Acoustic correlates of inflectional morphology in the speech of children with specific language impairment and their typically developing peers

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Abstract
The development of the use of the third-person singular –s in open syllable verbs in children with specific language impairment (SLI) and their typically developing peers was examined. Verbs that included overt productions of the third-person singular –s morpheme (e.g. Bobby plays ball everyday; Bear laughs when mommy buys popcorn) were contrasted with clearly bare stem contexts (e.g. Mommy, buy popcorn; I saw Bobby play ball) on both global and local measures of acoustic duration. A durational signature for verbs inflected with -s was identified separately from factors related to sentence length. These duration measures were also used to identify acoustic changes related to the omission of the –s morpheme. The omitted productions from the children with SLI were significantly longer than their correct third-person singular and bare stem productions. This result was unexpected given that the omitted productions have fewer phonemes than correctly inflected productions. Typically developing children did not show the same pattern, instead producing omitted productions that patterned most closely with bare stem forms. These results are discussed in relation to current theoretical approaches to SLI, with an emphasis on performance and speech-motor accounts.

Keywords: Specific language impairment, tense, finiteness, speech-motor control, acoustics

Introduction
Preschool children diagnosed with specific language impairment (SLI) have exceptional difficulty with the use of grammatical morphology (see Leonard, 1998). In particular, English-speaking children with SLI and young typically developing children have been shown to use finite forms (e.g. am, is, are, third-person singular –s and past tense –ed) variably in main clauses. In other words, sometimes the verb is correctly inflected for both tense and agreement (e.g. he is jumping, he jumps) and sometimes it appears as an uninflected form (e.g. *he jumping, *he jump). Overt use of the incorrect form (e.g. *he are jumping; *they jumps) is much more rarely reported in the literature.

A variety of theories have been proposed to account for this variability in both typically developing children and children with SLI. Linguistically based theories, such as the Optional Infinitive (OI) for typical children or Extended Optional Infinitive (EOI) hypothesis for children with SLI, hinge on the notion that these children do not know that
finiteness markers, such as third-person singular –s, are obligatory in main clauses (Rice, Wexler, & Cleave, 1995). This account is supported cross-linguistically with some minor modifications to the details (Rice, Noll, & Grimm, 1997; Wexler, 1998), but the general predictions described below appear to hold for English. Information processing accounts propose instead that children have the requisite underlying knowledge, but lack the ability to produce the morpheme due to processing limitations (Montgomery & Leonard, 1998). Children may experience difficulty at many levels, including retrieving the appropriate form of the morpheme, inserting it into the syntactic frame, and/or planning the articulatory movements associated with the form. One way of characterizing the differences between these two accounts, then, is on whether these children have knowledge about finiteness that they are unable to realize (processing accounts) or lack knowledge about how finiteness is used in English (linguistic accounts).

A third account, the usage-based approach (Tomasello, 2003) proposes that children learn grammatical morphology through the use of analogical reasoning. The omission of a grammatical morpheme by typical children has to do with use of previously heard memorized forms in inappropriate contexts or the overapplication of an existing pattern. This account claims that children under age 4 have no or limited abstract representations. Instead, children appear to be proficient in their use of forms previously thought of as abstract due to memorization and analogical reasoning. This account has not yet been applied to SLI. If this account were contrasted with the above two accounts, one might say that children’s errors are due to a failure to learn the exceptions to a highly frequent pattern. It is worth noting that the proponents of analogical reasoning as a language learning mechanism explicitly reject processing and working memory based explanations of language deficits (Tomasello, 2003, p. 312), thus omissions are not the result of performance difficulties.

Both children who are normally developing and those with phonological impairments may have more knowledge of a target production than is revealed by phonetic transcription. Researchers have used acoustic analysis to demonstrate that some productions that are perceived as overt errors actually include components of a phonetic contrast that are imperceptible to adult listeners. Subphonemic durational changes have been shown to reflect gradations in phonological representations of very young children and children with phonological disorders who are not yet using adult-like phonological forms consistently. These durational changes show that children may have underlying representations that approximate adult representations even in the absence of overt productions (Weismer, Dinnsen, & Elbert, 1981; Scobbie, Gibbon, Hardcastle, & Fletcher, 1997, 2000; Plonsker, Petrosino, & Colcord, 2001; Carter & Gerken, 2003). Hewlett (1988) first used the term “covert contrasts” to refer to these subphonemic contrasts. In a more recent paper, he defines them as “cases in which a child’s productions of two target phonemes sound the same to a listener but instrumental analysis reveals a subtle difference” (Hewlett & Waters, 2004, p. 524).

The present study incorporates acoustic measures of speech timing to explore the role that underlying representations may play in the realization of grammatical morphemes. In what follows, we will first review the literature related to subphonemic changes that have been documented in phonology, with an emphasis on what can be inferred from measures of duration. Then we will discuss the extension of these methods into the area of grammatical morphology, with a particular emphasis on the application to the acquisition of verb morphology by typically developing children and children with SLI.
Underlying representations in phonology

Vowel lengthening serves as a crucial contrast cueing listeners to the phonemic categories of voiced and voiceless final consonants (Peterson & Lehiste, 1960; DiSimoni, 1974). Such vowel lengthening prior to voiced consonants is a robust phenomenon and has been documented reliably in normal children as young as 21 months (Naeser, 1970). Weismer and colleagues (1981) exploited this acoustic signature of final consonants to assess the omission errors of three children with phonological disorders. They examined the length of the vowel in words in which the final consonant was overtly omitted. Two of the three children studied maintained the voicing contrast in the vowel, even when those consonants were omitted. These children also were able to produce the consonant that they had previously omitted when the final consonant occurred in a medial context, as in the diminutive (e.g. dog-doggy). The third child in this study failed to produce either the morphophonemic alternations associated with diminutives or to demonstrate differential vowel lengthening, which was interpreted as an absence of adult-like underlying representations of the target words. Similarly, Plonsker and colleagues (2001) observed a vowel lengthening effect when word final fricatives were omitted.

Longitudinal study of consonant cluster production by two children with phonological disorders has also demonstrated the emergence of a durational signature prior to the overt production of a cluster (Scobbie et al., 1997, 2000). These two children were recorded over four months saying words that contained /s/+stop clusters (e.g. spear) embedded in a carrier phrase while they received intervention targeting these consonant clusters. Although acoustic changes could be documented at early points in the study, trained listeners transcribed the sound as a /s/. At a later time point, the listeners reported an abrupt change from /s/ to /s/+stop productions. This is taken as evidence of covert contrasts and an indication that the child was making gradual progress in therapy despite the sudden change perceived by the listeners.

