Suprasegmental Characteristics of Speech Produced during Simultaneous Communication by Inexperienced Signers

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This study investigated suprasegmental variables of syllable stress and intonation contours in contextual speech produced during simultaneous communication (SC) by inexperienced signers. Ten hearing inexperienced sign language users were recorded under SC and speech-alone (SA) conditions speaking a set of sentences containing stressed versus unstressed versions of the same syllables and a set of sentences containing interrogative versus declarative versions of the same words. Results indicated longer sentence durations for SC than SA for all speech materials. Vowel duration and fundamental frequency differences between stressed and unstressed syllables as well as intonation contour differences between declarative and interrogative sentences were essentially the same in both SC and SA conditions. The conclusion that prosodic rules were not violated by inexperienced signers in SC is consistent with previous research indicating that temporal alterations produced during SC do not involve degradation of other temporal or spectral characteristics of English speech.

Suprasegmental, or prosodic, speech characteristics are important in both the accurate production and perception of speech (Borden, Harris, & Raphael, 2003). Significant research over the years has demonstrated the challenges that deaf speakers encounter in both the production (Levitt, 1971; Monsen, 1978) and perception (Most & Peled, 2007) of suprasegmental speech characteristics. Recent research has also considered the importance of prosody in the speech model presented to deaf and hard-of-hearing children who are developing speech (Whitehead, Schiavetti, Metz, Gallant, & Whitehead, 2000).

Most and Peled (2007) recently studied the perception of suprasegmental features by children who used cochlear implants (CIs) and hearing aids (HAs) and found performances varying across various speech perception tasks with no advantage of CI use over HA use in the perception of stress or intonation. They concluded that continuing research needs to investigate what variables may affect suprasegmental perception in these children. One variable of interest is the method used to communicate with children who have severe or profound hearing loss. Simultaneous communication (SC) is one method often used to enhance speech and language development of hard-of-hearing children through combining speech and manual communication at the same time. Some researchers, however, have concluded that SC presents an unnatural sounding speech model for hard-of-hearing children because of temporal slowing of the speech produced during SC (Huntington & Watton, 1984; Marmor &

Previous research (Huntington & Watton, 1984; Whitehead, Schiavetti, Whitehead, & Metz, 1995; Windsor & Fristoe, 1989) reported that speech produced during SC differed from speech alone (SA) in many temporal characteristics, including slower speech rate and increased sentence, word, and vowel durations. Whitehead et al. (1995) showed that the addition of a relatively simple fingerspelling task to SC further increased segmental durations. Windsor and Fristoe (1989, 1991) concluded that speakers slowed their speech movements during SC to maintain simultaneity between speech and manual communication. Huntington and Watton (1984) reported that teachers who used speech and signed English in a total communication classroom occasionally showed disruptions in the normal rhythm of speech because of their attempts to synchronize vocalizations with signs. They concluded that in some instances when using SC, children may not be exposed to the typical prosodic and segmental features of speech that are necessary for developing oral communication skills.

Schiavetti, Whitehead, and Metz (2004) recently reviewed research on acoustical and perceptual characteristics of speech produced during SC by both experienced and inexperienced signers. They concluded that, despite the slowness of speech in SC, experienced signers showed no violations of linguistic rules for a large number of important temporal and spectral segmental speech characteristics which are necessary for the perception of intelligible speech. For example, their review included research which documented that the segmental speech features of voice-onset time distinction between voiced and voiceless plosives, locus equation relationships of vowel formant transitions, and spectral moments of consonants were all maintained in SC in the same fashion as in SA. In addition, Schiavetti et al. (2004) cited the need for research on suprasegmental characteristics of the speech model presented during the use of SC.

