experiment**

Number of Arguments

Triad 1: adverb = *bi-frau* (wildly)

1. *ha-kalba im ha-parva ha-mavrika navxa* (1 argument, feminine) *bi-fraut al ha-yeladim* (The dog with the shiny fur **barked wildly** at the kids).
2. *ha-yalda im ha-xulca ha-civ'onit daxafa* (2 arguments, feminine) *bi-fraut et ha-agala shel ha-tinok* (The girl with the colorful shirt **pushed wildly** the baby's stroller).
3. *ha-isha im ha-se'ar ha-metultal sama* (3 arguments, feminine) *bi-fraut et ha-sfarim al ha-shulxan* (The woman with the curly hair **put wildly** the books on the table).

Triad 2: adverb = *be-hisus* (with hesitation)

4. *ha-xayelet im ha-kova ha-raxav shatka* (1 argument, feminine) *be-hisus axarei she-sham'a et ha-xadashot* (The soldier with the wide hat **kept silent with hesitation** after she heard the news).
5. *hacayeret im ha-lua'x ha-shaxor patxa* (2 arguments, feminine) *be-hisus et ha-delet shel ha-oto* (The artist with the black board **opened with hesitation** the door to the car).
6. *ha-naheget im ha-oto ha-gadol natna* (3 arguments, feminine) *be-hisus et ha-maftexot le-Ruti* (The driver with the big car **gave with hesitation** the keys to Ruti)

Triad 3: adverb = *be-simxa* (with joy)

7. *ha-tabax im ha-maceket ha-gdola caxak* (1 argument, masculine) *be-simxa le-mar'e ha-na'alaim ha-xadashot* (The cook with the big ladle **laughed with joy** when he saw the new shoes).
8. *ha-ganan im ha-magrefa ha-xuma kataf* (2 arguments, masculine) *be-simxa et ha-praxim ba-xacer* (The gardener with the brown rake **picked with joy** the nice flowers in the backyard).
9. *ha-rofe im ha-xaluk ha-meluxlax hixnis* (3 arguments, masculine) *be-simxa et ishto la-mexonit ha-mefo'eret* (The doctor with the dirty robe **got with joy** his wife into the fancy car).

Triad 4: adverb = *be-kalut* (easily)

10. *ha-saxyanit im ha-bgadim ha-shxorim calela* (1 argument, feminine) *be-kalut letox ha-brexa ha-a'muka* (The swimmer with the black clothes **dived easily** into the deep pool).

11. *ha-ne'ara im ha-xulca ha-kru'a hirdima* (2 arguments, feminine) **be-kalut** et *ha-tinok ha-shmanman* (The girl with the torn shirt **put to sleep easily** the chubby baby).
12. *ha-madrixa im ha-me'il ha-shaxor hifgisha* (3 arguments, feminine) **be-kalut** et *yaldei kvucata im rosh ha-'ir* (The guide with the black coat **caused to meet easily** the kids from her group with the mayor).

Triad 5: adverb = *ba-cohoraim* (at noon)

13. *ha-tinok im ha-xitul ha-meluxlax baxa* (1 argument, masculine) **ba-cohoraim** ad *she-ima higi'a* (The baby with the dirty diaper **cried at noon** until his mother arrived).
14. *ha-yaldon im ha-sharvul ha-mekupal hikpic* (2 arguments, masculine) **ba-cohoraim** et *ha-kadur be-migrash ha-misxakim* (The boy with the folded sleeve **bounced at noon** the ball in the play yard).
15. *ha-nehag im ha-galgal ha-mefunchar hoshiv* (3 arguments, masculine) **ba-cohoraim** et *ha-yeladim al ha-kis'ot ha-axori'im ba-otobus* (The driver with the flat tire **sat at noon** the children on the back seats of the bus).

