The Dynamic Relationship of Sentence Complexity, Childhood Stuttering, and Grammatical Development

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In recent years, studies have found that children who stutter (CWS) will stutter more frequently on longer and more grammatically complex utterances than on shorter and simpler utterances (see review in Zackheim & Conture, 2003). An increase in utterance length and complexity is thought to place greater processing demands on CWS; this is reflected in an increase in stuttering. Some studies have found a higher incidence of stuttering to occur on longer utterances (e.g., Logan & Conture, 1995; Yaruss, 1999); others on complex utterances (e.g., Logan & LaSalle, 1999). Other studies have found that both longer and more complex utterances play a comparable role in the incidence of stuttering (Gains, Runyan, & Meyers, 1991; Zackheim & Conture, 2003).

ABSTRACT: Purpose: The present study was conducted to determine if the relationship between sentence complexity and childhood stuttering is influenced by grammatical development. The study was cross-sectional in design and observed the spontaneous speech of 6 children who stutter ranging in age from 32 to 46 months. Method: The first 100 utterances from each child’s sample were scored using H. Scarborough’s (1990) Index of Productive Syntax (IPSyn) and were given a numeric score that was used as an indicator of grammatical development in place of the child’s age. The first 100 sentences containing a noun and verb in subject-predicate relationship were extracted from each sample and coded for their sentence complexity using L. L. Lee’s (1974) Developmental Sentence Scoring. The utterances were also measured for length in morphemes. Sample utterances were then separated into two categories: fluent and stuttered. Results: Results showed that when conducting group comparisons, the mean complexity levels of fluent and stuttered utterances were significantly different. The difference in complexity levels of the fluent and stuttered utterances, however, was not found to be significant when length of the utterance was held constant. To determine if the difference in sentence complexity of fluent and stuttered utterances was related to age and/or IPSyn, bivariate correlation analyses were conducted. Results showed that the differences between the mean complexity levels of the fluent and stuttered utterances were not significantly correlated with grammatical development. However, an apparent correlation was observed when the relationship was depicted in graph form. The difference in complexity of fluent and stuttered utterances became more apparent as a child increased in grammatical development. Conclusion: Findings suggest that as a child’s grammatical repertoire expands, simpler sentence forms are fluent whereas the newly acquired sentence forms are disfluent. Findings suggest that the incidence of stuttering shifts along a developmental continuum, occurring more often on the child’s emerging grammar forms.

KEY WORDS: stutter, childhood stuttering, grammatical development, complexity, length
A number of studies have found sentence complexity to play a significant role in the incidence of stuttering. Gaines, Runyan, and Meyers (1991) analyzed the length and complexity of the spontaneous speech of 12 CWS who ranged in age from 4 to 6 years. Results revealed that both the complexity scores and the length of the utterances were significantly greater for the stuttered utterances than for the fluent utterances. Eight out of the 12 children’s mean length comparisons of fluent versus stuttered utterances reached statistical significance, and all 12 children’s complexity scores reached statistical significance. Gaines et al.’s study was unique in employing Lee’s Developmental Sentence Scoring (DSS; Lee, 1974) as a means to measure the complexity of the sample utterances. Using DSS, a numeric score was given to each utterance based on its sentence complexity as opposed to forming two categorical variables, complex and noncomplex, based on the inclusion or omission of an independent clause or subordinate clause.

Logan and LaSalle (1999) determined whether the production of disfluency clusters (speech disfluencies that occur with close proximity to each other) was related to such linguistic characteristics as utterance length, syntactic complexity, and sentence location in the spontaneous speech of 14 CWS and 14 children who do not stutter (CWNS) with a mean age of 4.3 (years;months). They found that fluent utterances had low syntactic demand, stuttered utterances without the presence of clusters were characterized by medium syntactic demand, and stuttered utterances with the presence of clusters were syntactically complex and longer than the other two types of utterances. This suggested that sentence complexity was closely associated with the occurrence of stuttering. The sentence complexity of the utterance was considered to be the stronger variable.

Other studies have found that stuttering is more likely to occur on longer utterances. Yaruss (1999) examined several different components of a sentence in the spontaneous speech of 12 CWS between the ages of 3:3 and 5:5, including sentence type, voice, function, question type, and various syntactic constituents such as clause and phrase structure. He also analyzed the length of the utterance, which was determined by its count in morphemes, syllables, and words. Although results indicated that stuttered utterances were likely to be longer and more complex than fluent ones, the length of the utterance was the more determinant variable. However, a relationship was found among the incidence of stuttering and certain syntactic components that were not associated with utterance length. One possible explanation provided by Yaruss was that these syntactic components represented emerging linguistic forms that proved challenging to the speaker, thereby putting greater demands on the speaker (Bernstein Ratner & Sih, 1987; Bosshardt, Ballmer, & De Nil, 2002) and thus affecting the likelihood that stuttering would occur.

Logan and Conture (1995) also found length to be the dependent variable when observing the relationship between stuttering and utterance length, syntactic complexity, and speech rate of 15 CWS between the ages of 3 and 5 years. Twenty-five fluent and stuttered utterances from each child’s conversational speech were measured. DSS was used to measure the utterance’s syntactic complexity. The mean utterance length was greater in stuttered utterances than in fluent utterances across all 15 children, whereas syntactically complex utterances resulted in significantly more stuttering in only 11 of the children.

