Evaluating the Morphological Competence of Children With Severe Speech and Physical Impairments

Sean M. Redmond
Department of Communication Disorders
University of Utah
Salt Lake City

Susan S. Johnston
Department of Special Education
University of Utah
Salt Lake City

Reports present mixed findings on the extent to which the development of receptive language skills in children with severe speech and physical impairments (SSPI) is compromised by their difficulty with speaking (V. W. Berninger & B. M. Gans, 1986; D. V. M. Bishop, B. Byers Brown, & J. Robson, 1990; O. Udwin & W. Yule, 1990). In this study, grammaticality judgments were used to measure the sensitivity of 4 school-age children with SSPI to different morphological errors. These errors included violations of agreement between the subject and auxiliary verbs (e.g., *she are falling*), the marking of aspect (e.g., *she is play the horn*), and the marking of past tense on regular and irregular verbs (e.g., *he jump, he fall, he falled*). Performance of the participants with SSPI was compared to groups of typically developing children and adults. Results indicated that children in the SSPI and control groups made similar judgments. All groups showed high levels of sensitivity to agreement violations, aspect-marking errors, and tense-marking errors involving irregular verbs. Participants with SSPI had greater difficulty detecting tense-marking errors involving regular verbs. Implications for improving clinical assessments within this population are discussed.

KEY WORDS: augmentative / alternative communication, severe speech and physical impairments, grammatical morphology, grammaticality judgments, children's language impairments

The development of language in some children is complicated by the presence of severe speech and physical impairments (SSPI). Children with SSPI form a heterogeneous collection of individuals with respect to neurological etiology, severity of concomitant cognitive and perceptual impairments, and the quality and quantity of conversational interaction. The situation is complicated further by the fact that individuals with SSPI vary considerably in their exposure to different alternative/augmentative communication (AAC) systems. The only characteristic that children with SSPI seem to share is a significant motor impairment that results in either severe dysarthria or anarthria.

Given the amount of heterogeneity in this population, it is not surprising that reports present mixed findings on the extent to which the development of linguistic competence in children with SSPI is compromised (see Bishop, 1988; Paul, 1998; Sutton, 1999 for reviews). A few case studies report on individuals who have developed age-appropriate

1092-4388/01/4406-1362

levels of language and literacy skills (e.g., Fourcin, 1975; Stromswald, 1994), suggesting that receptive language impairment is not an inevitable consequence of severe dysarthria or anarthria. Other studies, however, suggest that as a group, children with SSPI tend to perform significantly worse than expected for their age across various receptive language tasks (Berninger & Gans, 1986; Sandberg & Hjelmquist, 1997; Udwin & Yule, 1990). Since many children with SSPI also have concomitant cognitive impairments, investigators have examined the linguistic performance of children with SSPI relative to other children with similar levels of handicap. Bishop, Byers Brown, and Robson (1990) compared the performances of 24 school-aged children with cerebral palsy and anarthria/severe dysarthria to 24 controls with cerebral palsy and normal speech on measures of receptive vocabulary, receptive grammar, and phoneme discrimination. Groups were matched on nonverbal performance (75% of the participants scored below the 5th percentile). Results indicated that the children with anarthria/severe dysarthria performed significantly worse than the control group on measures of phoneme discrimination and receptive vocabulary, whereas the receptive grammatical measure did not differentiate the groups. Group averages on the receptive grammar measure were well below age level in both groups. Yet, variation within groups was also large, and some participants in each group performed within one standard deviation. Based on their evidence, Bishop et al. concluded that "physical difficulty in speaking is associated with a distinctive pattern of receptive language function, in which vocabulary acquisition is impaired but grammatical competence is no worse than that of similarly handicapped people with normal speech" (Bishop et al., 1990, p. 33).

Other investigators, however, have found specific grammatical limitations in individuals with SSPI that may represent unique consequences of their physical difficulty with speaking. Blockberger (1997) used picture selection, grammaticality judgment, and writing tasks to examine the development of grammatical morphemes in school-age children with SSPI. Knowledge of the obligatory nature of regular past tense *-ed* (e.g., *Ben walked*), third person singular present tense *-s* (e.g., *Ben walks*), and possessive *-s* (e.g., *Ben's shoe*) was assessed. Twenty children with SSPI were compared to two groups of control children matched to the SSPI group on the basis of vocabulary test scores. The first control group consisted of 20 typically developing children, and the second group consisted of 15 children with language delays representing various developmental conditions (e.g., learning disability, ADHD, PDD). Information regarding the participants' nonverbal status was not provided. Results indicated that children in the SSPI group performed near chance (~50%) on all three tasks and significantly more poorly than their vocabulary-matched peers.

Sutton and Gallagher (1993) asked two adults with SSPI who communicated through picture-based AAC systems to generate past tense forms for regular and irregular verb stems. Both participants presented with considerable delays in several language areas as measured by standardized tests. One participant's nonverbal intelligence quotient was within normal limits, and the other's was measured at two standard deviations below the mean. There was no distinction between regular and irregular past tense verbs on the AAC systems used by each participant. A coding system devised for the study allowed the participants to produce distinct past tense forms for different verb stems that represented an "affixed past" (e.g., *help* ≡ *helped*) or a "separate past" (e.g., *come* ≡ *came*) modification of the stem. Frequent regular and irregular verbs were presented, as well as nonsense verbs. Results indicated that, after training, both participants relied heavily on the "separate past" strategy to generate past tense forms, regardless of verb type. Differences between verb types could not be explained in terms of the motor complexity associated with the two tense-marking strategies because similar responses were used.

In contrast to the conclusions drawn by Bishop et al. (1990), the results of Blockberger (1997) and Sutton and Gallagher (1993) suggest that children with SSPI might be at risk for problems with some aspects of receptive grammar. Specifically, knowledge about the obligatory nature of inflectional morphology appears to be vulnerable in individuals acquiring language through AAC systems. The deficits observed in the participants with SSPI were not sufficiently explained by the presence of vocabulary, cognitive, or motor limitations. Instead, other variables, such as the nature of the specific AAC system used by the participants, may have contributed to these limitations.

Morphological Representation in AAC Symbol Systems

The symbol systems used by AAC devices vary widely in the extent to which they allow users to modulate meaning through morphological affixation. On one end of the continuum, morphological mechanisms are completely unavailable to the user. These systems are typically developed for the purpose of enhancing communication efficiency. With this in mind, symbols that include the main semantic elements of the intended message are going to be favored over grammatical forms that are predictable from the context and contain relatively limited semantic information. Examples include systems that use Picture Communication Symbols (PCS;

Johnson, 1981). When these symbol systems are used with voice output communication aids, the user can select symbols in a telegraphic manner that allows access to more morphologically complete utterances. For example, a user may select the symbols “bus” and “work” to access the preprogrammed message “I rode the bus to work today.” Advantages offered by these kinds of systems are that they require low cognitive and physical response effort from the user and allow the user to generate a wide range of messages via a limited number of symbol selections.

On the other end of the continuum, some AAC systems provide access to the full range of morphological markers and provide the user with an input/output match that is more homologous to spoken English (Lloyd & Karlan, 1984). Examples include AAC systems that use traditional orthography as a symbol system. When these systems are incorporated into AAC devices, users can choose whether or not to include morphological markers as they generate novel utterances.

