Grammatical Tense Deficits in Children With SLI and Nonspecific Language Impairment: Relationships With Nonverbal IQ Over Time

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The relationship between children's language acquisition and their nonverbal intelligence has a long tradition of scientific inquiry. Current attention focuses on the use of nonverbal IQ level as an exclusionary criterion in the definition of specific language impairment (SLI). Grammatical tense deficits are known as a clinical marker of SLI, but the relationship with nonverbal intelligence below the normal range has not previously been systematically studied. This study documents the levels of grammatical tense acquisition (for third-person singular *-s*, regular and irregular past tense morphology) in a large, epidemiologically ascertained sample of kindergarten children that comprises 4 groups: 130 children with SLI, 100 children with nonspecific language impairments (NLI), 73 children with low cognitive levels but language within normal limits (LC), and 117 unaffected control children. The study also documents the longitudinal course of acquisition for the SLI and NLI children between the ages of 6 and 10 years. The LC group did not differ from the unaffected controls at kindergarten, showing a dissociation of nonverbal intelligence and grammatical tense marking, so that low levels of nonverbal intelligence did not necessarily yield low levels of grammatical tense. The NLI group's level of performance was lower than that of the SLI group and showed a greater delay in resolution of the overgeneralization phase of irregular past tense mastery, indicating qualitative differences in growth. Implications for clinical groupings for research and clinical purposes are discussed.

KEY WORDS: specific language impairment, language disorders in children, language disorders in mental retardation, grammatical tense marker, nonspecific language impairment

The relationship between children's language acquisition and their nonverbal intelligence has a long tradition of scientific inquiry. Because deficits in nonverbal intelligence are associated with deficits in language acquisition, there is widespread awareness of intellectual deficits as probable causal agents in language impairment. The condition of specific language impairment (SLI) is noteworthy because children show a developmental deficit in language acquisition even though their nonverbal intelligence is within or even above normal range (cf. Benton, 1964, for early writings about this condition). For these children, the term *specific* denotes a deficit specific to language, without any other concomitant developmental disabilities. In the research literature, the conventional definition of SLI excludes children whose nonverbal IQ is more than 1 *SD* below normative expectations (cf. Leonard, 1998).

The Boundary Issue

The nonverbal IQ boundary between SLI and nonspecific or developmental language impairment is undergoing reexamination in current investigations. Tager-Flusberg and Cooper (1999) summarized the research recommendations of a distinguished panel of scientists that includes a call for "the exploration of the similarities and differences among children at different levels of IQ" (p. 1277). At issue is the extent to which the phenotype for language disorders in children is similar above and below the conventional cutoff score of a nonverbal IQ of 85 (cf. Plante, 1998).

In an early report of outcomes of a large epidemiologically ascertained group of kindergarten children with language impairments, Tomblin and Zhang (1999) analyzed children's performance on the Test of Oral Language Development–Primary: 2 (TOLD-P: 2) and on a narrative language assessment. They compared three groups of children: normal controls, children with SLI (nonverbal IQ of 87 or above and no other exclusionary conditions), and children with a general delay of language (referred to as *nonspecific* language impairment [NLI], defined as a nonverbal IQ of 86 or lower and no other exclusionary conditions). They concluded that the two clinical groups shared the same profile across different dimensions of language, a profile characterized by greater difficulty on grammatical subtests than on semantics or narrative tasks. Also of note was the finding that there was a generally lower level of performance by the general delay group relative to the SLI group. Overall, the findings were interpreted as indicative of an "absence of a distinctive quality of learning difficulty" (p. 371) in SLI. They also observed that this interpretation was parallel to one from recent studies of dyslexia, which concluded that reading disabilities in children showed a continuum of difficulties that blended into the normal reading range (Fletcher, Foorman, Shaywitz, & Shaywitz, 1999).

Finally, Tomblin and Zhang (1999) cautioned that a possible limitation of their study was that conventional omnibus language assessments might not be sufficiently sensitive to the ways in which children with SLI might have distinctive linguistic profiles. Consider the items included in the Grammatic Completion subtest of the TOLD-P: 2, which was the most difficult subtest for the SLI and NLI groups. This subtest comprises items intended to elicit grammatical morphemes in various forms, including plurals, such as *girls,* and past tense, such as *cooked.* If the items drew on areas of morphology that were relatively easy for affected children as well as areas that were relatively difficult, the obtained score would not be as sensitive as would a score derived solely from items in an area that differentiated performance of affected versus unaffected children.

Grammatical Marker Approach to Identification

An alternative to omnibus language assessment is a clinical marker approach. A grammatical marker in the domain of tense marking is especially promising (cf. Tager-Flusberg & Cooper, 1999). In keeping with Rice, Wexler, and Cleave (1995), grammatical tense marking in English includes the following morphemes: third-person singular *-s*, as in "Patsy walk*s*"; regular past tense (e.g., "Patsy walk*ed*"); irregular past tense (e.g., "Patsy *ran*"); auxiliary and copula *be;* and auxiliary *do*. Rice and her colleagues have reported on longitudinal investigations of children with SLI and two groups of control children, one of the same chronological age and another of younger children of equivalent general language levels (Rice & Wexler, 1996; Rice et. al., 1995; Rice, Wexler, & Hershberger, 1998; Rice, Wexler, Marquis, & Hershberger, 2000). Children with SLI perform at lower levels of obligatory tense marking than either of the control groups, an effect evident on multiple measures of tense marking but not in comparative elements of morphological development. Although the growth curves in tense marking for children with SLI are at lower levels of accuracy than those of younger children, growth follows the same trajectory. This can be interpreted as a delay in this domain of the grammar that exceeds the general delay in language acquisition evident in children with SLI. Rice (2003) has described how the children with SLI perform similarly to the younger controls in their levels of utterance length and receptive vocabulary, over several years of measurement, but the grammatical tense marker lags behind. Rice (2004) has explored the theoretical import of the growth delays in affected children and implications for etiological studies.

A possible limitation of the available evidence on the grammatical tense marker is that affected children in the previous studies were recruited from clinicians' caseloads, following a clinical ascertainment method. Tomblin et al. (1997) reported that of the affected kindergarten children identified in an epidemiologically ascertained method, only 29% of the children were enrolled in intervention. This suggests that a large proportion of children affected with SLI would not be in the participant pool in samples that were clinically ascertained. What remains unknown is whether a grammatical tense marker would be characteristic of children who met the conventional definitions for SLI or NLI but were not clinically identified.

Performance IQ as a Nonpredictor of Grammatical Tense Marking

Of particular interest here, performance on the grammatical tense marker, and growth in usage over time, is not predicted by children's nonverbal intelligence levels in children with SLI or in younger children. This generalization is based on outcomes of experimental studies (Rice et al., 1998, 2000) and was replicated in the standardization trials of the Rice–Wexler Test of Early Grammatical Impairment (TEGI; Rice & Wexler, 2001). Conti-Ramsden, Botting, and Faragher (2001) investigated the association of performance IQ and grammatical tense marking in their sample of 11-year-old children with language impairments that included children with nonverbal scores as low as 2 *SD* below the population norm (i.e., down to 70). They reported that grammatical tense marking was lower in the affected group and correlated with nonverbal IQ at .20 for third-person singular *-s* and at .30 for past tense morphology. Conti-Ramsden et al. noted that although the correlations were statistically significant, they were not strong, which was important because "any marker for SLI should not be a proxy for general cognitive level" (p. 743). In a sample of 62 children with autism whose nonverbal IQ levels ranged from 43 to 153, Roberts, Rice, and Tager-Flusberg (2004) reported that autistic children with language impairments showed low levels of grammatical tense marking and that nonverbal intelligence was not significantly correlated with third-person singular *-s* at .24 but was significantly correlated with past tense at .36. These findings suggested that although nonverbal IQ was not a significant predictor of grammatical tense marking in children with language impairments in the nonverbal IQ range of 85 or above, it might be predictive for children performing in borderline normal or below levels of nonverbal intelligence, particularly in past tense marking.

Earlier studies also revealed that grammatical tense marking is not predicted by children's performance on receptive vocabulary tasks, for children with SLI or for younger language-equivalent controls (Rice et al., 1998, 2000). The lack of association with semantic indicators suggests that tense marking is a relatively independent dimension of language growth during the early-childhood period. On the other hand, in the study of tense marking in children with autism (Roberts et al., 2004), performance on the tense-marking tasks was correlated about .60 with verbal IQ on the Differential Abilities Scales (DAS; Elliott, 1990). This implies that the profile of associations of tense marking and semantics may be different for different clinical groups.

An important linguistic detail emerged from the studies of grammatical tense marking. Rice et al. (2000) found that children's percentage correct on irregular past tense forms, such as *fell*, showed important differences relative to regular past tense forms, such as *walked*. The differences were apparent for children with SLI as well as younger unaffected children. The two key differences are (a) growth over time is linear for percentage correct irregular forms, whereas for other indicators of grammatical tense, growth has quadratic as well as linear components, and (b) nonverbal intelligence, as well as receptive vocabulary, predicts growth for irregular percentage correct but not for other indicators of grammatical tense. Rice et al. (2000) concluded that these differences are attributable to two different elements required in past tense acquisition.

One element is at the level of morphosyntax, consisting of the knowledge that grammatical tense (i.e., finiteness) must be marked in each matrix clause in English. The second element is at the phonological level (i.e., the *spell-out* requirements), consisting of knowledge about the phonological rules for regular and irregular morphology (i.e., recognizing the phonological rules for converting a present tense form of a particular lexical verb to a past tense, including the exceptional rules for verbs that follow irregular past tense morphology). Both levels are required for correct usage of past tense morphology, but it is important to differentiate them if we are to understand fully how grammatical tense marking is acquired. There may be subtle but significant linguistic differences in the ways in which growth in a grammatical tense marker is manifest across groups of language-impaired children differentiated by levels of nonverbal intelligence. Roberts et al. (2004) reported that nonverbal IQ predicted both regular and irregular past tense accuracy in their sample of children with autism. Conti-Ramsden, Botting, and Faragher (2001) combined regular and irregular past tense in their calculations of the correlation with nonverbal IQ, so it was not possible to determine if the association was the same for the two forms.

