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Grammaticality judgments in adolescents with and without language impairment

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Abstract

Background—Existing evidence suggests that young children with specific language impairment (SLI) have unusual difficulty detecting omissions of obligatory tense-marking morphemes, but little is known about adolescents' sensitivity to such violations.

Aims—The study investigated whether limitations in receptive morphosyntax (as measured by grammaticality judgments) were present at age 16 years, and if so, whether participants' profiles showed less sensitivity to omissions of tense and agreement morphemes than to (a) inappropriate uses (intrusions) of these same morphemes, and (b) omissions of morphemes that do not encode tense and agreement. We also compared adolescents with language impairment and nonverbal IQ more than 1 SD below the mean (nonspecific language impairment; NLI) to adolescents with SLI.

Methods & Procedures—Adolescents with SLI (n = 48), adolescents with NLI (n = 25), and adolescents with normal language development (NLD, n = 108) performed speeded grammaticality judgments of sentences presented over headphones. Half of the sentences were ungrammatical. They included omissions of nontense morphemes (*-ing* and possessive *–s*), omissions of tense morphemes (*-ed* and third person singular present *–s*), and intrusions of the same tense morphemes. The A' statistic was used as the dependent variable for comparisons across groups and item types.

Outcomes & Results—Overall, the NLD group was more sensitive to grammatical violations than the SLI and NLI groups, and there was no significant interaction of group and item type. Post-hoc analyses showed that the SLI group was less sensitive to violations than the NLD group on each item type, and the SLI and NLI groups did not differ. Across groups, performance on omission of

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What this paper adds

What is already known on this subject. Previous research suggests that young children with specific language impairment (SLI) have unusual difficulty detecting omissions of obligatory tense-marking morphemes. Little is known, however, about whether adolescents with language impairment are sensitive to such violations.

What this study adds. The adolescents with language impairment in this study were not as good as their typically developing peers at detecting grammatical violations. Unlike younger children with SLI, these adolescents did not have more difficulty with omissions of tense-marking morphemes than with other violations. Although for many individuals, language impairment persists into the teenage years, the nature of the impairment may change over time.

past tense *–ed* was lowest, and properties of the items that may have contributed to this difference were explored.

Conclusions & Implications—The adolescents with language impairment in this study showed evidence of reduced sensitivity to morphological errors, including both tense-marking and nontense-marking morphemes, but no evidence of extraordinary difficulty in detecting the omission of tense-marking morphemes, in contrast to results from other research on younger children with SLI. Participants whose nonverbal IQ score was too low to meet the criteria for SLI performed similarly to their peers with SLI. Grammatical competence is compromised in these adolescents with SLI and NLI. Neither researchers nor clinicians can assume that adolescents with language impairment have fully mastered grammatical morphology.

Keywords

specific language impairment; nonspecific language impairment; adolescent language; receptive grammar

Introduction

Children with specific language impairment (SLI) present with deficits in many language domains, and the production of grammatical morphology marking tense and agreement is an area of particular weakness (Rice 2004, Leonard 1998). Much of the research describing the language deficits of children with SLI has been done with the preschool or early primary grade age groups. Research involving older children and adolescents, however, has found that language deficits persist at later ages. A brief review of this research indicates that a wide range of abilities are affected.

Outcomes in adolescents with a history of language impairment have been examined in a few studies. Aram *et al.* (1984) tested 20 children aged 13 to 16 years, who had been identified as having a language disorder 10 years earlier. They found that the majority of the participants scored 1 or more standard deviations below the mean for receptive vocabulary, comprehensive spoken and written language, phoneme discrimination in noise, and diadochokinetic rate.

Johnson *et al.* (1999) conducted a large-scale longitudinal study of children with speech and/or language impairments. When the participants were 19 years old, 78 participants were tested who had been identified as language impaired at age 5. The tests included receptive and expressive vocabulary, word finding, phonological processing, receptive and expressive syntax, verbal and performance IQ, reading, spelling, and math. On each measure, the group that had been language impaired 14 years earlier scored significantly below the control group and a group with speech impairment only. Phonological processing was an exception, in that the language impaired group scored significantly worse than controls, but the speech-only group was not different from either of the other two groups.

