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# Grammatical Morphology in School-Age Children with and without Language Impairment: A Discriminant Function Analysis

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## Abstract

**Purpose—**The purpose of this study was to test Bedore and Leonard's (1998) proposal that a verb morpheme composite may hold promise as a clinical marker for specific language impairment (SLI) in English speakers and serve as an accurate basis for the classification of children with and without SLI beyond the preschool level.

**Method—**The language transcripts of 50 school-age children with SLI ($M_{age}$ = 7;9) and 50 age-matched typically developing peers ($M_{age}$ = 7;9) were analyzed. Following the Bedore and Leonard procedure, three variables were measured: mean length of utterance in morphemes (MLU-morphemes), a noun morpheme composite, and a finite verb morpheme composite.

**Results—**Overall findings indicated that neither grammatical morpheme composite alone adequately discriminated the groups at this developmental level. Combining the noun and verb grammatical morpheme composite measures with MLU-morphemes resulted in good discriminant accuracy in classifying subgroups of the youngest children with and without SLI in the school-age sample.

**Conclusions—**We did not find that verb morphology alone served as a useful clinical marker of SLI in school-age children. Potential explanations for these findings and ideas for future research are discussed.

### Keywords

specific language impairment; language disorders; school-age; clinical marker; grammatical morphology

During the last decade, researchers in language disorders have been motivated to establish a phenotype of specific language impairment (SLI; Tager-Flusberg & Cooper, 1999). The search for a clinical marker of SLI has been motivated, in part, by research which raises

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questions about the ability of traditional norm-referenced language assessments to identify children with SLI and classify children with and without language impairments (e.g., Dunn, Flax, Sliwinski, & Aram, 1996; Plante & Vance, 1994; Spaulding, Plante, & Farinella, 2006). For example, Plante & Vance (1994) found that only one of four tests they administered to preschoolers with and without language impairment resulted in acceptable levels of accuracy (80% or above) in classifying children into their respective language groups. Dunn, Flax, Sliwinski, and Aram (1996) noted that using data from spontaneous language samples (including percent of utterances containing morphological or syntactic errors) was much more accurate at identifying children with SLI than using a psychometric discrepancy criterion (i.e., a one standard deviation difference between standardized measures of nonverbal cognition and language).

Spaulding, Plante, and Farinella's (2006) review of 43 standardized tests of child language revealed that only five reported acceptable accuracy of identification of the presence of language impairment (80% or better). The average mean group difference between children with language impairment and those with typically developing language on these tests was −1.34 standard deviations, indicating that a large percentage of children (43%) described as language impaired in the manuals scored within one standard deviation of the normative mean. On nine of the 43 tests, *most* children with language impairment earned scores within one standard deviation of the mean. Given these concerns about standardized language assessment, the identification of clinical markers of SLI could greatly assist clinicians in the accurate diagnosis of language impairment.

## Grammatical Deficit as a Clinical Marker of SLI

Numerous studies support the potential use of grammatical morphology and, more specifically, finite verb morphology as a clinical marker of SLI given that affected children exhibit a relative weakness in this language domain (see Leonard, 1998 for a review). Children with SLI produce fewer grammatical morphemes in obligatory contexts even when compared to typically developing children matched for mean length of utterance (MLU; e.g., Leonard, Bortolini, Caselli, McGregor, & Sabbadini, 1992; Leonard et al., 2007; Rice & Wexler, 1996), or lexical diversity (Leonard, Miller, & Gerber, 1999).

In an evaluation of psycholinguistic markers of SLI in five-year-old children, Conti-Ramsden (2003) reported that past tense marking and nonword repetition most accurately identified the children with SLI, whereas plural marking and digit recall did not contribute independently to the identification of children with SLI. Conti-Ramsden, Botting, and Faragher's (2001) investigation of psycholinguistic markers of SLI in 11-year-old children demonstrated that tense marking showed potential as a clinical marker of SLI, but more accurately identified children with current severe SLI than those whose impairment had resolved by age 11.

## Accounts of Tense Marking in SLI

Use of tense-marking morphemes appears to develop independently of general intelligence (Conti-Ramsden et al., 2001; Rice, Tomblin, Hoffman, Richman, & Marquis, 2004). Rice and colleagues (2004) have claimed that this finding seems to challenge Kail's (1994) hypothesis that SLI is the result of a generalized slowing of processing. Alternatively, Rice and colleagues have proposed the extended optional infinitive (EOI) account of SLI (Rice & Wexler, 1996; Rice, Wexler & Cleave, 1995; Rice, Wexler, & Redmond, 1999). Typically developing children generally master the use of grammatical morphemes around the age of five years (Rice & Wexler, 1996). Prior to this mastery of grammar, children treat verb tense markers as "optional" rather than using them consistently in obligatory contexts (Rice et al., 1995). Children with SLI have an extended period of omission of tense markers as compared with typically developing children (Rice & Wexler, 1996; Rice et al., 1995; Rice et al., 1999). This period may persist into adolescence for certain types of sentences, such as questions containing complementizer phrases (Rice, Hoffman, & Wexler, 2009).