Many symbol systems used by AAC devices fall in between these two extremes and combine various aspects of iconic representation and morphological affixation in different ways (e.g. Blissymbols: Bliss, 1965; Minspeak: Baker, 1986). For example, an AAC device using Minspeak symbols might use the icons ELEPHANT + TOMBSTONE + VERB to input the past tense verb “pushed” into the speech output. In this sequence of icons ELEPHANT represents the idea of moving large objects, TOMBSTONE represents the idea of occurring in the past and VERB encodes the part of speech.

Blockberger (1997) and Sutton and Gallagher (1993) hypothesized that the morphological limitations they observed resulted from the encoding limitations of the AAC devices their participants used. The symbol systems displayed on the AAC devices of some of their participants did not allow their users to encode grammatical features such as tense, number, or case through affixation but rather relied on telegraphic symbol systems that corresponded with the semantic content of their messages. A history of producing telegraphic messages in this manner may have contributed to limitations in the underlying linguistic representation of grammatical morphology. It is unclear, however, whether the morphological limitations associated with SSPI represent a problem with the general mechanics of affixation or are restricted to particular grammatical morphemes. Some grammatical morphemes may be more vulnerable to disruption than others. A related issue is the extent to which individuals with SSPI would demonstrate difficulty with other aspects of morphological knowledge—for example, understanding the contexts in which grammatical affixes are not allowed (e.g., *he falled off the chair*).

Using Grammaticality Judgments to Evaluate Morphological Competence

Grammaticality judgment tasks, in which participants are asked to evaluate the grammatical well-formedness of stimuli sentences, represent the empirical basis of modern linguistic inquiry (Schütze, 1996). As a methodology for assessing children’s understanding of morphophonemic and morphosyntactic restrictions, grammaticality judgments also offer many advantages over other evaluation procedures. Comprehension tasks, in which the participant is asked to point to the picture that best corresponds to the target sentence, are not adequate for evaluating morphological knowledge, because assessments using this procedure inevitably focus on the semantic elements of the sentence. For example, when a child is told to “show me, *he fell off the chair*,” a picture representing a person falling is contrasted with a picture of a person who has already fallen. This procedure does not allow for an assessment of morphological intuitions, because the same picture would be indicated for “*he falled off the chair*.”

With increasing regularity, the judgment paradigm has been used to examine linguistic competence in a variety of clinical populations, including individuals with aphasia and specific language impairment (SLI) (Baum, 1997; Linebarger, Schwartz, & Saffran, 1983; Montgomery & Leonard, 1998; Smith-Lock, 1995; van der Lely & Ullman, 1996; Redmond & Rice, 2001; Rice, Wexler, & Redmond, 1999). A common concern with using grammaticality judgment data to assess individuals with communication disorders is that results probably reflect the integrity of their metalinguistic skills rather than their underlying linguistic competence (e.g., Kahmi & Koenig, 1985). Recent studies of children with SLI, however, have challenged this perspective and suggest instead that a very high level of correspondence between judgments and elicited productions can be expected. That is, these children have been shown to be more likely to accept errors they produce and reject errors they do not produce (Montgomery & Leonard, 1998; Rice et al., 1999; Smith-Lock, 1995; van der Lely & Ullman, 1996).

The judgment paradigm represents a particularly attractive option for the assessment of linguistic competence in children with significant motor limitations. The main task demand is the ability to indicate a differentiating response, a “yes” and a “no,” which could be accomplished nonverbally through the selection of a symbol, the nod of a head, or the blink of an eyelid. One limitation in the use of grammaticality judgments and other receptive language tasks, however, is that error responses from individuals with SSPI could result from deficits in underlying knowledge or could be from motor fatigue, impulsiveness, or imprecision. The application of signal detection theory, that is, comparing rates of "hits," "misses," "correct rejections," and "false alarms" to grammaticality judgments, addresses this issue and further enhances the interpretability of data collected on individuals with SSPI. The nonparametric statistic A′, for example, can differentiate errors due to motor limitations from limitations in knowledge because it compares the relative rates of "hits" to "false alarms" and can identify sensitivity in the presence of response bias or inconsistent responding (cf. Linebarger et al., 1983). That is, perfect performance across all test items is not required to achieve perfect levels of discrimination between grammatical and ungrammatical sentences. Obtained A′ values can be interpreted as essentially analogous to the proportion correct if participants were asked which sentence they preferred (Grier, 1971). An A′ of .50, for example, indicates an indiscriminate preference for both grammatical and ungrammatical sentences. Similarly, A′ values close to 1.00 indicate a strong preference for grammatical sentences, and values below .50 indicate a preference for ungrammatical sentences.

In this study, we present additional information on the representation of grammatical morphemes in children with SSPI by evaluating the representation of aspect, agreement, and tense marking in 4 school-aged children with anarthria who use AAC systems to communicate. Specifically, we examined four areas of morphological knowledge: the obligatory nature of aspectual marking (*he is jumping* vs. *he is jump*), the restriction that auxiliary verbs must agree with their subjects (*he is jumping* vs. *he are jumping*), the obligatory nature of past tense marking on regular and irregular verbs (*he jumped/fell* vs. *he jump/fall*), and the restriction that the regular affix *-ed* cannot be used with irregular verbs (*he fell* vs. *he falled*). Grammaticality judgments were collected from children both with and without SSPI, and measures from signal detection theory were used to control for error responses due to motor limitations such as fatigue, impulsiveness, or distractibility.

Specific Questions and Predicted Outcomes

The specific research questions addressed in this study were: (1) What developmental trends are associated with the detection of aspectual, agreement, and tense-marking errors in typically developing individuals? (2) Do children with SSPI possess the requisite metalinguistic skills needed to reliably identify grammatical errors associated with verbal morphology? (3) Are some morphological errors easier for children with SSPI to detect? (4) Do children with SSPI have more difficulty detecting morphological errors than do typically developing children of equivalent vocabulary levels?

The first question represents an examination of differences across groups of typically developing children and adults in their intuitions about aspect, agreement, and tense marking. Developmental trends observed across these groups set up the interpretive context for the investigation of grammaticality judgments in children with SSPI and also establish the integrity of the protocol across different developmental levels.

The second question represents an examination of the overall accuracy of the participants with SSPI in terms of "hits" and "false alarm" rates. If children with SSPI lacked the necessary metalinguistic skills to perform these judgments, we would expect an equal amount of random responses or "guessing" across the different sentence types. Obtained A′ values across the different grammatical/ungrammatical contrasts would then be close to .50.

Predictions for the third question were based on hypotheses generated by Blockberger (1997) and Sutton and Gallagher (1993). According to these investigators, the development of grammatical morphology in individuals with SSPI is compromised because these forms are acquired through lexical/iconic means rather than through representational rules of affixation. If this is the case, we would expect children with SSPI to have limitations detecting most of the verbal forms examined, including omissions of aspectual *-ing*, incorrect subject-verb agreement (e.g., *she are walking*), and omissions of *-ed* on regular verbs. On the other hand, tense-marking errors involving irregular verbs would be easier because these forms are retrieved from memory and processed lexically (cf. Pinker, 1999).