Interpretations of Deficits in Grammatical Tense Marking

Rice and colleagues have hypothesized that the grammatical tense marker is reflective of an underlying deficit for affected children in grammatical representations in the particular domain of tense and agreement marking, in an *extended optional infinitive* stage. This deficit shows linguistic properties thought to be relatively independent of lexical knowledge and also not attributable to faulty general learning processes (cf. Rice, 2003; Wexler, 2003). Under this model, grammatical tense marking and nonverbal IQ are regarded as two relatively independent dimensions, allowing a youngster to be relatively high or low on either of the dimensions, thereby creating the possibility of a relatively high level of grammatical tense and low nonverbal IQ as well as vice versa.

A contrasting hypothesis is offered by Kail (1994), in which a generalized slowing of processing is proposed as the underlying deficit in the condition of SLI. Under this account, the generalized slowing is thought to be operative in both linguistic and nonlinguistic tasks. Specific problems with language, such as the grammatical tense marker, are interpreted as localized consequences of more generalized, limited time-dependent linguistic input processing. Miller, Kail, Leonard, and Tomblin (2001) investigated groups of normal age-matched controls, SLI children, and NLI children. They found that children with SLI, as a group, demonstrated generalized slowing relative to the controls (although they cautioned that a substantial number of children with SLI did not demonstrate this pattern) and that the group of children with NLI was slower than the SLI group. They concluded that differences in performance IQ might contribute to generalized slowing but could not completely account for it because the SLI group was matched to the normal controls on performance IQ. They suggested that the SLI and NLI groups might share an underlying slowed processing factor that contributed to language impairment and that the deficit was greater in children with NLI, so that it affected nonlinguistic as well as linguistic abilities.

Under the *general slowing* model, children with lower levels of performance IQ would be expected to have low levels of grammatical performance (i.e., low performance IQ levels would constitute a sufficient condition for a deficit in the grammatical marker). It would be unexpected for such children to have grammatical performance at normative levels because they would have to achieve those levels with a slowed rate of processing. On the other hand, if grammatical tense marking was relatively independent of nonverbal IQ, as suggested by the low correlations of earlier studies, then low levels of nonverbal IQ would not be sufficient conditions for grammatical tense deficits. Thus, children with low nonverbal IQ who were without grammatical impairments would provide a means of considering how general this slowing might be. Children with this profile are very difficult to identify, because they would not be eligible for practitioners' caseloads and they would not be included in studies of children with language impairments. Thus, there are no precedents in the literature for documentation of their grammatical abilities, although their performance carries strong interpretive import.

Rationale for This Study

In this study, we report on the outcomes of a longitudinal investigation of the grammatical marker in a subset of the epidemiologically ascertained sample of kindergarten children reported by Tomblin and Zhang (1999). We examine performance in four groups of children: unaffected children, children with SLI, children with NLI whose nonverbal IQ is below 85, and a fourth group of children whose nonverbal IQ is below 85 but whose language performance is above the impaired range, a group labeled *low cognition* (LC). This constitutes the first report of the grammatical tense marker in children with SLI in an epidemiologically ascertained sample. This is also the first report of performance of the NLI group and LC group on grammatical tense marking and the first comparison of children with SLI and those with LC. The LC group is of interpretive interest because it serves as a test of whether low performance IQ levels constitute a sufficient condition for a deficit in the grammatical marker. This study also is the first report of longitudinal growth curves for possible similarities between the NLI and SLI groups.

For expository purposes here, the study is reported in two parts: the kindergarten investigation and the subsequent longitudinal study. For the kindergarten study, the main empirical questions of interest are (a) Are there group differences on grammatical tense tasks at the kindergarten level (approximately 6 years of age)? (b) Is grammatical tense marking predicted by nonverbal IQ, semantics, or mother's education? For the longitudinal study, the questions are (a) Are the growth patterns for grammatical tense tasks similar across groups (mean age 6–10 years)? (b) Is growth on grammatical tense tasks predicted by nonverbal IQ, semantics, or mother's education; if so, is it similar across groups? (c) Do the SLI and NLI clinical groupings show equivalent growth in grammatical tense marking?

Kindergarten Study

Method

Participants

The participants for this study were drawn from an epidemiological study of language impairments in children (Tomblin et al., 1997). The investigation used a stratified cluster sample of 7,218 kindergarten children. This normative sample was stratified by residential setting (i.e., rural, 33%; urban, 37%; suburban, 30%) and cluster sampled by school building. Boys constituted 51% of the sample, and girls constituted 49% of the sample; 83% were White, 13% were Black, and 4% were Other. All available kindergarten children in selected schools were screened for language impairments. Children who failed the screening and a random sample who passed were given a test battery of language and other measures.

Data collection was carried out in two cohorts of kindergarten children, distributed evenly across 2 calendar years. The results of this assessment were used to estimate the prevalence of language impairments in kindergarten children (Tomblin et al., 1997).

In the 2nd year of the study, Cohort 2 children were recruited. Data collection for this half of the kindergarten sample included experimental measures of grammatical tense marking, described below. Follow-up assessments were carried out as part of a longitudinal investigation conducted by the Child Language Research Center, a National Institute on Deafness and Other Communication Disorders–funded collaborative center for the study of language impairments in children, under the directorship of Bruce Tomblin.

A total of 420 kindergarten children participated in this study, distributed across four groups. The groupings were determined by cross-classification on language and nonverbal intelligence subtests. The language criterion level for the original epidemiological study was determined by performance on the TOLD-P: 2 (Newcomer & Hammill, 1988) and a story-retelling narrative task. Five language composite scores were calculated: Vocabulary, Grammar, Narrative (aggregating across the receptive and expressive dimensions for each of these areas), Receptive (aggregating across the vocabulary, grammar, and narrative tasks), and Expressive (aggregating across vocabulary, grammar, and narrative tasks). Children were scored as failing the language assessments if two of the five composite scores were more than 1.25 *SD*s below the mean. In keeping with Aram, Morris, and Hall (1993), the cutoff level was determined by the diagnostic judgments of clinicians. Tomblin, Records, and Zhang (1996) determined that 1.25 was valid for clinical diagnosis and yielded acceptable levels of sensitivity and specificity.

Nonverbal intelligence was assessed by the Picture Completion and Block Design subtests of the Wechsler Preschool and Primary Scales on Intelligence (WPPSI; Wechsler, 1989), a performance IQ short form that correlates well with a full IQ assessment and has been used in previous studies (cf. Bishop & Adams, 1990; Conti-Ramsden et al., 2001; LoBello, 1991). The sum of the scaled scores of the two WPPSI subtests was calculated and used as the criterion for passing the cognitive tasks. The scaled scores for each subtest convert the distribution of raw scores at each age level to a scale with a mean of 10 and a standard deviation of 3. A pass was defined as a value of 16 or higher. Children in the control group passed both the language and cognition criteria; SLI was defined as failing the language criterion and passing the cognition criterion; NLI was defined as failing both the language criterion and the cognition criterion; and children who passed the language criterion but failed the cognition criterion were placed in the LC group. Estimated percentages of children in the kindergarten population for these clinical groups were as follows: SLI, 7.6%; NLI, 6.9%; and LC, 10.8% (Tomblin et al., 1997).

For this study, children were excluded if they spoke African American English or if their articulation was judged as inadequate for the morphemes of interest. All remaining affected participants in the Cohort 2 kindergarten sample participated, with a sample of 130 in the SLI group, 100 in the NLI group, and 73 in the LC group. The control group consisted of 117 children selected at random from the full sample of control children.

A parent of each of the participants completed a questionnaire, which included an item asking for the highest grade completed by the participant's biological mother. Maternal education is reported to be related to language development (cf. Dollaghan et al., 1999; Hart & Risley, 1995), although there is also evidence that it is not predictive of grammatical tense marking (Rice, Spitz, & O'Brien, 1999; Rice & Wexler, 1996; Rice et al., 1995, 1998, 2000). Data on this variable were available at kindergarten for 114 control children, 117 SLI children, 56 NLI children, and 32 LC children. See Table 1 for a report of the gender distribution, mean age, race/ethnicity, and maternal education levels for the kindergarten sample.

Procedure

Data collection was carried out by trained examiners, at local sites in mobile vans customized for data collection. Data collection was carried out between November and May of the school year, mostly in the spring semester. All language measures were administered by examiners certified in speech-language pathology. The integrity of data collection was monitored by an expert data collector via on-site observations and videotaping.

Two elicitation probes for grammatical tense marking were administered, one for third-person, singular, present tense *-s* (3Ps) and the second for past tense regular and irregular. The tasks were the same as used in earlier studies by Rice and her colleagues (Rice, Spitz, & O'Brien, 1999; Rice & Wexler, 1996; Rice et al., 1995, 1998, 2000) and were very similar to the tasks that appear in the TEGI (Rice & Wexler, 2001). The 3Ps consisted of 12 pictures that depicted a person in a particular occupation. The examiner showed the child a practice picture and said, "This is a firefighter. If I'm a teacher and I teach, he's a firefighter so he…" and the child completed the utterance. The past tense probe consisted of pairs of pictures, showing a child engaged in an activity in one picture and the child having completed the activity in the second picture. The examiner showed a practice set of pictures and said, "Here the

Table 1. Participant descriptives for the kindergarten and longitudinal samples.