Rice and Wexler (1996) compared the use of a set of morphemes that mark tense (third person singular -*s*, regular past -*ed*, and forms of *be* and *do*) in preschoolers with SLI (mean age 5 years) to age-matched peers and younger children matched on MLU. They found that accuracy levels on the target morphemes reliably differentiated children in the SLI group from both groups of peers. Moreover, they found that if a 5-year-old child in their sample was less than 50% accurate on more than one of the target morphemes, one could be certain that child fell in the SLI group. Interestingly, children with SLI produced other grammatical morphemes, particularly earlier developing morphemes such as plural –*s* and progressive -*ing* (Brown, 1973) at accuracy levels similar to their age-matched peers, suggesting that not all grammatical markers are problematic for children with language impairment Further investigations have extended these findings to reveal that deficits in tense marking persist into the school-age years (Rice et al., 2009; Rice, Wexler, & Hershberger, 1998).

Other accounts of grammatical deficits in SLI highlight the role of lexical development in tense marking (e.g., Leonard et al., 2007; Marchman, Wulfeck, & Ellis Weismer, 1999). Marchman et al.'s (1999) analysis of the error patterns on past tense production indicated that children with SLI may display oversensitivity to the phonological features of word stems, which may result in inefficient lexical processing. This inefficiency could contribute to deficits in the production of inflectional morphology. Leonard et al. (2007) suggested that the difficulties in tense marking exhibited by children with SLI could be the result of decreased sensitivity to the lexical aspect features of verbs. Although agreement has not been reached regarding the mechanisms contributing to grammatical deficits in children with SLI, the aforementioned findings have led to the conclusion that a measure of tense-marking morphemes may serve as a clinical marker of SLI.

## Genetic SLI Research

In recent years significant strides have been made in research investigating the genetic basis for SLI. A critical precursor for genetic research is the establishment of specific criteria for determining SLI status. Consequently, better-defined clinical markers for SLI is necessary for continued progress in this line of research (Bishop, 2002; Bishop & Hayiou-Thomas, 2008). Bishop and colleagues have provided evidence that deficits in verb inflections are heritable (i.e., influenced by genetic factors). For example, Bishop (2005) analyzed the use of verb inflections in 174 pairs of monozygotic (MZ) and dizygotic (DZ) same-sex six-year-old twins. Comparing MZ and DZ twins provides a unique opportunity to examine the influence of genetics while limiting environmental factors. The majority of twin pairs (120) included at least one twin who was considered to be at-risk for language impairment via parent report when children were four years of age. Specifically, if parents reported concerns about their child's language development, described their child as not yet talking in full sentences, and/or the child scored in the lowest 10% of a vocabulary checklist the child was classified as at-risk for language impairment. When children were six years old they completed two subtests from a pre-publication version of the Rice/Wexler Test of Early Grammatical Impairment (2001) to assess their use of the past-tense and third-person singular verb inflections. The authors employed a DeFries-Fulker analysis (DeFries & Fulker, 1985), an adaptation of multiple regression, to estimate the relative proportion of variance explained by genes, shared environment, and random environmental factors. Their results suggested that a single major gene may account for impairments in verb inflections, although the authors advise that these findings should be interpreted with caution given the small sample size and the limited range of simulations that were tested.

Bishop, Adams, and Norbury (2006) investigated genetic influences on grammar (i.e., verb tense marking) and phonological short-term memory (PSTM) deficits in 174 pairs of MZ and DZ six year-old twins. In approximately 10% of the twin pairs one or both children were considered to be at-risk for language impairment. Children were identified as at-risk for language impairment at four years of age via parent report using the same indices as Bishop (2005). At age six, the children completed a battery of assessments measuring language and cognition, including measures of verb tense marking and PSTM. Similar to Bishop (2005), a DeFries-Fulker multiple-regression analysis was used to estimate heritability of each skill. Based on their results, the authors concluded that deficits in both verb tense marking and PTSM were heritable and were good markers of heritable language impairment. Interestingly, they also found no evidence of a genetic link between deficits in PTSM and verb tense marking, suggesting that they are etiologically distinct abilities, rather than different manifestations of the same underlying impairment. A related study by Falcaro et al. (2008) investigated the heritability of tense marking in 93 individuals with SLI and 300 of their first-degree relatives. Results indicated that qualitative differences in verb tense marking may be familial (i.e., a heritable trait), whereas quantitative differences in verb tense marking most likely have non-familial (i.e., environmental) causes. Furthermore, Falcaro et al. (2008) suggested that verb tense marking may be a binary skill that is either acquired or not acquired in early school age, rather than a continuous measure (although this interpretation is challenged by Rice, Hoffman, & Wexler, 2009).