A third example of the phenomenon of covert contrasts can be found in a study of the omission of initial weak syllables by typically developing 2-year-olds (Carter & Gerken, 2003). The production of words with weak-strong-weak prosodic patterns was contrasted with the production of words with strong-weak stress patterns (e.g. Cassandra vs. Sandy). Although all children were able to produce the target words in isolation, five of the ten children were variable when the words were embedded in carrier phrases (e.g. Feed Cassandra; Feed Sandy). Children who omitted the initial weak syllable in the trisyllabic words showed a preserved timing slot associated with the initial weak syllable. For individual children, lengthening of the timing slot between the verb and the strong syllable in structures with omissions was positively correlated with an increased number of correct productions of the weak syllables. Although the timing slot was preserved, this was accomplished through lengthening of the verb rather than through addition of a pause, indicating that children make global rather than local changes to compensate for the missing syllable. Furthermore, the gradual increase in length of the timing slot combined with the increased production of weak syllables suggests that representations of prosodic units, such as the syllable (Carter & Gerken, 2003) are in place, at least to a degree, even when the syllable is overtly omitted.

Taken together, these studies provide converging evidence that some children with phonological disorders and young typically-developing children may have knowledge of the phonemic targets that are not yet clearly perceived by listeners as present in their speech. Their difficulty in accurately producing the target phonemes cannot be solely attributed to a lack of knowledge, but rather must be at least partially ascribed to some other deficit.
These studies differ in where the subphonemic changes may be found in the speech stream, with two studies reporting more localized changes (changes within the cluster (Scobbie et al., 1997, 2000) and vowel duration changes (Weismer et al., 1981)) and one reporting global changes affecting a larger phrasal unit (Carter & Gerken, 2003). These different results may have to do with the size and type of phonemic unit being analysed. One might expect that changes in syllables would cause larger changes in the prosodic structure of the sentence, while word initial clusters and word final consonant deletion might result in more localized changes in production.

Application to morphosyntax

As described above, evidence for covert contrasts has been found by a variety of researchers in different phonological contexts; however, similar work is only just beginning in the area of morphosyntax. Grammatical morphemes go through periods of gradual development, much like phonological acquisition, and should show a process of rule development and incorporation of that rule into overt productions. One long standing area of investigation that supports the notion of phonetically underspecified grammatical units and gradual morphological acquisition is work on filler syllables (e.g. Bloom, 1970; Peters, 1986, but see Peters, 2001, for a current review). Filler syllables are undifferentiated syllables (like [a]) that replace grammatical morphemes. Typically this syllable replaces several grammatical morphemes of the same class. For example a child might go through a period where he says “I [a] going to the store” or “he [a] running around”. Although there is still debate about the status of filler syllables in child language, it is clear that their use cuts across languages and morphological categories. While some researchers take the point of view that filler syllables serve a purely phonological role, other accounts characterize them as evidence of early awareness of adult grammatical categories or “syntactic units under construction” (Peters, 2001, p. 23). For instance, a case study by Winchester (2005) showed that syllables in the speech of an 18-month-old child gradually became function words by 23 months.

Filler syllables may provide evidence of underspecification in the grammatical arena, but unlike the phonological covert contrasts discussed above, they represent perceptible changes in the production of functional elements. Sadrzadeh (2003) showed that typically-developing 2-year-old children also show subphonemic durational differences when they omit articles before strong syllables. Specifically, these children produced slightly longer responses when they omitted an article than when they produced a near-minimal pair sentence that did not require the article (he kissed the pig vs. he kissed Peggy). Phonologically, articles are generally produced as weak syllables that tend to occur prior to the strong syllable that begins a trochaic lexical item, making them initial weak syllables as in the Cassandra/Sandy example above. The results are highly similar to Carter & Gerken’s earlier work in that children left imperceptible timing slots when they omitted the article as compared to sentences where articles were not required. In comparisons across the two studies a few differences were found. Children were more likely to omit weak syllables that were not independent morphemes than they were articles. Further, the slots that were maintained for weak syllables in content words tended to be longer than the slots that were left for the omitted articles.

Aside from the two lines of research described above, much of the research on grammatical morphology completed to date has focused on adult perception of the presence or absence of the morphemes in question. Demonstration of a durational
“signature” within the vowel of verbs ending in open syllables that is associated with the presence of the third-person singular –s morpheme would provide a starting point for answering the question about whether or not children with SLI have covert knowledge of that morpheme. Presumably, if the (omitted) third-person singular morpheme were simply unrealized but present in the representation, then this durational signature might also be present in the verb, much like the durational signature shown for final consonant deletion. Results such as these would be consistent with an information processing account of morpheme omission. Conversely, if the omitted morpheme were entirely absent from the underlying representation, as predicted by a linguistic-based account, then this durational signature would also be missing from the vowel of the verb. An analogical levelling account of morpheme omission would also predict that a durational signature would not be present in the verb. Presumably if children are over-generalizing a highly frequent pattern, they would be intending to produce a bare stem form and would not show a durational signature. Thus, in this study we ask several specific questions:

Analysis 1: Acoustic signature of third-person singular and bare stem verb inflections
1. Is there a durational signature present that distinguishes verb forms inflected with –s from bare stem verb forms? If so, what is the nature of that signature?
2. Are there differences in the production of third-person singular –s and bare stem targets among children with SLI and their typically developing age- and MLU-matched peers?

Analysis 2: Covert contrasts in omitted third-person singular –s verb inflections
3. Do typically developing children and children with SLI differ from each other with regard to the acoustic characteristics of omissions?
4. Do children’s omissions pattern more closely with overt third-person singular –s or correct bare stem forms?

Method
To examine durational changes that occurred within verbs, open syllable verbs were inserted into sentence contexts where clear third-person singular and bare-stem forms were obligated. These sentences were then elicited from three groups of children. A variety of durational measures were identified for each production, on which the verb forms could then be compared.

Participants
Twenty-four children, all white residents of central Indiana, participated in this study: a group of seven children diagnosed with SLI, a group of 8 children matched according to age, and a group of nine younger, typically developing children matched on mean length of utterance in words (MLU). An additional five SLI children and two MLU-matched children were excluded from analysis due to poor recordings (two SLI, one MLU), failure to produce analysable utterances in all conditions (two SLI, one due to dysfluencies and lexical substitutions; one due to omitting 100% of the time in the simple third-person singular condition), or failure to complete the protocol (one SLI, one MLU). Additionally, one child from the age-matched group and two children from the MLU-matched group were dropped from Analysis 1 to improve group matching. These three children were variable omitters and were retained for the second set of analyses.

