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The dynamic relationship of sentence complexity, childhood stuttering, and grammatical development

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The DYNAMIC RELATIONSHIP OF SENTENCE COMPLEXITY, CHILDHOOD
STUTTERING, AND GRAMMATICAL DEVELOPMENT

BY

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THESIS

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This thesis has been examined and approved.

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ABSTRACT

The DYNAMIC RELATIONSHIP OF SENTENCE COMPLEXITY, CHILDHOOD
STUTTERING, AND GRAMMATICAL DEVELOPMENT

BY

Kimberly R. Bauerly

University of New Hampshire, September, 2007

The present study was conducted to determine if the relationship
between grammatical complexity and childhood stuttering is influenced
by grammatical development. The study was cross-sectional in design
and observed the spontaneous speech of six children who stutter ranging
in age from 32 to 46 months. The first 100 utterances from each subject's
sample were scored using Scarborough's (1990) *Index of Productive
Syntax* (IPSyn) and given a numerical score which was used as an
indicator of grammatical development in place of the child's age. The
first one-hundred sentences containing a noun and verb in subject-
predicate relationship were extracted from each sample and coded for
their grammatical complexity using Lee's (1973) Developmental Sentence
Score. The utterances were also measured for the length in morphemes.
Sample utterances were then separated into two categories: fluent and
stuttered. 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 the

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 depicted in graph form. It was found that the difference

in complexity of fluent and stuttered utterances became more apparent

as a child increased in grammatical development. Findings suggest that

as a child's grammatical repertoire expands, simpler sentence forms are

fluent while the newly acquired sentence forms are dysfluent. Findings

suggest that the incidence of stuttering shifts along a developmental

continuum, occurring more often on the child's emerging grammar forms.

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INTRODUCTION

In recent years, studies have found that children who stutter will stutter more frequently on longer and more grammatically complex utterances (see review in Zacheim & Conture, 2003). An increase in utterance length and complexity is thought to place greater processing demands on the child and this is reflected in an increase in stuttering.

The length and complexity of utterances spoken by children have been analyzed by many disciplines and used as indicators of a child's stage in linguistic development. A child's mean length of utterance (MLU) is observed to increase by 1.2 morphemes per year between the ages of eighteen months and five years (Owens, 2005).[1] A correlation has been found between the child's MLU and age. While MLU may vary between children it is still considered a crude measure of a child's linguistic development (Owens, 2004; Paul, 2005).

The majority of studies presented in this study have defined a complex sentence as containing two or more main clauses or at least one main clause and one subordinate clause, whereas a simple sentence contains only one main clause (Bernstein Ratner & Costa Sih, 1987; Yaruss, 1999; Logan & Conture, 2003; Zackheim & Conture, 2003; Owens, 2005).

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[1] A morpheme is a linguistic unit that represents meaning. An entire word such as "walk" is considered a morpheme; while a suffix, prefix, or plural marker is also considered a morpheme such as the word ending "ed" as it changes the meaning of the word in "walk" to "walked".

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In other studies, the complexity of an utterance is given a numerical value, for example when employing Lee's (1973) grammatical assessment tool called *Developmental Sentence Scoring* (Gains, et al., 1991; Zackheim & Conture, 1995; Rispoli, 2001). Similar to the relationship between MLU and age, the development of sentence form has also been correlated with age. The majority of children begin to produce simple adult declarative sentences, which include a subject and verb between 28 and 32 months of age. Owens (2005) states that once the foundation of a sentence has been built, children begin to modify and expand from these basic sentence forms. These grammatical forms have been classified into norm- referenced developmental charts and used as references to a child's level of grammatical development.

Research addressing the influence of sentence length and complexity on the frequency of stuttering has focused primarily on the two as they occur together in a child's spoken sentence form. Less attention has been paid to either variable independently. Studies that have considered these two variables separately have resulted in dissimilar findings. Variably, either sentence length or complexity has been found to be the more significant variable. The most obvious reason for this lack of agreement is because length and complexity for the most part are co-occurring; an utterance is more apt to be grammatically complex as it increases in length. For example, if a sentence were to include a phrase

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or clausal constituent it might be more complex but also longer. Conversely, the moving of grammatical elements around in a sentence may result in a more grammatically mature sentence while not affecting its length (Owens, 2005). For example, reversing an auxiliary to form a question such as "*Is* he coming?" would be grammatically more advanced than a simple sentence such as "He *is* coming" (Lee, 1974). However, length remains the same. In this case, the complexity of the sentence is affected while the length of the utterance remains unchanged. These disparate findings may be a result of the influence from a third variable, grammatical development. A newly acquired sentence structure whether it be longer, more complex or both, may influence the incidence of stuttering.

Consistent with this, studies assessing grammatical development in children who stutter (CWS; Colburn & Mysak, 1982; Bernstein Ratner & Sih, 1987) and children who do not stutter (CWNS; Colburn & Mysak, 1982; Wijnen, 1990; Rispoli, 2001; Rispoli, 2003) have found that the production of newly acquired grammar forms contributes to the incidence of stuttering and normal disfluency. That is, children are more likely to demonstrate stutter-like and non stutter-like disfluencies when producing sentences that are relatively new to the child's linguistic repertoire.

This study explored the relationship between grammatical complexity and the frequency of stuttering in relation to a third variable,

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grammatical development. The intention of this study was to discern whether grammatical development acts a macro variable in the relationship between stuttering frequency and grammatically complex utterances, and to observe how this relationship changes as a child masters grammar. The purpose of this study is to determine if the relationship between childhood stuttering and sentence complexity is impacted by grammatical development and if this relationship becomes more significant as the child's grammatical skills increase.

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CHAPTER I

LITERATURE REVIEW

Sentence Length and Complexity in the Incidence of Stuttering

A number of studies have analyzed the role that sentence complexity plays in the incidence of stuttering. Gaines, Runyan & Meyers (1991) analyzed the length and complexity of the spontaneous speech of 12 CWS who ranged in age from 4 to 6 years. The subjects' sample utterances were divided into fluent and stuttered utterances and analyzed for their sentence length and complexity using Brown's morpheme count (1973) and Lee's (1974) *Developmental Sentence Scoring*, respectively. Results revealed that both the complexity scores and the length of the stuttered utterances were significantly greater than those of the fluent utterances. Eight out of the 12 subjects mean length comparisons of fluent vs. stuttered utterances reached statistical significance, while all 12 subjects' complexity scores reached statistical significance. Gains et al. (1991) study was unique in employing Lee's *Developmental Sentence Scoring* (DSS; 1974) as a means to measure the complexity of the sample utterances. In this case, a numerical score was given to each utterance based on its sentence complexity as opposed to forming two categorical variables, complex and non-complex, based on

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the inclusion or omission of an independent clause or subordinate clause.