In sum, previous linguistic research has indicated that verb tense markings are particularly impaired in SLI. In addition, genetic research on SLI suggests that these grammatical deficits may be heritable. The combination of linguistic and genetic research provides compelling evidence that a measure of finite verb morphology has potential to serve as a clinical marker of SLI. Identifying clinical markers would greatly benefit clinicians and researchers in terms of accurate diagnosis and classification for both behavioral and genetic research.

## Utility of Discriminant Function Analysis for Classification

Bedore and Leonard (1998) employed discriminant function analysis to determine whether or not the use of grammatical morphology could accurately classify children with SLI and their age-matched normal language (NL) peers. Their first experiment included 19 children with SLI, aged 3;7 to 5;9, and 19 typically-developing age-matched peers. The children with SLI scored at least one standard deviation below the mean on a general test of language ability, while scoring in the normal range on tests of nonverbal cognition. In addition, they exhibited normal hearing, oral motor functioning, and socio-emotional development, and accurately produced the phonemes that were included in the target grammatical morphemes.

They analyzed spontaneous language samples collected during picture description activities and free-play with the examiner. Between six and eight collection sessions occurred, resulting in large numbers of utterances per child. Three variables were included in the discriminant analysis used for classifying the two groups: 1) a finite verb morphology composite; 2) a noun morphology composite; and 3) MLU in morphemes. The verb morphology composite included regular past tense -*ed*, regular third person singular present inflection -*s*, and copula and auxiliary *be* forms. The noun composite included possessive -*'s*, plural -*s*, and articles (*a, an, the*). According to Brown (1973), typically developing children master these morphemes by 50 months of age. The obligatory contexts for the target morphemes were identified in each child's language sample. The number of correct productions were then divided by the total number of obligatory contexts and multiplied by 100 to obtain percentages of correct usage for the noun and verb composites.

The children included in Experiment 1 significantly differed on all three variables, with children in the SLI group exhibiting lower mean percentages of correct productions in both morpheme composites and lower mean MLUs. The discriminant function analysis revealed that the verb morpheme composite resulted in 84% sensitivity (i.e., accuracy in identifying children with SLI) and 100% specificity (i.e., accuracy in identifying NL peers). According to Plante and Vance (1994), discriminant accuracy of 80% or above is considered fair, and 90% or higher is good.

To further test the ability of these variables to classify children with SLI and NL peers, Bedore and Leonard (1998) applied the discriminant criterion generated from the first analysis to a second group of children (Experiment 2). This smaller group consisted of six children with SLI and six typically developing age-matched peers of similar ages to the children in Experiment 1. All methods and procedures were identical to the first analysis. In this case, the verb morpheme composite resulted in 100% sensitivity and 100% specificity.

Bedore and Leonard (1998) concluded that a measure of finite verb morphology shows promise as a clinical marker of SLI in preschool children. In addition, based on their results and those of Rice and Wexler (1997) indicating that deficits in finite verb morphology continue into the school-age years for children with SLI, they proposed that a measure of verb morphology also may serve as a clinical marker for SLI in school-age children.

The purpose of the present study was to extend the findings of Bedore and Leonard (1998), and to test their proposal that a verb morpheme composite may hold promise as a clinical marker for SLI and serve as an accurate basis for the classification of children with and without SLI beyond the preschool level.

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## Method

### Participants

The participants included 50 school-age children with SLI (24 female, 26 male, $M_{age}$ = 7;9 years;months, age range: 5;5 – 9;8) and 50 age-matched NL peers (26 female, 24 male, $M_{age}$= 7;9 years;months, age range: 6;0 – 9:9). All children were monolingual native speakers of Standard American English, primarily from the majority culture, who showed no signs of oral motor dysfunction, social-emotional disturbance, visual acuity problems, or frank neurological deficits. In addition, all children passed pure tone hearing screenings (20 dB HL at 500, 1000, 2000, and 4000 Hz per ASHA [1990] guidelines) and screening tympanometry of middle ear functioning. An informal phonological assessment was administered (cf. Smit, 2002) to ensure that all of the children possessed adequate phonological skills for producing morphological markers. All participating children were judged to be typically developing in terms of speech sound development. Children with speech sound delays or impairments were excluded from participating. For children in the current study who omitted a targeted grammatical morpheme within their language sample we looked for evidence that they had produced the same morpheme or a similar phonetic sequence elsewhere in the transcript (e.g., the article “an” was omitted, but the child produced words like “man” or “can”). In 100% of cases in which a child omitted a grammatical morpheme, the child successfully produced the morpheme or a similar phonetic sequence elsewhere within the transcript, suggesting that the grammatical morpheme omissions were not due to an inability to produce the required phonemes.