Each child passed a hearing screening and an oral mechanism examination (Robbins & Klee, 1987) and obtained above an 85 standard score on a measure of nonverbal
intelligence (the *Columbia Mental Maturity Scales* (Burgemeister, Blum, & Lorge, 1972) for children above 3;6 or the *Leiter International Performance Scales-Revised, Brief IQ Screener* (Roid & Miller, 1997) for children under 3;6). According to parent report, no child had had more than one episode of otitis media within the last 12 months. Children were not reported to have had any neurological damage or to have been identified as being on the autism/pervasive developmental disorder spectrum. All children appeared to be speakers of Standard American English (SAE) as judged by the first author. Even if a child was misclassified as a SAE speaker, omission of third-person singular marking on main verbs is rare in nonstandard forms of white English as well as standard forms (Oetting & Garrity, 2006). In addition, since we considered the use of the third-person singular /s/ marker (e.g. plays), we ensured that children were able to produce word-final consonants /s, z, t, d/ at least 80% of the time in monomorphemic contexts, such as *rose* or *coat*.

Children included in the SLI group performed below the 10th percentile on a version of the *Structured Photographic Expressive Language Test-II* (SPELT-II, Werner & Kresheck, 1983) or the *Reynell Developmental Language Scales, American Standardization* (Reynell & Gruber, 1990). In addition, these children had a finite verb morphology composite score (FVMC: per cent use of *am, is, are, third-person singular –s, and regular past tense –ed in obligatory contexts) in a 100 utterance language sample that was below what would be expected for their age (Goffman & Leonard, 2000). All children included in the SLI group were enrolled in speech/language therapy at the time of participation. See Table I for descriptive information about the children who participated.

Typically developing children performed above the 16th percentile on one of the following standardized language tests: the *Reynell Developmental Language Scales, American Standardization* (Reynell & Gruber, 1990), the SPELT-II (Werner & Kresheck, 1974), or the SPELT-P (Werner & Kresheck, 1983). Their FVMC in a 100-utterance language sample was within the typical range (Goffman & Leonard, 2000). None of these children were enrolled in therapy and all were developing typically by parental report and clinical judgment. Children in the age-matched group were matched within at least 4 months of age with one of the children in the SLI group. Children in the MLU-matched group were matched within .4 words with one of the children in the SLI group.

**Stimulus selection**

Two verbs (*buy* and *play*) were selected from the *Action Words* portion of the *MacArthur Communicative Development Inventory: Words and Sentences* (Fenson et al., 1993) to ensure that they were words likely to be familiar to children and could be easily elicited from the

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Table I. Characteristics of each subject group in analyses 1 and 2. Means and ranges are reported for chronological age (years; months), mean length of utterance in words (MLU), and finite verb morphology composites (FVMC; percent correct of finite verb morphemes in obligatory contexts calculated according to Goffman & Leonard, 2000)

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<th>Group</th>
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<td>Age</td>
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<td>MLU</td>
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youngest participants. We chose these verbs because they have an open syllable structure and include a stop consonant in word initial position. Open syllables were used so that the addition (or omission) of the third-person singular marker –s would have the maximum opportunity to affect the length of vowel. These two verbs were inserted into a series of carrier phrases which also contained highly familiar words and could be easily enacted with toys. The nouns included in the carrier phrases were also selected to begin with stop consonants for ease of segmentation.

Four carrier phrases were constructed for each of the verbs. Given that the two prominent accounts of omission in SLI centre around the children’s representation of finiteness, these sentences were constructed to be near minimal pairs that only differed on whether a third-person singular –s inflection was obligated. Two simple sentences were designed that required an overt –s inflection in order to be judged grammatical: a single clause sentence that utilized the third-person singular form, \textit{Mommy buys popcorn} (hereafter, simple third-person singular Condition) and an imperative form, \textit{Mommy, buy popcorn} (hereafter, simple bare stem Condition). Both sentences consisted of one clause and contained five syllables. We had two concerns about the bare stem stimuli, which will be addressed in the results: first, imperative forms are overtly finite in some languages (e.g. Spanish, see Zagona, 2002, pp. 52–54). It has been argued that these forms are finite even in languages where this is not overtly marked, as in English. Although from the point of view of analogical levelling, this form poses no concern, from the perspective of the minimalist program, these may not be distinguishable with regard to finiteness from unmarked forms of \textit{buy} which occur in third-person singular contexts (\textit{Mommy buy popcorn (everyday)}). In order to provide a fair test from this perspective, a form that is clearly analysable as non-finite should also be used. Second, imperative sentences carry a different prosodic contour than declarative sentences. We were concerned that this prosodic contour would affect the duration of the responses, our primary dependant measure.

To address these concerns two more stimuli were created: a complex bare stem sentence, \textit{I saw Mommy buy popcorn}, and a complex third-person singular sentence, \textit{Bear laughs when Mommy buys popcorn}. In the complex bare stem sentence, the bare stem form is clearly analysable as non-finite within the tradition of generative grammar (consider: \textit{I saw her buy popcorn}) and does not differ markedly from the prosodic contour seen in the complex third-person singular sentence. Both sentences required two clauses and placed the verb form to be analysed in the subordinate clause, thus they were equated on syntactic complexity. However, they were not equated on length; the complex bare stem sentence contained seven syllables while the complex third-person singular sentence contained eight. Sentence length is known to affect the duration of individual words within the sentence, but little is known about the role of syntactic complexity (Kent & Read, 1992). In this study length and complexity are closely approximated, though not identical; the two complex sentences are more comparable to each other than to the simpler forms. To summarize, children were asked to produce sentences in the following four conditions:

1. Simple third-person singular
   - Bobby plays ball.
   - Mommy buys popcorn.

2. Complex third-person singular
   - The bear laughs when Bobby plays ball.
   - The bear laughs when Mommy buys popcorn.

3. Simple bare stem
   - Bobby, play ball.
   - Mommy, buy popcorn.

4. Complex bare stem
   - I saw Bobby play ball.
   - I saw Mommy buy popcorn.
This combination of conditions provides the opportunity to compare children’s productions on the basis of whether the third-person singular –s inflection is obligated, while also manipulating sentence complexity as a factor.

**Elicitation**

In each condition, the child watched a short puppet show and then was asked a question that was meant to elicit the target response. The child was initially encouraged to respond to the question independently. If the child did not produce the target sentence or altered the lexical items in the target sentence, then the experimenter provided a model for imitation (e.g. *Say, Mommy buys popcorn*). Occasionally a brief cue might be given for the first several items if truncated answers were being given or if answers were being given in a slightly different format than the targeted structure (e.g. *start with I saw*). For example, an elicitation of an item might proceed as follows:

Mommy: I like to buy popcorn. I buy popcorn everyday. Oh! I’m done!
Mouse: Oh no! I can’t see. What did you see?
**Child: I saw Mommy buy popcorn.**

Allowable prompts (in order of use):
- Start with “I saw”...
- Can you say, “I saw Mommy buy popcorn”?  