Two important suprasegmental characteristics of spoken English are intonation and stress (Borden et al., 2003, p. 121). The experimental paradigm for examining these suprasegmental characteristics has included measurements of (a) the fundamental frequency contour difference between declarative and interrogative sentences (Lehiste, 1976) and (b) the vowel fundamental frequency and duration differences between stressed and unstressed syllables (Fry, 1958). Lehiste (1976) described the importance of intonation when she stated (p. 232) “Intonation does not change the meaning of lexical items but constitutes part of the meaning of the whole utterance—signaling, for example, a difference between a statement and question.” In addition, she summarized the importance of stress by stating (p. 237) “When stress functions at the sentence level, it does not change the meaning of any lexical item, but it increases the relative prominence of one of the lexical items.” Thus, both stress and intonation are important suprasegmental characteristics for enhancing the quality of the adult speech model presented to hard-of-hearing children who are developing speech.

Although these suprasegmental characteristics have been studied in the speech of experienced signers during SC (Whitehead et al., 2000), no external validity research has been reported on suprasegmental characteristics of the speech of inexperienced signers. Systematic replication for external validity is necessary to determine the extent to which results with experienced signers generalize across persons of less experience signing who are more representative of new parents or teachers who recently learned to sign. As Pedhazur and Schmelkin (1991, p. 229) stated (italics theirs) “Generalizing across concerns the validity of generalizations across populations.” They further stated (Pedhazur & Schmelkin, 1991, p. 229) that many of the threats to external validity can best be understood when cast in the form of an interaction .... Thus, when it is concluded that treatments, or independent variables, interact with attributes of the people being studied or the settings, to name but two factors, generalizations are limited accordingly. For example, when modes of communication interact with race of the receiver of the communication, a blanket statement about the effects of the modes of communication is inappropriate. Instead, it is necessary to specify the effects of each mode of communication for a given racial group.

By the same token, the effects of the SC mode of communication with experienced signers needs to be
studied with systematic replication to determine the external validity of the results to generalize across persons of less experience signing. Generalizing results beyond highly experienced signers is important for three reasons. First, inexperienced signers may demonstrate speech disruption during SC that is quite different from experienced signers. Second, many inexperienced signers such as parents, siblings, peers, or school teachers use SC with deaf and hard-of-hearing children. Woodward and Allen (1993), for example, reported that 21% of residential school teachers of the deaf and 52% of nonresidential school teachers of the deaf rated their own sign language skills as “greatly inferior” to their English skills, indicating that they were not experienced signers. In addition, Watson, Hardie, Archbold, and Wheeler (2008) concluded that parents still value the combining of speech with sign after cochlear implantation. Third, Lodge-Miller and Elfenbein (1994) found that inexperienced signers tended to overestimate their signing ability, implying that they may also overestimate their SC ability.

Whitehead et al. (2000) completed a study regarding the suprasegmental variables of intonation contour and syllabic stress during SA and SC produced by experienced signers. They investigated differences (a) between vocal fundamental frequency and vowel duration (essential acoustic correlates of syllabic stress) in stressed versus unstressed syllables and (b) between vocal fundamental frequency contours in declarative versus interrogative sentences. Their results indicated significantly longer sentence durations for SC than SA for all speech materials. However, vowel duration and fundamental frequency differences between stressed and unstressed syllables were essentially the same in both the SC and SA conditions. In addition, intonation contours for declarative and interrogative sentences followed the same pattern for both SA and SC.

The purpose of this investigation was to extend the external validity of the findings reported by Whitehead et al. (2000) by systematically replicating their study using persons who had recently learned SC and, therefore, were inexperienced users of this mode of communication. Specifically, this study was designed to examine (a) the fundamental frequency contour differences between declarative and interrogative sentences and (b) the vowel fundamental frequency and duration differences between stressed and unstressed syllables in inexperienced signers under two experimental conditions: (a) using SA versus (b) using SC.

### Method

#### Speakers

Speakers for this study were 10 hearing adult females, who were students in the Department of Communicative Disorders and Sciences at the State University of New York, Geneseo. All the speakers had just successfully completed a one semester beginning course in sign language, which included the use of speech combined with signed English and fingerspelling, when they were recorded for this study.