A unique study by Zackheim and Conture (2003) assessed the relationship between stuttering and utterance length in relation to the individual child’s mean length of utterance (MLU). Eighty utterances from 6 CWS and 6 age-matched CWNS were ranked into quartiles according to utterance length to assist in between-subjects comparisons. Sample utterances were also categorized as being either complex (i.e., presence of a subordinate clause or more than one independent clause) or noncomplex (i.e., absence of a subordinate clause or presence of only one independent clause). Results indicated that both CWS and CWNS produced significantly more disfluencies on utterances that were longer than their MLU and on utterances that were considered complex. However, unlike those of CWNS, the utterances of CWS that were shorter than their MLU were more likely to exhibit disfluencies on noncomplex utterances. Although CWS stuttered more on the noncomplex utterances, there was only a small number of complex utterances in the first two lower quartiles (below MLU) to begin with. The shorter utterances that fell into the first two quartiles tended to be noncomplex utterances, whereas the longer utterances that fell into the upper two quartiles (above MLU) tended to be complex utterances.

Suggestions that stuttering (Bernstein Ratner & Sih, 1987; Wall, 1980) and normal disfluencies (Muma, 1971; Rispoli & Hadley, 2001) are impacted by emerging grammatical forms have been introduced. Findings have suggested that stuttering may be a result of newly acquired, more task-demanding sentences. Bernstein Ratner and Sih addressed the degree to which increasing syntactic complexity affects the incidence of stuttering. This study administered sentence-imitation tasks with sentences of increasing length and complexity to CWS ranging in age from 3:11 to 6:4. Stimulus sentences included simple active declarative sentences, passives, negatives, questions, and right and center embedded clauses. Results indicated a significant correlation between an increase in syntactic complexity and the frequency of stuttering ($r = .90$). Sentences of increasing complexity were used to reflect the impact that newly acquired sentence structures had on the incidence of stuttering. Length did not prove to play a significant role ($r = .72$). Furthermore, a post hoc analysis using Spearman values depicted that when complexity was separated from length, the association between sentence length and stuttering during sentence-imitation tasks was reduced from $r = .70$ to approximately $r = .10$ (Bernstein Ratner, 1997).

Studies have also considered if normal disfluencies in CWS are influenced by developmentally complex sentences (Colburn & Mysak, 1982; Rispoli & Hadley, 2001; Wijnen, 1990). Similar to the relationship between stuttering and sentence complexity, normal disfluencies in CWS are thought to be a response of a child acquiring language. Results of these studies have been similar to Bernstein Ratner’s (1997) study with CWS. Gordon, Luper, and Crain (1986) replicated Pearl and Bernthal’s (1980) study by
observing the effects of various grammatical constructions and complexities on the incidence of disfluency in CWNS through the use of sentence-imitation tasks. Participants were asked to imitate six different syntactic constructions ranging in complexity. The complexity of the sentence constructions was designed to represent typical grammatical development. Both studies resulted in insignificant findings concerning the relationship between sentence complexity and the occurrence of disfluencies. However, Gordon et al. added a modeled sentence-production task to the study using the same six syntactic constructions as in the imitation task. Results showed a significant increase in disfluencies on sentence constructions with greater grammatical complexities. Gordon et al. posited that the production demands of syntactically complex sentences were better demonstrated through the sentence-modeling task as it required understanding of the construct meaning. Sentence modeling required linguistic processing similar to spontaneous speech and provided a representative sample of a child’s language performance that was not accomplished through sentence-imitation tasks.

Rispoli and Hadley (2001) analyzed the spontaneous speech of 26 typically developing children between the ages of 2:6 and 4:0. They extracted and coded the verb phrases from all active declarative sentences for the presence of disruption, length in morphemes and words, and clauses complexity. Results demonstrated that disrupted sentences were significantly longer and more complex than fluent ones. In addition, this relationship positively correlated with grammatical development; that is, as a child’s linguistic repertoire expanded, the highest incidence of speech disruptions was seen on the more advanced sentence forms or sentences that were at a child’s “leading-edge” of development (p. 1,140). In addition, this relationship remained significant even when the length of the utterance was held constant. This seems only logical as we consider the vast amount of grammatical knowledge that a child is acquiring in a relatively short period of time and the ability to use this knowledge for sentence comprehension and production in conversational speech (Rispoli & Hadley, 2001; Wijnen, 1990). Newly acquired sentence forms are placing even greater demand on the child’s language system and, as a result, disruptions in speech are more likely to occur.

Unique to Rispoli and Hadley’s (2001) study was the use of Scarborough’s Index of Productive Syntax (IPSyn; Scarborough, 1990) which, by means of a numeric score, replaced the chronological age of the child and acted as the child’s grammatical maturity measure. When the average verb phrase complexity for disfluent versus fluent sentences was correlated with age and IPSyn, significant results were obtained with IPSyn ($r = 0.70, p < .01$) but not with age ($r = .33, p > .05$). In addition, when the length of the sample utterances was controlled for, significant results were correlated with IPSyn ($r = .55, p < .05$) but not with age ($r = .11, p > .05$). These results suggest that the age of the child was not always the most effective indicator of the child’s stage in grammatical development. Although chronological age is a useful measure of grammatical development in clinical practice, it may not always be the most effective variable in research with limited sample numbers.

Studies observing this relationship in CWNS are limited (Bernstein Ratner & Sih, 1987). Few studies have measured utterance length and sentence complexity in relation to the incidence of stuttering on a developmental scale. Instead, utterance length and sentence complexity have been compared to group means and have not been considered relative to the child’s stage of grammatical development.

The majority of studies that have assessed grammatical development and speech disruption in CWNS (Bernstein Ratner & Sih, 1987) and CWNS (Gordon et al., 1986; Pearl & Bernthal, 1980) have used sentence-imitation and sentence-modeling tasks; the use of spontaneous speech has been limited. Although such studies offer insight into the ability of CWS to initiate and execute sentences that are developmentally more challenging, they are somewhat limited because the speech tasks are much simpler than what is required in conversational speech.