Each of the two verbs in each condition was elicited at least four times, resulting in approximately 32 productions by each child. Each elicitation of a condition was structured to include a teaching item, involving an additional character (*Baby* or *Daddy*), four alternating productions of the target items, a filler item involving a character and action of the child’s choice followed by four alternating productions of the target items. If the experimenter suspected online that a target sentence was lost due to errors in production, noise during recording, or other reasons an additional filler item and four more target items were presented. Each list was presented at least 20 minutes apart, and often on separate days. To maintain interest across conditions, each list utilized a different “toy family” of toys to elicit the productions. Pilot work showed that children who received the imperative condition first sometimes responded to future conditions as if they were participating in the imperative condition. Thus, the lists were presented in the same order each time in order to ensure that any omissions were true omissions and not confusion about the task: simple third-person singular, simple bare stem, complex bare stem, complex third-person singular.

**Recording and data analysis**

All sessions were audio recorded with a Sony TCD-D8 Digital Audio Tape Recorder. The children were encouraged to wear a Pro Series PRO 8Hex dynamic head-worn Hi Energy microphone which was connected to the digital recorder via a Crown PH-1A Phantom Power Supply. The microphone was adjusted to be approximately 2 inches from the children’s mouths. If children refused to wear the headset, they were encouraged to speak into the microphone while the experimenter held it approximately 2–3 inches from the child’s mouth. The data from each experimental session were uploaded directly from the DAT tape to a desktop PC in a wave file format, where all further processing of the data was completed using PRAAT software (Boersma & Weenink, 1992–2002).
The children’s target utterances were identified and coded for the elicitation method required (spontaneous, cued, and imitated), accuracy, fluency of the overall production, and use of third-person singular –s on the target verb. Minor pauses or hesitations often occurred during the main clause or between the main and subordinate clauses (e.g. between “bear” and “laughs” or between “bear laughs” and “when mommy buys popcorn”). Errors of this sort did not influence the analysis of the target verb and thus were not excluded. However, utterances were excluded that included significant revisions and hesitations within the verb phrase. As an example, if a child paused or hesitated at any time during the phrase *Mommy buys popcorn*, the utterance would be excluded from analysis. Some typical errors that might cause an utterance to be unusable included eliding part of the target utterance (e.g. *what does Mommy do everyday?—buy popcorn; When does the bear laugh?—when mommy buys popcorn*), altering the lexical items (e.g. *Bobby throws the ball, Bobby plays with his ball, Mommy gets popcorn*), or hesitating or repeating during the production of the target verb phrase (e.g. *Bobby pla-plays ball, Mommy she mommy buys popcorn*). Sentences that were correct in all respects except for the verb morphology on the target verb were segmented and retained for analysis.

For those utterances which were included in the analysis, four points were identified within the verb phrase: the onset of the burst of the stop consonant in the verb, the onset of the burst of the stop consonant in the noun immediately following the verb, the onset of the vowel in the verb, and the offset of the vowel in the verb. As shown in the example in Figure 1, onsets and offsets were identified using a simultaneous display of spectrogram and waveform information. The burst onsets were chosen based on the initial vertical striation in the spectrogram combined with onset of energy in the waveform display. Vowel onset was identified as the presence of the first and second formants following the initial burst combined with the presence of a quasi-periodic signature within the waveform display.

![Figure 1](image-url)

**Figure 1.** Line 1 includes a general gloss of the utterance segment. Line 2 contains points that indicate where each segment was placed: 1 = verb burst onset; 2 = vowel onset; 3 = vowel offset; 4 = object burst onset. The global duration measure was completed by measuring the duration from 1–4. The two local duration measures included the local vowel duration (measured from 2–3) and local consonant duration (measured from 3–4).
Analysis 1. Acoustic signature of third-person singular vs. bare stem verb inflections

In this set of analyses we address the following two questions, using all accurate productions across the three groups of children as our data:

1. Is there a durational signature present that distinguishes correctly produced third-person singular and bare stem verb forms? If so, what are the characteristics of this signature?
2. Are there differences in the production of correctly produced third-person singular and bare stem targets among children with SLI and their typically developing age- and MLU-matched peers?

Results

To consider the change in duration for each child all the usable tokens of accurate productions within a condition were averaged, yielding a mean for each condition. Responses were collapsed across verb types (play and buy) to maximize the number of responses available for each child/condition. Between two and 12 usable tokens were available for each child in each condition. The means for each child were then entered into

Vowel offset was identified by the decline of the intensity of the first and second formants in combination with the offset of quasi-periodic energy in the waveform display. Occasionally these two cues were dissociated, particularly when in the third-person singular conditions. In these cases, the offset of quasi-periodic energy was used as the primary cue, which resulted in shorter, or more conservative, segmentation decisions. In all cases a combination of visual and auditory information was used to segment the verb phrase.

These four points were then used to form one global and two localized duration measures upon which all further analyses were conducted. The duration in seconds of each of these measures was recorded by PRAAT for all usable utterances. See Figure 1 for an example.

1. Global Duration: measured from the verb’s burst onset to the noun’s burst onset (points 1 through 4 in Figure 1). Given that timing cues are distributed across units larger than the actual phoneme or syllable, this more global measure incorporates the possibility of both altered vowel length and the addition of time due to the phonetic substance of a final consonant (Carter & Gerken, 2003).
2. Localized Vowel Duration: measured from the vowel onset to the vowel offset (points 2 through 3 in Figure 1). This measure was constructed based on the rationale that the inclusion of a final voiced consonant /z/ will alter the length of the vowel, regardless of the morphological status of that final consonant (Weismer et al., 1981).
3. Localized Consonant Duration: measured from the vowel offset to the noun burst onset (points 3 through 4 in Figure 1). This measure was constructed based on the rationale that the inclusion of a final consonant will alter the timing of the onset of the noun, regardless of the voicing of the consonant. Additional phonetic substance, such as a bound morpheme, should require additional time within the prosodic structure of the sentence (Carter & Gerken, 2003). For verbs in conditions where the children included the third-person singular –s morpheme at the end, the “silence” is where the /z/ would appear; for verbs in bare stem conditions or in cases where the child did omit the third-person singular morpheme, this period usually contained little or no phonetic substance.
a 3 (Group) × 2 (Complexity) × 2 (Inflection) mixed model analysis of variance, with group serving as a between subjects factor and complexity and inflection serving as within subjects factors. Each duration measure was considered separately, thus three mixed model ANOVA’s were completed—one for the global duration measure and one for each of the localized duration measures (vowel and consonant effects). All post-hoc analyses reported Fisher Least Squared Differences comparisons. Based on prior work in the area of speech-motor control and SLI, we predicted that children with SLI will take longer to produce utterances than their typically developing peers (Smith, 1978; Kent & Forner, 1980; Smith & Goffman, 1998, Goffman, 1999), thus one-tailed tests will be used to examine group differences, and p-values will be set at p = .10. We had no basis for directional predictions for the other comparisons. Therefore, two-tailed tests will be used for all other comparisons and p-values will be set at p = .05.