#### Speech Stimuli

The speech materials (see Tables A1 and A2) spoken by the participants were based on those designed by Metz, Schiavetti, Samar, and Sitler (1990) to elicit utterances that would permit acoustic analysis of three prosodic variables: (a) fundamental frequency contour differences between declarative and interrogative sentences; (b) vowel duration differences between stressed and unstressed monosyllables; and (c) vowel fundamental

<table>
<thead>
<tr>
<th>Table A1</th>
<th>Declarative and interrogative sentences</th>
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<tbody>
<tr>
<td><strong>Declarative sentences</strong></td>
<td><strong>Interrogative sentences</strong></td>
</tr>
<tr>
<td>He swallowed the pill.</td>
<td>He swallowed the pill?</td>
</tr>
<tr>
<td>He is your pal.</td>
<td>He is your pal?</td>
</tr>
<tr>
<td>His name is Paul.</td>
<td>His name is Paul?</td>
</tr>
<tr>
<td>You need to pull.</td>
<td>You need to pull?</td>
</tr>
<tr>
<td>You swim in the pool.</td>
<td>You swim in the pool?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table A2</th>
<th>Stressed and unstressed vowels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1A</strong></td>
<td><strong>1B</strong></td>
</tr>
<tr>
<td>Is it a thin dog?</td>
<td>Is it a fat cat?</td>
</tr>
<tr>
<td>No, it is not a thin dog.</td>
<td>No, it is not a fat cat.</td>
</tr>
<tr>
<td>It is a fat dog.</td>
<td>It is a fat dog.</td>
</tr>
<tr>
<td><strong>2A</strong></td>
<td><strong>2B</strong></td>
</tr>
<tr>
<td>Is it a small bat?</td>
<td>Is it a big ball?</td>
</tr>
<tr>
<td>No, it is not a small bat.</td>
<td>No, it is not a big ball.</td>
</tr>
<tr>
<td>It is a big bat.</td>
<td>It is a big bat.</td>
</tr>
<tr>
<td><strong>3A</strong></td>
<td><strong>3B</strong></td>
</tr>
<tr>
<td>Is it a small cat?</td>
<td>Is it a big dog?</td>
</tr>
<tr>
<td>No, it is not a small cat.</td>
<td>No, it is not a big dog.</td>
</tr>
<tr>
<td>It is a big cat.</td>
<td>It is a big cat.</td>
</tr>
</tbody>
</table>

*Note: Bold = stressed.*
frequency \( (f_0) \) differences between stressed and un-stressed monosyllables. The stimulus material used to examine the \( f_0 \) contours associated with productions of the declarative and interrogative sentences consisted of a group of five sentences terminally punctuated with a period and a group of the same five sentences terminally punctuated with a question mark (e.g., “His name is Paul.” versus “His name is Paul?”). The speakers were instructed to read the sentence as if they were making a statement if it was punctuated with a period and to read the sentence as if they were asking a question if it was punctuated with a question mark.

To examine vowel \( f_0 \) and vowel duration differences between stressed (bold words in Table A2) and un-stressed monosyllables, each speaker read three sets of six sentence sequences that contrasted in stress on particular words. For example, in the sequence, “Was it a small bat? No, it was not a small bat. It was a big bat,” the word big in the third sentence should receive more stress than it would in the sequence, “Was it a big ball? No, it was not a big ball. It was a big bat.” Similarly, the word bat in the last sentence of the second sequence should receive more stress than it would in the last sentence of the first sequence. Vowel \( f_0 \) and vowel duration measures were made for each word, and the stressed versions were compared with the un-stressed versions of each word on these two variables.