Triad 6: adverb = *be-ta'ut* (by mistake)

16. *ha-zamar im ha-shirim ha-meshunim amad* (1 argument, masculine) **be-ta'ut** *leyad ha-menora ha-gvocha be-cad ha-bama* (The singer with the strange songs **stood by mistake** next to the tall lamp at the side of the stage).
17. *ha-baxur im ha-tarmil ha-'anaki hifxid* (2 arguments, masculine) **be-ta'ut** et *ha-baxura ha-blondinit* (The guy with the giant backpack **scared by mistake** the blonde girl).
18. *ha-kashish im ha-safam ha-mesulsal hoci* (3 arguments, masculine) **be-ta'ut** et *ha-trufa shelo me-ha-sakit* (The elderly person with the curly mustache **took out by mistake** his medicine from the bag).

Triad 7: adverb = *be-shalva* (calmly)

19. *ha-xatul im ha-'oznaim ha-ktanot yashan* (1 argument, masculine) **be-shalva** *befinat ha-xeder* (The cat with the small ears **slept calmly** at the corner of the room).
20. *ha-meltzar im ha-sinor ha-meguxax hidlik* (2 arguments, masculine) **be-shalva** et *ha-'or ba-mis'ada* (The waiter with the stupid-looking apron **turned on calmly** the light in the restaurant).
21. *ha-baxur im ha-zakan ha-meshune hish'in* (3 arguments, masculine) **be-shalva** et *ha-sulam ha-gavo'ha al ha-kir ha-shavur* (The guy with the weird beard **made calmly** the tall ladder **lean** against the broken wall).

Triad 8: adverb = *shilshom* (two days ago)

22. *ha-isha im ha-tabat ha-yafa gihaka* (1 argument, feminine) *shilshom a'xarei ha-aruxa* (The woman with the nice ring **burped two days ago** after the meal).
23. *ha-susa im ha-zanav ha-mitnafnef hipila* (2 arguments, feminine) *shilshom et ha-roxevet me-al gaba* (The horse with the wriggled tail **dropped two days ago** the rider off her back).
24. *ha-soferet im ha-tik ha-mefo'ar hikedisha* (3 arguments, feminine) *shilshom et ha-sefer shela la-yalda ha-xola* (The writer with the fancy bag **devoted two days ago** her book to the sick child).

Triad 9: adverb = *be-sheket* (quietly)

25. *ha-po'el im ha-patish ha-mekulkal pihek* (1 argument, masculine) *be-sheket axarei ha-avoda ba-mif'al* (The worker with the broken hammer **yawned quietly** after the work at the factory).
26. *ha-shomer im ha-panas ha-mehavhev kimet* (2 arguments, masculine) *be-sheket et ha-dapim shel ha-mivxan* (The guard with the blinking flashlight **wrinkled quietly** the pages of the test).
27. *ha-tayas im ha-kasda ha-xadasha hish'ir* (3 arguments, masculine) *be-sheket et ha-mishkafaim betox ha-megera ha-elyona* (The pilot with the new helmet **left quietly** his glasses inside the upper drawer).

Triad 10: adverb = *be-simxa* (happily)

28. *ha-saxkanit im ha-me'il ha-arox xiyexa* (1 argument, feminine) *be-simxa lexol ha-cofim* (The actresses with the long coat **smiled silently** to all of the viewers).
29. *ha-dodanit im ha-camid ha-nocec nishka* (2 arguments, feminine) *be-simxa et kol ha-yeladim* (The aunt with the shiny bracelet **kissed silently** all the kids).
30. *ha-madrixa im ha-tarmil ha-katan cerfa* (3 arguments, feminine) *be-simxa et ha-yeled ha-baxyan la-tiuyl* (The tour guide with the small backpack **joined silently** the crying boy to the trip).

#### Number of Structural Options in *binyan hiKTiL*

Pair 1: adverb = *be-fit'omiyut* (suddenly)

1. *ha-savta im ha-taxposet ha-yafa hifxida* (1 option, feminine) *be-fit'omiyut et ha-yeladim ba-mesiba* (The grandmother with the nice costume **scared suddenly** the kids at the party).
2. *ha-zikuk im ha-orot ha-nocecim he'edim* (2 options, masculine) *be-fit'omiyut et ha-shamaim ha-kxulim* (The firework with the sparking lights **reddened suddenly** the blue sky).