Visual inspection of the global duration measure suggested that the children with SLI were producing longer responses than the typically developing groups; the main effect of group was significant with a one-tailed test, F(2, 18) = 2.79, p = .09. Post-hoc testing revealed that the age-matched group and the SLI group were significantly different from each other (p = .03) but neither group was significantly different from the MLU-matched group (MLU-age, p = .54; MLU-SLI, p = .12). For all children the verbs in the simple utterances took longer to produce than the verbs in the complex utterances, F(1, 18) = 4.88, p = .04 and the verbs in the third-person singular utterances took longer to produce than the verbs in the bare stem utterances, F(1, 18) = 53.76, p < .0001. No interactions were found. See Table II for a summary of the data.

Somewhat different results were evident when the localized vowel effects were considered. The three groups of children did not differ from each other with regard to localized vowel duration, F(2, 18) = 2.44, p = .12. Vowel duration tended to be longer in the single clause utterances (M = .234) than in the two clause utterances (M = .220), but this comparison did not achieve significance, F(1, 18) = 3.69, p = .07. Importantly for later comparisons, the third-person singular utterances were longer (M = .237) than the bare stem utterances (M = .218, F(1, 18) = 5.81, p = .03). No interactions were found.

Localized consonant effects were more similar to the results from the localized vowel effects than to the global duration results. Once again, there were no main effects for group,

Table II. Means and standard deviations of each duration measure reported by condition for each group. Durations are reported in seconds.

<table>
<thead>
<tr>
<th>Duration Measure</th>
<th>Condition</th>
<th>ND-Age</th>
<th>ND-MLU</th>
<th>SLI</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Duration</td>
<td>Imperative (Simple bare stem)</td>
<td>.365 (.080)</td>
<td>.381 (.073)</td>
<td>.408 (.096)</td>
<td>.385 (.081)</td>
</tr>
<tr>
<td></td>
<td>Complex bare stem</td>
<td>.347 (.055)</td>
<td>.337 (.064)</td>
<td>.432 (.073)</td>
<td>.372 (.075)</td>
</tr>
<tr>
<td></td>
<td>Simple third-person singular</td>
<td>.453 (.038)</td>
<td>.494 (.041)</td>
<td>.543 (.095)</td>
<td>.497 (.071)</td>
</tr>
<tr>
<td></td>
<td>Complex third-person singular</td>
<td>.419 (.035)</td>
<td>.451 (.030)</td>
<td>.486 (.112)</td>
<td>.452 (.095)</td>
</tr>
<tr>
<td>Localized Vowel Duration</td>
<td>Imperative (Simple bare stem)</td>
<td>.218 (.062)</td>
<td>.216 (.035)</td>
<td>.242 (.081)</td>
<td>.225 (.060)</td>
</tr>
<tr>
<td></td>
<td>Complex bare stem</td>
<td>.198 (.031)</td>
<td>.190 (.063)</td>
<td>.241 (.057)</td>
<td>.210 (.055)</td>
</tr>
<tr>
<td></td>
<td>Simple third-person singular</td>
<td>.222 (.029)</td>
<td>.227 (.047)</td>
<td>.279 (.037)</td>
<td>.243 (.045)</td>
</tr>
<tr>
<td></td>
<td>Complex third-person singular</td>
<td>.218 (.046)</td>
<td>.213 (.058)</td>
<td>.263 (.071)</td>
<td>.231 (.061)</td>
</tr>
<tr>
<td>Localized Consonant Duration</td>
<td>Imperative (Simple bare stem)</td>
<td>.100 (.021)</td>
<td>.125 (.033)</td>
<td>.110 (.027)</td>
<td>.112 (.028)</td>
</tr>
<tr>
<td></td>
<td>Complex bare stem</td>
<td>.108 (.033)</td>
<td>.106 (.022)</td>
<td>.151 (.039)</td>
<td>.122 (.037)</td>
</tr>
<tr>
<td></td>
<td>Simple third-person singular</td>
<td>.183 (.029)</td>
<td>.224 (.032)</td>
<td>.221 (.082)</td>
<td>.209 (.054)</td>
</tr>
<tr>
<td></td>
<td>Complex third-person singular</td>
<td>.167 (.051)</td>
<td>.191 (.043)</td>
<td>.187 (.057)</td>
<td>.182 (.049)</td>
</tr>
</tbody>
</table>
F(2, 18) = 1.69, p = .21, or for utterance complexity, F(1, 18) = 1.34, p = .26. However, third-person singular utterances (M = .196) were significantly longer than bare stem utterances (M = .117, F(1, 18) = 106.30, p < .0001). An interaction between complexity and inflection, F(1, 18) = 5.67, p = .03, revealed that utterance complexity was more likely to influence the third-person singular conditions than the bare stem conditions. The simple third-person singular condition (M = .209) was significantly longer than the complex third-person singular condition (M = .182, p = .02) but the simple bare stem condition (M = .112) and the complex bare stem condition (M = .122) did not differ from each other (p = .38).

To summarize, the three groups only differed from each other on the global measures, but not on the more localized comparisons. For all children, the responses did vary based on the complexity and inflection status of the target item. This was especially true in the localized consonant measures, in which we saw that the simple third-person singular condition was longer than the complex third-person singular condition, both of which were longer than the bare stem conditions.

**Discussion of Analysis 1**

The results from Analysis 1 show that the overt inclusion of a morpheme resulted in longer responses across all three durational measures than those conditions that did not obligate the –s morpheme. The localized vowel measure also showed effects related to the presence or absence of the morphological inflection, despite the fact that the inflection was not directly included within the points that make up this measure. This result suggests that we may be able to use subphonemic changes when we examine the omission data in Analysis 2.

Length and complexity have previously been shown to influence aspects of speech production, including duration (Kent & Read, 1992). In the complex conditions children produced shorter global effects and localized vowel effects than in the simple conditions. Within the localized consonant measure this effect was less prominent. Recall that the complex conditions contained two or three more syllables than did the simple conditions. It is not surprising that length influenced vowels more than consonants, since “compression” of an utterance due to changes in rate applies most strongly to vowels and less so to brief segmental elements of the utterance for both adults and children (Gay, 1977; Smith, 1978).