Furthermore, the majority of studies that have observed the relationship between utterance complexity and childhood stuttering have measured utterance complexity in a categorical way. The complexity of an utterance has been considered complex/noncomplex according to the presence of one or more independent clauses or the presence or absence of a subordinate clause. Although this is a common measurement tool for sentence complexity, it may exclude utterances that are complex and short, such as the inversion of a copula or questions other than the one-word why. These utterances are considered to come at a later stage in language acquisition and can also be considered complex.

The present study was conducted to determine if the relationship between sentence complexity and childhood stuttering is dynamic and is influenced by a larger variable, grammatical development. Based on previous findings, it is assumed that although a relationship exists between sentence complexity and stuttering, it can be delineated further by considering the influence from developing grammar. It was predicted that childhood stuttering is more likely to occur on utterances that are newly acquired, and this relationship is likely to change as a child develops grammar; that is, children are more likely to stutter on newly acquired sentence forms than on familiar sentence forms. This study is unique to childhood stuttering research in that it employs the IPSyn in place of the child’s age in order to obtain the most accurate representation of the child’s stage in grammatical development. In addition, DSS was used to obtain a numeric score of the individual sample utterance’s complexity level. Furthermore, this study is the first to assess the significance of stuttering in the development of grammar by observing children’s spontaneous speech.

**METHOD**

**Participants**

This study examined the speech of 6 CWS who were between the ages of 32 and 45 months. They were volunteers who were recruited from the University of New Hampshire’s Speech-Language-Hearing Center or local
private practice where they had been diagnosed with and were receiving services for a fluency disorder. Study participants’ parents had originally self-referred their child to a university’s speech and language clinic or private practice for diagnosis.

Before recruitment, participants had been diagnosed by a certified speech-language pathologist (SLP) as having a stuttering disorder with no accompanying speech or language impairments. In addition to the testing that was conducted by a certified SLP, participants were administered the following battery of tests by the first author to ensure that no other concomitant speech or language problems were present: (a) The Preschool Language Scale (4th ed.; Zimmerman, Stein, & Pond, 2002) measured the participants’ receptive and expressive language, (b) the Goldman-Fristoe Test of Articulation—2 (Goldman & Fristoe, 2000) measured their speech sound development, and (c) the Stuttering Severity Instrument—3 (SSI–3; Riley, 1994) measured their stuttering severity level. A pure-tone hearing screening was also conducted using a portable audiometer to ensure that the participants’ hearing was within normal limits.

The children in this study presented with a stuttering disorder based on the following criteria: (a) an evaluation from a certified SLP, (b) results from the SSI–3 conducted just before the study observation, and (c) parent confirmation that their child was stuttering. Stuttering had been present for 12 months or longer for all children. Based on the battery of tests listed above and/or diagnostic results from certified SLPs, participants did not present with any other concomitant speech or language disorders.

Based on the parents’ reports, the following information was gathered: (a) the child’s age in months; (b) gender; (c) age of onset in months; (d) family history of stuttering; and (e) scores from Riley’s Stuttering Severity Instrument—3 (1994).

Table 1 presents individual data for the children in this study.

### Speech Samples

The spontaneous speech samples of each participant were audio- and video-recorded by the first author as the children played with their parent(s) during one recording session that lasted approximately 30 min.

The observations were conducted in either the participant’s home, a university playroom-laboratory, or a private practice office. Each parent/participant pair used developmentally appropriate toys to play with and were asked to engage in play as they commonly would at home. Parents were encouraged to use open-ended questions and limit their yes/no questions. Parents were also encouraged to include topics that might interest the child, such as special toys or movies.

### Analysis of Speech Samples

The audio- and videotapes from the observation session were orthographically transcribed and were given three passes to verify consensus reliability. The video recordings were used to observe nonverbal instances of stuttering, such as blocks. The initial transcription was performed by the first author. The second and third passes were independently performed by both the first and second author. Utterances were excluded from the final corpus if the utterance was characterized by the following: (a) It was not agreed on and/or was partly or completely unintelligible; (b) it was incomplete or interrupted; and/or (c) it was not spontaneously formulated, such as repetition, imitation, or singing.

The first 25 utterances in each transcript were considered warm-up utterances and were excluded from analysis. An utterance was defined according to Owens (2005) as a unit of language that is separated from other utterances by a “drop in the voice, a pause, and/or a breath that signals a new thought” (p. 292). Therefore, isolated affirmatives or negatives such as yes, no, and okay were considered an utterance by the preceding guidelines.

#### Grammatical development analysis

Excluding the first 25 utterances, the following 100 utterances were scored using the IPSyn to measure the participant’s present stage of grammatical development. The IPSyn analyzes the occurrence of 56 syntactic and morphological forms, including noun phrases, verb phrases, questions/negations, and sentence structures. It is an evaluation of grammatical types used by the child and requires that two occurrences of a grammatical form be used by the child in order to be considered within the child’s current repertoire. The IPSyn does not require that an utterance contain both a subject and verb in order to be included in analysis. The IPSyn includes many of the grammatical structures that are used in the assigning structure stage (Miller, 1981) while adding several other structures. Although the IPSyn focuses on a variety of grammatical forms, it measures their use rather than misuse (Scarborough, 1990). For these reasons, the IPSyn serves as a tool for measuring the emergence of syntactic and morphological forms. Numeric scores were derived from the analysis and were used in place of the participant’s age as a more accurate description of his or her stage in development.

Table 1. Individual data for study participants, including age, gender, time since onset, family history of stuttering, and scores from Riley’s Stuttering Severity Instrument—3 (1994).