Logan & LaSalle (1999) determined whether the production of disfluency clusters (speech disfluencies that occur with close proximity to each other) were related to such linguistic characteristics as utterance length, syntactic complexity, and sentence location. This study analyzed the spontaneous speech of 14 CWS and 14 CWNS with a mean age of 4.3. 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 groups. This suggested that grammatical complexity was closely associated with the occurrence of stuttering. The grammatical complexity of the utterance was considered to be the stronger variable. This observation was supported by the authors as they observed that 85% of the disfluency clusters were produced at the beginning of an utterance or a clause within an utterance, possibly indicating the effects from grammatical complexity.

Other studies have found that stuttering is more likely to occur on longer utterances. Yaruss (1999) conducted a thorough investigation of the relationship between utterance length, grammatical complexity,

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and childhood stuttering. He examined several different components of a sentence 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. Seventy-five utterance samples were taken from the spontaneous speech of 12 CWS between the ages of 3.3 and 5.5. While results indicated that stuttered utterances were likely to be longer and more complex, the length of the utterance was the more determinant variable. However, there was a relationship found among the incidence of stuttering and certain syntactic components that were not associated with utterance length. These sentences contained either a negative marker, a high valence of the main verb or were interrogative sentences. One possible explanation provided by Yaruss (1999) was that these syntactic components represented emerging linguistic forms that proved challenging to the speaker, putting greater demands on the speaker (Berstein Ratner & Sih, 1987) and thus affecting the likelihood that stuttering would occur.

Logan & 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 old. Twenty-five fluent and stuttered utterances were measured from each subject's conversational speech.

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Lee's *Developmental Sentence Score* (1974) 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 subjects, while syntactically complex utterances had significantly more stuttering in 11 out of 15 of the subjects.

Incidence of Stuttering and Grammatical Development

A unique study by Zackheim & Conture (2003) assessed the relationship between stuttering and utterance length in relation to the individual child's mean level of grammatical development. This was done by analyzing each child's mean length of utterance (MLU) that contained stuttering and normal disfluencies. Spontaneous speech samples were taken from 6 CWS and 6 age-matched CWNS and the mean length of utterance was calculated using Brown's (1973) morpheme rules and then converted into a z-score. Eighty utterances from each child were ranked into quartiles according to utterance length to assist in between-subject comparisons. Sample utterances were also categorized as being either complex (i.e., presence of a subordinate clause or more than one independent clause) or non-complex (i.e., the absence of a subordinate clause or presence of only one independent clause).

The results of Zackheim & Conture's (2003) study indicated that both CWS and CWNS produce significantly more disfluencies on utterances

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that were longer than their MLU and on those utterances that were considered complex. However, unlike CWNS, the utterances of CWS that were shorter than their MLU were more likely to exhibit disfluencies on non-complex utterances. Although CWS stuttered more on the noncomplex utterances, there were 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 non-complex utterances whereas the longer utterances that fell into the upper two quartiles (above MLU) tended to be complex utterances. This caveat may explain why a greater percentage dysfluencies was seen on the non-complex utterances below the subject's MLU. This observation may have also been affected by how the researchers measured utterance complexity. An utterance was interpreted as complex in the presence of a subordinate clause or more than one independent clause. Although this is a common measurement of complexity, it may have excluded utterances that were complex and short, such as the inversion of a copula or questions other than the one word "why", utterances which are considered to come at a later stage in language acquisition and can also be considered complex.

Incidence of Stuttering in Relation to Motor Speech Processes

Numerous studies have examined the relationship between stuttering and the motor speech processes of people who stutter. These

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studies are valuable because they have further delineated the relationship of stuttering to sentence length and complexity. These studies have observed the linguistic characteristics of individuals who stutter from a different perspective. By observing the motor speech processes of individuals who stutter, Kleinow & Smith (2000) assessed the effects of utterance length and complexity on the speech motor stability of people who stutter. This study observed the stability of lower lip movement in 8 adults who stutter (AWS) and 8 age-matched adults who do *not* stutter (AWNS) using a spatiotemporal index (STI). The subjects, ranging in age from 18 to 39 years old, were asked to imitate seven sentences that increased in length and complexity. Results indicated that AWS exhibited an increase in STI values, or less stability in their lower lip, across all sentence types when compared to AWNS. In addition, AWS demonstrated a significant increase in STI when subject to an increase in sentence complexity. In other words, an increase in utterance complexity negatively influenced stability of the lower lip movement. In addition, utterance length did not affect lower lip stability.

Speech initiation times have also been used to assess the effects longer and more complex utterances have on the planning and initiating of speech motor movements in adults who stutter (AWS). Findings from some studies have shown that AWS are slower at planning and initiating motor movements associated with such speech tasks as the production of

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words, phrases, and short sentences (Reich, Till, & Goldsmith, 1981; Watson et al., 1991). Logan (2003) expanded on these studies to determine if sentences with increasing complexity were significantly correlated with longer initiation times. Eleven AWS and eleven adults who do not stutter (AWNS) were asked to read, rehearse and produce 24 sentences with varying complexity. Results found no significant difference in speech initiation times between the sentences that varied in complexity spoken by the adults who stutter.

A unique study conducted by Anderson & Conture (2004) considered the effects of sentence length and complexity on stuttering by assessing the temporal components of overt speech. They employed a sentence structure priming paradigm to observe the syntactic processing abilities of CWS and CWNS. Participants were asked to describe black and white drawings with and without syntactic primes depicted on a computer screen. Speech reaction times (SRTs) were measured. Results indicated that CWS exhibited slower SRTs in the absence of priming sentences and greater SRTs in the presence of syntactic-priming compared with CWNS. These are interesting findings as they suggest CWS may have difficulty retrieving, processing or initiating syntactic frames and as a result benefit from syntactic primes.

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The Influence of Grammatical Development on Stuttering and Normal Disfluencies

Some posit that the connection between grammatical complexity and stuttering is further influenced by grammatical development. Suggestions that stuttering (Wall, 1980; Bernstein Ratner & Sih, 1989) and normal disfluencies (Muma, 1971; Rispoli, 2001) is 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 & Sih (1987) addressed the degree to which increasing syntactic complexity affected 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 – 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. Sentences of increasing complexity were used to reflect the impact newly acquired sentence structures had on the incidence of stuttering. Length did not prove to play a significant role.