Stothard *et al.* (1998) investigated outcomes at age 15-16 years for children who had been identified at age 5;6 as having SLI that had resolved (n = 26), and for children who had persistent SLI at that age (n=30). As adolescents, the persistent SLI group scored significantly lower than both the resolved SLI group and a control group on measures of receptive and expressive vocabulary, grammatical comprehension, sentence repetition, nonword repetition, spoonerisms (a measure of phonological awareness), and a reading test.

Other studies have shown similar wide-ranging deficits in school-aged children several years after diagnosis of a language disorder. Stark *et al.* (1984) tested groups of typically developing children and children with SLI between the ages of 8 and 12 years, 3 to 4 years after initial testing. The children with SLI performed within age-appropriate limits on performance IQ, but below the level of the typically-developing comparison group. The children with SLI performed below age level on receptive and expressive language (including measures of vocabulary and syntax). Reading scores were found to be at least two grades below age level for 23 of the 29 children with SLI.

Conti-Ramsden *et al.* (2001) tested, at age 11 years, children with SLI who had been identified and tested 4 years earlier. The areas tested were receptive and expressive vocabulary, expressive morphosyntax, receptive syntax, and word associations, as well as verbal and performance IQ, reading, and pragmatics. The presence of characteristics of autism spectrum disorder (ASD) was also measured. Of the 200 children in the sample, 115 were found to still meet criteria for SLI after excluding those whose language impairment had resolved (23), those with a performance IQ < 70 (55), and those with possible ASD (7). For each of the expressive and receptive vocabulary and expressive morphosyntax measures, more than half of the 115 children with persisting SLI scored at least 1 *SD* below the mean, and 43% were at least 1 *SD* below the mean on receptive syntax. Seventy-eight percent scored 1 or more *SD*s below the mean on reading comprehension, and 69% did so on single-word reading.

These results, while not an exhaustive review of the relevant literature, highlight the fact that SLI persists through childhood and into adolescence and young adulthood for many individuals, and that the areas of difficulty are many and varied. Measures of syntax are usually included, but as children get older, it is less likely that the tasks used to measure syntax will involve the morphosyntactic details that are most vulnerable in children with SLI during the preschool years (Conti-Ramsden *et al.* 2001 is an exception).

Comprehension of morphosyntax has been examined in primary grade children through grammaticality judgment tasks. Rice *et al.* (1999) conducted a longitudinal investigation of judgments of grammatical violations in children with SLI from 6 to 8 years of age. Children with SLI were more likely to detect omission of progressive *–ing* than omission of copula and auxiliary forms of *be* and third person singular present tense *–s*, but were able to detect incorrect use of the latter forms. Other work by the same researchers (Redmond and Rice 2001) found that 8-year-old children with SLI were more likely than age peers to accept an infinitive form where an irregular past tense was obligated. They were also more likely to accept a finite form (irregular past or an overregularization) where an infinitive was obligated, although they did not make these overt errors in production tasks.

Montgomery and Leonard (1998) also investigated the grammaticality judgments of 8-year-old children with SLI on violations involving missing progressive *–ing*, third singular *–s*, and regular past *–ed*. Children with SLI performed similarly to age- and language-matched peers on progressive *–ing* items, but more poorly than age peers on *–s* and *–ed* items.

Wulfeck *et al.* (2004) examined speeded grammaticality judgments by children with SLI aged 7 to 12 years, using sentences with three types of grammatical errors: word order, agreement, and omission. Each type of error occurred with noun determiners and auxiliary verbs. Children with SLI showed less sensitivity to grammatical errors overall, relative to age-matched peers and to children with focal brain lesions. All children were least sensitive to agreement errors and most sensitive to word order errors, with omission errors between the two. However, children with SLI had extraordinary difficulty with agreement errors and with auxiliary verbs relative to determiners.