Sample	*n*	No. boys	No. girls	Mean age (years; months)	Race/ethnicity (%) White	Black	Other	Mother's education (mean years)
Control								
Kindergarten	117	66	51	5;11	91.5	5.1	3.4	14.4
Longitudinal	24	13	11	5;10	87.5	4.2	8.3	13.9
Specific language impairment								
Kindergarten	130	80	50	6;0	83.8	13.1	3.1	13.4
Longitudinal	57	32	25	5;11	89.5	8.8	1.7	13.4
Nonspecific language impairment								
Kindergarten	100	53	47	6;0	66.0	30.0	4.0	12.3
Longitudinal	54	28	26	6;0	61.1	35.2	3.7	12.6
Low cognition								
Kindergarten	73	44	29	6;0	78.1	12.3	9.6	13.7
Total								
Kindergarten	420	243	177	6:0	80.7	14.8	4.5	13.3
Longitudinal	135	80	55	5;11	76.3	19.1	4.6	13.3

boy is raking (referring to the first picture). Now he is done (referring to the second picture). Tell me what he did to the leaves." There were 11 regular past tense verbs intermingled with 8 irregular past forms, for a total of 19 items.

The target lexical verbs appear frequently in talk to children (Hall, Nagy, & Linn, 1984), are monosyllabic, are easily named by children, and have overt past tense morphology (i.e., no zero-change morphemes, such as *put*, were included). Past tense for these verbs can be readily elicited via pictures for unaffected children (cf. Rice et al., 2000, for further details about the past tense task). On this task, children do not always use the exact verb that is expected. Scoring procedures credit a response to the appropriate category of lexical verb, that is, if a targeted lexical item is in the regular past tense category but the child uses a lexical item from the irregular class, then the item is scored in the irregular category (cf. Rice & Wexler, 2001). Because young children and children with language impairments are somewhat more likely to use verbs from the irregular class (cf. Rice & Bode, 1993), the actual scored items yield nearly equivalent numbers of attempted regular and irregular past tense verbs.

Results and Discussion

Are There Group Differences on Grammatical Tense Tasks?

In keeping with earlier studies with the experimental tasks, four indices of tense marking were calculated for the two tasks: percentage correct on the 3Ps, percentage correct on regular past tense (RegPT), percentage correct on irregular past tense (IrregPT), and percentage finiteness on irregular past tense (FinIrgPT). FinIrgPT was calculated per Rice et al. (2000), who credited a child with overregularizations as attempts to mark finiteness, for example, *falled* would be credited as an attempt at finiteness marking but would not be credited as a correct irregular form in the percentage correct variable. This is an example of morphosyntactic knowledge (knowing that finiteness marking is required) but incomplete morphophonological knowledge (knowing that *fall* does not use regular past tense *-ed* but instead uses an internal vowel change for past tense morphology). Also calculated was a composite tense score (CompTNS), calculated as the mean of 3Ps, RegPT, and FinIrgPT.

Means and standard deviations per variable per group are presented in Table 2.[1] Zero-order correlations among 3Ps, RegPT, and FinIrgPT, within each group, were significant, in the range of .50 to .80 for the clinical groups and down to .30 for the controls who showed ceiling effects, thereby reducing the size of the correlation. Correlations with the CompTNS variable per measure within each group were high, in the range of .66 to

[1]In this sample, as in Rice et al. (2000), the mean levels of performance on regular past tense were consistently higher than irregular past tense. These outcomes contrasted with other studies that reported that the level of accuracy on regular past tense was commensurate with irregular past tense. Vargha-Khadem, Watkins, Alcock, Fletcher, and Passingham (1995) reported equal impairment in a family sample in which the mean age was 24.4 years. Unfortunately, the tense task was not described in detail, and mean levels of performance were not reported. van der Lely and Ullman (1996) reported equivalence for a sample of 12 SLI children, ages 9–12 years, on a task with novel regular and irregular verbs as well as actual verbs and low-frequency as well as high-frequency stems. The means for the SLI group were about 20% for regulars and about 20% for irregulars. Thus the van der Lely and Ullman data were similar for the irregular performance of the SLI group in this study but much lower for the regular past tense.

Table 2. Means and standard deviations on tense-marking variables at kindergarten by group.

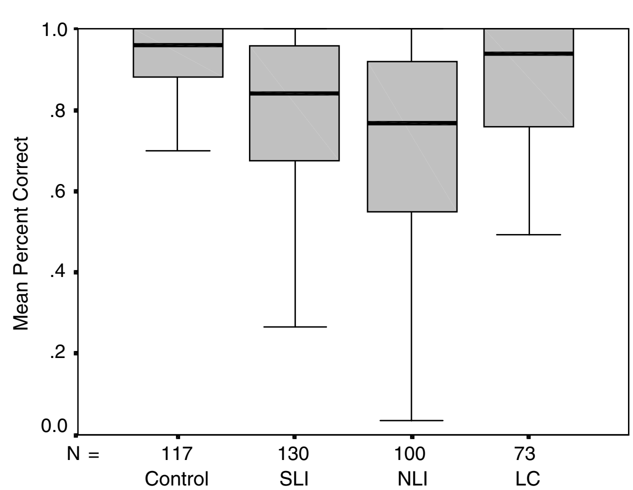
Group	Composite tense M	Composite tense SD	3rd-person singular M	3rd-person singular SD	Regular past tense M	Regular past tense SD	Finite irregular past tense M	Finite irregular past tense SD	Irregular past tense M	Irregular past tense SD
Control	.90	.14	.94	.15	.93	.16	.83	.22	.37	.26
Specific language impairment	.78	.22	.77	.31	.84	.22	.73	.26	.23	.22
Nonspecific language impairment	.71	.25	.67	.34	.78	.27	.69	.29	.25	.21
Low cognition	.86	.18	.87	.21	.89	.18	.81	.24	.29	.23

Note. Composite tense = (3rd-person singular + regular past tense + finite irregular past tense)/3.

.91. Finally, IrregPT correlations were consistently lower, in the range of .01 to .35. As in Rice et al. (2000), FinIrgPT was the most appropriate combined index of finiteness marking for the past tense task, and CompTNS was a psychometrically robust composite index of grammatical tense marking. Box-and-whiskers plots of the distributions of children within groups for CompTNS are reported in Figure 1.

Group effects were examined first for CompTNS. A one-way independent analysis of variance (ANOVA) revealed a significant effect of group, $F(3, 416) = 17.61$, $p < .001$, $MSE = 0.04$, $\eta^2 = .11$. Pairwise comparisons calculated with Tukey's honestly significant difference (HSD) test revealed that the control group scored higher than the SLI ($p < .001$) and NLI ($p < .001$) groups, the LC group scored higher than the SLI ($p = .01$) and NLI ($p < .001$) groups, and the SLI group scored higher than the NLI group ($p = .01$). Thus, on the composite index, there were clear group differences, so that control = LC > SLI > NLI.

Figure 1. Box plot of composite tense at kindergarten by group. Shaded boxes represent the 25th to 75th percentiles; the midline is the median. SLI = specific language impairment; NLI = nonspecific language impairment; LC = low cognition.



To determine if the group effects were apparent in the same way across tasks, a multivariate analysis of variance (MANOVA) was conducted with group as a between-subjects variable and the three tasks (3Ps, RegPT, and FinIrgPT) as multiple dependent measures. As expected, the overall effect of group was significant, $F(3, 416) = 17.36$, $p < .001$, $MSE = 0.13$, $\eta^2 = .11$. In addition, the multivariate effect of task was significant, $F(2, 415) = 59.65$, $p < .001$, $\eta^2 = .22$, as was the Task × Group interaction, $F(6, 832) = 2.73$, $p = .013$, $\eta^2 = .02$. The pattern of this significant interaction was examined via two series of follow-up analyses.

The simple effect of group was also significant within each task, as shown through a series of one-way between-groups ANOVAs with Tukey HSD pairwise comparisons. For 3Ps, $F(3, 416) = 20.89$, $p < .001$, $MSE = 0.07$, $\eta^2 = .13$, the control group scored higher than the SLI or NLI groups ($p < .001$) but did not differ from the LC group, which also scored higher than the SLI ($p = .008$) or NLI groups ($p < .001$). The SLI group scored higher than the NLI group ($p = .006$). Thus, 3Ps replicated the outcomes for CompTNS, that is., control = LC > SLI > NLI. For RegPT, $F(3, 416) = 10.16$, $p < .001$, $MSE = 0.07$, $\eta^2 = .07$, the control group scored higher than the SLI group ($p = .001$) or NLI group ($p < .001$) but did not differ from the LC group (alpha set at .05), which also scored higher than the NLI group ($p = .001$), but not the SLI group ($p = .104$). The SLI group again scored higher than the NLI group ($p = .028$). Thus, the RegPT outcomes were control > SLI > NLI; and Control = LC; LC = SLI > NLI. Finally, for FinIrgPT, $F(3, 146) = 6.85$, $p < .001$, $MSE = 0.07$, $\eta^2 = .05$, the control group scored higher than the SLI group ($p = .002$) or NLI group ($p < .001$) but did not differ from the LC group, which also scored higher than the SLI group ($p = .046$) or NLI group ($p = .004$). The SLI and NLI groups were not distinguishable ($p = .238$). Thus, Control = LC > SLI = NLI.