In addition, Gordon, et al. (1986) replicated Pearl & Bernthal (1980) study by observing the effects of various grammatical constructions and complexities on the incidence of disfluency in children who do *not* stutter

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through the use of imitation tasks. Subjects were asked to imitate 6 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 grammatical complexity and the occurrence of disfluencies. However, Gordan, et al. (1986) 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. Gordan, et al. (1986) 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 not accomplished through sentence imitation tasks.

Silverman & Ratner (1997) extended Bernstein Ratner & Sih (1987) study of the effects of increasing sentence complexity on the incidence of childhood stuttering by observing whether a pattern was present in adolescents who stutter. The study used a sentence imitation task with three discrete levels of sentence complexity. Results indicated that stuttering frequency was not significantly affected by an increase in

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syntactic complexity. Silverman & Ratner(1997) posited that the effects of syntactic complexity may lesson as an individual who stutters acquires the grammatical rules of a language.

Studies have considered if normal disfluencies in CWNS are influenced by developmentally complex sentences (Colburn & Mysak, 1982; Rispoli, 2001; Wijnen, 1990). Results of these studies have been similar to Ratner's (1987) study with CWS. Similar to the relationship between stuttering and sentence complexity, normal disfluencies in CWNS are thought to be a response of a child acquiring language. Rispoli, et al. (2001) analyzed the spontaneous speech of 26 typically developing children between the ages of 2.6 to 4.0. The verb phrases from all active declarative sentences were extracted and coded for the presence of disruption, length in morphemes and words, and clausal complexity. Results demonstrated that disrupted sentences were significantly longer and more complex. In addition, this relationship positively correlated with grammatical development. 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.1140). In addition, this relationship remained significant even when the length of the utterance was held constant. Rispoli, et al. (2001) described speech disruptions in CWNS as an effect of children undergoing "morphosyntactic development" (p.1140). Unique to

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this study was the use of Scarborough's *Index of Productive Syntax* (IPSyn; 1990) which, by means of a numerical score, replaced the chronological age of the child and acted as the child's grammatical maturity measure. When the average verb phrase complexity for disrupted versus fluent sentences was correlated with age and IPSyn, significant results (.70, p<.01) were obtained with IPSyn but were not obtained (r=.33, p>.05) with age. Partial correlations were also significant with IPSyn. In addition, when the length of the sample utterances was controlled for, significant results (r=.552, p<.05) were correlated with IPSyn but were not significantly correlated with age (r=.11, p>.05). These results suggested that the age of the child was not always the most effective indicator of the child's stage in grammatical development. While 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.

Conclusions

In the studies described above, both the length and complexity of an utterance have been shown to play a role in the incidence of childhood 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 utterance (e.g. Logan & LaSalle, 1999); while others have found that both longer and more complex utterances

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play a comparable role in the incidence of stuttering (Zackheim & Conture, 2003; Gains, Runyan & Meyers, 1991).

Studies have determined that the relationship between sentence length and complexity and the incidence of normal disfluency in non-stuttering children is further influenced by grammatical development (Gordan, et al., 1986; Rispoli et al., 2000). When spontaneous speech was observed in CWNS, Rispoli et al. (2001) found the highest incidence of disruption to occur on the developmentally most advanced sentence forms. This seems only logical as we consider the vast amount of grammatical knowledge 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 (Wijnen, 1990; Rispoli, 2001). 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.

Studies observing this relationship in children who stutter are limited. Few studies have measured utterance length and 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. Bernstein Ratner & Sih (1989) study observed this relationship with CWS by administering a sentence imitation

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task with sentences of increasing complexity. The gradual increase in sentence complexity was representative of a typical developmental hierarchy. The results demonstrated a significant correlation between an increase in syntactic complexity and the frequency of stuttering.

The majority of studies which have assessed grammatical development and speech disruption in CWS (Bernstein Ratner & Sih, 1989) and CWNS (Gordan, et al., 1986; Pearl & Bernthal, 1980) have used sentence-imitation and sentence-modeling tasks, while the use of spontaneous speech has been limited. Although such studies offer insight into the ability of children who stutter 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.

In addition, many studies use the chronological age of a child as a criterion for determining if a spoken utterance is longer or more complex when viewed in terms of a child's stage in grammatical development. However, a child's stage of grammatical development is not always reflective of their chronological age. Rispoli & Hadley (2001) found that speech disruption, sentence complexity and grammatical development were significant when correlated with IPSyn but not always when correlated with age. These results indicated that age is not always the most effective measurement of grammatical maturity in children.

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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/non-complex according to the presence of one or more independent clause or the presence or absence of a subordinate clause. While this is a common measurement tool for grammatical 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. Instead of employing a categorical measurement of sentence complexity, Gaines et al., (1991) employed Lee's *Developmental Sentence Scoring* (DSS; 1974) as a means to measure the complexity of utterances spoken by 12 CWS. Results indicated that for all 12 subjects, stuttered utterances were significantly greater in complexity scores than the subject's fluent utterances. In this case, a numerical score was given to each utterance based on its sentence complexity.

In summary, the present study was conducted to determine if the relationship between grammatical complexity and childhood stuttering is dynamic and influenced by a larger variable, grammatical development. Based on previous findings, it is assumed that while a relationship exists between sentence complexity and stuttering, it can be delineated further

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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. This study is unique to childhood stuttering research in that it employs Scarborough's (1900) *Index of Productive Syntax* in order to obtain the most accurate representation of the child's stage in grammatical development. In addition, Lee's *Developmental Sentence Scoring* was used to obtain a numerical 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.

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CHAPTER II

METHOD AND PROCEDURE

Method

Participants

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

      Prior to recruitment, subjects had been diagnosed by a certified speech-language pathologist as having a stuttering disorder with no other accompanying speech or language impairments. In addition to the testing conducted by a certified speech-language pathologist, subjects were administered the following battery of tests by the investigator to assure no other concomitant speech or language problems were present: (1) the *Preschool Language Scale 4th Edition* (Zimmerman,et al., 2002) measured the subject's receptive and expressive language, (2)the

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Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 2000) measured

their speech sound development, (3) and the *Stuttering Severity*

Instrument-3 (Riley, 1994) measured their stuttering severity level. A pure

tone hearing screening was also conducted with a portable audiometer

to assure that hearing was within normal limits.

The articulation and language tests listed above were administered

prior to observation only if the subjects had not been administered that

test by a certified speech-language pathologist within the last 6 months.