The fourth question considers the performance of the participants with SSPI relative to expectations based on their vocabulary achievement. If children with SSPI make more morphological errors than their vocabulary-matched peers, this would indicate a limitation in grammatical morphology that exceeds their general language levels.

Method

Participants

Four groups participated in this study: a group of four 11- to 15-year-old anarthric children with SSPI (age range: 134–189 months), a group of eleven 4- to 6-year-old typically developing children (age range: 50–78 months, *M* = 64 months—hereafter referred to as the Young TD group), a group of thirteen 7- to 10-year-old typically developing children (age range: 81–130 months, *M* = 101 months—hereafter referred to as the Old TD group), and a group of 21 typically developing adults.

The inclusionary criteria for entry into the SSPI group were (a) a spoken vocabulary of fewer than 5 word approximations; (b) use of an AAC system as a primary mode of communication; (c) an established discriminative response to indicate "yes" and "no," as indicated by a passing performance (9/10) on a truth-value judgment task where participants judged the veracity of sentences such as "*here are three spoons*"; (d) a primary diagnosis of cerebral palsy or other neuromotor disorder; (e) normal hearing and corrected to normal visual acuity, as indicated by clinical case reports; (f) a passing performance (9/10 correct) on an auditory detection probe of the presence/absence of word final -*t* and -*d* sounds (e.g., *bow* vs. *boat*); and (g) monolingual English status. Measures of receptive vocabulary and nonverbal achievement were collected on the participants with SSPI for comparative purposes, but performances on these measures were not used as either inclusionary or exclusionary criteria for the study. Table 1 displays the characteristics of participants in the SSPI group and shows the wide range in etiologies, response modalities, cognitive skills, semantic skills, and AAC device use that is associated with this population. The continuum of morphological affixation options is represented in the different symbol systems our participants used.

To be included in the Young TD and Old TD control groups, participants needed to (a) score within normal limits (within –1 *SD*) on a measure of receptive vocabulary, as measured by the Peabody Picture Vocabulary Test–3 (PPVT-III; Dunn & Dunn, 1997); (b) score within normal limits (within –1 *SD*) on a measure of nonverbal achievement—either the Columbia Mental Maturity Scale (CMMS; Burgemeister, Blum, & Lorge, 1972) or the Comprehensive Test of Nonverbal Intelligence (CTONI; Hammill, Pearson, & Wiederholt, 1996); (c) have a negative history of speech/language delay, learning disability, or ADD/ADHD, as indicated by parental report; (d) have normal hearing as measured by an audiometric screening at 500, 1000, 2000, and 4000 Hz at 25 dB and corrected to normal visual acuity; and (e) monolingual English status. Group means on the vocabulary and nonverbal measures for the Young TD and Old TD control groups were as follows: Young TD PPVT-III standard score: M = 113.30, SD = 5.72; Young TD Nonverbal age deviation score: M = 108, SD = 6.14; Old TD PPVT-III standard score: M = 110.55 SD = 12.75; Old TD nonverbal age deviation score: M = 107.70, SD = 8.1.

Participants in the SSPI group (2 girls and 2 boys; 3 Caucasian, 1 Hispanic) were recruited from the caseloads

Table 1. Characteristics of participants with SSPI.

	SSPI 1	SSPI 2	SSPI 3	SSPI 4
Age (years; months)	15;9	12;10	14;8	11;2
Sex	M	F	F	M
Etiology	Quadriplegia as a result of cerebral palsy	Quadriplegia as a result of cerebral palsy	Quadriplegia as a result of brainstem aneurysm at 12 years	Hemiplegia as a result of cerebral palsy
Signals for "yes/no"	Eye gaze toward partner/upward	Vocalization	Head nod/shake	Vocalization
Communication device	Eye gaze toward black and white drawings; BigMac device accessed with elbow	Liberator™ communication aid accessed via direct selection with headstick	Dynavox™ communication aid accessed via direct selection with index finger; "pidgin" signs	LightWriter™ communication aid accessed via direct selection with fingers; finger spelling
Affixation in symbol system	None	Minspeak symbols ***Example*** "pushed" = ELEPHANT Icon + TOMBSTONE Icon + VERB Icon	Dynasyms symbols ***Example*** "pushed" = symbol representing "push" + "past verb" command button	English orthography ***Example*** "pushed" = p+u+s+h+e+d
Standardized tests				
CTONI	68	67	77	128
PPVT-III	62	74	93	123

Note. CTONI = Comprehensive Test of Nonverbal Intelligence (Hammill, Pearson, & Wiederholt, 1996) nonverbal quotient. PPVT-III = Peabody Picture Vocabulary Test, 3rd edition (Dunn & Dunn, 1997) standard score.

of certified speech-language pathologists and were receiving services at the time of the study. Participants in the control groups (13 girls and 11 boys; 22 Caucasian, 1 Hispanic, 1 African American) were recruited from daycare and after-school programs located in the same communities where the children with SSPI resided.

Adult participants (5 men and 16 women) were college students recruited from a graduate course in special education. Only those who identified themselves as monolingual English speakers with a negative history of speech/language delays, learning disabilities, or ADD/ADHD participated.

Description of the Judgment Task

Judgments were elicited from participants as they observed scenarios involving various toys and actions. The children were introduced to a couple of action figures referred to in the task as the "moonguys" and were told that they "were from outer space and were just learning to speak English, so sometimes they say things right but sometimes they say things not so good. Sometimes they aren't quite right about the little parts of English." The children were then instructed to "listen carefully to how the moonguys talk" and to tell the examiner "if what they said was right or not so good." The contrast between "right" and "not so good" was used here because previous work has indicated that some children are reluctant to use more pejorative evaluations of good/bad, right/wrong, or happy face/sad face (Redmond, 1997; Rice et al., 1999). Adults were asked to indicate their choices in writing on a response sheet.

The task consisted of two phases, the training phase and the experimental phase. During the training phase, participants were presented with 5 grammatical and 5 ungrammatical sentences within a story-type format and asked to make judgments. Feedback was provided on the accuracy of the participant's response, and when errors occurred, correct responses were provided. It was during the training phase that a reliable contrast between "yes" and "no" responses to grammatically correct and incorrect sentences was established for each participant. Grammatical errors in the practice items consisted of omissions of plural *-s* and aspectual *-ing* (e.g., *these are three spoon; she is turn her head*). For the majority of participants, corrective feedback was not necessary during the training phase, and all four groups performed very well on the 10 training items (total number correct on practice items: SSPI M = 9.60, SD = .547; Young TD M = 9.09, SD = 1.22; Old TD M = 9.62, SD =.650; Adults M = 9.95, SD = .218).