The simple effect of task was also significant within each group, as shown through a series of separate MANOVAs for each group. In the control group, $F(2, 115) = 17.64$, $p < .001$, $\eta^2 = .24$, 3Ps and RegPT were not distinguishable ($p = .847$) but were both higher than FinIrgPT (3Ps, $p < .001$; RegPT, $p < .001$). In the LC group, $F(2, 71) = 12.03$, $p < .001$, $\eta^2 = .25$, 3Ps and RegPT were again not distinguishable ($p = .265$) but were both higher than FinIrgPT (3Ps, $p = .016$; RegPT, $p < .001$). In the SLI group, $F(2, 128) = 22.27$, $p < .001$, $\eta^2 = .26$, RegPT was higher than 3Ps ($p = .002$) or FinIrgPT ($p < .001$), which were not distinguishable ($p = .166$). Finally, in the NLI group, $F(2, 98) = 17.44$, $p < .001$, $\eta^2 = .26$, RegPT was also higher than 3Ps ($p < .001$) or FinIrgPT ($p < .001$), which were not distinguishable ($p = .470$). Thus, all four groups showed the lower performance on FinIrgPT than RegPT. What was different was that the 3Ps and RegPT were similar for the control and LC groups, whereas the 3Ps and FinIrgPT were similar for the SLI and NLI groups.

To summarize these results in relation to the above question, the control and LC groups showed patterns of response across the grammatical tense markers that were distinct from those of the SLI and NLI groups. Specifically, while the control and LC groups performed at a higher level than the SLI and NLI groups across the measures overall, the affected groups closed the gap somewhat on the RegPT measure. The advantage of the SLI over the NLI groups obtained for the 3Ps and RegPT measures but not for FinIrgPT, where both groups were at equally low levels of performance. Further explication of these Task × Group interactions is evident in the growth outcomes in the longitudinal study.

Table 3. Correlations among Composite tense (CompTNS), performance IQ, mother's education, and TOLD-P:2 Vocabulary per group at kindergarten.

Group	1	2	3	4
Control				
1. CompTNS	—			
2. Performance IQ	.24*	—		
3. Mother's education[a]	.09	.29*	—	
4. Vocabulary[b]	.10	.11	.28	—
Specific language impairment				
1. CompTNS	—			
2. Performance IQ	−.08	—		
3. Mother's education	.08	.21	—	
4. Vocabulary	.17	.08	−.32**	—
Nonspecific language impairment				
1. CompTNS	—			
2. Performance IQ	.26*	—		
3. Mother's education	−.02	.17	—	
4. Vocabulary	.17	−.09	−.03	—
Low cognition				
1. CompTNS	—			
2. Performance IQ	−.04	—		
3. Mother's education	.03	.21	—	
4. Vocabulary	.11	−.11	−.13	—

[a]Because of incomplete data on the kindergarten sample on this variable, fourth-grade data are reported. [b] Test of Oral Language Development–Primary: 2 (TOLD-P:2; Newcomer & Hammill, 1988) Picture Vocabulary raw score.

*$p < .05$. **$p < .0001$.

Is Grammatical Tense Marking Predicted by Cognitive and Semantic Performance or Mother's Education?

Performance IQ estimates at kindergarten consisted of the WPPSI mean summed scaled scores for Picture Completion and Block Design (control $M = 22.07$, $SD = 3.71$; SLI $M = 20.82$, $SD = 3.37$; NLI $M = 11.82$, $SD = 2.61$; LC $M = 13.26$, $SD = 1.78$). The TOLD-P:2 Picture Vocabulary raw score means and standard deviations per group were as follows: Control $M = 15.82$, $SD = 4.26$; SLI $M = 11.75$, $SD = 3.89$; NLI $M = 10.80$, $SD = 4.35$; LC $M = 15.01$, $SD = 3.57$. Table 3 contains zero-order correlations within each group for CompTNS, performance IQ, mother's education, and the TOLD-P:2 Picture Vocabulary subtest. Note that CompTNS was significantly associated with performance IQ in the control and NLI groups, although at a very low level of shared variance (i.e., 6%–7%). Mother's education was not a significant predictor of any of the variables in these samples of children.

Longitudinal Study

Method

Participants

For the follow-up study, subgroups of the kindergarten groups were selected for ongoing investigation. The control group was reduced to a randomly selected small number, 24, due to limited resources and likely ceiling effects. For the longitudinal study, this group's performance was expected to be near ceiling levels throughout; it was included as a check for possible measurement or procedural error. For the clinical samples, children were recruited if their kindergarten performance levels on grammatical tense markers were below ceiling (<95% correct on CompTNS). For the SLI and NLI groups, permission to participate was obtained for 68 and 62 children, respectively, for a total of 130. The sample sizes were further reduced by the criteria that participants had to have at least two times of measurement and complete data on the grammatical tense tasks, yielding final sample sizes of 57 for the SLI group and 54 for the NLI group (see Table 1 for gender distributions, age, ethnicity, and levels of mother's education for the two groups). The LC group was dropped from the longitudinal analyses because so many of the children performed above the 95% level; the number of permissions to participate was limited to 16; and the smaller group size was less stable for growth estimates.

Procedure

Data collection was carried out in first, second, third, and fourth grades, in the same way as for the kindergarten data collection. The grammatical tense-marking tasks were the same throughout. During the second-grade data collection, the performance subtests of the Wechsler Intelligence Scale for Children–III (WISC-III; Wechsler, 1991) were administered, consisting of Picture Completion, Coding, Picture Arrangement, Block Design, and Object Assembly. The correlation between the WPPSI subtest composite at kindergarten and the WISC at second grade, collapsed across the SLI and NLI groups, was .71 ($p <. 01$), which is close to the test–retest correlation reported for the WPPSI (i.e., .77 for Block Design and .81 for Picture Completion; Wechsler, 1989, p. 131). For the longitudinal analyses, children remained in the original clinical groupings. Thus, this was a study of outcomes of the original kindergarten groupings.[2]

Results and Discussion

Preliminary *t*-test comparisons of the kindergarten-only and longitudinal samples of children within each group indicated that the longitudinal sample of children in the SLI and the NLI groups did not differ from the kindergarten-only sample for cognitive performance or for the Picture Vocabulary raw scores. Thus, the longitudinal sample was representative of the full kindergarten sample in cognitive and vocabulary performance. The longitudinal sample of children in the SLI and NLI groups differed from the kindergarten-only sample in CompTNS performance, with the longitudinal sample lower than the kindergarten sample by virtue of elimination of the children with high scores at kindergarten, SLI kindergarten $M = .83$; longitudinal $M = .71$; $t(108) = 3.08$, $p < .01$; NLI kindergarten $M = .77$, longitudinal $M = .67$; $t(98) = 2.04$, $p = .05$. Mother's education was not available for 1 child in the SLI group and 11 in the NLI group.

Are the Growth Patterns and Predictor Relationships for Grammatical Tense Tasks Similar Across Groups (Mean Ages 6–10 Years)?

Observed means and standard deviations per time of measurement for the longitudinal samples of SLI and NLI children are reported in Table 4. The LSMEANS procedure within SAS PROC MIXED was used to examine the mean differences between the SLI and NLI groups in the CompTNS variable across time. In this procedure, means are estimated via generalized least squares to accommodate missing data points, and the standard deviations are estimated while taking into account the multiple sources of variance and correlations among the time points (for more information, see Littell, Milliken, Stroup, & Wolfinger, 1996). The estimated means and standard deviations from this analysis of CompTNS for the SLI group were .71 (.03), .88 (.02), .92 (.02), .96 (.02), and .97 (.01); for the NLI group, .67 (.03), .82 (.02), .86 (.02), .87 (.02), and .95 (.01), for kindergarten through fourth grade, respectively. There was a significant effect of time, $F(4, 109) = 41.16$, $p < .0001$; a significant effect of group, $F(1, 109) = 6.07$, $p = .015$; and a significant Group × Time interaction, $F(4, 109) = 4.14$, $p = .004$. Examination of the simple effect of group at each time point revealed that while there were no significant differences in kindergarten, first grade, or fourth grade, the SLI group had higher mean CompTNS scores than the NLI group during both second ($p = .019$) and third grade ($p < .0001$).

Growth-Curve Modeling

In the light of this interaction, we performed growth-curve modeling using SAS PROC MIXED to evaluate more specifically questions regarding the growth patterns within each group and the predictors of growth in the measures of grammatical tense marking. Because growth-curve modeling has been extensively discussed (Burchinal & Appelbaum, 1991; Raudenbush & Bryk, 2002; Rice et al., 2000), we describe only briefly the mathematical model. The analysis assumes a multilevel model in which the first level comprises the multiple measurements of the individual participant at different times on a specific outcome variable and the second level comprises measurements on the individual participant

[2]Given the measurement imprecision in available cognitive and language instruments, and possible real change over time, some children could have been classified differently at second grade than at kindergarten with respect to IQ. When we used nonverbal IQ of 85 as an arbitrary cutpoint, 2 of the control children (8%) dropped below this line at the second-grade testing on the WISC-III; 11 (20%) of the SLI group dropped below 85; 10 (21%) of the NLI group went above the line. The mean CompTNS scores for the children who moved across the line (movers) versus those who did not (nonmovers) were within 0.03 for the controls at each of the five times of measurement and within 0.02 at each time for the SLI group. For the NLI group, the movers were about 0.10 above the nonmovers at the first 4 times of measurement and 0.05 above at the final time of measurement. Thus, the possible import of including the movers in the NLI group in the outcomes study is perhaps to inflate the actual level of performance somewhat for this group, if the nonmovers are thought to be the actual members of this category, but such an assumption is at best arguable given the measurement complexities involved.

Table 4. Specific language impairment (SLI) and nonspecific language impairment (NLI) longitudinal sample performance across time on the grammatical tense variables.