These results also allow us to address one concern about our elicitation procedures. The complex conditions were introduced due to a concern that prosodic factors might influence the non-finite responses, since imperatives have a markedly different intonation contour than declarative sentences. In the only instance where an interaction between complexity and inflection status was found, it was driven primarily by differences between the third-person singular responses, not the bare stem responses. These results suggest that such concerns, while relevant, are likely not affecting our results overall.

Although it appears that our data replicate earlier findings about the role of sentence length on phoneme duration, the factors that contribute to compression are not entirely clear. While both the complex third-person singular and complex bare stem responses contained an additional clause, they were not exactly matched on number of syllables. Thus, one may be concerned that some of the differences found between the finite and bare stem conditions may actually be attributed to these small differences in length. However, the complex third-person singular condition (e.g. Bear laughs when Mommy buys popcorn), which has more syllables, words, and morphemes than the complex bare stem condition (e.g. I saw Mommy buy popcorn), actually had longer global duration measures and localized
vowel duration measures, in addition to longer localized consonant duration measures. Since these differences go in the opposite direction than would be predicted based on utterance length alone, the differences associated with the third-person singular conditions may be accepted as real differences related to the presence or absence of the /z/ associated with the third-person singular morpheme –s.

With regard to differences among the three groups of children, our results suggest that children with SLI take longer to produce the same utterances than their typically developing age-mates when global measures are used. They are not different than MLU-matched peers and no differences with either comparison group were found when more narrow duration measures were chosen. Although many of these results do not achieve significance, the trend in the responses is in the direction of previous findings (Smith, 1978; Kent & Forner, 1980; Smith & Goffman, 1998). The small number of children in each group may make it difficult to detect group differences, so these results should not be considered contradictory to previous findings and should be interpreted with caution.

To summarize, the results indicate that overtly marked finite productions show a durational signature of longer durations for the verb, vowel, and “silence” intervals associated with the finite verb. Although utterance complexity appears to play a role in durational differences, finiteness appears to be the overriding factor in determining the length of all of the chosen measures. The only group differences found were between age-matched children and the children with SLI on the global duration measures.

Analysis 2. Covert contrasts in omitted third-person singular verb inflections

In the following analysis we address the remaining two questions:

3. Do typically developing children and children with SLI differ from each other with regard to the acoustic characteristics of omissions?

4. Do children’s omissions pattern more closely with overt third-person singular –s or correct bare stem forms?

Participants

To address these questions, only those children who were variable omitters are included in the following analyses. If a child omitted at least once and produced at least one correct third-person singular and one correct bare stem response in the same complexity condition, he or she was included. This resulted in a typically developing group of eight children made up of three children from the age-matched cohort and five children from the MLU-matched cohort. This newly composed group of typical children ranged in age from 2;11 to 6;5 (M=4;1, SD=12.7 mos.) and had an average MLU of 4.49 (SD=.72). Five children from the SLI group also met the criteria of omitting variably during the task. These children ranged in age from 5;2–6;6 (M=5;9, SD=7.6 mos.) and had an average MLU of 4.57 (SD=.42). It is worth noting that the children with SLI were significantly older than the typically developing group (p=.008), but the two groups did not differ in MLU (p=.838).

Omissions and duration measures

Fluent, analysable tokens were sorted into categories of correct third-person singular, omitted third-person singular, and bare stem. We collapsed across verb types and length conditions here to maximize the number of tokens available. As before, all the usable tokens
were averaged yielding a mean for each condition. The number of omissions from each child ranged from 1–8; the number of correct responses in either the third-person singular or the bare stem conditions ranged from 6–20.

Once again, three duration measures were considered: the global duration and localized vowel and consonant durations. The means and standard deviations for the three duration measures are reported in Table III for all variable omitters and broken down by diagnostic group. Because of the small number of participants, these descriptive measures served as the core of this analysis, with statistical tests providing verification. Thus, for each duration measure, means for each child were entered into a 2 (Group) × 3 (Response type) mixed model ANOVA, where group served as a between subject factor and response type served as a within subject factor.

Looking first at the global duration analysis, there was a main effect of group, $F(1, 11)=8.89, p=.01$, with the children with SLI producing responses with longer durations than the typically developing children. There was also a main effect of response type, $F(2, 22)=5.82, p=.009$, which is best interpreted within the context of an interaction between response type and group, $F(2, 22)=4.71, p=.02$. Post hoc testing revealed that the omissions produced by the typically developing children tended to be shorter than their correct third-person singular responses ($p=.06$), but were not significantly different than their bare stem productions ($p=.45$). In one sense, these results are unsurprising since the surface forms of the omitted and bare stem productions are identical; however, the literature on covert contrasts would suggest that the omitted productions should be longer than the bare stem productions if the children have covert knowledge of the missing morpheme.

The children with SLI showed a different pattern—as can be seen in Figure 2, their omitted productions were significantly longer than both their correct third-person singular responses ($p=.04$) and their bare stem responses ($p=.002$), which did not differ from each other ($p=.23$). The covert contrast literature would predict that the omitted productions should be significantly longer than the bare stem productions, but not longer than the correct third-person singular productions. We observed longer durations in the omitted productions than in both the correct bare stem and the correct third-person singular productions.

We hypothesized that vowel lengthening might be one area that would reflect the omission of the grammatical morpheme, since the –s morpheme is produced as a voiced

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### Table III. Means and standard deviations of each duration measures for correct and omitted productions from all children who were variable omitters. Durations are reported in seconds.

<table>
<thead>
<tr>
<th>Duration Measure</th>
<th>Condition</th>
<th>Group</th>
<th>ND</th>
<th>SLI</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Duration</td>
<td>Correct third-person singular</td>
<td></td>
<td>.459 (.067)</td>
<td>.500 (.104)</td>
<td>.475 (.082)</td>
</tr>
<tr>
<td></td>
<td>Omitted third-person singular</td>
<td></td>
<td>.370 (.065)</td>
<td>.627 (.244)</td>
<td>.469 (.198)</td>
</tr>
<tr>
<td></td>
<td>Correct bare stem</td>
<td></td>
<td>.334 (.037)</td>
<td>.428 (.079)</td>
<td>.371 (.072)</td>
</tr>
<tr>
<td>Localized Vowel Duration</td>
<td>Correct third-person singular</td>
<td></td>
<td>.236 (.046)</td>
<td>.260 (.051)</td>
<td>.245 (.048)</td>
</tr>
<tr>
<td></td>
<td>Omitted third-person singular</td>
<td></td>
<td>.203 (.039)</td>
<td>.318 (.069)</td>
<td>.247 (.077)</td>
</tr>
<tr>
<td></td>
<td>Correct bare stem</td>
<td></td>
<td>.192 (.024)</td>
<td>.250 (.060)</td>
<td>.214 (.049)</td>
</tr>
<tr>
<td>Localized Consonant</td>
<td>Correct third-person singular</td>
<td></td>
<td>.185 (.034)</td>
<td>.237 (.040)</td>
<td>.205 (.044)</td>
</tr>
<tr>
<td></td>
<td>Omitted third-person singular</td>
<td></td>
<td>.126 (.044)</td>
<td>.261 (.131)</td>
<td>.178 (.107)</td>
</tr>
<tr>
<td></td>
<td>Correct bare stem</td>
<td></td>
<td>.102 (.016)</td>
<td>.131 (.027)</td>
<td>.113 (.025)</td>
</tr>
</tbody>
</table>
final consonant. As in the global duration measure reported above, children with SLI produced significantly longer local vowel effects than typically developing children did, $F(1,11)=10.23$, $p=.008$. The main effect of response type, $F(2, 22)=3.65$, $p=.04$, was mitigated by an interaction between group and response type, $F(2, 22)=4.67$, $p=.02$. Once again, there was a trend for the typically developing children’s correct third-person singular productions to be longer than their omitted productions ($p=.09$) but the omitted and bare stem productions were not significantly different from each other ($p=.56$). For the children with SLI, the local vowel measure in the omitted productions were significantly longer than the correct third-person singular productions ($p=.02$) and the bare stem productions ($p=.008$), which did not differ from each other ($p=.66$).