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Children were administered standardized tests of vocabulary comprehension (Peabody Picture Vocabulary Test-Revised, PPVT-R; Dunn & Dunn, 1981), grammatical comprehension (Test for Auditory Comprehension of Language-Revised, TACL-R; Carrow-Woolfolk, 1985), and nonverbal cognition (Columbia Mental Maturity Scale (CMMS)

Burgemeister, Blum & Lorge, 1972). All children scored within the normal range (above -1 SD) on nonverbal cognition. The mean scores between the NL and SLI groups were statistically different on the CMMS, $F(1,98) = 22.10$, $p<.001$ $\eta_p^2 = .18$ (see Table 1 for a summary of the children's age and performance on the language and cognitive measures); however, the effect size was small. Similar group differences have been reported previously in the literature (e.g., Ellis Weismer et al., 2000). Moreover, many experts argue that nonverbal IQ does not significantly impact the phenotypical profile for SLI (cf. Tager-Flusberg & Cooper, 1999).

Based on parent report of their educational levels and occupations, families in both groups ranged from working class to upper-middle class using the criteria employed by Hoff-Ginsberg (1991). Children with SLI had been previously diagnosed by certified speech-language pathologists and were receiving services in their schools (within the Madison Metropolitan School District, WI). In addition, each child with SLI scored below -1 SD on at least one language measure administered for the current study.

## Procedure

Language samples were collected from 100 school-age children as part of several prior cross-sectional studies (Ellis Weismer, Evans, & Hesketh, 1999; Ellis Weismer & Hesketh, 1996, 1998). The fifteen-minute language samples were conducted following standardized procedures. To elicit the language samples, the examiner used prompts such as asking the children to describe their favorite movie or television show, a typical day at school, a recent vacation, a recent birthday party, pets, how to cook a favorite meal, and explaining the rules of a sport or game. The resulting language samples consisted of predominantly narratives; however, describing how to cook a meal or the rules of a sport are prompts for expository discourse. Recent research by Nippold and colleagues (Nippold 2009, 2010; Nippold, Mansfield, Billow, & Tomblin, 2008) found that syntactic complexity is highest when children produce expository samples as compared to other types of discourse. In order to examine potential differences in the language samples across groups, transcripts were reviewed and examiner prompts were tallied for each child. Results indicated that children in both groups responded to a similar number of narrative prompts by the examiner (NL group mean = 4.14; SLI group mean = 4.04). Across groups, a higher percentage of language samples from NL children included some expository content than those of from the SLI group (33% and 23% respectively); however, no child's transcript was dominated by expository discourse. In sum, the language samples would be best described as predominantly narratives, with some expository content. Given that children in both groups responded to prompts which were predominately designed to elicit narrative discourse, it seems safe to conclude that the language sampling context was similar for children across groups.

Language samples were transcribed and analyzed using Systematic Analysis of Language Transcripts (SALT) and the SALT Profiler Reference Database (Miller & Chapman, 1993). Using SALT transcription conventions (Leadholm & Miller, 1992), a search was conducted within each child's transcript for utterances containing the target morphemes (regular past tense *-ed*, regular third person singular present inflection *-s*, copula and auxiliary *be* forms [*am, is, are, was, were, be, being, been*], possessive *-'s*, plural *-s*, articles *a, an, the*), including correct productions (e.g., walk/ed), omissions, (e.g., walk/*ed), and other errors at the word level (EW) such as over-regularizations (e.g., EW: breaked) using SALT computer software. From this output, two trained research assistants first determined the number of obligatory contexts for each of the morphemes included in the grammatical composites, and then the number of correct productions (see Appendix A for an example of obligatory contexts). The identification of which verb tense was obligatory in a specific instance (e.g., past, present) was determined by the temporal context that had been established by the child.

From these data, percentages of correct usage in obligatory contexts for the verb and noun composites were calculated for each child (see Appendix B for an example). Following the procedures used in Bedore and Leonard (1998), three variables were included in the discriminant function analysis: the noun morpheme composite, the finite verb morpheme composite, and MLU in morphemes.

### Reliability

Interrater reliability of the language sample transcription was measured using 15% of the total number of samples, resulting in 97% morpheme to morpheme agreement. Subsequently, interrater reliability of scoring the noun and verb grammatical morpheme composites was assessed using 10% of the total sample (5 children with SLI and 5 children with NL). Within each transcript, obligatory contexts for the verb morphemes ranged from 34 to 134 instances ($M_{verb}$ = 74), and obligatory contexts for the noun morphemes ranged from 42 to 142 ($M_{noun}$ = 91). Interrater agreement was 98% (1620/1646) in judging the correct productions of the target morphemes.