Comprehension of tense and agreement morphology appears to be an area of weakness for children with SLI, but it is not clear if this weakness is unique to SLI or is associated with language impairment in general. In a series of studies conducted by Tomblin and his colleagues (Miller *et al.* 2001, Miller *et al.* 2006, Tomblin and Zhang 1999, Ellis Weismer *et al.* 2000), participants included a group of children with both language impairments and nonverbal IQ scores below the customary SLI cutoff of -1 *SD*, as well as a group of children with SLI and a group of typically developing same-age peers. Although the children with low scores on both language and nonverbal IQ tests (hereafter, the children with nonspecific language impairment or NLI) showed a tendency for poorer performance on the language and processing tasks employed in these studies, they did not appear to show a different profile of language use or comprehension (e.g., Tomblin and Zhang 1999). These findings create some doubt as to whether these children should be regarded as distinct from children with SLI.

Research questions

The studies demonstrating that receptive morphosyntax is impaired in younger children with SLI corroborate the more extensive literature on expressive morphosyntax (see Leonard 1998). Children with SLI not only omit grammatical morphemes in their productions, but fail to recognize that such omissions are incorrect when produced by others. Given the persistent deficits observed in many areas of language in older children and adolescents with SLI, it is reasonable to expect that this age group will also demonstrate limitations in grammaticality judgment tasks. The current study tests this prediction, asking two questions. The first question is whether limitations in receptive morphosyntax (as measured by grammaticality judgments) persist at age 16 years. The second question is whether a similar performance profile will be seen at age 16 as has been observed in younger children. This profile consists of less sensitivity to omissions of tense and agreement morphemes than to (a) intrusions (inappropriate uses) of these same morphemes, and (b) omissions of morphemes that do not encode tense and agreement.

A third question of interest in the present study is whether the profile observed for adolescents with SLI is particular to individuals with this clinical diagnosis, or applies more generally to individuals with language impairments. In the present study we pursue this issue further by asking whether adolescents with NLI differ from adolescents with SLI and typically developing peers not only in overall performance level, but in their performance profile across conditions in our grammaticality judgment task.

Methods

Participants

The participants were a subset of those involved in a large-scale longitudinal investigation of SLI (Tomblin *et al.* 1997). A large sample of kindergarten children was drawn from urban, suburban, and rural schools in midwestern communities. All children received a brief language screening test composed of 40 items from the Test of Language Development-Primary, second edition (TOLD-P:2, Newcomer and Hammill 1988). All children who failed the screening, and approximately 33% of those who passed, were recruited to participate in a diagnostic test battery. Children were excluded from participation in the diagnostic phase if they a) did not have English as their primary language, or came from a home where English was not the predominant language; b) had a history of mental retardation, autism, or neurological problems; or c) were blind or used hearing aids. Details of the sampling and procedure can be found in Tomblin *et al.* (1997).

The diagnostic battery included measures of hearing, language, speech, and nonverbal intelligence. Children with persistent bilateral hearing deficits were excluded from further testing. For performance IQ, a combined standard score greater than 87 on two subtests of the Wechsler Preschool and Primary Scale of Intelligence-Revised (Wechsler 1989) was considered to be an age-appropriate level. Language ability was measured by a battery including selected subtests of the TOLD-P:2 (Newcomer and Hammill 1988) and a narrative story task involving both production and comprehension (Culatta *et al.* 1983). Scores were standardized based on local norms and combined to form five composite scores. A child was considered below age level on the language battery when two or more composite scores were 1.25 *SD* below the mean for the child's age group. Further information about the diagnostic testing is given in Tomblin *et al.* (1996).

The parents of all children who participated in the diagnostic procedure were invited to join a registry. All children in the registry who were language impaired at kindergarten were invited to participate in a longitudinal study, and 231 (82% of those invited) agreed to join. In addition, 442 children whose language status was normal at kindergarten were randomly sampled and invited to participate, and 373 agreed. See Tomblin *et al.* (2000) for details regarding the subject recruitment and selection process.

The children received similar diagnostic batteries two, four, and six years after the original diagnostic phase. At the last testing point, when most of the participants were in eighth grade, this battery included the Peabody Picture Vocabulary Test-Revised (PPVT-R, Dunn and Dunn 1981), the expressive scale of the Comprehensive Receptive and Expressive Vocabulary Test (CREVT, Wallace and Hammill 1994), the Concepts and Directions and Recalling Sentences subtests of the Clinical Evaluation of Language Fundamentals-3 (CELF-3, Semel *et al.* 1994), and the Qualitative Reading Inventory-3 (QRI, Leslie and Caldwell 2001) as an assessment of discourse comprehension and production. For the purposes of placing children into diagnostic categories, the Block Design and Picture Completion subtests of the Wechsler Intelligence Scale for Children-III (Wechsler 1991) were used as a measure of performance IQ. Composite scores were computed in the same manner as for the kindergarten battery and diagnostic classifications were made.