Recording Procedures

The experimental sentences were spoken at a comfortable conversational loudness level as they were presented on flashcards. Audio recordings were made in a sound-treated booth using an Audio-Technica AT-816 microphone that was placed 15 cm from each speaker’s mouth. The microphone was connected to a Tascam 202MKII tape deck. The speakers produced each group of sentences under two conditions: (a) SA and (b) SC using speech combined with signed English and fingerspelling. The sentences were presented to the speakers on flashcards in two different random orders, one for each experimental condition, and the order of experimental condition (SA vs. SC) was counterbalanced across speakers. The speakers were shown the words before recording so they could familiarize themselves with the signs to be used in SC.

Acoustic Analysis Procedures

Sentence-level measurements. For each speech sample, total sentence duration measured in milliseconds was determined for the declarative and interrogative sentences and for the last sentence in each sequence containing the stressed and unstressed words. The acoustic signal from the audio recording of each sentence was digitized with 16-bit precision at a sampling rate of 20 kHz using Kay Elemetrics Computerized Speech Lab (CSL Model 4300B). When the digitizing process is initiated, the Computerized Speech Lab applies an appropriate internal low-pass anti-aliasing filter to the raw acoustic signal (at a sampling rate of 20 kHz, the upper frequency cutoff is 8 kHz), stores the digital results in memory, and displays the resultant waveform on a graphics monitor.

Total sentence duration in each experimental condition was measured in order to verify that speech rate was slower in SC than in the SA condition. Total sentence duration was measured by visually isolating the first positively going portion of the waveform associated with the initiation of speech and marking the location with a cursor. The cursor was then stored and the cursor moved to the end of the sentence, and the last positive going portion of the waveform was visually isolated and marked as the second cursor position. The temporal interval between the two cursor positions was taken as the value for total sentence duration.

Syllable-level measurements. All measurement procedures of syllable-level variables were identical to those established by Metz et al. (1990). Thus, \( f_0 \) contours associated with the last word (pull, pal, Paul, or pill) in both the declarative and interrogative sentence productions were derived by isolating, with the cursors, the sixth, seventh, eighth, ninth, and tenth vowel periods immediately after the /p/ release and extracting the \( f_0 \) of each period. Those specific periods were used because the influence of the preceding stop consonant on the adjacent vowel’s \( f_0 \) is negligible after the first vowel period (Ohde, 1984). The average of the five measured vowel periods was taken as the initial \( f_0 \) value. Similarly, the last five voiced periods associated with the lateral /l/ productions in the target words were located with the cursors, and the \( f_0 \) of each period

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was extracted. The average of those five periods was taken as the terminal \( f_0 \) value. The initial \( f_0 \) value was then subtracted from the terminal \( f_0 \) value to derive the \( f_0 \) contour change.

Vowel \( f_0 \) and vowel duration associated with stressed and unstressed vowels were measured by locating the vowel nucleus in the target word with cursors. To facilitate segmentation of the vowels, all the target words used for these measures were stop consonant—vowel—stop consonant words. Vowel \( f_0 \) was calculated by taking the average \( f_0 \) of five vowel periods in the center of the vowel's waveform. Vowel duration was measured by placing a cursor at the beginning of the first regular vowel period after the stop release and then placing the second cursor on the last regular vowel period before the terminal stop. The time between these two cursors was then measured and that value was taken as the vowel duration parameter. Vowel \( f_0 \) and vowel duration measures were then compared between the stressed and the unstressed counterpart words.

The measurements of sentence duration and \( f_0 \) contours in declarative and interrogative sentences were made by the first author (R.L.W.) who was highly experienced in acoustic waveform analysis. The measurements of sentence duration, vowel duration, and \( f_0 \) for stressed and unstressed words were made by a trained research assistant under the direct supervision of the second author (D.E.M.).