The *Stuttering Severity Instrument – 3* (Riley, 1994) was administered to all

subjects prior to observation in order to gather a current representation of

their stuttering severity. In addition to the testing, an interview with the

subject's primary caregiver was conducted to discuss any concerns they

had about a possible speech, language, or hearing disorder.

The children in this study presented with a stuttering disorder based

on the following criteria: (1) an evaluation from a certified speech-

language pathologist, (2) results from the Riley's *Stuttering Severity*

Instrument-3 (1994) conducted just prior to the study observation, and (3)

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 speech-

language pathologists, subjects did not present with any other

concomitant speech or language disorders. Three of the children in this

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study were receiving therapy for their stuttering disorder at the time of observation while the other three children were undergoing the diagnostic stage of the therapy process and had not received any stuttering therapy at the time of observation.

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

Table 1

Individual Data for Subjects, Including Age, Gender, Time since Onset, Family History of Stuttering and Scores from Riley's Stuttering Severity Instrument – 3 (SSI-3; 1994).

Subject	Age in months	Gender	Age of onset/mo.	Family history of stuttering	Stuttering Severity Instrument-3
A	46	M	36	yes	61-77%, moderate
B	46	F	24	yes	5-11%, mild
C	45	M	24	no	5-11%, mild
D	39	M	29	yes	61-77%,moderate
E	43	M	40	yes	78-88%, severe
F	32	M	29	no	61-77%,moderate

Procedure

Speech Samples

The spontaneous speech samples of each subject were audio and video recorded by the primary researcher as they played with their parent(s) during one recording session that lasted approximately 30 minutes. A digital camera was used as the primary audio and visual recording device while an audio recorder was employed as a backup.

The observations were conducted either in the subject's home, a university playroom-laboratory or at a private practice office. If the observations took place at home, a section of the house was set aside for observation. The time and place of the observations were coordinated so to eliminate any interruptions. Each parent/subject pair used developmentally appropriate toys to play with and were asked to engage in play as they commonly would at home. Some of the more common toys used were play dough, race cars, train sets, and action figurines. 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.

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Analysis of Speech Sample

    Transcribing the speech sample. The audio- and videotapes from the observation session were orthographically transcribed and given three passes to verify consensus reliability. The video recordings were also used to observe non-verbal instances stuttering, such as blocks. The initial transcription was performed by the primary researcher. The second and third passes were independently performed by both the primary researcher and primary advisor. Utterances were excluded from the final corpus if the utterance was characterized by the following: (1) it was not agreed upon and/or was partly or completely unintelligible, (2) it was incomplete or interrupted and/or (3) 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 the 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 then scored using the *Index of Productive*

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Syntax (IPSyn; Scarborough, 1990) to measure the subject's present stage of grammatical development. The IPSyn (Scarborough, 1990) 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 the analysis. It includes many of the grammatical structures used in the Assigning Structure Stage (ASS; Miller, 1981) while adding several other structures. "By focusing on a variety of grammatical forms, the IPSyn serves as a measure of their use, rather than misuse, by the child" (Scarborough, 1990, p.2) For these reasons, the IPSyn serves as a tool for measuring the emergence of syntactic and morphological forms. Numerical scores were derived from the analysis and used in place of the subject's age as a more accurate description of their stage in development.

Sentence complexity analysis. Utterances were then prepared for Lee's *Developmental Sentence Scoring* analysis. (DSS; 1974) Following the first 25 warm-up utterances, 100 sentences were coded following the DSS criteria. Sentences were included in analysis if they were completely

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intelligible, 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 (1) indefinite pronoun or noun modifier, (2) personal pronoun, (3) main verb, (4) secondary verb, (5) negative, (6) conjunction, (7) interrogative reversal in questions, and (8) 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. So each utterance received a numerical score derived from the eight categories described above.

Utterance length analysis. Each sentence in the 100-sample corpus was then measured for the number of morphemes using Brown's Rules for Counting Morphemes (Owens, 2004). For example, one morpheme was counted for the following: compound words, ritualized duplications, irregular past-tense verbs, auxiliary verbs, and irregular plurals. Conjunction words found at the beginning of an utterance were also counted as one morpheme as they represented a part of the linguistic and motoric

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processing that constitutes the speech act. However, conjunction words at the beginning of an utterance were not given complexity points by the DSS criteria; rather they were only counted as part of the grammatical unit of a sentence and therefore given a morpheme point for utterance length analysis. Two morphemes were counted for the following: possessive nouns, plural nouns, third person singular, regular past-tense verbs, and present progressive verbs. 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 then evaluated using procedures similar to those reported in Logan & Conture (1995) for the presence of within word stutters (e.g. sound/syllable repetitions, within syllable pauses, silent/audible prolongations), between-word stutters (i.e., whole/part multi-syllabic word repetitions, phrase repetitions, interjections), or whole, mono-syllabic word repetitions. Utterances were coded as stuttered if one or more core stuttering behaviors were present. Stutter-like repetitions were considered if the iteration occured more than two times and/or the rate of the iteration was faster than the speaker's normal rate of speech. Prolongations appear in voiced and voiceless sounds and are described as a continuation in phonation while the

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movement of articulators has stopped. Blocks are characterized as a stop in air flow and articulation so phonation has usually stopped as well (Guitar, 2006). A normal disfluency was recorded if the following characteristics occurred: (1) 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, (2) a prolongation was used as emphasis, or (3) 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. As stated above, audio and video tapes were orthographically transcribed. Video recordings were also observed to verify non-verbal stuttering as well as to clarify the intention of an utterance such as whether an utterance was performed as an imperative or declarative. Each transcript received three passes from the primary researcher and two passes from a second rater to verify consensus reliability. The second rater is an ASHA certified speech and language pathologist. 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. During this transcription

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phase, the presence or absence of stuttering – like disfluencies was coded for each utterance. Utterances that included the presence or absence of stuttering – like disfluencies that were not agreed on were to be excluded from the final corpus. However, there were no disagreements on the presence or absence of a stuttering-like disfluency.

Interjudge (author and an independent judge who was trained in each of the measures used in this study) 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 subject's 100-sample utterance and scored for the following measures: (1) grammatical development analysis (IPSyn), (2) grammatical complexity analysis (DSS), and (3) 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%.

Data Analysis

The following statistical analyses were used to answer each of the questions posed earlier and listed below.

Sentence Complexity, Length, and the Incidence of Stuttering

1. How did sentence complexity relate to the incidence of stuttering? To answer this question, utterances from each 100 – sample

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transcript were separated into two categories: fluent and stuttered utterances based on the fluency analysis previously described above. The mean sentence complexity level was calculated for the fluent and stuttered categories. Independent sample *t* tests were then calculated for individual subjects to determine whether a significant difference existed between the sentence complexity levels of the 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.