Two years after the diagnostic battery, when the participants were about 16 years old and most were in tenth grade, the grammaticality judgment tasks of the current study were administered to 181 adolescents. These individuals had participated in earlier response time experiments at third and eighth grade (Miller *et al.* 2001, Miller *et al.* 2006). The sample comprised the normal language development (NLD group; n = 108), the SLI group (n = 48), and the nonspecific language impairment (NLI) group (n = 25), who scored below cutoffs on both language and performance IQ. Characteristics of the sample are summarized in table 1.

Materials

A total of 84 sentence pairs were created. One sentence in each pair was fully grammatical, and the other contained a particular violation of adult grammar but in all other respects was identical to the first. One violation type was the omission of a non-tense grammatical morpheme. For 14 sentences, the error was an omission of progressive *–ing*, as in *The children are hide so they can surprise their friend*. For another 14 sentences, the error was an omission of the possessive inflection *'s*, as in *I like Lucy dentist better than my dentist*. Together these two types of errors are referred to as “nontense omissions.”

An additional 14 sentences contained a commission error – the intrusion of a present third person singular *–s* inflection in an inappropriate context, as in *Sue helped to hangs a picture last night*. Another 14 sentences contained a commission error involving the past tense inflection *–ed*, as in *It is impolite to stared at people at the Mall*. Together these two types of errors are referred to as “tense intrusions.”

The remaining errors are referred to as “tense omissions.” For 14 sentences, present third person singular *–s* was omitted from a context that requires it in the adult grammar, as in *Every day he tell a joke at lunch*. For the other 14 sentences, past tense *-ed* was omitted, as in *Yesterday the friends look at the magazine together*.

Given the different amounts of linguistic information required to detect each type of error, the sentences reflecting each error type were not matched for number of words in the sentence or for the location in the sentence where the error occurred. Table 2 provides length and position information for the sentences of each error type. For example, in the sentence *Yesterday the friends look at the magazine together*, the sentence length is 8, and the sentence position of the error is 4 (the word *look* which should be *looked*).

In order to reduce any effect of unfamiliar words on grammaticality judgments, all words containing errors met minimum frequency criteria. Across all sentence types the median frequency of occurrence (Francis and Kucera 1982) of the word containing the grammatical error was 56 for verbs (for nontense *–ing* omissions, tense *–s* intrusions, tense *–ed* intrusions, tense *-s* omissions, and tense *–ed* omissions), and 68.5 for nouns (nontense *'s* omissions). All of the words containing errors had a frequency of occurrence of 2 or greater.

The sentences were recorded in a sound-attenuated booth using a head-mounted Shure WH20 microphone connected to a Marantz PMD650 portable minidisc recorder. The speaker was a male native speaker of American English with training in vocal performance. The first author was present with the speaker at all recording sessions. The grammatical and ungrammatical versions of each sentence were spoken separately, and the speaker rehearsed all sentences, so as to produce the ungrammatical versions with natural intonation and without inappropriate hesitation or emphasis on the word containing the error. At least two tokens of each sentence were recorded. The first author monitored all productions and requested that the speaker record additional tokens of sentences if there was any question of the first two tokens being unsuitable. A research assistant independently listened to all recordings and selected pairs of grammatical and ungrammatical tokens to be as similar and as natural-sounding as possible. The selected recordings were digitized at sampling rate of 22 kHz, low-pass filtered, and amplitude normalized.

For the purposes of creating stimulus lists, the sentences were divided into six types: the three categories described above (nontense omission, tense omission, tense intrusion) with two morphemes within each category. A stimulus list was created with 14 blocks of six items, one of each type. Items were randomly assigned to blocks and randomly ordered within blocks. Within each block, half of the items were randomly assigned to be grammatical, with the constraint that no more than 3 consecutive grammatical or ungrammatical sentences were allowed. A second stimulus list was created, which was the same as List 1 except that all sentences that were grammatical in List 1 were ungrammatical in List 2, and vice versa. Half of the participants in each group (NLD, SLI, NLI) received List 1 and half received List 2. The stimulus lists were presented and responses collected using E-Prime version 1.1 software (Schneider *et al*. 2002). The software was run on a Toshiba Satellite Pro 4600 laptop computer, and responses were collected by a Psychology Software Tools serial response box.