Feedback was not provided during the experimental phase. During this phase, participants were presented with 20 grammatical and 25 ungrammatical sentences that incorporated regular and irregular verb forms in simple declarative sentences. A story-type format was continued through this phase. Five of the grammatical and five of the ungrammatical sentences represented correct use and omission of aspectual *-ing* (e.g., *She is pulling the box* vs. *She is pull the box*). Five of the grammatical and five of the ungrammatical sentences represented correct and incorrect instances of subject-verb agreements in Subject+Aux+VERB-ing sentences (e.g., *She is opening the box* vs. *She are opening the box*). The remaining 25 test sentences were constructed using five regular verbs (*open, jump, pull, push, play*), five irregular verbs (*fall, eat, throw, catch, break*), and three verbal forms (bare stem, correct past, overregularization—for example, *jump/fall, jumped/fell, falled*). Table 2 displays the sentence stimuli used in the study.

Experimental Controls on the Judgment Task

All 10 of the verbs used in this study represent high-frequency English words (Francis & Kucera, 1982; Hall, Nagy, & Linn, 1984; Moe, Hopkins, & Rush, 1982). To further rule out potential interactions between verb type and frequency, the frequency of past tense forms was matched across the regular and irregular verbs using Francis and Kucera's (1982) corpus of 1,014,000 words of running text in English (regular verb mean: 55.2 tokens; irregular verb mean: 53.8 tokens).

To ensure that participants were interpreting the temporal contexts as intended, toys and props were used to present sentences in a story format rather than a decontextualized list. By asking participants to judge sentences after observing completed or ongoing events, we reduced misinterpretations of obligatory contexts for different grammatical morphemes. This accommodation also guards against spurious truth-value judgments (i.e., judging a sentence as correct/incorrect on the basis of its actuality or plausibility), and previous research indicates that children's performances on grammaticality judgments improve substantially when these procedures are used (Blackmore, Pratt, & Dewbury, 1995; McDaniel & Cairns, 1996). A random presentation of items was not possible due to the story format used, but items were spaced so that sentences containing correct or incorrect subject-verb agreement alternated with those containing bare stems, correct aspect, correct past tense, or overregularized forms. To guard against errors due to expectancy effects, grammatical and ungrammatical response runs were no longer than four sentences.

Reliability

After being trained with pilot testing sessions to administer the protocol consistently and in a way that

Table 2. Sentence stimuli used in grammaticality judgment task.

Contrast	Grammatical sentence	Ungrammatical sentence
Aspectual *-ing* vs. Bare Stem	She is opening the box	You are open the box
	She is jumping away	I am jump up and down
	She is pulling the box back	She is pull the box
	She is pushing the box away	I am push the box
	I am playing the horn	Now she is play the horn
Good vs. Bad Agreement	She is opening the box	She are opening the box
	She is jumping up and down	She am jumping up and down
	She is throwing the ball	She am throwing the ball
	She is catching the ball	She are catching the ball
	She is falling down	She are falling down
Regular Past vs. Bare Stem	She opened the box again	Look, she open her box
	You jumped on the box	Look, she jump on the box
	We pushed the box	She push our wall down
	Hey, she pulled out a horn	She pull out a toothpick
	She played the horn	She play the horn again
Irregular Past vs. Bare Stem	I fell off the box	She fall off the box
	Hey, she ate all the doughnuts	She eat a doughnut
	She caught the ball	I catch it
	I threw it back	She throw the ball over here
	Look, she broke another one	She break a toothpick
Irregular Past vs. Overregularization	I fell off the box	You falled off the box again
	Hey, she ate all the doughnuts	She eated two doughnuts
	She caught the ball	I catched it
	I threw it back	She throwed the ball at you
	Look, she broke another one	I breaked one too

minimized prosodic cues for the different sentence types, three examiners collected the data. To determine reliability, simultaneous coding of responses was conducted by two examiners during the administration of the protocol to 6 participants from the typically developing groups of children (3 from the Young TD and 3 from the Old TD groups). Results indicated high levels of interrater agreement: 98% [324 agreements/(330 agreements + disagreements) × 100]. Simultaneous coding by two examiners was also conducted during collection of responses from each participant with SSPI. Results indicated high levels of interrater agreement here as well: 99% (218/220).

Results

The experimental protocol was first administered to groups of typically developing adults and children to validate the procedures and to identify the presence of any developmental trends across the different error types. Four typically developing participants were matched to 4 children with SSPI on the basis of PPVT-III raw scores. This comparison allowed us to evaluate the sensitivity of participants in the SSPI group to different morphological errors in comparison to expectations based on vocabulary achievement.

Age-Related Differences in Sensitivity to Violations of Verbal Morphology

Forty-five experimental items were presented to each participant in the Young TD, Old TD, and Adult groups, and the following group means of total correct responses was observed: Young TD: M = 35.58, SD = 4.82; Old TD M = 40.5, SD = 4.52; Adult M = 43.6, SD = .74). An omnibus one-way between-subjects ANOVA, with number of correct items as the dependent variable and age group as the between-subjects factor, verified the presence of significant group differences [$F(2, 42) = 18.11$, $p < .0001$ (η^2 .463)]. Follow-up Dunn-Sidak pairwise analyses indicated that the following pairwise comparisons reached the .05 level of significance: Adult > Old TD > Young TD. Subsequent analyses were directed at characterizing the observed differences between the younger children, older children, and adults as being one of increasing overall performance across the different items or as the presence of different patterns of sensitivity to the different error types.

Data reduction and analyses of grammaticality judgments were guided by procedures developed in signal detection theory and followed the conventions established by Linebarger et al. (1983). Observed proportions of hits (acceptance of grammatical sentences) and false alarms (acceptance of ungrammatical sentences) were used to calculate the nonparametric statistic A′ following the formula provided by Grier (1971): $0.5 + [(y - x)(1 + y - x)]/4y(1 - x)$, where x = proportion of false alarms and y = proportion of hits.

An A′ was calculated for each participant on five different kinds of contrasts of grammatical/ungrammatical sentences. A′ values associated with these contrasts were initially entered into a two-way analysis of variance with group (Young TD, Old TD, Adult) as the between-subjects factor and contrast type (aspectual *-ing* omissions, agreement errors, regular past omissions, irregular past omissions, overregularizations) as the within-subjects factor. Group means for hit rates, false alarm rates, and A′ values are displayed in Table 3.

Both main effects were significant. The main effect for group [$F(2, 42) = 12.842$, $p < .001$ (η^2 .379)] with subsequent Dunn-Sidak post hoc tests showed that the A′ values for the Adult group were higher than those for the Old TD group, which were higher than those for the Young TD group. The main effect for contrast type [$F(4, 39) = 20.021$, $p < .001$ (η^2 .323)] with subsequent Dunn-Sidak post hoc tests showed that the following pairwise comparisons reached the .05 level of significance: aspectual *-ing* omissions = agreement errors > regular past omissions = irregular past omissions > overregularization errors. These results suggest that the detection of tense-marking errors (especially overregularizations) was more difficult than the detection of non-tense-marking errors.