Age	Composite tense		3rd-person singular		Regular past tense		Finite irregular past tense		Irregular past tense	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
SLI (*n* = 57)										
Kindergarten	.72	.22	.72	.31	.80	.22	.65	.25	.21	.23
1st grade	.88	.13	.91	.18	.90	.14	.84	.18	.37	.24
2nd grade	.92	.09	.94	.13	.93	.11	.90	.13	.50	.25
3rd grade	.97	.06	.94	.12	.98	.05	.96	.09	.62	.26
4th grade	.97	.09	.98	.05	.97	.13	.97	.12	.70	.27
NLI (*n* = 54)										
Kindergarten	.67	.25	.62	.32	.74	.29	.64	.31	.21	.21
1st grade	.83	.22	.85	.25	.87	.22	.76	.28	.33	.27
2nd grade	.86	.16	.89	.20	.88	.17	.81	.22	.35	.25
3rd grade	.87	.16	.87	.22	.91	.14	.83	.20	.51	.26
4th grade	.95	.09	.97	.06	.96	.09	.93	.15	.63	.27

of variables that do not vary across time and may be related to the level of the outcome variable or the change in the outcome variable across time. For these analyses, time was set equal to 0 for measurements taken in kindergarten. Mathematically, a typical model for linear, quadratic, and cubic change in the individual could be represented as follows:

$$\text{Level 1:}\quad Y_{ij} = \pi_{i0} + \pi_{i1}\,(\text{time}_{ij}) + \pi_{i2}\,(\text{time}_{ij})^2 + \pi_{i3}\,(\text{time}_{ij})^3 + e_{ij},$$

where Y_{ij} is the dependent variable for person *i* at observation *j* and time_{ij} indicates the measurement occasion. The coefficient π_{i0} represents the expected level of the outcome variable for person *i* in kindergarten. The coefficients representing change over time are π_{i1} (a linear change), π_{i2} (a quadratic change), and π_{i3} (a cubic change). The within-person random variability in the outcome variable is represented by the residual term e_{ij}.

Characteristics of the individual that may affect the outcome variable may be represented by using the parameters at Level 1 as dependent variables. For example, if the researcher thought that IQ affected the level of performance on the outcome variable, this could be represented by using the level parameter (π_{i0}) in the above equation as an outcome variable itself in another equation, commonly termed a *Level 2* model. The interpretation of the Level 2 parameters (β_0 and u_{io}) depends on the specific additional variables in the model and their location. In this study, the growth models were determined for each group separately, and the Level 2 explanatory variables were centered at the group mean value for the variable. An example with IQ as an explanatory variable is

$$\text{Level 2:}\quad \pi_{i0} = \beta_0 + \beta_1(\text{IQ}_i) + u_{i0},$$

where β_0 represents the expected value at kindergarten for a person whose IQ score is at the mean (i.e., equals zero for the centered IQ variable); $\beta_1(\text{IQ}_i)$ represents the effect on the expected level of the outcome for person *i* whose specific deviation from the mean is IQ_i. The u_{i0} is the deviation from the expected value for person *i* conditional on their IQ; u_{i0} represents random variation in the expected value of the outcome due to differences among persons. Similarly, one can model the other growth parameters (e.g., the parameter for the linear effect or the quadratic effect) by including additional predictors or explanatory variables. By substituting the Level 2 expressions for the parameters into the Level 1 equation, one can determine the full mathematical model for the outcome variable of interest. The full model describes the pattern of growth and the factors that affect that pattern.

Separate models were developed for each of the SLI and NLI groups for each of the four outcome measures and the composite measure in turn. We first examined the pattern of growth (e.g., linear or quadratic) and determined the appropriate components for the model by means of maximum likelihood estimates (*mle*s) in which only the intercept term was allowed to vary across participants. We then examined which growth parameters varied significantly among the participants (random effects) through restricted maximum likelihood estimates (*remles)* in which the fixed effects were held constant. We also examined the effect of alternative covariance structures on the fit of the model. In most of the models reported below, an unstructured covariance matrix was found to have significantly better fit than a variance components matrix, as indicated by the difference in the *remle* log-likelihood functions related to the difference in degrees of freedom between the two nested models.

Finally, we examined the effects of three participant-level variables previously used in modeling of grammatical tense. Mother's education was not a significant predictor of growth for any of the four outcome measures in preliminary growth-curve modeling, and we were concerned about the greater data loss in the NLI group. For these reasons, this variable was dropped from subsequent models. The remaining two participant-level variables (vocabulary score, as measured by the TOLD-P:2 Picture Vocabulary raw score, and performance cognition, as measured by the WISC assessment at second grade) were each group-mean centered before analysis. For these growth analyses, we used only participants who had data for the participant-level variables. No participants were missing data on the TOLD-P:2. One participant in the SLI group was missing a WISC score, reducing the group to 56 participants; 6 participants in the NLI group were missing WISC scores, reducing the NLI group to 48. All statistical tests on the participant-level variables were conducted via *mle*s, with the random effects held constant. The alpha level was set at .05. The denominator degrees of freedom were determined using the *between/within* method. Table 5 contains the parameter estimates, standard errors, and degrees of freedom for the fixed effects in each model, as presented below.

Table 5. Growth-curve modeling outcomes for the specific language impairment (SLI) and nonspecific language impairment (NLI) groups per grammatical tense measure.

	SLI group (*n* = 56)			NLI group (*n* = 48)		
Effect	Estimate	*SE*	*df*	Estimate	*SE*	*df*
CompTNS						
Intercept	.719**	.027	55	.664**	.035	46
Linear	.218**	.027	216	.259**	.038	182
Quadratic	−.071**	.015	216	−.112**	.023	182
Cubic	.008*	.002	216	.016**	.004	182
WISC				.002*	.001	46
3Ps						
Intercept	.712**	.039	55	.634**	.044	47
Linear	.294**	.045	213	.357**	.047	179
Quadratic	−.121**	.026	213	−.165**	.028	179
Cubic	.016*	.004	213	.024**	.005	179
RegPT						
Intercept	.802**	.028	55	.733**	.042	47
Linear	.101**	.022	217	.203**	.048	181
Quadratic	−.015*	.005	217	−.086*	.027	181
Cubic				.012*	.004	181
FinIrgPT						
Intercept	.645**	.031	55	.624**	.044	46
Linear	.256**	.041	213	.214*	.064	180
Quadratic	−.077*	.024	213	−.088*	.039	180
Cubic	.008*	.004	213	.013*	.006	180
WISC				.005*	.002	46
IrregPT						
Intercept	.186**	.029	55	.196**	.032	47
Linear	.193**	.028	217	.104**	.008	183
Quadratic	−.016*	.006	217			

Note. CompTNS = composite tense score; 3Ps = third-person singular task; RegPT = percentage correct on regular past tense; FinIrgPT = percentage finiteness on irregular past tense; IrregPT = percentage correct on irregular past tense.

*$p < .05$. **$p < .0001$.

Composite Tense

Figure 2 contains the predicted and observed growth curves of CompTNS for both groups. Both the SLI and NLI groups exhibited significant linear, quadratic, and cubic fixed effects, as well as significant intercept, linear, and quadratic random effects. These components were manifest in rapid growth from kindergarten to first grade, a general slowing between first grade and third grade, and then another period of accelerated growth between third and fourth grade. Although the cubic effect was significant for both groups, the increase between third and fourth grade was especially evident for the NLI group. Although no participant-level variables predicted the growth trajectory for the SLI group, performance IQ had a significant positive effect on the intercept for the NLI group, so that children with higher performance IQ's (relative to the NLI group mean) had higher CompTNS scores at kindergarten. It appears from Figure 2 that the SLI group exhibited better performance overall than did the NLI group.

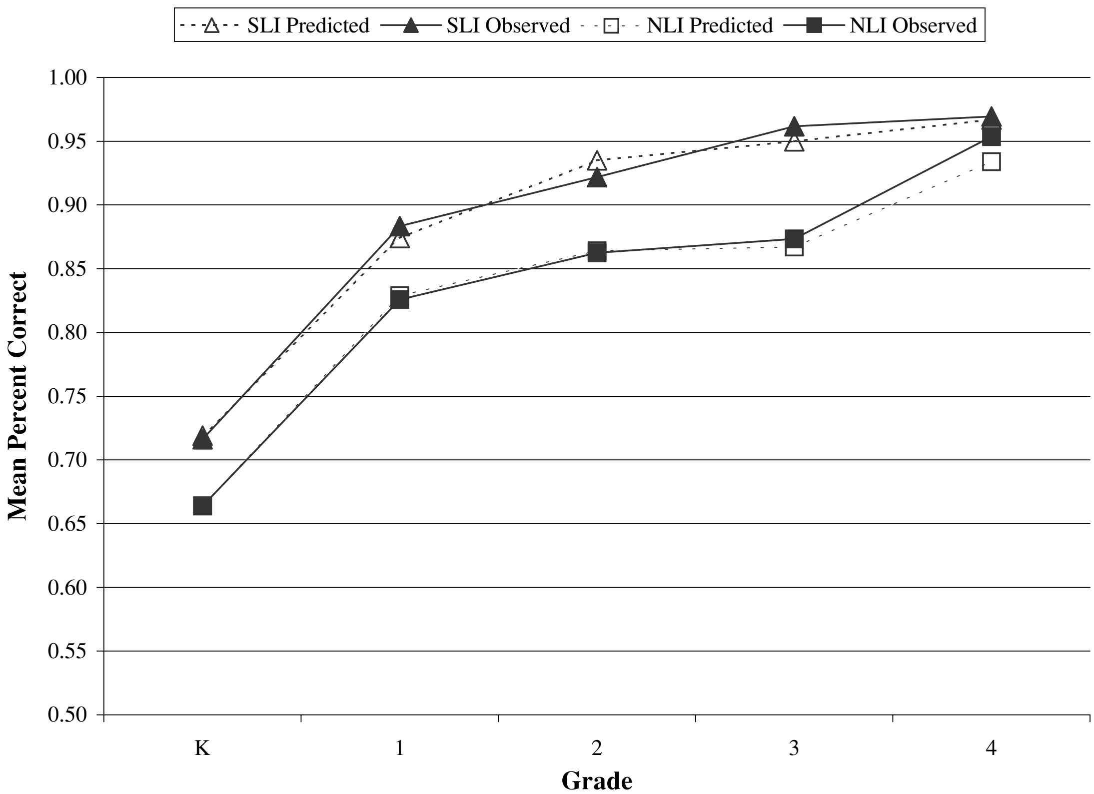
Third-Person Present

Figure 3 contains the predicted and observed growth curves of 3Ps for both groups. Both the SLI and NLI groups exhibited significant linear, quadratic, and cubic fixed effects, as well as significant intercept, linear, and quadratic random effects. Informal inspection of the estimates in Table 5 suggests what while the NLI group started out somewhat lower than the SLI group in kindergarten (intercepts of .63 and .71, respectively), the NLI group also experienced more rapid growth both initially (linear terms of .36 and .29, respectively) and between third and fourth grade (cubic terms of .024 and .016, respectively). No participant-level variables predicted the growth trajectory for the SLI or NLI groups. The SLI group again exhibited better performance overall than did the NLI group, as seen in Figure 3.