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age in months</th>
<th>Gender</th>
<th>Age of onset in months</th>
<th>Family history of stuttering</th>
<th>Stuttering Severity Instrument—3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>46</td>
<td>M</td>
<td>36</td>
<td>yes</td>
<td>61%–77%, moderate</td>
</tr>
<tr>
<td>B</td>
<td>46</td>
<td>F</td>
<td>24</td>
<td>yes</td>
<td>5%–11%, mild</td>
</tr>
<tr>
<td>C</td>
<td>45</td>
<td>M</td>
<td>24</td>
<td>no</td>
<td>5%–11%, mild</td>
</tr>
<tr>
<td>D</td>
<td>39</td>
<td>M</td>
<td>29</td>
<td>yes</td>
<td>61%–77%, moderate</td>
</tr>
<tr>
<td>E</td>
<td>43</td>
<td>M</td>
<td>40</td>
<td>yes</td>
<td>78%–88%, severe</td>
</tr>
<tr>
<td>F</td>
<td>32</td>
<td>M</td>
<td>29</td>
<td>no</td>
<td>61%–77%, moderate</td>
</tr>
</tbody>
</table>

Bauerly • Gottwald: Sentence Complexity, Childhood Stuttering, and Grammatical Development 17
**Sentence complexity analysis.** Utterances were then prepared for DSS analysis. Following the first 25 warm-up utterances, 100 sentences were coded following the DSS criteria. Sentences were included in analysis if they were completely intelligible, were not repetitive in nature, and possessed a noun and verb in a subject-predicate relationship or were imperative statements. The 100 utterances in this sample block were used for the remaining analytical procedures.

Once a transcript block of 100 DSS-eligible utterances was formed, each utterance was scored using the eight categories of grammatical forms in the DSS, including (a) indefinite pronoun or noun modifier, (b) personal pronoun, (c) main verb, (d) secondary verb, (e) negative, (f) conjunction, (g) interrogative reversal in questions, and (h) wh-question. A sentence point of 1 was also given to a sentence that met all adult standard sentence rules. A mean sentence score for the entire corpus was not derived; instead, the DSS analysis was used only to assess the samples on an utterance-by-utterance basis. Each utterance received a numeric score derived from the eight categories described above.

**Utterance length analysis.** Each sentence in the 100-sample corpus was then measured for number of morphemes using Brown’s (1973) rules for counting morphemes. Stuttering events and normal disfluencies as well as filler words such as um-m or ah-h were not counted as morphemes. Each utterance was then summed to record the total morpheme length for each utterance.

**Fluency analysis.** Each utterance was next evaluated using procedures similar to those reported in Logan and Conture (1995) for the presence of within-word stutters (e.g., sound/syllable repetitions, within syllable pauses, silent/audible prolongations); between-words stutters (i.e., whole/part multisyllabic word repetitions, phrase repetitions, interjections); or whole, monosyllabic word repetitions. Utterances were coded as stuttered if one or more core stuttering behaviors was present. A normal disfluency was recorded if the following characteristics occurred: (a) a part- or whole-word repetition contained less than two units in repetition and was without the presence of physical tension or a faster rate, (b) a prolongation was used as emphasis, or (c) interjection or revision was in the presence of relaxed speech and clearly an indication of a normal disruption in speech. See Guitar (2006) for a complete description of core stuttering behavior and the characteristics of normal versus stuttered speech.

**Reliability.** Each transcript received three passes from the first author and two passes from a second rater to verify consensus reliability. The second rater was an American Speech-Language-Hearing Association-certified SLP. Utterances containing words or phrases that were not agreed on by the two examiners were excluded from the final corpus. Additionally, utterances that were incomplete, interrupted, or unintelligible were excluded from the final corpus. The presence or absence of stuttering-like disfluencies was coded for each utterance. There were no disagreements on the presence or absence of a stuttering-like disfluency.

Interjudge reliability was estimated for all of the analyses conducted in this study using Cohen’s kappa coefficient. Simple random samples were extracted from 25% of each participant’s 100-sample utterance and were scored for the following measures: (a) grammatical development analysis (IPSyn), (b) sentence complexity analysis (DSS), and (c) length analysis (Brown’s morphemes). Reliability measurements were obtained and the Cohen’s kappa coefficient for IPSyn analysis was 0.84%, for DSS analysis was 0.82%, and for length of utterance was 0.96%. These results translate to excellent reliability.

**Sentence Complexity and Length, and the Incidence of Stuttering**

Utterances from each 100-sample transcript were separated into two categories—fluent and stuttered utterances—based on the fluency analysis described above. The mean sentence complexity level was calculated for the fluent and stuttered categories. Independent-sample \( t \) tests were then calculated for individual participants to determine whether a significant difference existed between the sentence complexity levels of their fluent and stuttered utterances. Last, a comparison of group means using a paired-samples \( t \) test was performed to test whether the fluent and stuttered utterances were significantly different in complexity.

A frequency analysis was performed to determine if the incidence of stuttering was influenced by the complexity of an utterance when the length of the utterance was controlled. An utterance length of five morphemes was found to be the most frequent length of utterance and was used most frequently by the majority of participants. Next, the sample utterances that were five morphemes in length were extracted and were used for analysis following the procedures described previously. The mean sentence complexity level was calculated for the fluent and stuttered utterances that were five morphemes in length. Independent-sample \( t \) tests were then calculated for individual participants to determine whether a significant difference existed between the sentence complexity levels of their fluent and stuttered utterances when length was controlled. Last, a comparison of group means using a paired-samples \( t \) test was performed to test whether the fluent and stuttered utterances were significantly different in complexity when sentence length was controlled.

**Sentence Complexity and Length, Grammatical Development, and Stuttering**

Bivariate correlation analyses were performed to determine if the difference in sentence complexity of fluent and stuttered utterances was related to age and/or IPSyn. First, the difference between the participant’s average obtained from the DSS of fluent and stuttered utterances was obtained. The difference between the mean complexity levels of fluent and stuttered utterances were then correlated with the participant’s IPSyn and age.