Procedure

The experiment was administered to participants as part of a battery of tasks. The battery was administered over three sessions, each lasting 1.5-1.75 hours, for a total of 4.5-5 hours. The experiment was presented in a fixed position within a session, but was counter-balanced so that approximately equal numbers of participants received it during the first, second, or third session. The experiment began with instructions presented on the computer screen. These instructions defined correct sentences as “they will sound like something a person would really say” and incorrect sentences as “they will sound funny or wrong.” The response box had five buttons, only two of which were used. The right-most button was labeled in red with the word “NO” and the button immediately to its left was labeled in green with the word “YES.” Participants were instructed to press the green button for a correct sentence and the red button for an incorrect sentence. The instructions stated, “As soon as you are sure of your answer, press a button as fast as you can. You don't have to wait for the sentence to end, but you can if you need to."

A trained examiner was seated near the participant. Two sets of headphones were connected to the laptop computer, and both the participant and the examiner listened to the stimuli. Before the task began, six practice items were presented. The examiner monitored the participant's performance, and reiterated the instructions as needed, but did not provide feedback about accuracy. The practice items were repeated if the examiner believed it was necessary. Experimental items were not repeated.

Results

Sensitivity to grammatical violations was measured with the statistic A' (Grier 1971), which has been used in previous studies (e.g., Rice *et al.* 1999, Wulfeck *et al.* 2004). The A' statistic compares the proportion of hits (correct acceptance of a grammatical sentence relative to incorrect rejection of a grammatical sentence) to the proportion of false alarms (incorrect acceptance of an ungrammatical sentence relative to correct rejection of an ungrammatical sentence)[1]. The value of A' varies between 0.5, which indicates chance responding, and 1.0, which indicates perfect sensitivity. For the analyses described below, A' values were arcsine transformed, but untransformed means are reported.

A MANOVA was performed with group (NLD, SLI, NLI) as the between-subjects variable and conditions (tense omission 3S, tense omission ED, tense intrusion 3S, tense intrusion ED, nontense omission ING, nontense omission POS) as the dependent variables. The main effect of group was significant ($F(2, 172) = 33.29$, $p = .000$, partial $\eta^2 = 0.28$), and a post-hoc Unequal N HSD test (a modification of the Tukey test) showed that the NLD group had significantly higher A' scores than the SLI group ($p = .000$) and the NLI group ($p = .000$), while the SLI and NLI groups did not differ significantly ($p = .99$). There was a significant effect of condition ($F(5, 168) = 40.13$, $p = .000$, Wilks Lambda = .46) but the interaction of group and condition was not significant ($F(10, 336) = 0.71$, $p = .716$, Wilks Lambda = .96). Means for each group in each condition are shown in table 3. Post-hoc comparisons of the condition means using the Tukey test showed that tense omission ED had a significantly lower mean A' ($p < .05$) than all other conditions. The mean for nontense omission POS was significantly greater than tense omission ED and significantly less than the remaining conditions.

A series of univariate analyses was performed to determine if the group differences were consistent across conditions. For each condition, the main effect of group was significant (all *p*s = .000) and the effect size partial η^2 ranged from 0.10 for tense omission 3S and ED to 0.19 for tense intrusion ED. Unequal N HSD post-hoc tests were conducted, with alpha set at 0.05. For nontense omission ING and POS, the pattern of differences was NLD > SLI; NLI = NLD, SLI. For tense omission 3S and ED, the pattern was NLD > SLI = NLI. For tense intrusion 3S, NLD > SLI; NLI = NLD, SLI and for tense intrusion ED, NLD > SLI = NLI. The SLI group was less sensitive than the NLD group for all violation types, and the NLI group did not differ from the SLI group. For nontense omission and for tense intrusion 3S, the NLI group also did not differ from the NLD group.