The two-way interaction involving group by contrast type was also significant [$F(8, 39) = 8.806$, $p < .001$, (η^2 .295)]. Based on conventional interpretations (cf. Cohen, 1988), the observed size of the obtained interaction effect can be regarded as "large," suggesting that age-related differences associated with the detection of morphological errors were dependent on the particular type of morphological error under examination. Follow-up analyses indicated that two of the five contrasts showed no age-related differences. No significant group differences were observed in participants' intuitions regarding the marking of aspectual *-ing* or the marking of subject-verb agreement [$F(2, 55) = 2.283$, $p = .114$; $F(2, 55) = 1.165$, $p = .297$]. These items included grammatical sentences and ungrammatical sentences containing bare stem aspectual verbs (*she is walking* vs. *she is walk*) or verbs marked incorrectly for agreement (*she is walking* vs. *she are walking*). As indicated in Table 3, all three groups were capable of consistently making accurate judgments about the presence/absence or incorrect use of a grammatical morpheme. These findings are consistent with other reports of the sensitivity of typically developing children to these types of errors (Montgomery & Leonard, 1996; Rice et al., 1999).

Age-related differences were observed on the remaining three contrasts. Significant group differences were observed with levels of sensitivity to grammatically correct sentences and ungrammatical sentences containing bare stem regular verb errors [$F(2, 42) = 4.41$, $p = .018$ (η^2 .174)], and the following pairwise comparisons were significant at $p < .05$: Adult > Old TD = Young TD, indicating that both groups of children were more willing to accept bare stem regular verbs (e.g., *she open her box*) than was the adult group.

Significant group differences were observed with levels of sensitivity to grammatically correct sentences and sentences containing bare stem irregular verb errors [$F(2, 42) = 6.420$, $p = .004$ (η^2 .234)], and the following pairwise comparisons were significant at $p < .05$: Adult = Old TD > Young TD, indicating that children in the younger group were more willing to accept irregular bare stems (e.g., *she fall off the box*) than were the older children and adults.

Significant group differences were also found with levels of sensitivity to grammatically correct sentences and sentences containing overregularization errors [$F(2, 42)$ 20.49, $p < .0001$ (η^2 .494)], and the following pairwise comparisons were significant at $p < .05$: Adult > Old TD > Young TD, indicating an increase in sensitivity to overregularization errors (e.g., *she falled off the box*) with increasing age.

In sum, the analysis of developmental trends associated with the judgment protocol demonstrated the integrity of the procedure with typically developing children and adults. All three groups of typically developing participants demonstrated high levels of sensitivity to the errors involving bare stem aspectual verbs and subject-verb agreement errors (group A′ ranges: .86–1.00). Developmental changes indicating improved performance with increasing linguistic maturation were most observable in the children's levels of sensitivity to errors involving bare stem irregular verb errors and overregularizations. Differences were not observed between the two groups of typically developing children in their levels of sensitivity to errors involving bare stem regular verbs. The observed effect sizes associated with each significant group difference obtained can be regarded as "large" (cf. Cohen, 1988), which indicates that the grammaticality judgments captured significant developmental differences associated with the acquisition of morphological competence.

Table 3. Performance of the typically developing participants across five grammatical contrasts.

Contrast	Hits "Yes" to grammatical sentences	False alarms "Yes" to ungrammatical sentences	A′
Aspectual *-ing* vs. Bare Stem	Young TD: 85.46% (23.8)*	Young TD: 5.46% (9.34)	Young TD: .96 (.002)
	Old TD: 98.47 (5.55)	Old TD: 4.62 (8.77)	Old TD: .98 (.001)
	Adult: 100 (0)	Adult: 0.95 (4.36)	Adult: .99 (.001)
Good vs. Bad Agreement	Young TD: 68.57% (15.74)	Young TD: 17.14% (21.38)	Young TD: .86 (.197)
	Old TD: 78.00 (6.32)	Old TD: 8.00 (25.29)	Old TD: .95 (.158)
	Adult: 100 (0)	Adult: 0 (0)	Adult: 1.00 (0)
Regular Past vs. Bare Stem	Young TD: 74.54% (28.4)	Young TD: 18.18% (20.89)	Young TD: .86 (.168)[a] **
	Old TD: 95.38 (8.77)	Old TD: 16.92 (30.38)	Old TD: .91 (.152)[a]
	Adult: 100 (0)	Adult: 2.86 (7.17)	Adult: .99 (.004)[b]
Irregular Past vs. Bare Stem	Young TD: 72.72% (32.59)	Young TD: 16.36% (19.63)	Young TD: .83 (.198)[a]
	Old TD: 96.92 (7.51)	Old TD: 6.154 (22.19)	Old TD: .97 (.111)[b]
	Adult: 100 (0)	Adult: 2.857 (7.17)	Adult: .98 (.004)[b]
Irregular Past vs. Overregularization	Young TD: 72.72% (32.59)	Young TD: 50.91% (27.37)	Young TD: .62[a]
	Old TD: 96.92 (7.51)	Old TD: 30.77 (39.68)	Old TD: .84[b]
	Adult: 100 (0)	Adult: 0 (0)	Adult: 1.00 (0)[c]

Note. Young TD = young typically developing children (4–6 years); Old TD = older typically developing children (7–10 years); Adult = adult participants. * Standard deviations are indicated in parentheses, ** Pairwise comparisons significant at $p < .05$ are indicated (e.g., a < b < c).

Sensitivity of Children With SSPI to Violations of Verbal Morphology

The entire protocol of 45 experimental items was administered to 4 children with SSPI and compared to 4 children from the Young TD and Old TD groups of equivalent vocabulary levels, hereafter referred to as the Vocabulary Match Group (VM; age range, 69–130 months). Participants' PPVT-III raw scores were matched within ± 7 points (SSPI raw scores: 87, 118, 144, 162: *M* = 127.75; VM raw scores: 84, 117, 139, 169: *M* = 127.25). The criterion of 7 points was an arbitrary one. PPVT-III raw scores were then ranked from lowest to highest and used to match participants from both groups—SSPI 1/VM 1 to SSPI 4/VM 4. Tables 4 and 5 display each child's hit rates, false alarm rates, and A′ values.

Because the number of participants was small, inferential statistics were not used, and A′ results were analyzed descriptively (cf. Bakeman & Robinson, 1997). As the A′ values in Table 4 indicate, all 4 participants with SSPI demonstrated levels of sensitivity above chance (i.e., A′ > .50) for most of the morphological errors examined, indicating that these children possessed the requisite metalinguistic skills needed to reliably identify grammatical errors associated with verbal morphology. In the context of overall high levels of sensitivity within the SSPI group, however, there are some important individual differences across these children. Participants SSPI 3 and SSPI 4 consistently demonstrated high levels of sensitivity to all ungrammatical sentences (i.e., A′ > .70), whereas the performances of participants SSPI 1 and SSPI 2 showed clear areas of weakness. Participant SSPI 1 rejected most of the sentences containing regular verbs, whether correctly inflected or not; thus, his A′ value of .50 with this contrast indicated no preference or chance performance. His hit rate (acceptance of grammatical sentences) was 20%, whereas the hit rates across the other SSPI participants were 40–100%. Participant SSPI 2 also demonstrated some difficulty with the sentences containing regular verbs in that she accepted all bare stem errors as correct. Her A′ value of .37 indicated a preference for bare stem regular verbs over correctly inflected verbs.