Calculations were then made to determine if the difference in sentence complexity of fluent and stuttered utterances related to age and/or IPSyn when length was held constant. The differences between the mean complexity
levels of fluent and stuttered sentences that were five morphemes in length were correlated with age and IPSyn using a bivariate correlation analysis.

RESULTS

Sentence Complexity and Length, and the Incidence of Stuttering

The observed means of sentence complexity for the stuttered utterances were greater than those for the fluent utterances for all 6 participants. Table 2 shows that the stuttered utterances were significantly greater in complexity than the fluent utterances, \( t(5) = 2.9, p < .05 \).

A comparison of group means for fluent and stuttered utterances when length was controlled at five morphemes was also conducted using a paired-samples \( t \) test (see Table 3). Results revealed that as a group, the stuttered utterances were not significantly greater in complexity than the fluent utterances when length of utterance was held constant, \( t(5) = –1.07, p > .05 \). Although 4 out of 6 participant’s mean stuttered utterances were greater than their mean fluent utterances, as a group, the stuttered utterances were not significantly greater in complexity than the fluent utterances. This is a result of a large standard deviation exhibited for the mean stuttered utterances (see Table 3).

Sentence Complexity and Length, Grammatical Development, and Stuttering

A bivariate correlation revealed that the relationship between the difference in complexity scores was not significantly correlated with IPSyn, \( r = .64, p > .05 \). Results indicated that the difference between the average complexity scores of the stuttered and fluent utterances did not significantly increase as a child developed in grammar. Figure 1 is a scatterplot showing the relationship between the difference scores and the participant’s IPSyn scores.

Although the statistical data are insignificant, when results are depicted in graph and table form, a relationship is apparent. Figure 1 depicts a trend of increasing difference scores as IPSyn scores increase. In addition, a rank order correlation was conducted to further analyze an apparent trend, and the results are depicted in Figure 2.

Table 2. Comparison of group mean complexity levels of fluent and stuttered utterances.

<table>
<thead>
<tr>
<th>Utterance</th>
<th>No. of participants</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluent</td>
<td>6</td>
<td>6.77</td>
<td>1.73</td>
</tr>
<tr>
<td>Stuttered</td>
<td>6</td>
<td>9.57</td>
<td>2.95</td>
</tr>
</tbody>
</table>

Table 3. Comparison of group mean complexity levels of fluent and stuttered utterances when length was five morphemes.

<table>
<thead>
<tr>
<th>Utterance</th>
<th>No. of participants</th>
<th>Group mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluent</td>
<td>6</td>
<td>5.65 2.02</td>
</tr>
<tr>
<td>Stuttered</td>
<td>6</td>
<td>6.50 0.77</td>
</tr>
</tbody>
</table>

A bivariate correlation analysis revealed that the difference in sentence complexity of fluent and stuttered utterances did not significantly correlate with age, \( r = .40, p > .05 \). Results indicated that the difference in complexity scores for stuttered and fluent utterances did not significantly increase as age increased. Figure 3 is a scatterplot showing the relationship between the difference scores in complexity of fluent and stuttered utterances and the participant’s age.

Table 4 shows the results of the correlations between age, IPSyn, and the differences in the average sentence complexity of fluent and stuttered utterances. Although not significant, a stronger correlation exists when correlating the difference in complexity with IPSyn than with age.

The difference in sentence complexity of fluent and stuttered utterances that were five morphemes in length was not significantly correlated with IPSyn, \( r = .31, p > .05 \). Results indicated that the difference in complexity of the fluent and stuttered utterances did not significantly increase with IPSyn when length was held constant. Refer to Table 3 for a comparison of group mean complexity levels of fluent and stuttered utterances when length is controlled at five morphemes.

Figure 1. Scatterplot of difference in complexity scores between fluent and stuttered utterances with Scarborough’s (1990) Index of Productive Syntax (IPSyn) scores.
DISCUSSION

How Did Sentence Complexity Relate to the Incidence of Stuttering?

The current investigation supports the results of previous studies with preschoolers (Gaines et al., 1991; Logan & LaSalle, 1999; Weiss & Zebrowski, 1992) by showing that the stuttered utterances of the participants were significantly greater in complexity than the fluent utterances. Similar to the Gaines et al. study, the current study found that for each participant, the mean stuttered utterance was greater in complexity than was the typical fluent utterance. Group comparisons also indicated that the stuttered utterances were significantly greater in complexity. Logan and Conture (1995) also found similar results; however, the proportion of difference was slightly smaller. In their study, 11 out of 15 participants exhibited this relationship. Yaruss (1999) found sentence length to be the more potent determinant factor when considering the incidence of stuttering. However, as stated earlier, he also found that some aspects of sentence complexity that were not directly associated with sentence length were found to be related to the incidence of stuttering. Stuttering was found to occur on sentences that contained either a negative marker, a high valence of the main verb, or an interrogative. Similar observations were made in the current study. The incidence of stuttering was found to rise on developmentally complex sentences that contained negative markers (e.g., don’t) or developmentally more advanced main verbs (e.g., I do like candy). In addition, sentences in the current study were more apt to be stuttered if they contained developmentally more advanced secondary verbs such as a passive infinitive complement (e.g., I want to be scary).

Is the Incidence of Stuttering Influenced by the Complexity of an Utterance When the Length of the Utterance Is Controlled?

Results showed that, as a group, the stuttered utterances were not significantly greater in complexity than the fluent utterances when length of the utterance was held constant. The outcome of this investigation coincides with other studies (e.g., Gaines et al., 1991) in which the length and complexity of an utterance played a comparable role in the incidence of stuttering. Although results are insignificant, our data showed that 4 out of the 6 participants’ mean stuttered utterances were greater in length than the mean of their fluent utterances. These findings are similar to the Logan and Conture (1995) study in which although results were insignificant, they found that the stuttered utterances were grammatically more complex than the fluent utterances for 11 out of the 15 participants.