## Results

Table 2 summarizes the performance of the SLI and NL groups on the grammatical morpheme composites and MLU-morphemes. Note the high level of proficiency for children in both groups on their grammatical morpheme composite scores. Prior to completing the discriminant analysis, one-way analysis of variance tests ANOVAs were conducted to confirm that the NL and SLI groups differed on these measures. Arcsine-transformed values of the morpheme composite percentage scores were used for these analyses to normalize the data. Results indicated that the scores for children with SLI were significantly lower than the NL group for the verb morpheme composite, $F(1,98) = 13.35$, $p<.001$, $\eta_p^2 = .12$, noun morpheme composite, $F(1,98) = 25.34$, $p<.001$, $\eta_p^2 = .21$, and MLU-morphemes, $F(1,98) = 26.04$, $p<.001$ $\eta_p^2 = .21$.

The means and standard deviations for the number of obligatory contexts for the verb and noun morphemes were compared across groups. Language samples of children in the NL group contained a mean of 68.9 (SD = 21.3) obligatory contexts for the verb morphemes, compared to 55.8 (SD = 25.5) for the SLI group, $F(1,98) = 7.79$, $p=.006$. For the noun morphemes, the NL group's mean was 97.7 (SD = 24.1), and the SLI group's mean was 69.1 (SD = 23.7), $F(1,98) = 26.49$, $p<.001$. Although the differences between groups were significant, the means for both groups were high, and the ranges in the number of obligatory contexts were overlapping across groups for both the verb composite (17 – 126 and 5 – 111 for the TD and SLI groups, respectively) and the noun composite (33 – 154 and 13 – 135 for the NL and SLI groups, respectively).

Discriminant analysis and cross validation procedures (SPSS, 2009) were used to determine how well the grammatical morpheme composites and MLU-morphemes discriminated between children with SLI and those with NL (Table 3). Discriminant analysis generates a discriminant criterion that maximally separates the groups. Cross validation procedures assess the accuracy of the discriminant criterion in classifying individuals according to their original group membership. At best, the measures resulted in fair classification accuracy (80% or above; Plante & Vance, 1994) for children at this developmental level. In terms of single classification variables, MLU-morphemes resulted in the highest overall classification accuracy, with 76% of the children correctly identified as either SLI or NL, $\Lambda$=.79, $\chi^2(1, N = 100) = 22.98$, p < .001. Note that sensitivity was poor (72%) and specificity was fair (80%). Although the noun and verb composites individually resulted in slightly better specificity (i.e., correct classification of NL children) than MLU-morphemes, neither of the composite measures was adequate in identifying children with SLI. The best overall

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accuracy in classification was obtained using the three-variable model which combined MLU-morphemes with both the noun and verb composites (80%), $\Lambda$=.65, $\chi^2(3, N = 100) = 41.29$, p < .001.

Additional analyses were conducted using two subsets of children from the larger sample to see if higher discriminant accuracy results could be achieved. The first analysis included the 20 youngest children with SLI ($M_{age}$ = 6;8 years;months, age range: 5;5 – 7;4), who were slightly older than the oldest children in Bedore and Leonard's study. The second subgroup included the 20 children with the lowest MLU-morphemes ($M_{age}$ = 7;2 years;months, age range: 5;5 – 8;10). Each subgroup was compared to an equal number of age-matched NL peers. Results from the discriminant analysis of the youngest children showed that the verb composite provided 45% sensitivity and 62.5% overall accuracy, $\Lambda$ = .92, $\chi^2(1, N = 40) = 3.00$, p = .083 (Table 4). As a single variable, MLU-morphemes was the most sensitive measure (75%), $\Lambda$ = .59, $\chi^2(1, N = 40) = 19.74$, p < .001. The highest sensitivity, specificity and overall classification accuracies came from the combination of MLU-morphemes and the noun composite (82.5%), $\Lambda$ = .56, $\chi^2(2, N = 40) = 21.57$, p < .001, and also the combination of all three variables (82.5%), $\Lambda$ = .55, $\chi^2(3, N = 40) = 21.67$, p < .001. Results from the discriminant analysis of the lowest MLU-morphemes group showed that the verb composite was 45% sensitive and 65% accurate, $\Lambda$ = .93, $\chi^2(1, N = 40) = 2.90$, p = .089 (Table 5). As a single variable, MLU-morphemes was the most sensitive measure (100%), and provided the best overall classification accuracy, $\Lambda$ = .34, $\chi^2(1, N = 40) = 40.23$, p < .001. Adding the noun and/or verb composites resulted in the same classification accuracy (92.5%).