As a measure of intraobserver reliability of the measurement procedure, the recordings of two speakers were selected at random, and all three parameters described above were measured a second time by a different person who had been trained in the measurement procedures. The correlations between the original and remeasured sets of SA data were .951 for \( f_0 \) contour difference (declarative vs. interrogative sentences); .903 for vowel duration (stressed vs. unstressed words); and .947 for vowel \( f_0 \) (stressed vs. unstressed words). The correlations between the original and remeasured sets of SC data were .922 for \( f_0 \) contour difference (declarative vs. interrogative sentences); .930 for vowel duration (stressed vs. unstressed words); and .947 for vowel \( f_0 \) (stressed vs. unstressed words). The high correlations indicate substantial intra- and interobserver reliability for the measures.

Statistical Analysis of Duration and Frequency Data

Statistical analysis of the sentence durations was accomplished by comparing the overall values for all SA sentences versus all SC sentences with a \( t \)-test for repeated measures. Statistical analysis of the declarative and interrogative sentence \( f_0 \) contours was accomplished with a two-way (2 \( \times \) 2) analysis of variance (ANOVA) with repeated measures on all independent variables: (a) experimental condition (two levels: SA vs. SC) and (b) sentence type (two levels: interrogative vs. declarative). Statistical analysis of the stressed and unstressed word vowel \( f_0 \) measures was accomplished with a two-way (2 \( \times \) 2) ANOVA with repeated measures on all independent variables: (a) experimental condition (two levels: SA vs. SC) and (b) stress value (two levels: stressed vs. unstressed). Statistical analysis of the stressed and unstressed word vowel duration measures was accomplished with a two-way (2 \( \times \) 2) ANOVA with repeated measures on all independent variables: (a) experimental condition (two levels: SA vs. SC) and (b) stress value (two levels: stressed vs. unstressed).

Results

Sentence Duration

The \( t \)-tests revealed a significant effect of communication mode (SA vs. SC) on sentence duration for the declarative and interrogative sentences, \( t(19) = 13.17, \ p < .0001 \), Cohen’s \( d = 5.02 \), and for the stressed and unstressed sentences, \( t(19) = 9.86, \ p < .0001 \), Cohen’s \( d = 3.89 \). Table 1 shows the means, standard
deviations, and ranges of sentence duration of the declarative and interrogative sentences in the SA and SC conditions. These data indicate that sentence duration was always longer in the SC condition than in the SA condition because of the slowing of speech while speakers attempted to sign and speak at the same time.

Declarative and Interrogative Sentence Fundamental Frequency Contours

The ANOVA revealed no significant effect of communication method (SA vs. SC) on $f_0$ contour, $F(1, 9) = 3.15, p = .10, \eta^2 = 0.26$, a significant effect of sentence type (declarative vs. interrogative) on $f_0$ contour, $F(1, 9) = 279.71, p = .0001, \eta^2 = 0.96$, and no significant interaction effect. Table 2 shows the means, standard deviations, and ranges of the $f_0$ contour frequency changes of the declarative and interrogative sentences for both the SA and SC conditions. Inspection of Table 2 reveals the expected contrastive frequency changes between the declarative and interrogative sentences and similar frequency changes for both SA and SC conditions: fundamental frequency increased at the end of interrogative sentences and decreased at the end of declarative sentences.

Syllable Stress Vowel Fundamental Frequency and Duration Measures

The ANOVA revealed no significant effect of communication method (SA vs. SC) on vowel $f_0$, $F(1, 9) = 0.19, p = 0.67, \eta^2 = 0.02$, a significant effect of stress pattern (stressed vs. unstressed) on vowel $f_0$, $F(1, 9) = 8.50, p = 0.01, \eta^2 = 0.49$, and no significant interaction effect. Table 3 shows the means, standard deviations, and ranges of the vowel $f_0$ measures of the stressed and unstressed words for both the SA and SC conditions. Inspection of Table 3 reveals the expected differences in vowel $f_0$ measures between the stressed and unstressed words and similar stress pattern results for both SA and SC conditions: vowel $f_0$ was higher in stressed than in unstressed syllables.