A comparison between the SSPI and VM groups shows that they were very similar in their levels of sensitivity with most of the error types (see Figure 1). For example, all 8 children demonstrated high levels of sensitivity to ungrammatical sentences containing bare stem aspectual verbs and subject-verb agreement errors (SSPI A′ range: .83–1.00; VM A′ range: .90–1.00). There were also similarities between the two groups in their performances on sentences containing the irregular verbs. Participants in the SSPI group were sensitive to ungrammatical sentences containing bare stem irregular verb errors (perfect discrimination was observed with 2 of the participants), but as a whole, they were not as sensitive as the VM group (SSPI A′ range: .75–1.00; VM A′ range: .90–1.00). On the other hand, 3 of the 4 children in the SSPI group had higher levels of sensitivity to sentences containing overregularization errors than their vocabulary-matched peers (SSPI A′ range: .63–1.00; VM A′ range: .50–1.00).

As displayed in Figure 1, the one area where the performance of the SSPI group was consistently different from the VM group was in their levels of sensitivity to ungrammatical sentences containing bare stem regular verbs (SSPI group A′ range: .37–.75; VM group A′ range: .90–1.00), indicating that the SSPI participants were more willing to accept bare stem regular verbs (e.g., *she open her box*) than the VM participants. In contrast to the other grammatical/ungrammatical contrasts examined in this study, there was no overlap in performance between the two groups in this area. The false alarm rate for participants in the SSPI group varied from 20 to 100%, whereas all sentences containing bare stem regular verbs were correctly rejected by 3 of the 4 participants in the VM group (VM false alarm range: 0–20%). In addition, all 4 children in the SSPI group performed below the mean of the youngest group of control children, who were 5–9 years younger (.65 – 3.0 standard deviations below the Young TD mean). It is important to restate here that developmental changes in sensitivity to morphological errors across the typically developing children were observed with the irregular verbs only. Younger children and older children performed equally well with the regular verb errors. These results suggest that identifying bare stem regular verbs as errors was particularly challenging for the participants with SSPI.

Discussion

Reports present mixed findings on the extent to which the development of linguistic competence in children with severe speech and physical impairments is compromised by their physical difficulty with speaking. In this study, we used a grammaticality judgment task to assess morphological intuitions of 4 school-age children with SSPI and compared them to patterns observed in typically developing children and adults. Hit and false alarm rates to grammatically correct and incorrect sentences were used to calculate A′, an index of sensitivity

Table 4. Performance of the participants with SSPI across five grammatical contrasts.

Contrast	Hits “Yes” to grammatical sentences	False alarms “Yes” to ungrammatical sentences	A′
Aspectual *-ing* vs. Bare Stem	SSPI 1: 60%	SSPI 1: 20%	SSPI 1: .83
	SSPI 2: 80%	SSPI 2: 0%	SSPI 2: 1.00
	SSPI 3: 100%	SSPI 3: 20%	SSPI 3: 1.00
	SSPI 4: 100%	SSPI 4: 0%	SSPI 4: 1.00
Good vs. Bad Agreement	SSPI 1: 60%	SSPI 1: 20%	SSPI 1: .83
	SSPI 2: 80%	SSPI 2: 0%	SSPI 2: 1.00
	SSPI 3: 80%	SSPI 3: 20%	SSPI 3: 1.00
	SSPI 4 80%	SSPI 4: 20%	SSPI 4: 1.00
Regular Past vs. Bare Stem	SSPI 1: 20%	SSPI 1: 20%	SSPI 1: .50
	SSPI 2: 80%	SSPI 2: 100%	SSPI 2: .37
	SSPI 3: 40%	SSPI 3: 20%	SSPI 3: .75
	SSPI 4: 100%	SSPI 4: 60%	SSPI 4: .75
Irregular Past vs. Bare Stem	SSPI 1: 80%	SSPI 1: 40%	SSPI 1: .75
	SSPI 2: 80%	SSPI 2: 40%	SSPI 2: .75
	SSPI 3 : 80%	SSPI 3: 0%	SSPI 3: 1.00
	SSPI 4: 100%	SSPI 4: 0%	SSPI 4: 1.00
Irregular Past vs. Overregularization	SSPI 1: 80%	SSPI 1: 20%	SSPI 1: .88
	SSPI 2: 80%	SSPI 2: 60%	SSPI 2: .63
	SSPI 3: 80%	SSPI 3: 0%	SSPI 3: 1.00
	SSPI 4:100%	SSPI 4: 20%	SSPI 4: .90

that takes into consideration inconsistent responses due to motor fatigue, imprecision, or impulsiveness. These factors had not been controlled for in earlier studies.

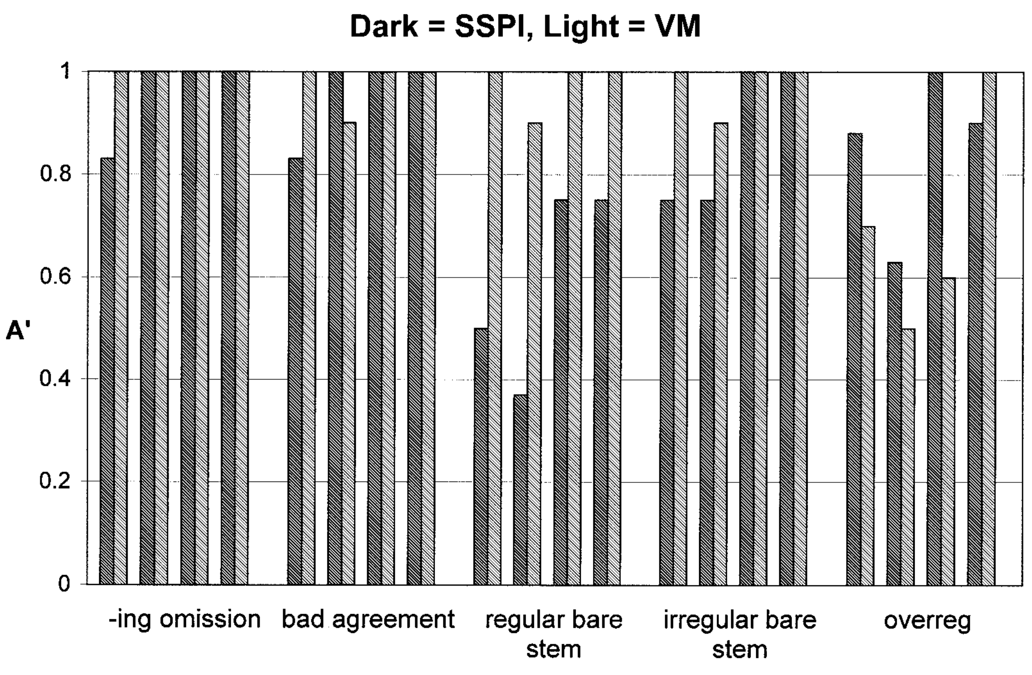
Although our participants with SSPI varied dramatically in their levels of vocabulary development, nonverbal achievement, etiology, and AAC use, all 4 participants demonstrated a similar pattern of performance. Across the majority of grammatical/ungrammatical contrasts examined, A′ values were high enough to conclude that the participants with SSPI had sufficient metalinguistic skills to identify morphological errors. Children in the SSPI group demonstrated intact linguistic knowledge regarding many important aspects of English morphology. These areas included the obligatory nature of aspect marking and the restriction that verbal auxiliaries must agree in person and number with their subjects. Interestingly, our findings are consistent with reports on other groups of children with language impairments. Children with specific language impairment, for example, have also shown high levels of discrimination with these kinds of errors (Montgomery & Leonard, 1998; Rice et al., 1999), suggesting that the encoding of aspect and agreement are areas of morphological competence that are particularly resilient. Another area of strength for the participants with SSPI was their intuitions regarding the marking of past tense with irregular verbs. This included the recognition that irregular verbs must be marked for tense and that the regular affix *-ed* cannot attach to irregular stems. In contrast, study samples of children with SLI have demonstrated limitations in identifying bare stem errors with irregular verbs (Redmond & Rice, 2001; van der Lely & Ullman, 1996).