2. Is the incidence of stuttering influenced by the complexity of an utterance when the length of the utterance is controlled? To answer this question, a frequency analysis was performed in order to determine the length of utterance that involved the largest number of sentences and was produced by the largest number of subjects. The frequency analysis revealed an utterance length of 5 morphemes to be the most frequent length of utterance and used most frequently by the majority of subjects. Next, the sample utterances that were 5 morphemes in length were extracted and used for analysis following the procedures described in question number 1. The mean sentence complexity level was calculated for the fluent and stuttered utterances that were 5 morphemes in length. Independent sample *t* tests were then calculated for individual subjects to determine whether a significant difference existed between the sentence

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complexity levels of the fluent and stuttered utterances when the 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, Stuttering, and Grammatical Development

1. Is the difference in sentence complexity of fluent and stuttered utterances related to age and/or IPSyn? To answer these questions, bivariate correlation analyses were performed. The differences between the mean complexity levels of the fluent and stuttered utterances were correlated with age and IPSyn.

2. Is the difference in sentence complexity of fluent and stuttered utterances related to age and/or IPSyn when the length is held constant? To answer this question, all of the utterances that were 5 morphemes in length were extracted and used for analysis. The differences between the mean complexity levels of fluent and stuttered sentences that were 5 morphemes in length was then calculated. The difference score for each subject was correlated with age and IPSyn using a bivariate correlation analysis.

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CHAPTER III

RESULTS

Results

The purpose of this study was to investigate whether the relationship between grammatical complexity and the incidence of stuttering is influenced by grammatical development. Six children who stutter (CWS) were audio and video recorded as they interacted with their parent(s). Each child's 100-utterance sample was scored for the following variables: grammatical development, sentence complexity, sentence length and the presence of stuttering. Subject's sample utterances were divided into two categories: fluent and stuttered utterances. Results from speech samples of six CWS are reported in this chapter. Five specific areas of inquiry were pursued. Individual and group data will be presented following a description of each question.

Sentence Complexity, Length and the Incidence of Stuttering

The first area of investigation was to determine the relationship between sentence length and complexity, and the incidence of stuttering. To explore this area, two questions were addressed: (1) How did

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sentence complexity relate to the incidence of stuttering? and (2) Is the incidence of stuttering influenced by the complexity of an utterance when the length of the utterance is controlled?

Sentence complexity and the incidence of stuttering. To determine whether sentence complexity relates to the incidence of stuttering, independent sample t-tests were calculated on individual subjects. Determinations were made as to whether a significant difference existed between the sentence complexity levels of fluent and stuttered utterances. The means for these analyses are presented in Table 2. A comparison of group means using a paired-sample t test was also performed to test whether the fluent and stuttered utterances were significantly different in complexity. The means for these analyses are presented in Table 3.

Table 2

Means and p-values of Individual Subject Comparisons for Sentence Complexity of Fluent and Stuttered Utterances.

| Subject | Means | | Level of Significance |
	Fluent	Stuttered	
A	8.66	11.31	p=.154
B	7.91	13.94	p=.032*
C	7.49	10.76	p=.026*
D	5.73	6.22	p=.518
E	3.75	8.20	p<.001*
F	6.75	7.18	p=.770

* These subjects made the greatest contribution to the overall effect (p<-.05) shown in Table 2.

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Table 3

Comparison of Group Mean Complexity Levels of Fluent and Stuttered
Utterances.

Utterances	No. of Subjects	Group Means	
		M	SD
Fluent	6	6.77	1.73
Stuttered	6	9.57	2.95

As Table 2 shows, the observed means of sentence complexity for

the stuttered utterances were greater than the fluent utterances for all six

subjects. When conducting group comparisons, a paired t-test revealed

that the stuttered utterances were significantly greater in complexity, $t=$

2.97; p<0.05.

Sentence complexity and the incidence of stuttering when the

length is controlled. Calculations were performed to determine if

sentence complexity related to the incidence of stuttering when the

length of the utterance was controlled. A frequency analysis was

performed to determine the length of utterance that involved the largest

number of sentences and was produced by the largest number of

subjects. The frequency analysis revealed an utterance length of 5 to be

the most frequent length of utterance and used most frequently by the

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majority of subjects. Independent sample *t* tests were calculated on the

individual 100- utterance samples to determine whether a significant

difference existed between the sentence complexity levels of the fluent

and stuttered utterances. The individual subject's means for fluent and

stuttered utterances when length was controlled are presented in Table 4.

A comparison of group means was also conducted using a paired-

samples *t* test. This was performed to determine whether group fluent and

stuttered utterances were significantly different in complexity when the

length was controlled at 5 morphemes. The means for these group

analyses are presented in Table 5.

Table 4

Means and p-values of Individual Subject Comparisons of Sentence
Complexity for Fluent and Stuttered Utterances when Length = 5
morphemes. The number of sample utterances is shown in parenthesis.

| Subject | Means | | Level of Significance |
	Fluent(n)	Stuttered(n)	
A	5.92(12)	7.50(6)	p=.425
B	7.38(13)	5.50(2)	p=.419
C	4.50(14)	6.50(2)	p=.387
D	8.60(5)	7.25(16)	p=.550
E	4.00(2)	6.38(13)	p=.006
F	3.50(2)	5.88(17)	p=.027

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Table 5

Comparison of Group Mean Complexity Levels of Fluent and Stuttered
Utterances when Length = 5 Morphemes.

Utterances	No. of Subjects	Group Means	
		M	SD
Fluent	6	5.65	2.02
Stuttered	6	6.50	0.77

Results revealed that as a group the stuttered utterances were not

significantly greater in complexity than the fluent utterances when the

length of the utterance was held constant, p= -1.075, p>.05. Table 4

demonstrates that 4 out of the 6 subject's mean stuttered utterances

were greater than the mean of their fluent utterances. Table 5 also reveals

that as a group the mean complexity of the stuttered utterances was

greater than the fluent utterances. However, as a group the stuttered

utterances were not significantly greater in complexity than the fluent

utterances as a result of a large standard deviation exhibited for the

mean stuttered utterances (see Table 5).

Sentence Complexity, Stuttering, and Grammatical Development

The second area of investigation was to observe the relationship

between sentence complexity and the incidence of stuttering as it relates

to grammatical development. To accomplish this goal three questions

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were addressed: (1) Is the difference in sentence complexity of fluent and stuttered sentences related to IPSyn scores? (2) Is the difference in sentence complexity of fluent and stuttered utterances related to age? (3) Is the difference in sentence complexity of fluent and stuttered sentences related to IPSyn when the sentence length is held constant?