Past Regular

Figure 4 contains the predicted and observed growth curves of RegPT for both groups. Both the SLI and NLI groups exhibited significant linear and quadratic fixed

Figure 2. Predicted and actual mean percentage correct for composite tense for the specific language impairment (SLI) and nonspecific language impairment (NLI) groups. K = kindergarten.



effects, as well as significant intercept, linear, and quadratic random effects. The NLI group also exhibited a significant cubic fixed effect, however, indicating that their growth trajectory was characterized by an additional burst of growth between third and fourth grade. No participant-level variables predicted the growth trajectories for either group. The SLI group again exhibited better performance overall than did the NLI group.

Past Irregular Finite

Figure 5 contains the predicted and observed growth curves of FinIrgPT for both groups. Both the SLI and NLI groups exhibited significant linear, quadratic, and cubic fixed effects, as well as significant intercept, linear, and quadratic random effects. These components were again manifest in rapid growth from kindergarten to first grade, a general slowing between first grade and third grade, and then another period of accelerated growth between third and fourth grade. As for CompTNS and 3Ps, the cubic effect is significant for both groups, although the increase between third and fourth grade is greater for the NLI group. Although no participant-level variables predicted the growth trajectory for the SLI group, performance IQ had a significant positive effect on the intercept for the NLI group, so that children with higher performance IQs (relative to the NLI group mean) had higher FinIrgPT scores at kindergarten. It appears from Figure 5 that the SLI group exhibited better performance overall than did the NLI group.

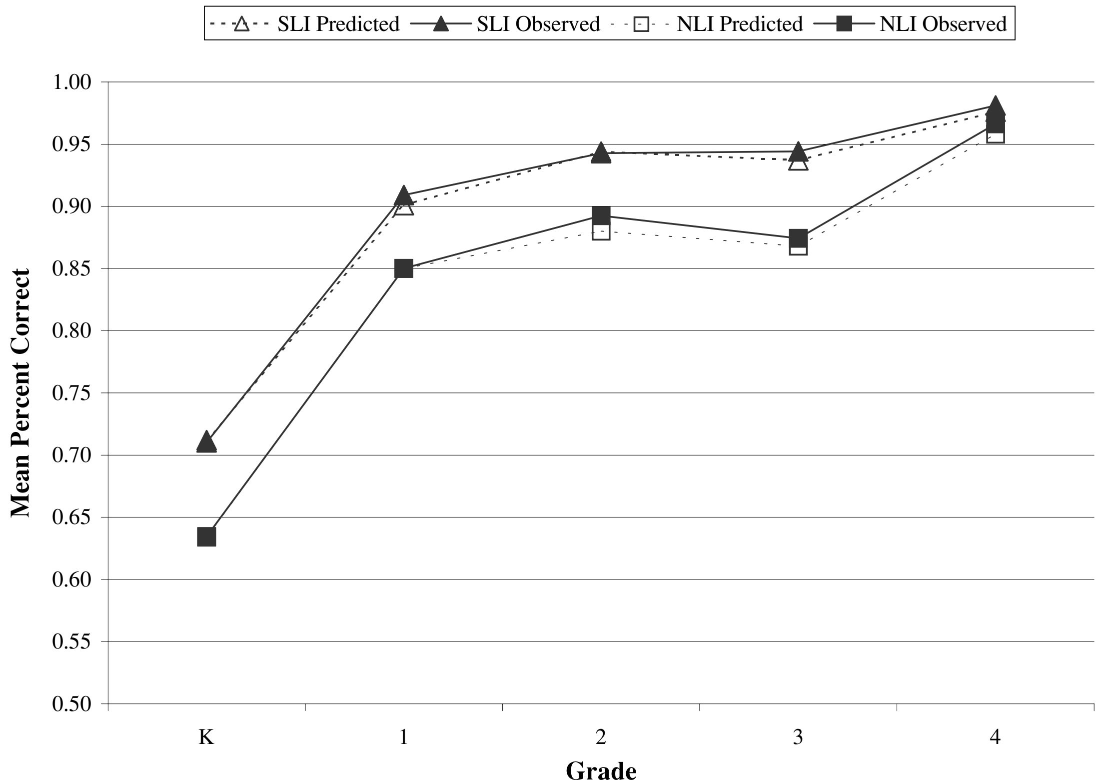
Past Irregular

Figure 6 contains the predicted and observed growth curves of IrregPT for both groups. The SLI group had significant linear and quadratic fixed effects, as well as significant random intercept and linear effects. For the NLI group, however, only a significant linear fixed effect and significant random intercept was obtained. Informal inspection of the estimates in Table 5 suggests greater linear growth for the SLI group than for the NLI group (linear terms of .19 and .10, respectively), resulting in a higher level of performance overall, as seen in Figure 6. No participant-level variables predicted the growth trajectories for either group.

Comparison of Past Regular and Past Irregular Finite

A more complete understanding of growth in grammatical tense for the two groups requires a closer look at past-tense marking and inspection of performance on RegPT and FinIrgPT. Recall that FinIrgPT is adjusted

Figure 3. Predicted and actual mean percentage correct for third-person singular for the specific language impairment (SLI) and nonspecific language impairment (NLI) groups.



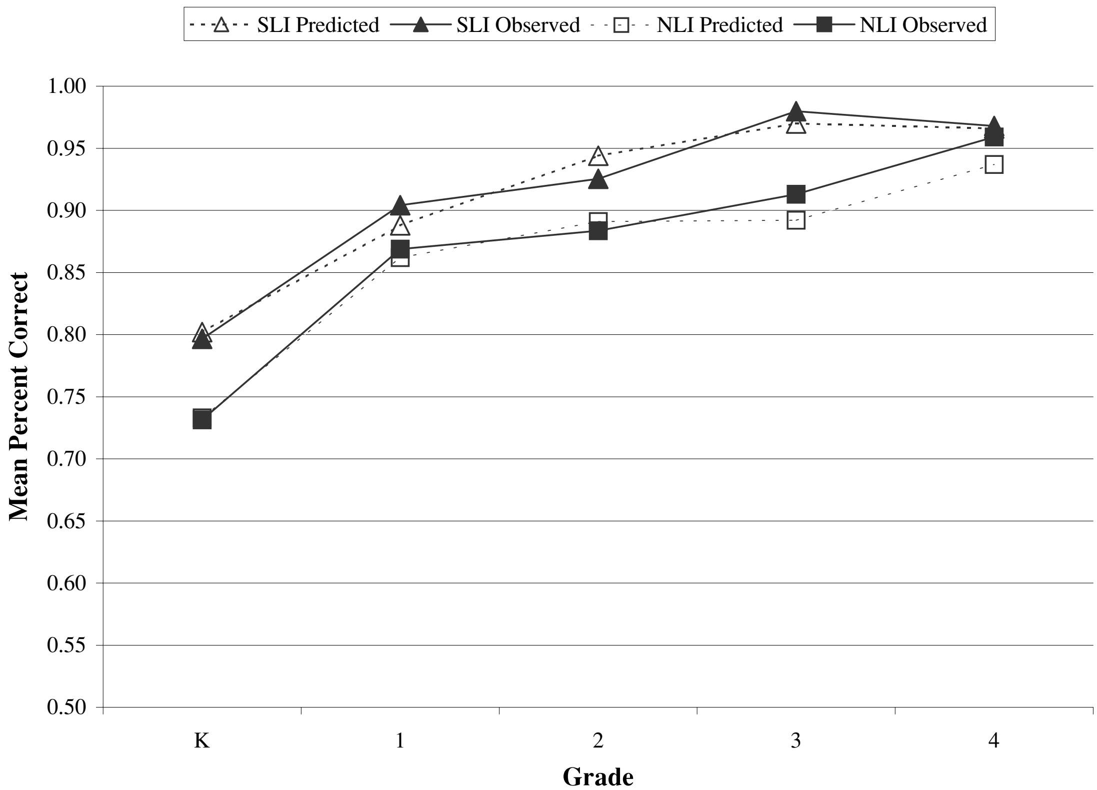
for overgeneralizations as attempts to mark finiteness, so that *falled* would be credited for finiteness (the morphosyntactic element) although the morphophonology of irregular past tense would not be accurate. Figure 7 shows the growth of these two variables within each group. Note that the adjusted FinIrgPT variable was close to the RegPT levels of performance for the SLI group in first to fourth grade, but not at kindergarten. This suggests that once overregularization is under way, the likelihood of generating an overregularized form of past tense, such as *falled*, is similar to the likelihood of generating a regular past tense form, such as *walked,* an outcome similar to the findings of Rice et al. (2000) for SLI and younger unaffected children. In contrast, the NLI group showed a more pronounced gap between the two variables, in the period of first through fourth grade. Error analyses revealed that this was attributable to a lower likelihood of overregularization attempts of the NLI group, whose irregular past tense errors persisted in the form of bare stems for a long period.

