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

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**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 [years;months]) and 50 age-matched typically developing peers ($M_{age}$ = 7;9) were analyzed. Following the Bedore and Leonard (1998) procedure, 3 variables were measured: a finite verb morpheme composite, a noun morpheme composite, and mean length of utterance in morphemes ($MLU_m$).
**Results:** Overall findings indicated that neither grammatical morpheme composite alone adequately discriminated the groups at this developmental level. However, combining the verb and noun grammatical morpheme composite measures with $MLU_m$ resulted in good discriminant accuracy in classifying subgroups of the youngest children with and without SLI in the school-age sample.
**Conclusion:** Verb morphology alone is not a useful clinical marker of SLI in school-age children. Potential explanations for these findings and ideas for future research are discussed.

**Key Words:** specific language impairment, language disorders, school-age, clinical marker, grammatical morphology

During the last decade, researchers of 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 that raises questions about the ability of traditional norm-referenced language assessments to identify children with SLI and classify children with and without language impairment (e.g., Dunn, Flax, Sliwinski, & Aram, 1996; Plante & Vance, 1994; Spaulding, Plante, & Farinella, 2006). For example, Plante and 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%) in classifying children into their respective language groups. Dunn, Flax, Sliwinski, and Aram (1996) noted that using data from spontaneous language samples (including percentage 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 1-*SD* 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%). The average mean group difference between children with language impairment and those with typically developing (TD) language on these tests was –1.34 *SD*s, indicating that a large percentage of children (43%) who were described as language impaired in the manuals scored within 1 *SD* of the normative mean. On nine of the 43 tests, *most* children with language impairment earned scores within 1 *SD* of the mean. Given these

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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, deficits in 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 TD 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 5-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 deficits in 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) 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 proposed the extended optional infinitive account of SLI (Rice & Wexler, 1996; Rice, Wexler & Cleave, 1995; Rice, Wexler, & Redmond, 1999). TD children generally master the use of grammatical morphemes around the age of 5 years (Rice & Wexler, 1996). Before 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 TD 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 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 are necessary for continued progress in this line of research (Bishop, 2002; Bishop & Hayiou-Thomas, 2008). Bishop and colleagues 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 6-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 4 years of age. Specifically, if parents reported concerns about their child's language development or 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 being at risk for language impairment.

In the Bishop (2005) study, 6-year-old children completed two subtests from a prepublication version of the Rice/Wexler Test of Early Grammatical Impairment (TEGI; Rice & Wexler, 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), which is 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 advised that these findings 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 6-year-old twins. In ~10% of the twin pairs, one or both children were considered to be at risk for language impairment. Children were identified as being at risk for language impairment at 4 years of age via parent report using the same indices as Bishop (2005). At age 6, 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 (Bishop et al., 2006) concluded that deficits in both verb tense marking and PSTM were heritable and were good markers of heritable language impairment. Interestingly, they also found no evidence of a genetic link between deficits in PSTM 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 nonfamilial (i.e., environmental) causes. Furthermore, Falcaro et al. 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, and Wexler, 2009).

In sum, previous linguistic research has indicated that verb tense markings are particularly impaired in children with SLI. In addition, genetic research on children with 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 TD peers. Their first experiment included 19 children with SLI, ages 3;7 (years; months) to 5;9, and 19 TD age-matched peers. The children with SLI scored at least 1 *SD* below the mean on a general test of language ability and scored in the normal range on tests of nonverbal cognition. In addition, they exhibited normal hearing, oral motor functioning, and socioemotional development, and accurately produced the phonemes that were included in the target grammatical morphemes.

In the study, Bedore and Leonard (1998) analyzed children's spontaneous language samples that had been 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: (a) a finite verb morphology composite, (b) a noun morphology composite, and (c) mean length of utterance in morphemes ($MLU_m$). 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), TD 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 was then divided by the total number of obligatory contexts and multiplied by 100 to obtain percentages of correct usage for the verb and noun composites.

The children in Bedore and Leonard's (1998) study 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 TD 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 TD peers, Bedore and Leonard (1998) applied the discriminant criterion generated from the first analysis to a second group of children. This smaller group consisted of six children with SLI and six TD age-matched

peers to the children in the first experiment. 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 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.

# METHOD

## Participants

Study participants included 50 school-age children with SLI (24 female, 26 male, $M_{age}$ = 7;9, age range: 5;5–9;8) and 50 age-matched TD peers (26 female, 24 male, $M_{age}$ = 7;9, 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, socioemotional 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 American Speech-Language-Hearing Association [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 TD 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.