It had been anticipated that the complexity of the stuttered utterances would continue to be significantly different than the fluent utterances when length of the utterance was held constant. Table 3 reveals that as a group, the mean complexity of the stuttered utterances was greater than the fluent utterances; however, this difference was not significant. These insignificant findings may have occurred for the following reasons. First, a large standard deviation was exhibited for the complexity levels of the stuttered utterances. The large standard deviation observed for the stuttered utterances may be a result of the younger children in the study, whose stuttering was more equally

Table 4. Correlation of age and IPSyn with the difference in the average complexity of stuttered and fluent utterances.

<table>
<thead>
<tr>
<th>Bivariate correlation</th>
<th>Significance</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>.406</td>
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<tr>
<td>IPSyn</td>
<td>.638</td>
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distributed throughout the sample. Children in earlier stages of grammatical development may find all sentences equally difficult to produce.

Rispoli and Hadley (2001) observed similar findings with normal disfluencies in CWNS. Similar to the current study, Rispoli and Hadley’s participants ranged in age from 2:6 to 4:0. Findings suggested that the length and complexity of the fluent and nonfluent sentences were approximately the same for children who were in their earlier stages of grammatical development. However, as the children developed in grammar, a difference in length and complexity began to appear between the fluent and nonfluent sentences. In contrast, studies (Logan & Conture, 1995; Yaruss, 1999) observing children who were farther along in grammatical development have continued to find utterance length to be the more determinant variable in the incidence of stuttering. It is not clear, however, whether the difference in the present and past studies was a result of methodological differences, as these studies varied in terms of the complexity measures employed, length of speech samples analyzed, and number of participants used.

Second, the low number of sample utterances used in the present investigation may have influenced the results. Although a frequency analysis that included all participants and involved the largest number of sentences was performed to determine the length of utterance, it was difficult to obtain an equal number of utterances among participants who varied in age and, thus, level of grammatical development. As a result, there were low sample utterances for some of the participants when utterance length was held constant.

Finally, another factor that may have influenced the results of the present investigation can be found in the methodology that was used to score the complexity of an utterance. DSS was used to measure the complexity of a sentence in this study. The complexity scores were very similar in number to the scores that were derived from counting the length of the utterance in morphemes. The most apparent reason for this similarity is because length and complexity for the most part co-occur early in grammatical development. An utterance is more apt to be grammatically complex as it increases in length. For example, the DSS system credits the conjunction of two simple clauses by giving points to all main verbs in a sentence as well as for use of the conjunction. As a result, a sentence such as, “I stopped to play and I found a ball” is considered to have a high complexity score, 11 points, as a result of two main past tense verbs and a conjunction. The mean length of this utterance is 10 morphemes. The similarity between the complexity score and utterance length was consistent throughout the participants’ sample utterances. It was difficult to control for length without indirectly controlling for complexity.

However, the complexity of an utterance is not always equal to the length of an utterance in morphemes. One situation where the complexity of an utterance may be greater than its length in morphemes is when the grammatical elements within a sentence are permuted within the sentence, resulting in a more linguistically mature sentence while not affecting its length (Owens, 2005). For example, reversing an auxiliary to form a question such as “Is he going?” would be grammatically more advanced than the simpler declarative sentence, “He is going.” In this case, the complexity of the sentence is affected but the length of the utterance remains unchanged. It may be that a greater number of sample utterances per participant would have allowed for more opportunity to differentiate between sentence length and complexity.

Perhaps employing another measure of complexity would have yielded different results. Previous studies (Logan & Conture, 1995; Zackheim & Conture, 2003) have employed a dichotomous measure to analyze the complexity of an utterance: Utterances were considered noncomplex in the absence of a subordinate clause or presence of only one independent clause and were considered complex in the presence of a subordinate clause or more than one independent clause. Although this measure of complexity will still vary along with the length of an utterance, it may not be as closely associated with the length of the utterance, as seen in the DSS analysis. For example, unlike the DSS, this measure of utterance complexity does not account for developmentally advanced sentence constituents such as conjunctions, pronouns, or noun modifiers. Another unique way of measuring utterance complexity was provided by Rispoli and Hadley (2001). In this case, each active declarative sentence was analyzed according to the complexity of the verb phrase. Analysis was specifically focused on one sentence component, the verb phrase. By discounting all other grammatical elements of a sentence, analysis yielded an average complexity score that was not related to the length of the utterance.

Is the Difference in Sentence Complexity of Fluent and Stuttered Utterances Related to IPSyn Scores?

In the present study, the relationship between sentence complexity and the incidence of stuttering did not significantly correlate with grammatical development (IPSyn scores). The difference between the average complexity scores of the stuttered and fluent utterances did not significantly increase as a child developed in grammar. Although results were insignificant, when the results were depicted in graph and table form, a relationship became apparent. That is, as a child increased in grammatical development, the difference in complexity of fluent and stuttered utterances also increased. CWS exhibited a greater incidence of stuttering on utterances that were grammatically more advanced. This relationship found among the spontaneous speech of CWS supports Bernstein Ratner and Sih’s (1987) study. They used a sentence-imitation task to determine a positive relationship between the incidence of stuttering and sentences of increasing complexity.