Difference in sentence complexity of fluent and stuttered utterances with IPSyn. The first step was to determine if the difference in sentence complexity of fluent and stuttered utterances was related to the subject's score on the grammatical test *Index of Productive Syntax* (Scarborough, 1990). A bivariate correlation analysis was performed. First, the difference between the subject's average obtained from the *Developmental Sentence Scoring* (Lee, 1974) of fluent and stuttered utterances was obtained. The difference was then correlated with the subject's IPSyn scores. Table 6 represents the subject's age, IPSyn score and DSS difference score. Figure 1 is a scatterplot showing the relationship between the difference scores and the subject's IPSyn scores.

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Table 6

Subject's Age, IPSyn, and DSS Difference between Fluent and Stuttered
Utterances.

Subject	Age	IPSyn	DSS difference
A	3.10	95	2.65
B	3.10	88	6.03
C	3.90	69	3.27
D	3.30	68	0.49
E	3.70	76	4.45
F	2.80	68	0.43

Figure 1: Scatterplot of Difference in Complexity Scores between Fluent
and Stuttered Utterances with IPSyn Scores
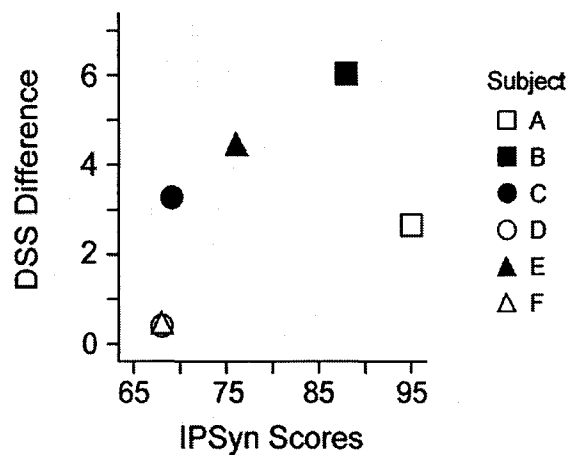
A bivariant correlation revealed that the relationship between the
difference in complexity scores was not significantly correlated with IPSyn,
r = 0.638, p>.05. Results indicated that the difference between the
average complexity scores of the stuttered and fluent utterances did not
significantly increase as a child developed in grammar.

Although the statistical data is insignificant, when results are depicted in graphic and table form a relationship is apparent. Table 6 and Figure 1 depict 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 below.

Figure 2: Scatterplot of the Rank Order Difference in Complexity Scores between Fluent and Stuttered Utterances with IPSyn Scores

Difference in sentence complexity of fluent and stuttered utterances with age. To determine if the difference in sentence complexity of fluent and stuttered utterances was related to age, a bivariate correlational analysis was performed. Difference scores between the individual averages of fluent and stuttered utterances were correlated with the subject's age. Refer to Table 6 above for a representation of the subject's age in relation to their difference score.

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Figure 3 is a scatterplot showing the relationship between the difference scores in complexity of fluent and stuttered utterances and the subject's age.
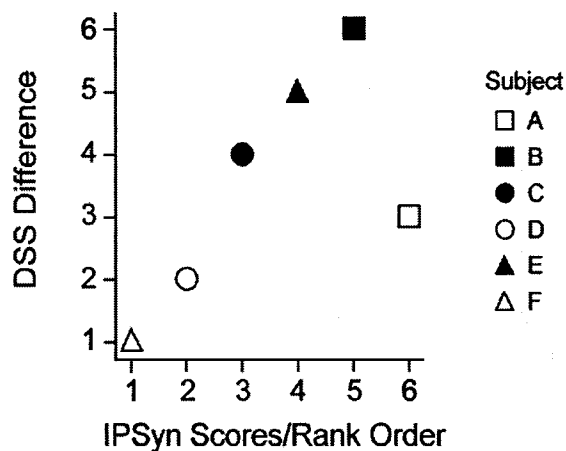
Figure 3. Scatterplot of Difference in Complexity Scores between Fluent and Stuttered Utterances with Subject's Age
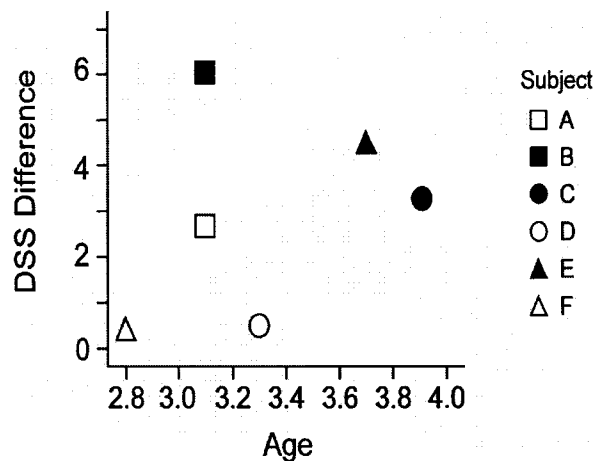
A bivariate correlation analysis revealed that the difference in sentence complexity of fluent and stuttered utterances did not significantly correlate with age, $r = .406$, $p > .05$. Results indicated that the difference in complexity scores for stuttered and fluent utterances did not significantly increase as age increased.

Table 7 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.

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Table 7

Correlation of Age and IPSyn with the Difference in the Average
Complexity of Stuttered and Fluent Utterances.

	Bivariate Correlation	Significance
Age	.406	.425
IPSyn	.638	.173

Difference in complexity of fluent and stuttered sentences with

IPSyn when length is held constant. Analyses were performed to

determine if the difference in complexity of fluent and stuttered sentences

was related to IPSyn when the length of the utterance was held constant.

A frequency analyses revealed an utterance length of 5 morphemes to

be the most frequently spoken utterance and used most frequently by the

majority of subjects. Sentences that were 5 morphemes in length were

extracted from each subject's 100-utterance sample. A bivariate

correlation analysis was then conducted.

The difference in sentence complexity of fluent and stuttered

utterances that were 5-morphemes in length was not significantly

correlated with IPSyn (r=0.309, p>.05). Results indicated that the

difference in complexity of the fluent and stuttered utterances did not

significantly increase with IPSyn when the length was held constant.

Please refer to Table 4 for the means and p-values of individual subject

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comparisons of mean sentence complexities for fluent and stuttered

utterances when the length is controlled at 5 morphemes. Refer to Table 5

for a comparison of group mean complexity levels of fluent and stuttered

utterances when the length is controlled at 5 morphemes.