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 (> –1 *SD*) on nonverbal cognition. The mean scores between the TD 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 (SLPs) 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 &

**Table 1.** Means and standard deviations of the study participants' age and their scores on standardized tests of language and cognition.

| | Group | | | |
|---|---|---|---|---|
| | *SLI (*N = *50)* | | *TD (*N = *50)* | |
| *Variable* | M | SD | M | SD |
| Chronological age (in months) | 93.62 | 12.51 | 92.96 | 12.15 |
| PPVT–R | 94.56* | 10.94 | 117.85 | 17.07 |
| TACL–R | 41.00* | 7.93 | 52.85 | 8.17 |
| CMMS | 103.50* | 9.81 | 113.38 | 11.16 |

***Note.*** SLI = specific language impairment, TD = typically developing, PPVT–R = Peabody Picture Vocabulary Test—Revised (Dunn & Dunn, 1981) standard scores, TACL–R = Test for the Auditory Comprehension of Language—Revised (Carrow-Woolfolk, 1985) standard scores, and CMMS = Columbia Mental Maturity Scale (Burgemeister, Blum, & Lorge, 1972) standard scores.

*$p < .001$.

Hesketh, 1996, 1998). The 15-min 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 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 (TD group mean = 4.14; SLI group mean = 4.04). Across groups, a higher percentage of language samples from TD children included some expository content than those 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 that 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) software and the SALT Profiler Reference Database (Miller & Chapman, 1993). Using SALT transcription conventions (Leadholm & Miller, 1992) and SALT software, 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 such as overregularizations (e.g., *breaked*). 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 finite verb morpheme composite, the noun morpheme composite, and $MLU_m$.

## 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 verb and noun grammatical morpheme composites was assessed using 10% of the total sample (5 children with SLI and 5 TD children). 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 instances ($M_{noun}$ = 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 TD groups on the grammatical morpheme composites and $MLU_m$. Note the high level of proficiency for children in both groups on their grammatical morpheme composite scores. Before completing the discriminant analysis, one-way analyses of variance (ANOVAs) were conducted to confirm that the SLI and TD 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 the children with SLI were significantly lower than those for the TD 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 $MLU_m$, $F(1, 98) = 26.04$, $p < .001$ $\eta_p^2 = .21$.

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

**Table 2.** Means and standard deviations of the study participants' percentage of accurate production on the verb and noun morphological composites and mean length of utterances in morphemes ($MLU_m$).

| | *SLI* | | *TD* | |
|---|---|---|---|---|
| *Variable* | M | SD | M | SD |
| Verb composite | 93.56* | 6.35 | 97.76 | 3.98 |
| Noun composite | 96.30* | 3.19 | 98.92 | 1.32 |
| $MLU_m$ | 7.19* | 2.24 | 9.32 | 1.94 |

*$p < .001$.

the TD 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 TD 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 TD and SLI groups, respectively).

Discriminant analysis and cross-validation procedures (SPSS, 2009) were used to determine how well the grammatical morpheme composites and MLU-m discriminated between children with SLI and TD children (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%; Plante & Vance, 1994) for children at this developmental level. In terms of single classification variables, $MLU_m$ resulted in the highest overall classification accuracy, with 76% of the children correctly identified as either SLI or TD, $\Lambda = .79$, $\chi^2(1, N = 100) = 22.98$, $p < .001$. 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 TD children) than $MLU_m$, neither of the composite measures was adequate in identifying children with SLI. The best overall accuracy in classification was obtained using the three-variable model that combined $MLU_m$ with both the verb and noun 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, age range: 5;5–7;4), who were slightly older than the oldest children in Bedore and Leonard's (1998) study. The second subgroup included the 20 children with the lowest $MLU_m$ ($M_{age}$ = 7;2, age range: 5;5–8;10). Each subgroup was compared to an equal number of age-matched TD 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, $MLU_m$ 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 $MLU_m$ 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 $MLU_m$ 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, $MLU_m$ was the most sensitive measure (100%) and provided the best overall classification accuracy (92.5%), $\Lambda = .34$, $\chi^2(1, N = 40) = 40.23$, $p < .001$. Adding the noun and/or verb composite 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 impairment 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

**Table 3.** Percentages and total number of children in the SLI and TD groups ($N$ = 100) who were correctly classified in the discriminant analysis and cross-validation procedures.