## Discussion

The current research was conducted to test Bedore and Leonard's (1998) suggestion that a verb morpheme composite may serve as a clinical marker of SLI in school-age children. Clinical markers of SLI are needed due to the poor identification accuracy of language impairments by standardized language tests (e.g., Spaulding, Plante, & Farinella, 2006). Results of the current study indicated that a measure of verb morphology alone resulted in low sensitivity and poor overall classification of school-age children with SLI and NL. Similar patterns of findings were noted for the sample as a whole and for the two subsets of children (youngest and lowest MLU-morphemes). For the entire set of participants, the three-variable model with verb composite, noun composite, and MLU-morphemes provided the best overall classification (80%). For the youngest subset, a two variable-model combining MLU-morphemes and the noun composite was equal in accuracy to the 3-variable model (82.5%). The second subset included children with the lowest MLU-morphemes and their age-matched peers. Not surprisingly, any variable that included MLU-morphemes, either alone or in combination with one or both of the grammatical composites, resulted in high classification accuracy (92.5%).

The results of the current study examining school-age children differed from those of Bedore and Leonard (1998), whose discriminant function analysis indicated that verb morphology demonstrated good accuracy in classifying preschool children with and without language impairment. Although the age range of the participants in the current study did overlap somewhat with the age range of the children in Bedore and Leonard's study, the differing results may be due to the developmental order of acquisition of the target grammatical morphemes. According to Brown's (1973) account of the acquisition of the first 14 English morphemes, the morphemes within the noun composite are acquired earlier than those within the verb composite. The children with SLI in Bedore and Leonard's (1998) study may have been at a developmental stage in which they had acquired more of the noun morphological markers than the verb morphemes. Therefore, their lower verb composite scores may have been due to a delay in their language development. By the time children with SLI are examined at the school-age level, they have acquired the verb morphemes, thereby decreasing the sensitivity of verb morphology to group differences. However, recall that children with SLI in this study did produce significantly more morphological errors than the children with NL, suggesting that morphology is a problematic area of language for school-age children with SLI, although this difficulty may not be specific to verb morphology. These results concur with prior investigations indicating that difficulty with grammatical morphology extends beyond the preschool years (Conti-Ramsden et al., 2001; Marchman et al., 1999, Redmond & Rice, 2001; Rice et al., 2009; Rice et al., 1998). The current findings suggest that English-speaking children with SLI have an extended period of omitting tense markers as compared with typically developing children, as proposed by Rice and colleagues' extended optional infinitive (EOI) account of SLI (Rice et al., 1995; Rice & Wexler, 1996; Rice et al., 1998; Rice et al., 1999).

The dissimilar results between Leonard and Bedore (1998) and the current research may also be due to differences in language sampling procedures. As described previously, the children in the current study were asked to discuss a topic of their choice within the broad domains of movies, sports, school, and so forth for a 15-minute period. This resulted in minimal examiner control over the content of the interactions. Bedore and Leonard (1998) collected the language samples used in their study during picture description activities designed to elicit the target morphemes and free-play with the examiner. Although only spontaneous talking was included, the language that was produced may have been influenced by the picture description activity that was occurring simultaneously. The children may have attempted to produce the target morphemes with a higher frequency than would have typically occurred. If this were the case, the children in the SLI group may have produced more errors as compared to their age-matched peers, resulting in lower composite scores and increased discriminant accuracy. Perhaps the children with SLI in the current study looked more similar to their age-matched peers because they did not have as many opportunities to produce errors, since they were not involved in a simultaneous activity that was eliciting the target morphemes. Some researchers argue that spontaneous, conversational language samples may not be the most useful context for eliciting impaired language because children will avoid forms that are difficult (e.g., Oetting & Horohov, 1997). However, there is some evidence to suggest that the difference in data collection methods did not influence the morphological composite scores. Rice and Wexler (1996) used picture description activities as well as spontaneous language samples to elicit the morphemes they were targeting and found no within group differences between conditions in terms of accuracy of morpheme use.

Another methodological difference between the current study and Bedore and Leonard (1998) was that they collected language samples over several sessions, resulting in total samples that were often hundreds of utterances in length for each child (range of 100-1,302 across both experiments). In contrast, the language samples in the current study consisted of one 15-minute interaction that yielded some transcripts consisting of fewer than 100 utterances. The length of language sample in the current study is more reflective of the type of sample that would be feasible to collect in clinical (rather than research) settings when attempting to assess language abilities. For example, Miller et al. (2005) suggest language samples containing 50 to 100 complete and intelligible utterances are sufficient in number to be used for diagnostic purposes. In terms of employing discriminant function analyses, it might be argued that the relatively shorter language samples used in the current study were offset to some extent by the considerably larger sample of children.