The ANOVA also revealed no significant effect of communication method (SA vs. SC) on vowel duration, $F(1, 9) = 0.26, p = 0.62; \eta^2 = 0.03$, a significant effect of stress pattern (stressed vs. unstressed) on vowel duration, $F(1, 9) = 20.34, p = 0.001; \eta^2 = 0.69$, and no significant interaction effect. Table 3 shows the means, standard deviations, and ranges of the vowel duration measures of the stressed and unstressed words for both the SA and SC conditions. Inspection of Table 3 reveals the expected differences in vowel duration measures between stressed and unstressed words and similar stress pattern results for both SA and SC conditions: vowel duration was longer in stressed than in unstressed syllables.

Discussion

The present results are consistent with previous research demonstrating lengthened sentence duration when signed English and fingerspelling are combined with speech in SC by individuals who are either experienced (Whitehead et al., 2000) or inexperienced signers (Whitehead, Schiavetti, Metz, & Farrell,
Because SC attempts to combine simultaneously the rapid speech production act with the slower sign production act, combining the two communication systems operating at different rates results in a slowing of the more rapid speech act to maintain simultaneity (Windsor & Fristoe, 1989, 1991).

However, despite the temporal slowing of speech during SC, the inexperienced signers maintained the suprasegmental rules for differentiating declarative from interrogative sentences and for differentiating stressed from unstressed syllables, similar to results reported by Whitehead et al. (2000) for experienced signers. That is, speakers consistently increased fundamental frequency at the end of interrogative sentences and decreased fundamental frequency at the end of declarative sentences in both the SA and SC conditions. In addition, speakers consistently increased vowel duration and vowel fundamental frequency when moving from unstressed to stressed syllables in both the SA and SC conditions. Thus, for inexperienced signers, it may be concluded that although an elongated temporal pattern of speech occurs during SC, the resultant speech pattern does not violate these specific suprasegmental rules of spoken English.

It is also interesting to note that the inexperienced signers showed approximately 1000 ms more lengthening of the sentences than the experienced signers did during SC (Whitehead et al., 2000). However, despite the even slower speech rate of the inexperienced signers, comparison of the present data to the experienced signers’ sentence intonation data in Table 2 (Whitehead et al., 2000, p. 436) and syllable stress data in Table 3 (Whitehead et al., 2000, p. 437) shows very similar values for both experienced and inexperienced signers of sentence intonation frequency changes as well as vowel fundamental frequency and vowel duration of stressed versus unstressed syllables.

To further substantiate this observational inference, a meta-analysis was undertaken to compare the effects of SC versus SA on the sentence durations and on each of the dependent variables for the experienced and inexperienced signers using Cohen’s $d$ and $\eta^2$ statistics (Schiavetti & Metz, 2006). An effect size was calculated separately for each group of participants for the SC–SA difference on the sentence duration variable using Cohen’s $d$ for this bivalent comparison. An effect size was also calculated separately for each group of participants for the significant multivalent effects of sentence type and stress condition in the ANOVAs for the declarative/interrogative $f_0$ differences and stressed/unstressed vowel $f_0$ and duration differences using $\eta^2$ for these multivalent comparisons. Table 4 displays the effect sizes for the experienced and inexperienced signers for each variable.

Table 4 reveals that the inexperienced signers’ SC–SA effect sizes for sentence duration were more than double the experienced signers’ SC–SA effect sizes, indicating that the inexperienced signers slowed their speech much more than the experienced signers. Inspection of Table 4 reveals, however, that the effect sizes for frequency changes in declarative and interrogative sentences and for vowel fundamental frequency differences and vowel duration differences in unstressed versus stressed words were quite similar for the experienced and inexperienced signers. These similar effect sizes for the dependent variables indicate that, despite the greater speech rate reduction in SC for the inexperienced signers, the declarative/interrogative
intonation contour differences and stressed/unstressed vowel $f_0$ and duration differences were similar for both the experienced and inexperienced signers, indicating conformity with the temporal and spectral suprasegmental characteristics of English for both groups of participants. This meta-analysis further buttresses the importance of systematic replication for extending the external validity of SC results with experienced signers on a variety of dependent variables.