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

**Table 4.** Percentages and total number of the 20 youngest children in the SLI group and their age-matched TD peers who were correctly classified in the discriminant analysis and cross-validation procedures.

| | *SLI* (n = *20*) | *TD* (n = *20*) | *Overall* (N = *40*) |
|---|---|---|---|
| Noun+Verb+$MLU_m$ | 80% (16) | 85% (17) | 82.5% (33) |
| Noun+$MLU_m$ | 80% (16) | 85% (17) | 82.5% (33) |
| Verb+$MLU_m$ | 80% (16) | 80% (16) | 80% (32) |
| Noun+Verb | 65% (13) | 75% (15) | 70% (28) |
| Noun | 55% (11) | 75% (15) | 65% (26) |
| Verb | 45% (9) | 80% (16) | 62.5% (25) |
| $MLU_m$ | 75% (15) | 85% (17) | 80% (32) |

**Table 5.** Percentages and total number of the 20 children with the lowest MLU in the SLI group and their age-matched TD peers who were correctly classified in the discriminant analysis and cross-validation procedures.

| | *SLI (n = 20)* | *TD (n = 20)* | *Overall (N = 40)* |
|---|---|---|---|
| Noun+Verb+$MLU_m$ | 100% (20) | 85% (17) | 92.5% (37) |
| Noun+$MLU_m$ | 100% (20) | 85% (17) | 92.5% (37) |
| Verb+$MLU_m$ | 100% (20) | 85% (17) | 92.5% (37) |
| Noun+Verb | 65% (13) | 85% (17) | 75% (30) |
| Noun | 50% (10) | 85% (17) | 67.5% (27) |
| Verb | 45% (9) | 85% (17) | 65% (26) |
| $MLU_m$ | 100% (20) | 85% (17) | 92.5% (37) |

and TD children. Similar patterns of findings were noted for the sample as a whole and for the two subsets of children (youngest and lowest $MLU_m$). For the entire set of participants, the three-variable model with verb composite, noun composite, and $MLU_m$ provided the best overall classification accuracy (80%). For the youngest subset, a two-variable model combining $MLU_m$ and the noun composite was equal in accuracy to the three-variable model (82.5%). The second subset included children with the lowest $MLU_m$ and their age-matched peers. Not surprisingly, any variable that included $MLU_m$, 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 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 TD children, 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 TD children, as proposed by Rice and colleagues' extended optional infinitive account of SLI (Rice et al., 1995; Rice & Wexler, 1996; Rice et al., 1998; Rice et al., 1999).

The dissimilar results between Bedore and Leonard (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-min period. This resulted in minimal examiner control over the content of the interactions. Bedore and Leonard 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 did not have as many opportunities to produce errors because they were not involved in a simultaneous activity that was eliciting the target morphemes. As a result, they may have looked more similar to their age-matched peers. 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-min 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) suggested that language samples containing 50–100 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 TD peers. Although the SLI group was less accurate than the TD group on the verb and noun composites, the effect sizes were relatively 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 TEGI.

## 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 extended optional infinitive 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 used in their study (i.e., complementizer phrase projection) have potential value as clinical markers 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 using more demanding language sampling techniques. Language samples requiring children to summarize new, complex content in narrative or expository form may help to separate children with SLI from their TD peers (Scott & Windsor, 2000). Activities requiring higher processing demands, such as speeded or elicited tasks, may also result in greater group differences between children with SLI and their TD peers. Tasks could include describing pictures, retelling complex stories, or producing expository discourse with time pressures imposed. For example, students could be asked to describe the rules of a game or to discuss the various viewpoints surrounding a controversial issue in 5 min or less. The higher complexity of the tasks with the additional time pressures may reveal language deficits that would not be evident in typical conversational language samples. Elicitation procedures could be used to elicit low-frequency grammatical forms or constructions. For example, sentence completion tasks can be used to elicit infinitival complements (Eisenberg, 2005). 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. Scott and Windsor 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 found that the use of subordinate clauses increases with age, particularly during expository discourse. In the present study, $MLU_m$ may have been a more sensitive indicator of language impairment than the grammatical composites because it is an index of complex syntax, which is an aspect of language that is actively developing in school-age children and is challenging at this age for children with language impairment. 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, $MLU_m$ 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 $MLU_m$ 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 temporal context of the narrative. [d]Present tense had been established within the temporal 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 specific language impairment 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, seven morphemes were produced correctly, resulting in a score of 70%.

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