Pair 2: adverb = *be-haclaxa* (successfully)

3. *ha-gever im ha-agil ha-mesulsal hexin* (1 option, masculine) ***be-haclaxa*** *ugat tapuxim* (The man with the curly earring **prepared successfully** a tasty apple cake).
4. *ha-xomer im ha-'avka ha-reixanit hilbin* (2 options, masculine) ***be-haclaxa*** *et xulcat ha-shabat shel aba* (The detergent with the fragrant powdered **whitened successfully** Daddy's Sabbath shirt).

Pair 3: adverb = *be-hadruga* (gradually)

5. *ha-na'ar im ha-mavreg ha-mekulkal hif'il* (1 option, masculine) ***be-hadruga*** *et kol maxshirei ha-xashmal ba-bait axarei she-tiken et ha-takala* (The boy with the broken screwdriver **activated gradually** all the electrical appliances at home after fixing the problem).
6. *ha-ovesh al ha-kirot ba-sherutim hishxir* (2 options, masculine) ***be-hadruga*** *et kol ha-kiorim* (The mold on the walls of the bathroom **blackened gradually** all the sinks).

Pair 4: adverb = *be-hitlahavut* (with enthusiasm)

7. *ha-tayeset im ha-me'il ha-arox hetisa* (1 option, feminine) ***be-hitlahavut*** *et ha-matos me'al he-harim* (The pilot with the long coat **flew with enthusiasm** the airplane above the mountains).
8. *ha'ovedet im ha-panas ha-gadol hexshixa* (2 options, feminine) ***be-hitlahavut*** *et ulam ha-mofa'im likrat ha-hofa'a* (The worker with the big flashlight **darkened with enthusiasm** the performance hall in preparation for the show).

Pair 5: adverb = *be-haclaxa* (successfully)

9. *ha-saba shel tali ve-uzi hirdim* (1 option, masculine) ***be-haclaxa*** *et ha-tinok ha-shmanman* (The grandfather of Tali and Uzi **put to sleep successfully** the chubby baby).
10. *ha-oxel shel savta Nexama hishmin* (2 options, masculine) ***be-haclaxa*** *et Yael ha-raza ve-ha-xolanit* (The food of grandma Nexama **caused successfully** skinny and sick Yael to become "fuller").

Pair 6: adverb = *ba-cohoraim* (at noon)

11. *ha-yaldon im ha-sharvul ha-mekupal hikpic* (1 option, masculine) ***ba-cohoraim*** *et ha-kadur be-migrash ha-misxakim* (The boy with the folded sleeve **bounced at noon** the ball in the play yard).
12. *ha-moxer im ha-karaxat ha-dgola hivrik* (2 options, masculine) ***ba-cohoraim*** *et pamotei ha-kesef ha-yekarim* (The seller with the big bold spot **brightened at noon** the silver candle holders).

Pair 7: adverb = *be-'ituyut* (slowly)

13. *ha-'ca'ir im ha-se'ar ha-meshune he'exil* (1 option, masculine) ***be-'ituyut*** et *ha-tinok ha-menumnam* (The teenager with the funny looking hair **fed slowly** the sleepy baby).
14. *ha-isha im ha-sirim ha-xadashim hifshira* (2 options, feminine) ***be-'ituyut*** et *ha-basar la-aruxa* (The woman with the new pots **defrosted slowly** the meat in preparation for the meal).

Pair 8: adverb = *be-ta'ut* (by mistake)

15. *ha-yalda ha-shovava ha-xamuda hipila* (1 option, feminine) ***be-ta'ut*** et *ha-calaxat im ha-oxel* (The wild and cute girl **dropped by mistake** the plate with the food).
16. *ha-shita ha-xadasha shel ha-rofe hixmira* (2 options, feminine) ***be-ta'ut*** et *macava shel ha-xola* (The new method of the doctor **worsened by mistake** the condition of the patient).