The current investigation found that the difference in complexity of fluent and stuttered utterances became more apparent as a child increased in grammatical development. This observation coincides with studies examining the relationship between normal disfluency and grammatical development in CWNS (Rispoli, 2003; Rispoli & Hadley, 2001). Similar to Rispoli and Hadley’s study with CWNS,
the gap between the fluent and stuttered utterances in CWS in this study widened as the participants increased in grammatical development. The difference was smaller for children who were grammatically less mature. This observation suggests that early in grammatical development, sentences of all levels of complexity are equally difficult to produce. However, as a child’s grammatical repertoire expands, fluency is seen on the simpler sentence forms and stuttering is observed on the newly acquired sentence forms. It can be predicted that the relationship between stuttering and sentence length and complexity is dynamic and is further influenced by developing grammar. This relationship is consistently changing in response to a child’s growing repertoire. The incidence of stuttering can be predicted to shift along a developmental continuum so as to occur more often on the child’s emerging grammar forms.

The insignificant findings in this study were also most likely a result of a low sample number. Studies that have found a positive relationship between childhood stuttering and an increase in syntactic complexity (Bernstein Ratner & Sih, 1987) have included more participants. A rank order correlation (see Figure 2) strengthened our assumption that as a child develops in grammar, the gap between the complexity scores of the fluent and stuttered utterances widens.

**Is the Difference in Sentence Complexity of Fluent and Stuttered Utterances Related to Age?**

Although Rispoli and Hadley (2001) found a correlation between the complexity scores of disrupted and fluent utterances in CWNS when correlated with IPSyn, they did not find a significant correlation between the scores when correlated with age. Similar to Rispoli and Hadley’s study, the difference in complexity scores for stuttered and fluent utterances in our study did not significantly increase as age increased. Results support Rispoli and Hadley’s findings in that a weaker relationship existed when correlating the difference in complexity with age than with IPSyn. Although these two studies differed in their study population, this is an important similarity to point out as it indicates that for research purposes, age may not always be the most appropriate indicator of a child’s stage of grammatical development. Research aiming to achieve a more adequate representation of a child’s grammatical level of development may benefit from seeking alternative measures such as a numeric value obtained in Scarborough’s (1990) IPSyn.

**Is the Difference in Sentence Complexity of Fluent and Stuttered Utterances Related to IPSyn When Sentence Length Is Held Constant?**

This study showed that the difference in complexity of the fluent and stuttered utterances did not significantly increase with IPSyn when length was held constant. It has already been mentioned that when utterance length was held constant and the difference in complexity between the fluent and stuttered utterances was compared, results were also insignificant. Consequently, when these difference scores were correlated with IPSyn, results remained insignificant. Results of the current investigation contradict other studies in which a relationship between the incidence of disfluency and sentences of increasing sentence complexity was found to occur independent of sentence length in both CWS (Bernstein Ratner & Sih, 1987) and CWNS (Rispoli & Hadley, 2001).

As noted earlier in this section, a low number of sample utterances per participant may have affected the results; for example, when controlling for length (5 morphemes), only two stuttered utterances were used for analysis for Participants B and C. In addition, DSS was used to measure the complexity of a sentence. This measurement yielded a numeric value that was very similar to the length in morphemes of that sentence. As a result, it was difficult to separate the complexity of a sentence from its length.

**THEORETICAL IMPLICATIONS**

The current investigation found stuttering to occur more often on sentences that were longer and more complex than those that were shorter and simpler. This relationship continued to remain apparent when the differences in sentence complexity of the fluent and stuttered utterances were correlated with grammatical development. Children were more likely to stutter on complex and/or longer sentences that were grammatically more advanced, and this relationship became more apparent as children’s grammar skills matured.

One explanation for these findings may be that newly acquired sentences place greater demands on the resources used for planning and producing speech, and that these demands exceed the capacity of CWS. The end result is a breakdown in fluency. This explanation is consistent with a demands and capacity model (e.g., Starkweather, Gottwald, & Halfond, 1990) in that environmental or self-imposed demands exceed the individual’s cognitive, linguistic, motoric, and/or emotional capacity. This theory does not predict that CWS exhibit a disorder in such abilities, but rather that the conversational demands simply exceed the capacity of the individual. It seems evident, however, that an abnormality in the system that is used to plan and produce speech must be present for such breakdowns in fluency to occur because CWNS experience similar fluency disruptions.

A number of studies (e.g., Bernstein Ratner & Sih, 1987; Gaines et al., 1991; Rispoli & Hadley, 2001) have found the incidence of stuttering to be related to the length and/or complexity of a sentence. It is not unreasonable to suggest, therefore, that some CWS have difficulty formulating and/or executing morphosyntactic processes. A delay in retrieving, processing, and/or assembling morphosyntactic units may affect the remaining stages of sentence production. As Perkins, Kent, and Curlee (1991) posited, a delay in grammatical processing will subsequently affect the sequencing of the remaining linguistic and paralinguistic information for that sentence. This may explain why some
studies have found CWS to benefit from sentence priming (Anderson & Conture, 2004). Consequently, as greater resources are being allocated to syntactic processing, less attention is being placed on executing the remaining portions of a sentence.

Studies have found that children are more likely to stutter on syntactic structures that are newly developing than on those with which they are familiar (Bernstein Ratner & Sih, 1987; Rispoli & Hadley, 2001; Yaruss, 1999). The production of emerging syntactic structures requires an increase in linguistic and cognitive resources, thus placing greater demands on the child. This relationship between stuttering and novel sentence forms seems to be more evident during spontaneous speech tasks. Some studies (Gordon et al., 1986) have found no significant difference between the complexity of fluent and stuttered sentences during a sentence-imitation task while finding significant differences during a sentence-modeling task. Compared to a sentence-imitation task, a sentence-modeling task requires resources similar to what is expected during spontaneous speech, such as the need for sentence formulation and processing.