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CHAPTER IV

SUMMARY AND DISCUSSION

Summary

Past studies assessing the impact of sentence length and complexity on the incidence of stuttering in children have resulted in dissimilar findings. Either length or complexity has been found to be the more significant variable. Studies have focused on the motor processing abilities of people who stutter when producing longer or more complex sentences. The majority of these studies have found that complex utterances negatively influence the motor speech processes of people who stutter while the length of an utterance does not seem to play a role.

Some have speculated that this relationship between stuttering, sentence length and syntactic complexity is further influenced by grammatical development. Studies that have assessed the relationship between grammatical development and disfluency in CWS as well as CWNS have found that a disruption in the flow of speech is positively correlated with sentences of increasing length and complexity. Studies that have assessed this relationship with CWS have been limited to sentence modeling and imitation tasks.

The present study expanded on research with preschool children

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who stutter by examining their spontaneous speech to determine if the relationship between grammatical complexity and childhood stuttering is influenced by grammatical development. The following discussion will focus first on the findings pertaining to each research question, followed by sections on theoretical and clinical implications.

How did Sentence Complexity Relate to the Incidence of Stuttering?

The current investigation supports the results of previous studies with preschoolers (Gaines, Runyan & Myer, 1991; Weiss & Zebrowski, 1992; Logan & LaSalle, 1999) by showing that the stuttered utterances were significantly greater in complexity than the fluent utterances. Similar to the Gaines, et al. (1991) study, the current study found that for each subject, the mean stuttered utterance was greater in complexity than the typical fluent utterance. Group comparisons also indicated that the stuttered utterances were significantly greater in complexity.

Logan & Conture (1995) found similar results; however, the proportion of difference was slightly smaller. In their study 11 out of 15 participants exhibited this relationship. Similar to the current study, Logan & Conture (1995) employed Lee's DSS to measure sentence complexity. However the two studies varied in methodology. First, Logan & Conture (1995) observed 25 fluent and 25 stuttered utterances for each subject while the current study observed a total of 100 utterances per subject.

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Second, Logan & Conture (1995) observed 15 subjects while the current study was limited to 6 subjects.

Yaruss (1999) found sentence length to be the more potent determinant factor when considering the incidence of stuttering. However, he also found that some aspects of sentence complexity were found to be related to the incidence of stuttering that were not directly associated with sentence length. 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 the length of the utterance was held constant. The outcome of this investigation coincides with other studies (e.g. Gaines, et al., 1991) in

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which the length and complexity of an utterance played a comparable role in the incidence of stuttering. Although results are insignificant, Table 4 demonstrates that 4 out of the 6 subjects' mean stuttered utterances were greater in length than the mean of their fluent utterances. These findings are similar to the Logan & 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 subjects.

It had been anticipated that the complexity of the stuttered utterances would continue to be significantly different than the fluent utterance when the length of the utterance was held constant. Table 5 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 distributed throughout the sample. Children in earlier stages of grammatical development may find all sentences equally difficult to produce. Rispoli, et al. (2001) observed similar findings with normal disfluencies in children who do not stutter. Similar to the current study, Rispoli's subjects ranged in

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age from 2.6 to 4.0. Findings suggested that the length and complexity of the fluent and non-fluent sentences were about 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 non-fluent sentences. In contrast, studies (Yaruss, 1999; Logan & Conture, 1995) observing children who are 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 is a result of methodological differences as these studies vary 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. While a frequency analysis was performed to determine the length of utterance that included all subjects and involved the largest number of sentences, it was difficult to obtain an equal number of utterances among subjects who varied in age and thus level of grammatical development. As a result, there were low sample utterances for some of the subjects when the length was held constant. For example, the analysis included two fluent utterances that

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were five morphemes in length for subjects E and F and two stuttered utterances that were five morphemes in length for subjects B and C.

Finally, another factor that may have influenced the results of the present investigation can be found in the methodology used to score the complexity of an utterance. Lee's (1974) *Developmental Sentence Scoring* was used to measure the complexity of a sentence in this study. The complexity scores were very similar in number to the scores 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* scoring system credits the conjunction of two simple clauses by giving points to all main verbs in a sentence as well as for the 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 subjects' sample utterances. It was difficult to control for length without indirectly controlling for complexity.

The complexity of an utterance is not always equal to the length of an utterance in morphemes, however. One situation where the

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complexity of an utterance may be greater than its length in morphemes is when the grammatical elements with-in a sentence are moved around the sentence, resulting in a more linguistically mature sentence while not affecting its length (Owens, 1995). For example, reversing an auxillary 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 while the length of the utterance remains unchanged. It may be that a greater number of sample utterances per subject 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. An utterance has been considered *non - complex* in the absence of a subordinate clause or presence of only one independent clause. Likewise utterances were considered *complex* in the presence of a subordinate clause or more than one independent clause. While 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

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conjunctions, pronouns, or noun modifiers. Another unique way of measuring utterance complexity was provided by Rispoli, et al. (2001). Each active, declarative sentence was analyzed according to the complexity of the verb phrase. In this case, 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 graphic 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 & Sih (1987) study. They used a sentence imitation task to determine a positive relationship between the incidence of stuttering and

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sentences of increasing complexity. Furthermore, studies have found the relationship between normal disfluency and grammatical development to exist in CWNS when employing sentence modeling tasks (Gordon, et al., 1986) as well as spontaneous speech samples (Colburn, et al., 1982; Wijnen, 1990; Rispoli, et al., 2001). In these studies, as CWNS develop grammar normal disfluencies were found on the emerging grammatical forms.

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 on the relationship between normal disfluency and grammatical development in children who do not stutter (Rispoli, et al, 2001; Rispoli, 2003). Similar to Rispoli's et al. (2001) study with CWNS, the gap between the fluent and stuttered utterances in CWS in this study widened as the subjects 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 while stuttering is observed on the newly acquired sentence forms. In other words, stuttering is more likely to be found on the child's emerging grammar forms. It can be predicted that the relationship between

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stuttering and sentence length and complexity is dynamic and 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 to occur more often on the child's emerging grammar forms.

The insignificant findings in this study are also most likely a result of a low sample number. Studies which have found a positive relationship between childhood stuttering and an increase in syntactic complexity (Bernstein Ratner & Sih, 1987) have included more subjects. 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?