Three further univariate analyses were performed, one each for nontense omission, tense omission, and tense intrusion, with group as the between-subjects variable and morpheme as the within-subjects variable. These analyses provided a direct comparison of morphemes within violation types. In each of the three analyses, there was a significant effect of group

[1]Alternatively, hits can be defined as correct rejection of an ungrammatical sentence and false alarms as incorrect rejection of a grammatical sentence (cf. Wulfeck *et al.* 2004). The resulting A' value is the same in either case.

(*p*s = .000) and Unequal N HSD post-hoc tests showed the pattern NLD > SLI = NLI was significant at the $p < .05$ level. The group by morpheme interaction did not reach significance at the .05 level in any of the analyses. For nontense omission, there was a significant main effect of morpheme ($F(1, 175) = 58.63$, $p = .000$, partial $\eta^2 = 0.25$), with ING ($M = 0.95$) greater than POS ($M = 0.89$). For tense omission, there was also a significant main effect of morpheme ($F(1, 175) = 83.64$, $p = .000$, partial $\eta^2 = 0.32$), with 3S ($M = 0.92$) greater than ED ($M = 0.82$). The main effect of morpheme was not significant for tense intrusion (3S $M = 0.94$, ED $M = 0.93$).

The lowest performance for all groups was observed on the tense omission ED items (see table 3). A peculiarity of some tense omission ED items provides a possible explanation for the relatively low performance; therefore, we examined these items further in a secondary analysis. The tense omission ED items can be divided into two types. Some items with missing ED are ungrammatical regardless of whether past or present tense is intended. For example, “Yesterday she scratch her car when she hit the shopping cart” is ungrammatical locally; that is, “she scratch” cannot be grammatical, whether the listener supposes that the correct form would be *scratched* or *scratches*. Other items with missing ED are ungrammatical only if the listener monitors the entire sentence, such as “I was so hungry that I dip a chip in the salsa.” “I dip” is grammatical in present tense. The listener must take note that the occurrence of a past tense form in the matrix clause obligates past tense in the embedded clause.

We divided the tense omission ED items into those that required the listener to monitor the entire sentence in order to detect a violation (*global* items) and those that did not require such monitoring (*local* items). Unfortunately, there were not equal numbers of the two types, as the experiment was not designed to control for this variable, and they were not distributed equally within each stimulus list. In List 1, there were 1 grammatical and 4 ungrammatical global items, but there were 6 grammatical and 3 ungrammatical local items. Grammaticality was reversed in List 2, meaning that there was only one ungrammatical global item. Despite these imbalances, an analysis seemed worthwhile.

We expected that if performance on the tense omission ED items was driven in part by differences among the sentences, we would expect lower accuracy for global items, which demand more resources to keep in mind that past tense is obligated. A repeated-measures ANOVA was performed, using proportion correct (not A') as the dependent variable. Proportions were arcsin transformed, but where means are reported, they are untransformed. Item type (global, local) and grammaticality (grammatical, ungrammatical) were the within-subjects variables. Significant main effects were found for grammaticality ($F(1, 169) = 296.99$, $p < .0001$, partial $\eta^2 = 0.64$), and item type ($F(1, 169) = 21.67$, $p < .0001$, partial $\eta^2 = 0.11$), and the interaction was also significant ($F(1, 169) = 43.03$, $p < .0001$, partial $\eta^2 = 0.20$). Overall, performance on global items was poorer than performance on local items. This difference, however, was attributable to the ungrammatical items, producing the grammaticality-by-item type interaction. For grammatical items, the means for global and local items, respectively, were 0.93 and 0.92. The mean for ungrammatical global items was 0.42, compared to 0.69 for ungrammatical local items. A similar pattern held for each participant group; an ANOVA with group as a between-subjects variable and grammaticality and item type as within-subjects variables found no significant three-way interaction between group, grammaticality, and item type ($F(1, 167) = 2.67$, $p > .07$, partial $\eta^2 = 0.10$). The NLD was more accurate overall ($M = 0.79$) than the SLI ($M = 0.69$) and NLI ($M = 0.63$) groups; the main effect of group was significant ($F(2, 167) = 13.24$, $p < .000$, partial $\eta^2 = 0.14$).