Pair 9: adverb = *be-hadruga* (gradually)

17. *ha-baxura ha-yafa ve-ha-nexmada hinxita* (1 option, feminine) ***be-hadruga*** et *ha-masok axarei she-hevina she-ha-mano'a hitkalkel* (The pretty and nice woman **landed gradually** the helicopter after realizing that the engine has been broken).
18. *ha-'avoda ha-kasha ve-ha-yomyomit hizkina* (2 options, feminine) ***be-hadruga*** et *ha-'isha ha-'adina ve-ha-mefuneket* (The hard daily work **caused gradually** the gentle and spoiled lady to look older).

Pair 10: adverb = *be-ta'ut* (by mistake)

19. *ha-nehag im ha-kasda ha-cehuba hignbir* (1 option, masculine) ***be-ta'ut*** et *ha-mehirut be-mahalax ha-sivuv* (The driver with the yellow helmet **increased by mistake** the speed during the turn).
20. *ha-pakid me-hakoma ha-rishona hexmic* (2 options, masculine) ***be-ta'ut*** et *ha-pgisha ha-xashuva* (The secretary from the first floor **missed by mistake** the important meeting).

### Number of Structural Options for Verbs with Sentential Complements

Pair 1: adverb = *be-emet* (really)

1. *ha-shoteret im ha-'ekdax ha-shaluf xashda* (2-3 options, feminine) ***be-emet*** ba-'isha ha-gvoha (The policewoman with the drawn gun **suspected really** the tall woman).
2. *ha-moxeret im ha-arnak ha-gadol xashva* (5-7 options, feminine) ***be-emet*** al ha-haca'a ha-mefata (The sells woman with the big purse **thought really** about the tempting offer).

Pair 2: adverb = *be-ferut* (meticulously)

3. *ha-ganevet im ha-mafte'ax ha-shavur badka* (2-3 options, feminine) ***be-ferut et ha-knisa la-bait*** (The thief with the broken key **checked meticulously** the entrance to the house).
4. *ha-naheget im ha-sharsheret ha-ksufa yad'a* (5-7 options, feminine) ***be-ferut et kol misparei ha-telefon shel ha-nos'im*** (The driver with the silver chain **knew meticulously** all the phone numbers of the passengers).

Pair 3: adverb = *bimhirut* (quickly)

5. *ha-kone im ha-arnak ha-yerakrak hitxaret* (2-3 options, masculine) ***bimhirut al kniyat ha-televizya ha-'anakit*** (The buyer with the green purse **regretted quickly** buying the giant T.V.)
6. *ha-madrixa shel ha-tiyul la-golan hisbira* (5-7 options, feminine) ***bimhirut la-ne'arim et ha-toxnit le-hemshex ha-yom*** (The Golan tour guide **explained quickly** to the boys about the plan for the rest of the day).

Pair 4: adverb = *be-hitragshut* (enthusiastically)

7. *ha-saxkan im ha-kadur ha-civ'oni hit'anyan* (2-3 options, masculine) ***be-hitragshut be-misxak ha-kaduregel shel ha-yeladim*** (The player with the colorful ball **was interested enthusiastically** in the football game of the children).
8. *ha-no'em im ha-maxshev ha-gadol hizkir* (5-7 options, feminine) ***be-hitragshut et ha-krav ha-gadol al yerushalaim*** (The preacher with the large computer **mentioned enthusiastically** the big battle over Jerusalem).

Pair 5: adverb = *miyadit* (immediately)

9. *ha-more ha-xadash le-biologia carix* (2-3 options, masculine) ***miyadit ezra behaf'alat ha-maxshev shelo*** (The new Biology teacher **needs immediately** assistance with activating his new computer).
10. *ha-ca'ir ha-xaruc ve-ha-sportivi gila* (5-7 options, masculine) ***miyadit et ha-derech la-ocar ha-gadol*** (The young, athletic guy **discovered immediately** the path to the big treasure).