For hard-of-hearing children to develop accurate perception and production of speech, it is necessary for them to be exposed to speakers who do not violate the segmental and suprasegmental rules of spoken English. The speech model being presented to hard-of-hearing children by individuals who use SC appears to be accurate in both segmental and suprasegmental characteristics despite the overall slowed rate of speech, regardless of the SC skill level of the speaker. Perceptual studies of speech produced during SC have shown no deterioration of perception of key phonemic features such as voicing distinctions among consonants (MacKenzie, Schiavetti, Whitehead, & Metz, 2006) and overall intelligibility (Whitehead, Schiavetti, MacKenzie, & Metz, 2004). Thus, although the speech which occurs during SC may be considered unnatural (Huntington & Watton, 1984; Marmor & Petitto, 1979; Strong & Charlson, 1987; Vernon & Andrews, 1990), it maintains the rules of spoken English that enhance the hard-of-hearing child’s ability to more accurately understand speech. This supports the empirical results of Hyde, Power, and Leigh (1998) who concluded that “the slowed rate [of speech] of many teachers using SC improves the intelligibility of that speech for deaf students” (p. 124). Future research should address whether such improved intelligibility of spoken English during the slower SC may, in turn, increase hard-of-hearing children’s ability to produce accurate segmental and suprasegmental aspects of speech.

In addition, future research should be aimed at exploring other suprasegmental characteristics of speech during SC, such as sentence division into breath groups, syntactic components of suprasegmental aspects of phonology, or emotional modification of intonation contours (Lieberman, 1967). It would be important in such research to compare experienced and inexperienced signers in order to differentiate the cumulative effect of SC use on these more complex suprasegmental variables. It would also be important to determine if these factors affect the intelligibility and perceived naturalness of speech during SC by both experienced and inexperienced signers.

Since a large body of data already exists on segmental and suprasegmental speech characteristics of experienced signers (Schiavetti et al. 2004), future research should concentrate more on the growing body of inexperienced signers who are communicating with deaf and hard-of-hearing children via SC. Generalizing these results beyond experienced signers is important because of the many inexperienced signers in deaf and hard-of-hearing children’s communication environments, including parents, siblings, peers, and regular classroom teachers who use SC. Also, because Lodge-Miller and Elfenbein (1994) found that inexperienced signers tend to overestimate their signing ability, future research should investigate whether or not they also overestimate their SC ability by systematic replication with inexperienced signers. Systematic replication with different forms of rate-altered speech, such as speaking clearly for the deaf and hard of hearing (Picheny, Durlach, & Braida, 1985, 1986), would also be important in extending the generalization of these results.

### Table 4

<table>
<thead>
<tr>
<th></th>
<th>Experienced signers</th>
<th>Inexperienced signers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentence duration (Cohen $d$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declarative and interrogative sentences</td>
<td>1.87</td>
<td>5.02</td>
</tr>
<tr>
<td>Stressed and unstressed word sentences</td>
<td>1.68</td>
<td>3.89</td>
</tr>
<tr>
<td>Frequency change ($\eta^2$)</td>
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<tr>
<td>Declarative versus interrogative sentences</td>
<td>0.845</td>
<td>0.960</td>
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<tr>
<td>Vowel fundamental frequency difference ($\eta^2$)</td>
<td></td>
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<tr>
<td>Stressed versus unstressed words</td>
<td>0.585</td>
<td>0.485</td>
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<tr>
<td>Vowel duration difference ($\eta^2$)</td>
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<tr>
<td>Stressed versus unstressed words</td>
<td>0.614</td>
<td>0.693</td>
</tr>
</tbody>
</table>

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References


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