General Discussion

To return to the first research question, it is clear that there are group differences on grammatical tense tasks at the kindergarten level. Of the four groups, the groups with language impairments (SLI and NLI) performed below the non-language-impaired groups (control and LC) across the measures overall. The control and LC groups were at similar levels of performance on all measures, demonstrating that low levels of nonverbal IQ are not sufficient conditions for delayed acquisition of grammatical tense. Furthermore, there are indications that the group differences were modulated by subtle differences within the domain of tense marking. The SLI group performed higher than the NLI group for CompTNS, 3Ps, and RegPT, but not on FinIrgPT. Discussion of these differences appears later.

The findings of SLI performing worse than the controls clearly replicate previous findings from clinically ascertained samples of children with SLI, thereby establishing that evidence from clinically ascertained samples for the grammatical tense marker is likely to be generalizable to the broader group of unidentified children affected with SLI. The previously reported experimental studies of clinically ascertained samples also demonstrate that the affected children as a group perform below the levels of a language-equivalent control group about 2 years younger (cf. Rice et al., 1995). Using 2 years as an approximate estimate of the language

Figure 4. Predicted and actual mean percentage correct for regular past tense for the specific language impairment (SLI) and nonspecific language impairment (NLI) groups

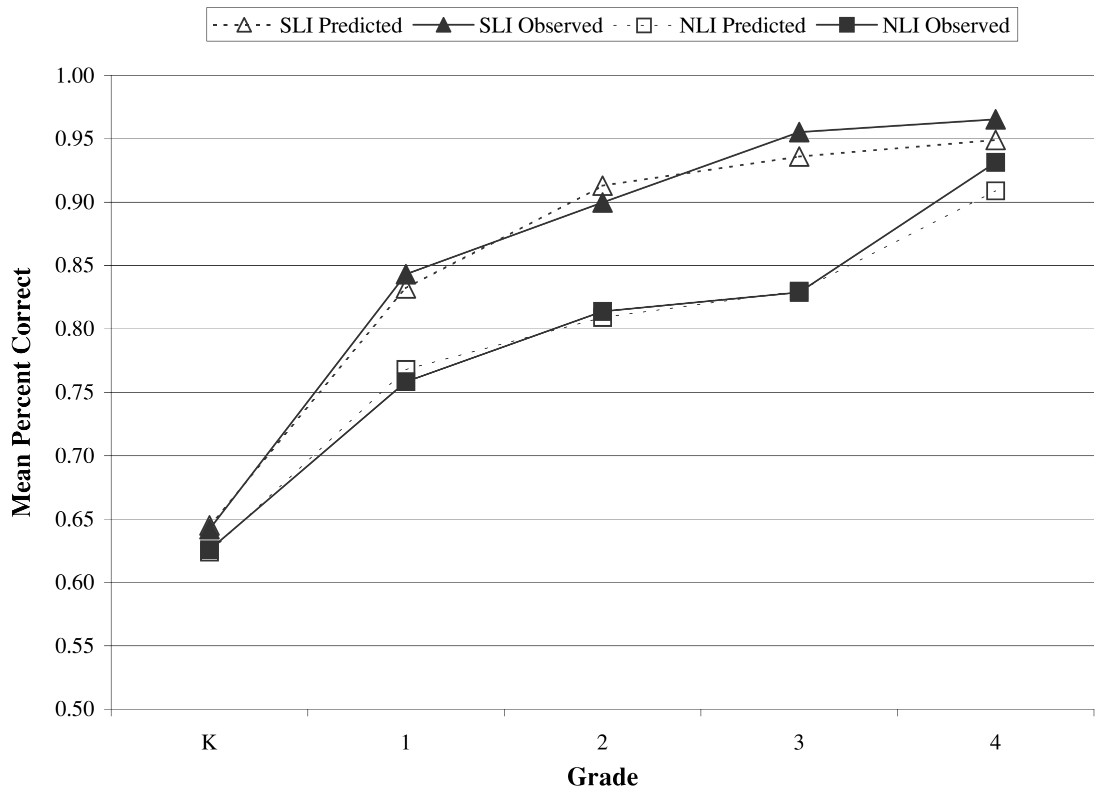


delay of affected children, one can compare the children's performance on CompTNS for the kindergarten sample (at 6 years of age, on average) with that of the national sample reported in the TEGI Screener normative values (for children 4 years to 4 years 5 months; cf. Rice & Wexler, 2001). The CompTNS mean scores for each group were as follows, with the TEGI specificity and sensitivity values for 4-year-old unaffected children listed behind each: SLI, .78 (.78, .90); NLI, .71 (.86, .88). The specificity values of .78 and .86, respectively, show that the affected groups' mean scores are at levels exceeded by 78% or 86% of the younger unaffected children, that is, in the bottom 22% or 14% of the sample of the younger unaffected children. The sensitivity values of .90 and .88, respectively, correspond to the level that identifies 90% or 88% of the 2-years-younger children with language impairments. It appears that the epidemiologically ascertained sample of SLI children also replicates the expectation that the children's performance will be below that of children 2 years younger. A further observation is that the NLI group scored at median levels for children in the 3.00–3.05 years age group of the TEGI Screener norms, suggesting even greater language delays.

When we turn our attention to growth outcomes, we see that the quantitative differences among groups persist, and we have a better view of possible qualitative differences in acquisition in the domain of grammatical tense marking. The NLI group's performance on CompTNS lagged behind that of the SLI group at second and third grade. More specifically, although the growth curves for this summative measure exhibited the same qualitative components for each of the two groups (i.e. linear, quadratic, and cubic), the magnitude of these components appeared to differ somewhat for the two groups, indicating a general slowing for the NLI group between first and third grade (roughly 7–9 years) and then a late catch-up acceleration between third and fourth grade to a larger degree than for the SLI group. However, *catch-up* may be a misleading term because the grammatical probes used for this study require use of tense marking on lexical verbs in short simple sentences only, and there may remain important ways in which tense marking is more delayed for the NLI group, especially in more complex sentence contexts.

Consideration of the differences in acquisition of past tense forms in the SLI and NLI groups provides further clarification of the source of the NLI group's more extended delays. Recall that the NLI group made steady growth in regular past tense marking during the observed period, showing that finiteness marking was

Figure 5. Predicted and actual mean percentage correct for finite irregular past tense for the specific language impairment (SLI) and nonspecific language impairment (NLI) groups.



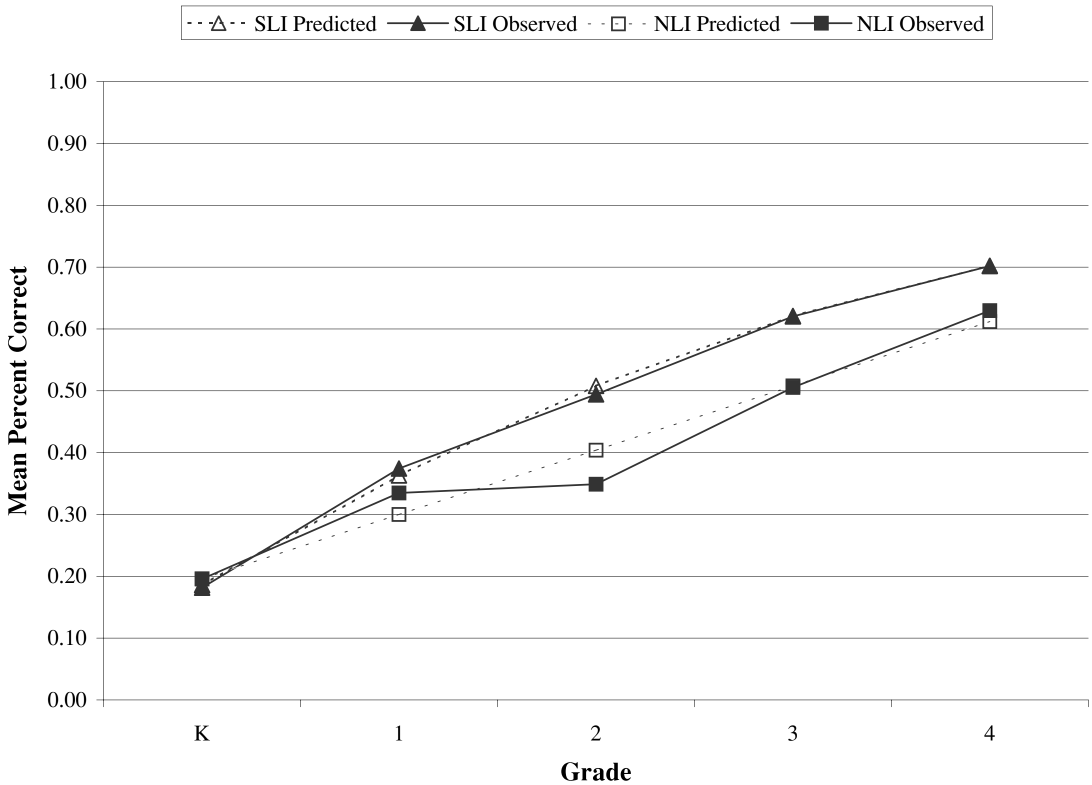
increasing during this time. Unlike the SLI group during this period, the growth in regular past tense marking for the NLI group did not grow close to finite irregular past tense marking until the last time of measurement. This means that the NLI group was much slower to use overregularizations as a way of marking finiteness on irregular past verb forms. Use of overregularizations requires productive application of the morphophonological system involved in the way past tense morphology is "spelled out" for lexical verbs. Thus we can see that finiteness marking is increasing for the NLI group, shown by progress in regular past tense and third-person singular present tense marking, during the same time that the morphophonological learning of irregular past tense verb stems is especially protracted.

Further indicators of qualitative differences in growth in the SLI and NLI groups are to be found in the predictors of growth. Nonverbal IQ was not a predictor of either level or shape of growth for any of the measures in the SLI group, but higher performance IQ was related to a higher level of performance at kindergarten for the FinIrgPT and CompTNS measures in the NLI group.