Across all 4 participants with SSPI, the lowest A′ values were associated with the detection of bare stem regular verb errors. This was most clearly observed in the performances of participants SSPI 1 and SSPI 2, whose levels of verbal and nonverbal achievement were lower than those of the other 2 participants. These results are consistent with Blockberger's (1997) finding that children with SSPI have limited understanding of the obligatory nature of regular inflections. Likewise, the differences we found in the levels of sensitivity to regular and irregular past tense errors across our participants with SSPI were consistent with patterns previously observed in adults (Sutton & Gallagher, 1993). Our results support Sutton and Gallagher's characterization that individuals with SSPI prefer to use the "separate past" option when marking past tense. Significant and long-lasting limitations with regular past tense *-ed* have also

Table 5. Performance of the vocabulary matches across five grammatical contrasts.

Contrast	Hits "Yes" to grammatical sentences	False alarms "Yes" to ungrammatical sentences	A′
Aspectual *-ing* vs. Bare Stem	VM 1: 100%	VM 1: 0%	VM 1: 1.00
	VM 2: 100%	VM 2: 0%	VM 2: 1.00
	VM 3: 100%	VM 3: 0%	VM 3: 1.00
	VM 4: 100%	VM 4: 0%	VM 4: 1.00
Good vs. Bad Agreement	VM 1: 80%	VM 1: 0%	VM 1: 1.00
	VM 2: 100%	VM 2: 20%	VM 2: .90
	VM 3: 100%	VM 3: 0%	VM 3: 1.00
	VM 4: 100%	VM 4: 0%	VM 4: 1.00
Regular Past vs. Bare Stem	VM 1: 80%	VM 1: 0%	VM 1: 1.00
	VM 2: 100%	VM 2: 20%	VM 2: .90
	VM 3: 100%	VM 3: 0%	VM 3: 1.00
	VM 4: 100%	VM 4: 0%	VM 4: 1.00
Irregular Past vs. Bare Stem	VM 1: 100%	VM 1: 0%	VM 1: 1.00
	VM 2: 100%	VM 2: 20%	VM 2: .90
	VM 3: 100%	VM 3: 0%	VM 3: 1.00
	VM 4: 80%	VM 4: 0%	VM 4: 1.00
Irregular Past vs. Overregularization	VM 1: 100%	VM 1: 60%	VM 1: .70
	VM 2: 100%	VM 2: 100%	VM 2: .50
	VM 3: 100%	VM 3: 80%	VM 3: .60
	VM 4: 80%	VM 4: 0%	VM 4: 1.00

Figure 1. A′ values for the SSPI participants and their vocabulary matches across five different grammatical contrasts.



been documented in grammaticality judgments collected on children with SLI (Rice et al., 1999; van der Lely & Ullman, 1996). The acquisition of adultlike intuitions regarding the marking of regular past tense may be a particularly vulnerable area of English morphology, one that is susceptible to many types of developmental disruption.

It is clear that more work needs to be done in order to understand the development of grammatical morphology in children with SSPI. Many empirical and conceptual obstacles remain before the relative roles of neurological impairment and history of AAC use can be integrated into theories of typical and atypical morphological development. Further research is needed to determine whether morphological development in children with SSPI follows a path similar to that of typically developing children, similar to that of other children with language impairments, similar to that of any other group of children, or a path that is unique. Our results, however, do not support the hypothesis that the acquisition of language through augmented or alternative means leads to generalized limitations in the mechanics of affixation. Limitations in the development of grammatical morphology, when they are present in children with SSPI, are probably more specific to certain morphemes and particular aspects of morphological knowledge.

The extent to which the design of a user's AAC system influences these particular aspects of morphological knowledge warrants further study. The challenge for theories of language development in children with SSPI will be to integrate two important dimensions of grammatical morphology into their predictions. First, morphosyntactic aspects, such as the nature of the underlying grammatical features associated with different grammatical morphemes (e.g., TNS, AGR), probably influence their relative difficulty as well as their vulnerability to developmental disruption (cf. Rice, Wexler, & Cleave, 1995; Rice, Wexler, & Hershberger, 1998; Wexler, 1996). Second, relative levels of difficulty across different grammatical morphemes may also be partially determined by important morphophonemic differences in frequency, perceptual saliency, and regularity (cf. Elman et al., 1996; Leonard, 1998; Pinker, 1999).

The results of this study, and others, suggest directions for improving current assessment practices. For children with SSPI, underlying morphological knowledge is probably not well indexed by general measures of vocabulary or nonverbal achievement. Fortunately, there is increasing recognition that grammaticality judgments represent a viable procedure for identifying linguistic deficits in children with communication disorders. As an assessment methodology, grammaticality judgments appear to be uniquely designed to address the needs of children with significant motor impairments. The application of signal detection theory to grammaticality judgments further enhances the interpretation of error responses that may be influenced by motor limitations. It was certainly true that our participants with SSPI produced a significant number of errors across the different items. However, as our A′ analyses indicate, inconsistent responding does not have to result in low levels of sensitivity or in the conclusion of impaired linguistic representations. A common concern among the speech-language pathologists working with our participants was that standardized test scores underrepresented their intuitions about the children's competence. It is possible that the adoption of signal detection procedures into other aspects of communicative assessment will allow speech-language pathologists to interpret with greater confidence the performance of individuals with SSPI.

Acknowledgments

The authors wish to thank members of the Utah Augmentative Alternative Assistive Communication Technology Team and teachers from the Professional Childcare and Learning Center for their assistance in recruiting potential participants. We also thank Carol Hammond and Robin Ottesen for their contributions to data collection and reliability measurement. We are especially grateful for the generosity of the children and adults who participated in this study.

References

Bakeman, R., & Robinson, B. F. (1997). When *N*s do not justify the means: Small samples and scientific conclusions. In L. B. Adamson & M. A. Romski (Eds.), *Communication and language acquisition: Discoveries from atypical development* (pp. 49–72). Baltimore: Paul H. Brookes.

Baker, B. (1986). Using images to generate speech. *Byte, 3*, 160–168.

Baum, S. R. (1997). The processing of morphology and syntax in aphasia: A test of the fast decay and slow activation hypotheses. *Aphasiology, 10*, 783–800.

Berninger, V. W., & Gans, B. M. (1986). Language profiles in nonspeaking individuals of normal intelligence with severe cerebral palsy. *Augmentative and Alternative Communication, 2*, 45–50.