We also wished to determine if there were changes that were localized to the region of the final consonant, altering the slot where the grammatical morpheme should have been had it been produced. To examine this we compared the duration of the localized consonant measure across response types and groups. As with the other measures, children with SLI produced responses with longer durations than the typically developing children, $F(1, 11)=13.26$, $p=.004$. There was also a main effect of response type, $F(2, 22)=11.16$, $p=.0005$. The omitted responses were significantly longer than the bare stem responses ($p=.005$) but not different from the correct third-person singular responses ($p=.20$) when all children were considered together. There was also a marginally significant interaction between group and response type, $F(2, 22)=3.36$, $p=.053$. Post-hoc analyses suggested that the two groups of children were using opposing response patterns. The typically developing children produced omissions that were significantly shorter than their correct third-person singular responses ($p=.04$), but not different from their bare stem responses ($p=.37$). The children with SLI, on the other hand, produced omissions that were longer than their bare stem productions ($p=.0008$) but not different from their correct third-person responses ($p=.50$). This suggests that, on this measure, the omitted responses were
patterning more closely with the third-person singular responses than the bare stem responses for the children with SLI.

Discussion of Analysis 2

The duration data reported here suggest that children with SLI and typically developing children are employing different strategies for producing their responses. The omitted third-person singular productions from the typically developing children were not significantly different from the bare stem productions, but were significantly shorter than their correct third-person singular responses. These results are consistent with the surface forms being produced. The bare stem production and the omitted third-person singular production have identical surface realizations. The correct third-person singular form is longer than both of these, which is to be expected since a phoneme is being added. A trend of gradually declining durations can be seen in Figure 2, which appears to be consistent with the predictions of the covert contrast literature, but is not supported statistically. Thus, we must conclude that these children do not have an underlying representation of the third-person singular –s that is affecting their omitted productions, which would be consistent with either the OI or analogical levelling approaches to omissions.

The children with SLI present a very different picture. The omitted productions were significantly longer than either the correct third-person singular or bare stem responses for both the global duration measure and the localized vowel duration measure. This was unexpected. None of the available accounts would explicitly predict increases in duration above and beyond the correct target response. However, it is difficult to explain away the differences between the three types of productions unless covert knowledge is considered as a factor. For the localized consonant duration measure the omitted productions were significantly longer than the bare stem productions and not different from the correct third-person singular productions, which is in line with accounts of covert contrasts. The increased durations for the omissions cannot be explained by changes in surface form or prosody, particularly because two of three analyses documented durations for omitted productions that were even longer than the correct target forms. These results suggest that children with SLI are treating omitted third-person singular responses in a fundamentally different way than their other responses.

To summarize, in Analysis 2 we found that there was no evidence for covert contrasts in the productions by typically developing children. However, productions with omissions by children with SLI were longer than both correct third-person singular and bare stem productions.

Discussion

In this paper, we explored the question of whether there was evidence of underlying morphological knowledge when children omitted the third-person singular –s. We used durational measures to consider whether evidence of covert contrasts exist in children’s speech with regard to verb morphology. This is an especially important question for children with SLI, because many theoretical accounts of these children’s deficits make inferences about underlying knowledge of finiteness based on the pattern of omissions of grammatical inflections.

In the signature analyses we found that all children showed clear differences between the production of third-person singular and bare stem forms, regardless of age or diagnostic
status. These differences existed at both global and local levels and were generally similar across all three groups. The existence of global and local durational signatures enabled us to complete a second set of analyses with a subset of children, comparing omitted productions to correctly produced third-person singular and bare stem forms. In these analyses, we found that typically-developing children do not show evidence of covert contrasts—their omitted productions pattern most closely with the productions with which they share a surface representation, bare stem forms. In contrast, the children with SLI produced omissions that were noticeably longer than either of the correct forms on both the global duration measure and the local vowel duration measure. The local consonant duration measure was more in line with our predictions, with the omitted forms patterning most closely with the overtly inflected forms. Although it is not clear if children with SLI are demonstrating hidden knowledge, it does appear that their omitted productions are being produced in a different manner than their correct third-person singular and correct bare stem productions and in a way that is different from the omissions by the typically developing children.

It is first important to consider how developmental changes in speech rate have been interpreted in earlier studies. Many previous studies have shown that younger children produce longer speech movement durations than older children and adults (e.g. Kent & Forner, 1980; Goffman & Smith, 1999; Smith & Zelaznik, 2004). Such duration differences are thought to show that processing load is higher for younger children. These studies have typically compared discrete and well separated age groups (e.g. Smith & Goffman, 1998, compared 4-year-olds, 7-year-olds, and adults). The children in the present study ranged in age from 2;11 to 6;6, with many younger MLU matched children included. Given the method of group comparisons in these prior studies, it is not surprising that we did not find group differences in comparisons to the younger MLU-matched group. As expected, group differences were found between the age-matched group and children with SLI. The fact that these findings were only found at the global level suggests that children with SLI have difficulty producing correct responses throughout the response planning and it is not isolated to a particular portion of the utterance.