Discussion

In this study, sensitivity to three types of grammatical errors was measured in adolescents with SLI, adolescents with NLI, and adolescents with normal language. Morphemes that mark tense and agreement were included, as well as nontense morphemes. Both omissions and intrusions of the tense-related morphemes were included. The results showed that the SLI group and the NLI group were less sensitive than the NLD group to tense omissions, nontense omissions and tense intrusions. The overall group effect in the MANOVA was significant and accounted for 28% of the variance in A', with NLD demonstrating greater sensitivity than the two language impairment groups, and no significant interaction between group and condition. Univariate analyses confirmed the pattern of group differences for each condition, with a consistent advantage for adolescents with NLD across all conditions, and the group effect accounting for small but significant proportions of the variances.

With regard to our first research question, it appears that 16-year-olds with SLI have limitations in the understanding of morphosyntax. Their overall sensitivity to grammatical violations, as measured by A', was around 0.90, indicating a small number of judgment errors, but they were not as sensitive as same-age peers without language impairment. With regard to the second research question, there was little evidence of a distinctive profile of sensitivity in the adolescents with SLI. Young children with SLI have been found in some studies to be more sensitive to intrusions of finite morphology than to omissions, and more sensitive to omissions of nontense morphology than finiteness morphology (Rice *et al.* 1999, Montgomery and Leonard 1998), but the participants with SLI in the current study appeared to have reduced sensitivity to omissions of finite and nonfinite morphology, as well as intrusions of finite morphology.

The third research question of this study was whether adolescents with NLI would show a performance profile distinct from that of the adolescents with SLI. Whereas the adolescents with SLI performed below the level of the NLD group for all violation types, the adolescents with NLI differed from the NLD group only for tense omissions 3S and ED and for tense intrusion ED. Nevertheless, we found no differences between the NLI group and the SLI group. In general, the evidence supports the view that the two groups with language impairment showed a similar profile across the conditions.

Limitations

Although all three groups showed similar patterns of performance across sentence types, overall differences were observed between ING and POS nontense omission items, and between 3S and ED tense omission items. These differences may be attributable to features of the stimuli. The relatively lower A' scores by all groups on the nontense omission POS items (see table 3) may have been due to a peculiarity of these items. Of the 14 POS items, 8 involved a possessive marker on a proper name (e.g., They went to the party but Sue['s] friend was not there) as opposed to a common noun (e.g., Mary went to her friend['s] house to pick up the book). When a proper name is used with the possessive morpheme missing, the sentence may be grammatically acceptable if the word following the name can somehow be interpreted as a surname, i.e., the person who was not at the party was named Sue Friend. This possibility became evident as the sentences were being recorded, and an effort was made to use intonation that would not favor such an interpretation. However, this unlikely but possible interpretation may have influenced performance on some items.

Lower performance was observed in all groups on tense omission ED items. One possible explanation is that the recordings were not of sufficient quality to allow the participants to distinguish between, for example, *kick* and *kicked*. Another explanation, which was explored with a post hoc analysis, is that the lower performance was partially due to the presence of global items, which required the listener to monitor and remember the occurrence of a past tense form in the matrix clause in order to realize that past tense was obligated in the embedded clause. Local items, in contrast, obligated past tense without reference to the matrix clause. Problems with detecting the *–ed* morpheme due to recording quality seem unlikely, as the participants were well able to detect the presence or absence of a past tense *–ed* for the local items and for the tense intrusion items, where no morpheme difference was observed. All three groups, however, were less accurate in detecting violations for the global items, suggesting that tracking tense across a complex clausal structure taxed the language processing of typically and atypically developing adolescents.

There were other possible limitations related to the nature of the stimuli. Sentences were not matched across conditions for length and position of the word containing the grammatical violation. Our highest priority was ensuring that the sentence context provided sufficient information for a judgment to be rendered. With different crucial grammatical elements in different conditions, and the differences in the natural positions for these elements, matching might have also had a disadvantage, by rendering some sentences less appropriate than others. The procedures for recording and selecting stimuli relied heavily on the judgments of members of the research team. Future studies might employ systematic judgments by naïve listeners to further ensure the quality of the auditory stimuli.