Pair 6: adverb = *bircinut* (seriously)

11. *ha-tayar im ha-mizvada ha-ktana berer* (2-3 options, masculine) ***bircinut al ha-tiyul le-yerushalaim*** (The tourist with the small suitcase **investigated seriously** about the trip to Jerusalem).
12. *ha-macil im ha-mishkefet ha-shvura lamad* (5-7 options, masculine) ***bircinut et kol ha-shitot le-limud sxiya*** (The life-guard with the broken binocular **learned seriously** all the swimming techniques).

Pair 7: adverb = *bi-tkifut* (with decisiveness)

13. *ha-xashud bagneva shel ha-maxshevim hikxish* (2-3 options, masculine) **bi-tkifut et kol ha-'ashma** (The suspect in the robbery of the computers **denied with decisiveness** his guilt).
14. *ha-pa'ut ha-xamud im ha-ra'ashan raca* (5-7 options, masculine) **bi-tkifut et ha-glida shel Tami** (The sweet toddler with the rattle **wanted with decisiveness** the ice-cream of Tali).

Pair 8: adverb = *etmol* (yesterday)

15. *ha-more im ha-oto ha-mefo'ar ixel* (2-3 options, masculine) **etmol le-xol ha-yeladim xufshat kaic ne'ima 'u-betuxa** (*the teacher with the fancy car wished yesterday to all the children a nice and safe summer vacation*)
16. *ha-madrix im ha-sefer ha-patu'ax siper* (5-7 options, masculine) **etmol le-xol ha-xanixim al tkufat hakamat ha-medina** (The guide with the open book **told yesterday** to all the pupils about the building of the state).

Pair 9: adverb = *miyadit* (immediately)

17. *ha-baxur im ha-safam ha-mekurzal xayav* (2-3 options, masculine) **miyadit harbe kesef le-xanut ha-makolet ha-shxunatit** (*the guy with the curly mustache owes immediately a lot of money to the local grocery store*).
18. *ha-ganav im ha-sigarya ha-gdola amar* (5-7 options, masculine) **miyadit et kol ha-emet la-shotrim be-taxanat ha-mishtara** (the thief with the big cigarette **told immediately** the whole truth to the policemen in the police station).

Pair 10: adverb = *mecuyan* (with excellence)

19. *ha-talmid im ha-ciyunim ha-tovim zaxar* (5-7 options, masculine) **mecuyan et kol ha-she'elot la-mivxan be-tanax** (The student with the high grades **memorized with excellence** the questions for the exam in Bible studies).
20. *ha-mitxare ba-misxak ha-metuxkam nixesh* (2-3 options, masculine) **mecuyan et ha-chuva la-she'ela ha-axrona** (The participant in the sophisticated game **guessed with excellence** the answer to the last question).

### Thematic Structure

Pair 1: adverb = *ba-cohoraim* (at noon)

1. *ha-yeled im ha-kova ha-'adom hishta'el* (unergative, masculine) **ba-cohoraim lelo hafsa** (The boy with the red hat **coughed at noon** without a break).
2. *migdal ha-kubiyot ha-'anaki hitmotet* (unaccusative, masculine) **ba-cohoraim al ha-ricpa be-gan ha-yeladim** (The giant tower of blocks **collapsed at noon** on the floor of the kindergarten).

Pair 2: adverb = *etmol* (yesterday)

3. *ha-kelev im ha-oznaim ha-shmutot hit'atesh* (unergative, masculine) **etmol** *ba-meluna shelo* (The dog with the sloping ears **sneezed yesterday** in his dog house).
4. *ha-sveder im ha-sharvulim ha-xumim hityabesh* (unaccusative, masculine) **etmol** *ba-shemesh ha-xama ba-cohoraim* (The sweatshirt with the brown sleeves **dried-up yesterday** in the hot sun).

Pair 3: adverb = *be-Shabbat* (on Saturday)

5. *ha-'isha im ha-magevet ha-kru'a hishtolela* (unergative, feminine) **be-Shabbat** *al ha-kvish leyad ha-bayit* (The woman with the torn towel **went wild (on Saturday)** on the road in front of the house).
6. *ha-yalda im ha-einaim ha-kxulot hictanena* (unaccusative, feminine) **be-Shabbat** *bizman ha-se'ara ha-gdola* (The girl with the blue eyes **got a cold on Saturday** during the big storm).