While Rispoli, et al. (2001) found a correlation between the complexity scores of disrupted and fluent utterances in CWNS when correlated with IPSyn, he did not find a significant correlation when correlated with age. Similar to Rispoli's et al. (2001) study, the difference in complexity scores for stuttered and fluent utterances did not significantly increase as age increased. Results support Rispoli, et al. (2001) findings in that a weaker relationship existed when correlating the difference in complexity with age than with IPSyn. Although these two

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studies differ 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 numerical value obtained in Scarborough's (1990) *Index of Productive Syntax*.

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

When examining the results of this study, we see that the difference in complexity of the fluent and stuttered utterances did not significantly increase with IPSyn when the length was held constant. It has already been mentioned that when the 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 grammatical complexity was found to occur independent of sentence length in both CWS (Bernstein Ratner & Sih, 1989) and CWNS (Rispoli & Hadley, 2000).

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As noted earlier in this section, a low number of sample utterances per subject may have affected the results; for example, when controlling for length, only 2 stuttered utterances (5 morphemes in length) were used for analysis for Subject B and C. In addition, Lee's (1974) *Developmental Sentence Scoring* was used to measure the complexity of a sentence. This measurement yielded a numerical value 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. 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 the child who stutters. The end result is a breakdown in fluency. This

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explanation is consistent with a Demands and Capacity model (e.g. Starkweather & Gottwald, 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 disordered cognitive, linguistic, motoric and/or emotional abilities, but rather that the conversational demands simply exceed the capacity of the individual. It seems evident that an abnormality in the system used to plan and produce speech must be present for such breakdowns in fluency to occur since children who do not stutter experience similar fluency disruptions.

A number of studies (e.g. Bernstein Ratner & Sih, 1987; Gaines, et al., 1991; & Rispoli et al., 2001) have found that the incidence of stuttering is 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) posit, 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

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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 (Bernstein Ratner & Sih, 1987; Yaruss, 1999; Rispoli &Hadley, 2001). 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 an imitation task while finding significant differences during a sentence modeling task. Compared to an 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

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are executed in a serial as well as parallel order. In order to produce sentences at a 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. As each increment of a sentence is executed, an opportunity for a glitch in the execution of the entire sentence is presented. A speaker must retain the parts of the sentence already 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 (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

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portions (Yaruss, 1999). This includes the segmental as well as the super-segmental 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 (Wingate, 1986; Rispoli, 2001) 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 while fluency breakdowns was more apt to occur on novel sentence forms. Rispoli, et al. (2001) 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 their 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 children who stutter (Wingate, 1986) and children who do not stutter (Colburn & Mysak, 1982) increase in fluency in response to a frequently occurring syntactic structure. Colburn & Mysak (1982) observed this relationship in the spontaneous speech of CWNS. They found that normal disfluency tended to move along a

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developmental continuum as a child expanded their 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. The 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

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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 have some clinical implications. A number of studies have helped to determine that the production of longer and more complex utterances increases the incidence of stuttering. At the same time, the current investigation expanded on this relationship by demonstrating that stuttering, sentence length, and grammatical complexity may be further influenced by grammatical development. These observations lend support for a 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. While 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 & Zebrowski (1992) found that CWS were more likely to be fluent when responding to a question than when making an

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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 to eliminate the demands of initiating a topic as well as allowing the speaker to use pre-established words and syntactic frames. It is research such as this that will help to determine the most effective approach for treating childhood stuttering by manipulating grammatical complexity.

While it is important to consider grammatical complexity in therapeutic intervention with children who stutter, it may also be important to consider other linguistic and paralinguistic demands that are present in conversational speech. 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, spontaneous speech) yield 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 the child who stutters. This is the line of thinking by Ratner (1995) as she describes how to incorporate these complexities into a treatment program. As a child

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begins with simple, less complex target utterances, Ratner (1995) proposes 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.

Limitations to the Study

The most obvious limitation to this study is the small sample size. The difference in complexity scores between the stuttered and fluent utterances was not significantly correlated with grammatical development. However, when the results were depicted in a scatterplot a relationship became apparent. A rank order correlation also revealed an apparent trend between the difference in stuttered and fluent utterances and grammatical development. Perhaps a larger sample size would have provided sufficient power to yield significant results.

Another limitation was the number of unequal fluent and stuttered utterances that were analyzed in each sample. Some subjects demonstrated very few fluent utterances while others exhibited very few

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stuttered utterances. This discrepancy became more apparent when controlling for the length of an utterance. To answer the question, is the difference in sentence complexity of fluent and stuttered utterances related to grammatical development when the sentence length is held constant, only utterances that were 5 morphemes in length were analyzed. This group was then separated into fluent and stuttered categories resulting in a small number of utterances that were unequally distributed. The reason for the discrepancy between fluent and stuttered utterances may be found in the variability of the subjects' age. This study attempted to control for the length of an utterance from a spontaneous speech sample in children who varied in age and thus stages of grammatical development. As a result, it was difficult to obtain an adequate representation of a child's language (large sample number of utterances per subject) while also determining the length of utterance that is produced by the largest number of subjects.

Children who vary in stages of grammatical development will tend to produce utterances that differ in grammatical complexity. A large standard deviation was exhibited for the complexity scores of the mean stuttered utterances and was a result of the younger subjects producing simpler, less-complex sentences when compared to the older subjects. As a result of the large standard deviation, the difference in complexity of fluent and stuttered utterances was found to be insignificant.

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Finally, it was difficult to control for the length of an utterance without indirectly controlling for sentence complexity. The utterance complexity scores were very similar in number to the scores derived from counting the length of the utterance in morphemes (see page 51). So when controlling for length in the individual subject comparisons, there was an insignificant difference between the sentence complexity of fluent and stuttered utterances. Subsequently, the insufficient statistical power observed in the individual subject comparisons affected the ability to detect a significant relationship in the group, correlation analysis.

Future studies that analyze a specific grammatical structure within a sentence (e.g. verb phrase) as opposed to scoring the sentence in its entirety may prove more beneficial. In this way, the confounding variable of sentence length can be eliminated.

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APPENDIX

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23-Jan-2007

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IRB #: 3598
Study: The Dynamic Relationship of Sentence Complexity, Childhood Stuttering and Grammatical Development
Review Level: Expedited
Approval Expiration Date: 27-Jan-2008

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved your request for time extension for this study. Approval for this study expires on the date indicated above. At the end of the approval period you will be asked to submit a report with regard to the involvement of human subjects. If your study is still active, you may apply for extension of IRB approval through this office.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the document, *Responsibilities of Directors of Research Studies Involving Human Subjects.* This document is available at http://www.unh.edu/osr/compliance/irb.html or from me.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or Julie.simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Manager

cc: File
    Gottwald, Sheryl

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