### Clinical Implications

Results indicated that the verb and noun composites were not clinically useful for classifying school-age children with and without language impairment, even though some children with SLI continue to have difficulty with grammatical morphology compared to NL peers. Although the SLI group was less accurate than the NL group on the verb and noun composites, the effect sizes were small (.12 and .21, respectively) and the accuracy rates were high. Rather than a time-consuming analysis based on a spontaneous language sample (which only assesses those grammatical morphemes the child attempts to produce), it is recommended that clinicians administer an assessment that specifically examines a broad range of grammatical morphemes using elicitation techniques such as the *Rice/Wexler Test of Early Grammatical Impairment* (TEGI; Rice & Wexler, 2001).

**Future directions—**Classification accuracy between children with and without SLI may be improved by examining later-developing grammatical morphemes (e.g., the past perfect *have+be*, "He has been eating"; Leonard et al., 1999), and grammatical morphemes within complex grammatical frames (e.g., tense matching across increasing distances) given evidence that children with SLI may have outgrown their earlier period of EOI in simple declarative clauses, yet they continue to demonstrate difficulty with verb finiteness marking and judgment within specific clause constructions (Rice, Hoffman & Wexler, 2009). Rice et al. (2009) suggested that grammatical judgments of the type utilized in their study (i.e., complementizer phrase projection) have potential value as clinical makers for school-age children and adolescents with SLI. More research is needed to clearly identify these more advanced grammatical markers and the appropriate assessment contexts.

Future research in this area should also include utilizing more demanding language sampling techniques. Activities requiring higher processing demands, such as speeded or elicited tasks, may result in greater group differences between children with SLI and their peers. Language samples requiring children to summarize new, complex content in narrative or expository form may further separate children with SLI from their NL peers (Scott & Windsor, 2000). The utilization of written language samples may also increase classification accuracy. Scott and Windsor (2000) found that a higher grammatical error rate in spoken language samples distinguished school-age children with language learning disabilities from their chronological age-matched peers; however, in written language samples, children with language learning disabilities produced higher grammatical error rates than both language- and chronological age-matched comparison groups. The authors suggest that omission of obligatory past tense *-ed* in written language samples may be a clinical marker of SLI in school age children.

Research by Nippold and colleagues (Nippold 2009, 2010; Nippold, Mansfield, Billow, & Tomblin, 2008) examining syntactic development in older children and adults has found that the use of subordinate clauses increases with age, particularly during expository discourse. In the present study, MLU-morphemes may have been a more sensitive indicator of language impairment than the grammatical composites because it is an index of complex syntax, an aspect of language that is actively developing in school-age children, and challenging at this age for children with language impairments. The utility of measuring subordinate clause use as a clinical marker of children with school-age SLI is warranted.

In conclusion, we did not find that verb morphology alone served as a useful clinical marker of SLI in school-age children. Rather, MLU-morphemes was the best single classification variable, (although it did not reach acceptable levels of classification). However, combining measures of morphological use with a measure of MLU-morphemes enhanced the discriminant accuracy and overall classification of the school-age children in this study.

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## Appendix A

## Examples of Obligatory Contexts and Errors of Verb and Noun Morphological Markers

| |
|---|
| Verb morphology |
| Jasmine was the princess and Aladdin *wanted* to marry her.[a, c] |
| Jasmine was the princess and Aladdin *want* to marry her.[b] |
| My aunt *lives* in town.[a, d] |
| My aunt *live* in town.[b] |
| Noun morphology |
| I saw *an* elephant at the zoo.[a] |
| I saw *a* elephant at the zoo.[b] |
| He went to his *friend's* house.[a] |
| He went to his *friend* house.[b] |

[a]The morphological marker is obligatory in this context.

[b]Production of the morphological marker is in error.

[c]Past tense had been established within the context of the narrative.

[d]Present tense had been established within the context of the narrative.

## Appendix B

## Computation of the Finite Verb and Noun Morphology Composites

An example of how the finite verb and noun morphology composites were calculated is demonstrated below. The utterances were excerpted from a language sample of a child with SLI who was describing the television show ALF.

1. It/'s about an alien. (copula produced, article produced)
2. He/'s the dad. (copula produced, article produced)
3. And Kate, that/*'s the mom. (copula omitted, article produced)
4. And then that/*'s the daughter. (copula omitted, article produced)
5. I can/'t remember (um) *the little boy/*z name. (article omitted, possessive omitted)
6. Alf get/3s in trouble. (regular third person singular produced)
7. He try/ed to eat the cat. (regular past tense produced, article produced)
8. He call/3s his planet Melmac. (regular third person singular produced)

9. And he always eat/3s cat/s. (regular third person singular produced, plural produced)
10. It is the boy/z cat. (copula produced, article produced, possessive produced)
11. And he *is try/ing to eat it. (auxiliary omitted)

Finite verb composite: Out of 10 obligatory contexts, 7 morphemes were produced correctly, resulting in a score of 70%.