Bishop, D. V. M. (1988). Language development in children with abnormal structure or function of the speech apparatus. In D. V. M. Bishop & K. Mogford (Eds.), *Language development in exceptional circumstances* (pp. 202–238). Edinburgh, U.K.: Churchill Livingstone.

Bishop, D. V. M., Byers Brown, B., & Robson, J. (1990). The relationship between phoneme discrimination, speech production and language comprehension in cerebral-palsied individuals. *Journal of Speech and Hearing Research, 33*, 210–219.

Blackmore, A. M., Pratt, C., & Dewbury, A. (1995). The use of props in a syntactic awareness task. *Journal of Child Language, 22*, 405–421.

Bliss, C. K. (1965). *Blissymbolics*. Sydney, Australia: Semantography Publications.

Blockberger, S. J. (1997). *The acquisition of grammatical morphology by children who are unable to speak*. Unpublished doctoral dissertation, University of British Columbia, Vancouver, Canada.

Burgemeister, B. B., Blum, L. H., & Lorge, I. (1972). *The Columbia Mental Maturity Scale*. San Antonio, TX: Psychological Corporation.

Cohen, J. (1988). *Statistical power analyses for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum.

Dunn, A., & Dunn, A. (1997). *Peabody Picture Vocabulary Test* (3rd ed.). Circle Pines, MN: American Guidance Service.

Elman, J. L., Bates, E. A., Johnson, M. H., Karmiloff-Smith, A., Parisi, D., & Plunkett, K. (1996). *Rethinking innateness: A connectionist perspective on development*. Cambridge, MA: MIT Press.

Fourcin, A. J. (1975). Language development in the absence of expressive speech. In E. Lenneberg & E. Lenneberg (Eds.), *Foundations of language development* (Vol. 1, pp. 263–268). New York: Academic Press.

Francis, W. N., & Kucera, H. (1982). *Frequency analysis of English usage: Lexicon and grammar*. Boston: Houghton Mifflin.

Grier, J. B. (1971). Nonparametric indexes of sensitivity and bias: Computing formulas. *Psychological Bulletin, 75*, 424–429.

Hall, W. S., Nagy, W. E., & Linn, R. (1984). *Spoken words: Effects of situation and social group on oral word usage and frequency*. Hillsdale, NJ: LEA.

Hammill, D. D., Pearson, N. A., & Weiderholt, J. L. (1996). *Comprehensive Test of Nonverbal Intelligence*. Austin, TX: Pro-Ed.

Johnson, R. (1981). *The picture communication symbols*. Solana Beach, CA: Mayer-Johnson.

Kahmi, A. G., & Koenig, L. A. (1985). Metalinguistic awareness in normal and language-disordered children. *Language, Speech, and Hearing Services in Schools, 16*, 199–210.

Leonard, L. B. (1998). *Children with specific language impairment*. Cambridge, MA: MIT Press.

Linebarger, M. C., Schwartz, M. F., & Saffran, E. M. (1983). Sensitivity to grammatical structure in so-called agrammatic aphasics. *Cognition, 13*, 361–392.

Lloyd, L. L., & Karlan, G. R. (1984). Non-speech communication symbols and systems: Where have we been and where are we going? *Journal of Mental Deficiency Research, 28*, 3–20.

McDaniel, D., & Cairns, H. S. (1996). Eliciting judgments of grammaticality and reference. In D. McDaniel, C. McKee, & H. S. Cairns (Eds.), *Methods for assessing children's syntax* (pp. 233–254). Cambridge, MA: MIT Press.

Moe, A., Hopkins, C., & Rush, R. (1982). *The vocabulary of first-grade children*. Springfield, IL: Thomas.

Montgomery, J. W., & Leonard, L. B. (1998). Real-time inflectional processing by children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 41*, 1432–1443.

Paul, R. (1998). Communicative development in augmented modalities: Language without speech? In R. Paul (Ed.), *Exploring the speech-language connection* (pp. 139–161). Baltimore: Paul H. Brookes.

Pinker, S. (1999). *Words and rules: The ingredients of language*. New York: Basic Books.

Redmond, S. M. (1997). *A grammatical analysis of irregular past tense forms in school age children with and without histories of specific language impairment*. Unpublished doctoral dissertation, University of Kansas, Lawrence.

Redmond, S. M., & Rice, M. L. (2001). Detection of irregular verb violations by children with and without SLI. *Journal of Speech, Language, and Hearing Research, 44,* 655–669.

Rice, M. L., Wexler, K., & Cleave, P. (1995). Specific language impairment as a period of extended optional infinitive. *Journal of Speech, Language, and Hearing Research, 38,* 850–863.

Rice, M. L., Wexler, K., & Hershberger, S. (1998). Tense over time: The longitudinal course of tense acquisition in children with specific language impairment. *Journal of Speech and Hearing Research, 41*, 1412–1431.

Rice, M. L., Wexler, K., & Redmond, S. M. (1999). Grammaticality judgments of an extended optional infinitive: Evidence from English speaking children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 42*, 943–961.

Sandberg, A. D., & Hjelmquist, E. (1997). Language and literacy in nonvocal children with cerebral palsy. *Reading and Writing, 9*, 107–133.

Schütze, C. T. (1996). *The empirical base of linguistics: Grammaticality judgments and linguistic methodology*. University of Chicago Press.

Smith-Lock, K. (1995). Morphological usage and awareness of children with and without specific language impairment. *Annals of Dyslexia, 45*, 163–185.

Stromswald, K. (1994, November). *Language comprehension without production: Implications for theories of language acquisition*. Paper presented at the Boston Child Language Conference.

Sutton, A. (1999). Linking language learning experiences and grammatical acquisition. In F. T. Loncke, J. Clibbens, H. H. Arvidson, & L. L. Lloyd (Eds.), *Augmentative and alternative communication: New directions in research and practice* (pp. 49–61). London: Whurr Publishers.

Sutton, A. E., & Gallagher, T. M. (1993). Verb class distinctions and AAC language-encoding limitations. *Journal of Speech and Hearing Research, 36*, 1216–1226.

Udwin, O., & Yule, W. (1990). Augmentative communication systems taught to cerebral palsied children: Findings from a longitudinal study 1. *British Journal of Disorders of Communication, 25,* 295–309.

van der Lely, H. K., & Ullman, M. (1996). The computation and representation of past-tense morphology in specifically language impaired and normally developing children. In A. Stringfellow, D. Cahana-Amitay, E. Highers, & A. Zukowski (Eds.), *Proceedings of the 20th annual Boston University Conference on Language Development* (pp. 804–815). Somerville, MA: Cascadilla Press.

Wexler, K. (1996). The development of inflection in a biologically based theory of language acquisition. In M. L. Rice (Ed.), *Toward a genetics of language* (pp. 113–144). Mahwah, NJ: Lawrence Erlbaum Associates.

Received March 3, 2001

Accepted September 5, 2001

DOI: 10.1044/1092-4388(2001/106)

Contact author: Sean Redmond, PhD, Dept of Communication Disorders, University of Utah, 390 S 1530 E, BEHS Rm 1201, Salt Lake City, UT 84112
E-mail: sean.redmond@health.utah.edu