Children’s omissions of grammatical morphemes have traditionally been assessed on purely linguistic grounds. Investigators have attempted to explain children’s variable production of verb morphology by proposing that children do not know that finiteness is obligatory in main clauses (Rice et al., 1995; Rice & Wexler, 1996) or by suggesting that children have difficulty with formal linguistic movement (Van der Lely, 1998). Both of these accounts stem from the generative tradition and explain SLI as a language-specific deficit that affects some element of formal grammar. In these cases, variable production refers to the fact that sometimes children produce the correct finite form and sometimes they fail to produce the finite form. These accounts usually claim that the child is producing a truly non-finite form instead and may be supported by the duration results from the typically developing children in the omission analyses. That is, because the omission results patterned most closely with the non-finite productions, there is no reason to believe that the typically developing children were doing anything except omitting the finiteness marker both at the surface and in underlying representations. However these accounts cannot explain the results found for the children with SLI. If children with SLI are truly optionally marking finiteness, we would expect that surface forms that are bare stems would be non-finite. Thus, we would not predict that children would take longer to produce the omitted forms than either the accurate finite or non-finite targets.
An alternative explanation stems from the usage-based approach, which hypothesizes that children either produce a series of memorized forms (item-based use) or construct an abstract morphological paradigm through the process of analogical reasoning. Analogical levelling would predict that high frequency forms in the input are overextended leading to apparently incorrect productions. Children go through a period of over-regularization before they learn the exceptions to the rule and infrequent forms are eventually dropped from the language entirely. Diachronically, this has led to the regularization of irregular past tense forms (consider formerly irregular forms: blend/blent, pen/pent, Pinker, 1999). Currently, some investigators believe that third-person singular –s may also be fading from our language, because the bare stem form of the verb occurs much more often than the inflected form. None the less, the predictions of this account for durational measures are indistinguishable from the linguistic accounts described above. Depending on your theoretical orientation, this could be a plausible explanation for the omissions seen in the typically developing children in this study. However, the duration measures do not appear to be consistent with this account for the children with SLI.

The primary rationale for asking the present question was to understand whether omissions of third-person singular inflections indicate a lack of knowledge. It may be that performance factors influence the overt expression of a form, but that at least some degree of knowledge is present even in the case of omission. Previous work on covert contrasts has indicated that forms overtly omitted may, to some degree, be represented and can be observed through fine-grained analyses (Weismer et al., 1981; Scobbie et al., 2000; Carter & Gerken, 2003).

A similar observation about covert contrasts has been made using measures of oral movement as an indicator of knowledge of different prosodic categories (Goffman, 1999, 2004; Goffman, Heisler, & Chakraborty, 2006). Children with SLI are known to have difficulty with prosodic structure; grammatical inflections occurring in unfooted prosodic environments are especially prone to omission (McGregor & Leonard, 1994). Direct recordings of oral movement reveal that, even when these syllables are not omitted, children with SLI have difficulty producing the small and short oral movements required for the production of weak syllables (Goffman, 1999, 2004; Goffman et al., 2006). These children are also more variable in their movement patterning than their age-matched ND peers. Even in the face of these movement implementation differences, children with SLI do produce distinctions across different prosodic categories, such as iambic and trochaic (Goffman, 1999, 2004; Goffman et al., 2006). Thus, children with SLI show performance limitations in their production of prosodic structure. However, these data suggest that these children have a similar degree of knowledge of prosodic categories as their normally developing peers. In the present study, errors of omission may be occurring partially as a result of performance factors. Both sets of data suggest that children with SLI have knowledge of language categories that is masked by performance factors from within the cognitive or motor domains.

Given that we often think of children with SLI as being similar to younger controls, it is curious that duration data suggest that the typically developing group treats omissions differently from the group of children with SLI. It is worth noting that even though the group of typical children in the second analyses remained closely matched on MLU, they had significantly higher finite verb morphology composites, indicating a higher degree of proficiency with finite morphemes in spontaneous language. The typically-developing children may have been more fluent and more automatic, even in their omitted productions than the children with SLI. One explanation for the increased durations shown by the
children with SLI is related to the fact that they are aware that a grammatical morpheme is necessary and are attempting to incorporate it into fluent speech. Carter and Gerken (2003) showed that children who were more accurate at producing initial weak syllables also left longer “slots” for the syllable even when they omitted. Similarly, Scobbie and colleagues (1997) found that over time children gradually altered their production of s+stop clusters to allow for an increased closure during the stop portion of the cluster. The change was not an abrupt reorganization of the phonological system but a gradual transition towards the target. Due to the cross-sectional nature of our analyses and the low rate of omissions, it is difficult for us to determine if children from the SLI group were moving towards increased use of the target morphemes. Perhaps what we are seeing in the duration measure is an increased “timing slot”, with children attempting to leave enough time for the finiteness marker to be incorporated into the surface production. In some cases children succeed and produce correct third-person singular –s forms. In other cases, children do not succeed, but some of these children may be lengthening the timing slot to accommodate future production of the surface form.

Clinical implications and future directions

To summarize, it would seem that children with SLI and typically developing children omit grammatical morphemes for different reasons. The omissions of children with SLI are characterized by increased duration and variability while the omissions of typically developing children most closely resemble their non-finite productions, which share the same surface form. From a practical perspective, this means that children with SLI may know that a morphological marker should appear in all main clauses, but may have difficulty actually incorporating that marker into fluent speech. That is, these children may know what present tense is and that a tense marker is required in the utterance, but are having difficulty realizing the morpho-phonological form. Children who show the profile seen here likely do not need to work on building the distinction between bare stem forms and present or past tense. For children who have partial representations or underlying knowledge of the form, the focus in therapy should be on making production so automatic that processing limitations will not restrict the child’s ability to produce the target form. It might be that the most effective form of therapy would allow the maximal number of opportunities to produce the target form. Such an approach is documented as effective within the area of phonological intervention (Shriberg & Kwiatkowski, 1982).

In contrast, for children who are omitting without leaving a timing slot, we lack evidence that they know the difference between inflected and bare stem forms. In these cases therapy techniques that focus on understanding the concept of tense and finiteness may be a critical first step, much as the use of minimal pairs in perception activities can be a critical first step in eliminating phonological processes. Emphases on naturalistic approaches which show the child when each type of form should be used might be more appropriate. For instance, focused stimulation, conversational recasts, and intentional errors on the part of the clinician followed by immediate and explicit corrections have been shown to be effective in increasing the use of grammatical morphemes marking tense and agreement (Leonard, Camarata, Brown, & Camarata, 2004).

Significant future work is necessary to develop this account of children’s omissions. Specifically, a wider variety of sentences and verb types would provide more support and rule out potential confounds due to factors like prosody and segmentation artifacts. More responses for each item type and/or a larger number of participants would allow for
stronger statistical analyses to be completed. Of course, replication in another laboratory with different stimuli would provide the strongest possible support. Longitudinal work with younger typically developing children and children with SLI is also necessary in order to clarify the role that gradual subphonemic changes play in the acquisition of grammatical morphemes. This would also allow us to determine if these changes are specific to children with SLI or occur across all children, albeit at different ages.

Acknowledgements

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References