The import of the possible qualitative differences between the SLI and NLI groups is that the status of the groups at kindergarten is only partially predictive of their status at subsequent time periods. Furthermore, the analysis of irregular past tense forms suggests that the ability of the NLI group to learn linguistic regularities could differ in qualitatively important ways that could be manifest in clinical settings when such linguistic elements are the focus of intervention. During this age period, the SLI children show that like younger unaffected children, they recognize that the regular past tense *-ed* is a candidate for how to mark pastness for irregular lexical verbs such as *fall*. This is generally viewed as a prototype of the generalized rule induction that is a hallmark of language growth. The fact that the NLI group showed a protracted delay in this domain of language learning suggests that they may also show similar limitations in other domains as well, which could appear as clinically significant differences in an instructional setting. Overall, it cannot be assumed that the SLI and NLI groups show equivalence in level of performance on grammatical tense, or in growth trajectories, or in the induction of particular linguistic rules.

Another way to consider the trajectories of the SLI and NLI groups is from the distinction of delayed versus different patterns of growth, relative to expected age-referenced growth. Francis, Shaywitz, Stuebing,

Figure 6. Predicted and actual mean percent correct for irregular past tense for the specific language impairment (SLI) and nonspecific language impairment (NLI) groups.

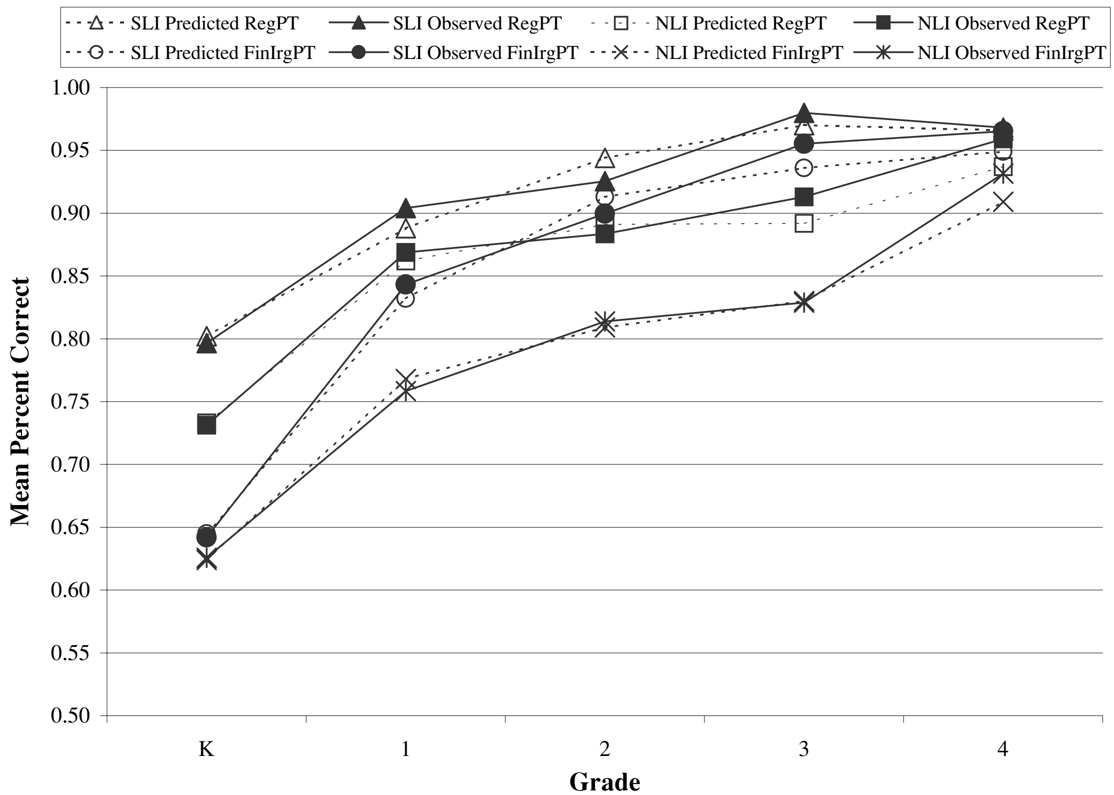


Shaywitz, and Fletcher (1996) have provided an important precedent for the evaluation of developmental lag versus deficit models in the domain of reading that uses individual growth curves similar to the ones reported here. Groups of children with reading disabilities and groups of unaffected children were compared. Using a model of quadratic growth to a plateau, they estimated the age and level at which reading scores plateaued for each child. They found that the age of plateau was the same for affected and unaffected children, although the reading levels were lower for affected children, indicating a deficit instead of a lag. In comparison, the findings here suggest a lag for the SLI group, relative to the unaffected controls, and a lag for the NLI group, relative to the SLI group, that is largely attributable to a greater delay in resolution of the overgeneralization phase of irregular past tense mastery. Formal evaluation of the lag model of grammatical tense marking requires analyses beyond the descriptive models of this study, but such methods are clearly relevant and potentially valuable.

The other two predictors evaluated, those of mother's education and the children's vocabulary level, were not significant predictors for any of the variables, an outcome that held for both groups. There is some caution for the mother's education outcomes for the NLI and LC groups given the somewhat higher rate of missing data for these groups. The outcome pattern replicates findings from earlier studies, however, and is further indication that performance levels in grammatical tense marking at 5–6 years of age are not linked with the environmental variables associated with mother's education, nor is level or growth linked with the children's growth of general language dimensions indexed by receptive vocabulary performance.

It is of interest that this study did not replicate the earlier finding that nonverbal IQ, along with receptive vocabulary, predicts the acquisition of IrregPT (cf. Rice et al., 2000). The measures of receptive vocabulary differed across the two studies (the Peabody Picture Vocabulary Test–Revised; Dunn & Dunn, 1981, was the vocabulary index in the earlier study), so the nonreplication for this measure could be attributable to instrument differences. The experimental tasks for tense marking were identical, so task differences can be ruled out. Other possibly crucial differences were that the affected children in Rice et al. (2000) were 1 year younger at the outset, and there were seven times of measurement instead of five, over a younger age period (age 5–8 years). It may well be that the predictive status holds at an earlier period but is washed out at older ages.

Figure 7. Regular past tense compared with finite irregular past tense for SLI and NLI groups for the specific language impairment (SLI) and nonspecific language impairment (NLI) groups.



The outcomes of this study suggest that the role of nonverbal intelligence in young children's language impairments is not straightforward. In the domain of grammatical tense marking, nonverbal performance IQ below 85 is not a sufficient condition for impairment in this domain at 5–6 years of age, as is clearly demonstrated by the LC group, who performed well in spite of limited performance on IQ measures. This poses a challenge for the generalized slowing account of the limited language performance of the SLI and NLI groups. The hypothesized slowed processing factor that causes language impairment, under this account, is thought to be greater for the NLI group because it affects performance IQ as well as language performance. The question, then, is how this generalized slowing could affect the LC group's performance on IQ tests, but at the same time it apparently did not affect their acquisition of grammatical tense markers.

Windsor, Milbrath, Carney, and Rakowski (2001) evaluated methodological considerations that caused them to suggest that the general slowing model was insufficiently robust to account for language impairments in children. Specifically, they found the data to be insufficient to establish task difficulty as a more crucial factor in task performance than task content and also insufficient to isolate the link between nonverbal IQ and general slowing. So the question of general slowing remains open for accounts of language impairments, and conceivably there could be other possible information-processing accounts of language impairments, although the protracted acquisition of grammatical tense marking remains as a challenging phenomenon to be explained. The performance of the LC group on the grammatical tense markers adds the requirement that any processing limitations must be such that high performance on grammar tasks can coexist with low performance on nonverbal tasks in nonsyndromic populations of children.

On the other hand, the findings are congruent with a model of grammatical tense in which growth in this linguistic domain is hypothesized to be relatively independent from general cognitive mechanisms and the domain of semantic development. Under such a model, the lower level of performance by the NLI group would be attributable to low levels of competencies in both nonverbal IQ and the linguistic mechanisms underlying grammatical tense marking. In contrast, the LC group's performance would be attributable to low levels of competence in nonverbal IQ but sufficient (or better) levels of competence in the underlying linguistic mechanisms, including the learning involved in morphophonology.

To paraphrase Conti-Ramsden et al. (2001), it is clearly possible to have a marker for language impairment that is not a proxy for general cognitive level.

To return to the initial question of the boundary issue, highlighted by Tager-Flusberg and Cooper (1999), the findings reported here suggest the need for further studies of the ways in which children's language performance above and below the traditional cutoff of a performance IQ of 85 may be similar and different. It is clear that in a literal sense the groups are not equivalent, especially when we consider growth patterns and linguistic details involving morphophonological generalization. It may well be the case that in some domains the differences across the arbitrary performance IQ boundary may not be of import, or for some studies the differences are not relevant. In our current state of limited information, caution is warranted, however. What is needed is further investigation to determine which language domains, under which forms of measurement, are affected by levels of performance IQ. Longitudinal studies will be essential to explicate the similarities and differences and to evaluate precise growth models such as the age-at-plateau models evaluated by Francis et al. (1996).

At the level of clinical services, it is obvious that both groups of affected children warrant strong advocacy for clinical services and that grammatical tense marking is a useful domain for the identification of affected children at kindergarten. Thus, at the level of who is to be served, and the role of tense marking as a potential clinical marker, there is no differentiation between the SLI and NLI groups. At the same time, further investigation will be needed to explore the role of nonverbal performance IQ as a guide to how to provide services (cf. Cole & Fey, 1996). This study suggests that linguistic details may need to be adjusted for differences in children's nonverbal cognitive levels.

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