Pair 4: adverb = *bimhirut* (quickly)

7. *ha-pa'ut ha-mefunak ve-ha-baxyan hitgalesh* (unergative, masculine) **bimhirut** *ba-maglesha ha-gvoha be-migrash ha-misxakim* (The spoiled and cranky toddler **sled down quickly** on the high slide in the play yard).
8. *ha-me'il ha-mehudar im ha-parva hitlaxlex* (unaccusative, masculine) **bimhirut** *me-ha-kafe ve-ha-'ugiot ba-mis'ada* (The fancy coat with the fur **became dirty quickly** from the coffee and the cookies at the restaurant).

Pair 5: adverb = *ba-xoref* (in the winter)

9. *ha-talmid im ha-tarmil ha-karu'a hizdaxel* (unergative, masculine) **ba-xoref** *axarei kulam betox ha-boc ve-ha-shluliot* (The student with the torn backpack **crawled in the winter** after everybody in the mud and in the puddles).
10. *ha-maxshev im ha-masax ha-shatu'ax hitkalkel* (unaccusative, masculine) **ba-xoref** *bezman hafsakat ha-xashmal* (The computer with the flat screen **broke in the winter** during the power break).

Pair 6: adverb = *be-kalut* (easily)

11. *ha-rakdan im ha-raglaim ha-kcarot hitno'e'a* (unergative, masculine) **be-kalut** *al ha-bama bizman ha-xazarot* (The dancer with the short legs **moved easily** on the stage during the rehearsals).
12. *ha-balon im ha-pasim ve-ha-semel hitnape'ax* (unaccusative, masculine) **bekalut** *be-ezrat ha-mash'eva shel aba* (The balloon with the stripes and the symbol **became inflated easily** with daddy's pump).

Pair 7: adverb = *etmol* (yesterday)

13. *ha-baxur ha-muzar im ha-mizvada hishtolel* (unergative, masculine) *etmol leyad bet ha-kneset ha-gadol* (The strange guy with the suitcase **acted wildly yesterday** next to the big synagogue).
14. *ha-me'il ha-yafe im ha-kaftorim hitkavec* (unaccusative, masculine) *etmol me-hakvisa she ima* (The nice coat with the buttons **got shrunk yesterday** as a result of Mom's laundry).

Pair 8: adverb = *be-kalut* (easily)

15. *ha-yaldon im ha-kfafot ve-ha-kova hitgalesh* (unergative, masculine) *be-kalut al ha-sheleg baxermon* (The little boy with the gloves and the hat **sled easily** on the snow at mount Hermon).
16. *ha-mivne ha-mekushat ve-ha-yafe hitparek* (unaccusative, masculine) *be-kalut axrei she-dani heziz et ha-'avanim* (The decorated and beautiful structure **came apart easily** after Dani moved the stones).

Pair 9: adverb = *be-Shabbat* (on Saturday)

17. *ha-duba ha-mafxida ve-ha-gdola hitpar'a* (unergative, feminine) *be-Shabbat bakluv shela* (The scary big bear **raged on Saturday** in her cage).
18. *ha-xola im ha-shapa'at ha-kasha hit'alfa* (unaccusative, feminine) *be-Shabbat beveit ha-xolim be-Tel Aviv* (The patient with the bad flu **fainted on Saturday** at the hospital in Tel Aviv).

Pair 10: adverb = *ba-layla* (at night)

19. *ha-kalba im ha-ragla'im ha-xumot hit'acha* (unergative, feminine) *ba-layla axarei ha-tiyul* (the dog with the brown legs **sneezed at night** after the trip).
20. *ha-simla ha-xadasha shel Na'ama hityabsha* (unaccusative, feminine) *ba-layla be-meyabesh ha-kvisa* (the new dress of Na'ama **was dried at night** in the dryer).

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