Implications

Despite the limitations regarding the POS and ED sentences, there is no evidence for particular vulnerability of tense marker omissions in this sample, even if the nontense omission POS and tense omission ED items are disregarded. The SLI and NLI groups performed similarly on omission of the nontense morpheme *–ing*, omission of the tense morpheme third singular *–s*, and intrusion of the tense morphemes third singular *–s* and past tense *–ed*. Deficits in receptive morphosyntax were found to be both persistent and pervasive. From a theoretical perspective, it is important to replicate and extend these findings in order to understand how language impairment, both specific and nonspecific, plays out after the primary grades. Relatively greater problems with omission of tense-marking morphemes in younger children with SLI are thought to indicate a specific grammatical deficit (Rice *et al.* 1999), but the small yet pervasive group differences observed in the current study suggest that language impairment in adolescents may be better described by a model of general processing limitations.

Most of the research testing grammatical deficit models and processing limitation models of SLI has been conducted with children of preschool or primary school age, but it is not known if conclusions from such studies will generalize to adolescents with SLI. Some evidence consistent with processing limitations in adolescence comes from two recent studies drawing on the same longitudinal sample described in this paper. In a neuroimaging study by Ellis Weismer *et al.* (2005) adolescents with SLI demonstrated under-activation as well as unusual patterns of coordination of activation in areas associated with attention, memory, and language processing. Leonard and colleagues (2007) found that regression models including processing speed and working memory as latent variables accounted for over half the variance in concurrent language measures in 14-year-olds, including those with NLD, SLI, and NLI. However, as Bishop (1997) argued, profiles of performance are likely to vary over time, making it difficult to draw viable conclusions about developmental mechanisms based on cross-sectional data alone, as these studies were. There is a great need for prospective longitudinal studies of language impairment that propose and test hypotheses about how underlying mechanisms affect, and are affected by, language development from infancy through adolescence.

The results of the current study have clinical implications. It cannot be assumed that an older child or adolescent who produces few morphological errors has fully mastered grammatical morphology. Clinicians should monitor their clients' grammatical comprehension and sensitivity to violations, and provide continued practice with a variety of forms in novel and challenging activities. Further research will help in the development of appropriate assessment and treatment for the often under-served adolescent age group.

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Table 1

Mean (SD) Participant Data by Group

Group	Age in years[a]	Mother's education in years[b]	Performance IQ	Language composite Z-score[c]
NLD	15.8 (.3)	13.7 (2.2)	102 (10)	-.18 (.76)
SLI	15.9 (.4)	12.9 (1.5)	98 (9)	-1.54 (.35)
NLI	15.9 (.4)	12.6 (1.5)	76 (6)	-1.76 (.61)

[a] Age data missing for 1 participant in NLD group;

[b] Mother's education data missing for 2 participants in NLD group, 1 participant in NLI group;

[c] Z-scores based on standardization of entire longitudinal sample of 527 participants.

Table 2
Means and Ranges of Sentence Length and Error Position for All Item Types

Sentence Type	Sentence Length In Words		Sentence Position of Error	
	Mean	Range	Mean	Range
Nontense Omissions				
-ing	10.57	8-12	4.50	3-7
's	9.07	6-12	4.71	3-8
Tense Intrusions				
-s	8.93	6-12	4.93	3-8
-ed	8.14	6-11	3.86	3-5
Tense Omissions				
-s	10.14	8-12	7.29	4-10
-ed	10.71	8-12	5.57	3-8

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Table 3

Mean (SD) A' Values for each Item Type by Group

Group	n	Nontense ING	Nontense POS	Tense Omission 3S	Tense Omission ED	Tense Intrusion 3S	Tense Intrusion ED
NLD	108	.98 (.03)	.94 (.06)	.96 (.06)	.89 (.08)	.97 (.04)	.98 (.04)
SLI	46	.93 (.09)	.87 (.09)	.91 (.10)	.80 (.18)	.92 (.08)	.91 (.11)
NLI	21	.94 (.07)	.89 (.09)	.89 (.15)	.80 (.17)	.94 (.06)	.91 (.10)

Note. Two participants were excluded from the SLI group and 4 from the NLI group due to missing data in 1 to 2 conditions.