The potential deficits in the syntactic processing abilities of CWS can be explained more specifically through Levelt’s (1989) incremental processing model of sentence production (Kempen & Hoenkamp, 1987). According to this model, the formulation and production of a sentence is broken down into modular or procedural units such as the noun phrase, verb phrase, and so forth. These modular units are formulated and produced in increments according to the hierarchy of a sentence. They are executed in a serial as well as parallel order. In order to produce sentences at the rate of a normal conversation, it can be assumed that a sentence is not formulated in its entirety before it is produced. Rather, a sentence is produced in increments (one or more modular units) so that the beginning portions of a sentence are being executed while the remaining portions of that sentence are still being formulated and processed. A speaker must retain the parts of the sentence that have already been produced in short-term memory in order to complete the remaining portions of a sentence. Longer and/or more complex sentences contain more incremental units and, when combined with an attempt to produce a novel sentence structure, will result in greater vulnerability for error. Perhaps CWS exhibit a lower threshold for error and are more vulnerable to an increase in processing demands.

In line with the incremental processing model, greater processing demands may result in a number of ways. First, an increased number of incremental units will result in greater demands being placed on short-term memory abilities (Bosshardt, 2002; Yaruss, 1999). Second, a greater number of incremental units will require greater resources to attend to the production of the sentence as a whole. The speaker must “hold on” to the initial parts of a sentence in order to correctly produce the remaining portions (Bosshardt, 2002; Yaruss, 1999). This includes the segmental as well as the supersegmental components of speech. In this view, CWS may experience “glitches” in the sentence production system where stalls and/or hesitations result in a breakdown in fluency.

Studies (e.g., Rispoli & Hadley, 2001; Wingate, 1986) have found a decrease in stuttering and normal disfluency in CWS and CWNS to occur on sentence structures that are frequently occurring in a child’s grammatical repertoire, whereas fluency breakdowns were more apt to occur on novel sentence forms. Rispoli and Hadley posited that, in many cases, children expand their grammatical repertoire by learning to build longer and more complex sentences from simpler ones, as described in Levelt’s (1989) incremental procedures model (Kempen & Hoenkamp, 1987). The simple sentence structures, with few incremental units, become learned and well-established as a result of frequent exposure. The more often a grammatical structure is incorporated into a child’s sentence building, the more fluent it will become as a result of practice. Subsequently, shorter and simpler sentences become fluent.

Evidence for this practice effect can be found in studies where CWS (Wingate, 1986) and CWNS (Colburn & Mysak, 1982) increase in fluency in response to a frequently occurring syntactic structure. Colburn and Mysak observed this relationship in the spontaneous speech of CWNS. They found that normal disfluency tended to move along a developmental continuum as a child expanded his or her grammatical repertoire and built more complex sentences from simpler ones. They found that when a syntactic structure such as a noun phrase was used regularly, disfluency decreased on that structure. At the same time, disfluency on a newly forming syntactic constituent such as a verb phrase would increase as it occurred in conjunction with the noun phrase. The new syntactic structure, in this case, the verb phrase, became the structure to be practiced.

This may explain the results of the present study in that children who were just beginning to develop grammar showed little difference in complexity between their fluent and stuttered utterances: All sentences were difficult to produce. However, the children who were more advanced in grammatical development demonstrated a significant gap between their fluent and stuttered utterances. Their fluent utterances were shorter and less complex than their stuttered utterances. This relationship became more apparent with grammatical maturity. The CWS exhibited greater fluency on the simple sentences while showing a higher incidence of stuttering on the most advanced sentence forms. In this case, fluency may be a result of learned linguistic and/or motoric activity where the processes of sentence formulation and execution become strengthened.

The complex integration of the components that make up our speech system synchronize as a result of practice. When compared with CWNS, it can be predicted that CWS experience a lower threshold for a disruption in processing linguistic and motoric information.

**CLINICAL IMPLICATIONS**

The results of the current investigation lend support for a stuttering treatment program that moves from shorter and simpler sentences to longer and more complex ones. The use of fluency-enhancing, shorter, and simpler sentences
may be a good starting point for a treatment program as it encourages the practice and learning of less demanding sentence forms while at the same time instilling confidence in the child.

Eliciting such language can be done through the use of imitation, modeling, reading, or conversational tasks. Although research has determined that CWS are affected by the length and complexity of a sentence, research is sparse in how to carry such observations into the treatment setting. Weiss and Zebrowski (1992) found that CWS were more likely to be fluent when they were responding to a question than when making an assertion. The responses to questions were shorter and less complex on average than the assertions. The responses to questions were also more likely to contain information from the question itself so as to eliminate the demands of initiating a topic as well as allowing the speaker to use preestablished words and syntactic frames.

Although it is important to consider sentence complexity in therapeutic intervention with CWS, it may also be important to consider other linguistic and paralinguistic demands that are present in conversational speech. Bernstein Ratner (1995) has considered the effects that linguistic and environmental complexities typical of conversational speech have on a child’s ability to produce fluent speech. Studies have found that an increase in linguistic demands (e.g., imitation, modeling, and spontaneous speech) yields a higher percentage of stuttering (Colburn & Mysak, 1982). In addition, environmental complexities such as time restraints or topic initiation may place greater demands on the speaker and thus elicit a higher incidence of stuttering. A treatment approach that includes an increasing hierarchy of grammatical, linguistic, and environmental complexities may prove beneficial to CWS. This is the line of thinking by Bernstein Ratner as she describes how to incorporate these complexities into a treatment program. As a child begins with simple, less complex target utterances, Bernstein Ratner proposes that the clinical procedures should also include less demanding linguistic tasks such as imitation or reading. Environmental tasks would also progress in complexity from a situation fostering a slow speaking rate with an increase in latency between turns to a more “real world” environment that requires greater demands to produce sentences in a more time-pressed manner. As fluency is achieved and the child is encouraged to produce more grammatically complex sentences, so should the linguistic and environmental complexities increase as well.

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