Noun composite: Out of 10 obligatory contexts, 8 morphemes were produced correctly, resulting in a score of 80%.

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**Table 1**

**Means (and Standard Deviations) of the Participants' Age and Scores on Standardized Tests of Language and Cognition**

| Variable | Group | |
|---|---|---|
| | SLI[a] (N=50) | NL[b] (N=50) |
| CA[c] | 93.62 (12.51) | 92.96 (12.15) |
| PPVT-R[d] | 94.56* (10.94) | 117.85 (17.07) |
| TACL-R[e] | 41.00* (7.93) | 52.85 (8.17) |
| CMMS[f] | 103.50* (9.81) | 113.38 (11.16) |

[a]Specific language impairment

[b]Normal language

[c]Chronological age in months

[d]Standard scores on the Peabody Picture Vocabulary Test-Revised

[e]Standard scores on the Test for the Auditory Comprehension of Language-Revised

[f]Age deviation scores (standard scores) on the Columbia Mental Maturity Scale

*$p<.001$

**Table 2**

**Means (and Standard Deviations) of the Participants' Percent Accurate Production on the Verb and Noun Morphological Composites and MLU-morphemes**

| Variable | SLI | NL |
|---|---|---|
| Verb Composite | 93.56 * (6.35) | 97.76 (3.98) |
| Noun Composite | 96.30 * (3.19) | 98.92 (1.32) |
| MLU-morphemes | 7.19 * (2.24) | 9.32 (1.94) |

* $p<.001$

**Table 3**

**Percentages and Total Number of Children in the SLI and NL Groups (N=100) Correctly Classified in the Discriminant Analysis and Cross Validation Procedures**

| | SLI (n=50) | NL (n=50) | Overall (N=100) |
|---|---|---|---|
| Noun+Verb+MLU-morphemes | 72 (36/50) | 88 (44/50) | 80 (80/100) |
| Noun+MLU-morphemes | 72 (36/50) | 84 (42/50) | 78 (78/100) |
| Verb+MLU-morphemes | 74 (37/50) | 84 (42/50) | 79 (79/100) |
| Noun+Verb | 62 (31/50) | 86 (43/50) | 74 (74/100) |
| Noun | 54 (27/50) | 86 (43/50) | 70 (70/100) |
| Verb | 50 (25/50) | 86 (43/50) | 68 (68/100) |
| MLU-morphemes | 72 (36/50) | 80 (40/50) | 76 (76/100) |

**Table 4**

**Percentages and Total Number of the 20 Youngest Children in the SLI Group and Their Age-matched NL Peers Correctly Classified in the Discriminant Analysis and Cross Validation Procedures**

| | SLI (n=20) | NL (n=20) | Overall (N=40) |
|---|---|---|---|
| Noun+Verb+MLU-morphemes | 80 (16/20) | 85 (17/20) | 82.5 (33/40) |
| Noun+MLU-morphemes | 80 (16/20) | 85 (17/20) | 82.5 (33/40) |
| Verb+MLU-morphemes | 80 (16/20) | 80 (16/20) | 80 (32/40) |
| Noun+Verb | 65 (13/20) | 75 (15/20) | 70 (28/40) |
| Noun | 55 (11/20) | 75 (15/20) | 65 (26/40) |
| Verb | 45 (9/20) | 80 (16/20) | 62.5 (25/40) |
| MLU-morphemes | 75 (15/20) | 85 (17/20) | 80 (32/40) |

**Table 5**

**Percentages and Total Number of the 20 Lowest-MLU Children in the SLI Group and Their Age-matched NL Peers Correctly Classified in the Discriminant Analysis and Cross Validation Procedures**

| | SLI (n=20) | NL (n=20) | Overall (N=40) |
|---|---|---|---|
| Noun+Verb+MLU-morphemes | 100 (20/20) | 85 (17/20) | 92.5 (37/40) |
| Noun+MLU-morphemes | 100 (20/20) | 85 (17/20) | 92.5 (37/40) |
| Verb+MLU-morphemes | 100 (20/20) | 85 (17/20) | 92.5 (37/40) |
| Noun+Verb | 65 (13/20) | 85 (17/20) | 75 (30/40) |
| Noun | 50 (10/20) | 85 (17/20) | 67.5 (27/40) |
| Verb | 45 (9/20) | 85 (17/20) | 65 (26/40) |
| MLU-morphemes | 100 (20/20) | 85 (17/20) | 92.5 (37/40) |