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Temporal Characteristics of Fluent Speech in the Stuttered Utterances of Children

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THESIS APPROVAL

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ABSTRACT

An abstract of the thesis of Dixon Ira Kirsch for the Master of Science in Speech Communication: Speech and Hearing Science presented May 9, 1997.

Title: Temporal Characteristics of Fluent Speech in the Stuttered Utterances of Children

Studies investigating the stuttered speech of children are fewer in number as compared to those exploring adult dysfluency. This is notable as the features that characterize child stuttering are generally thought to be significantly different from those that describe advanced stuttering. Clinical intervention programs currently use timing-based interventions as one means of treating stuttering. As such, acoustic data describing the timing disorder is critical to determining the efficacy of these programs for both children and adults.

The present study investigated the difference in duration (in msec) between words of stuttered and non-stuttered utterances of children. The words immediately before and after a stuttered event were compared with the

same words, produced by the same speaker, in the same non-stuttered utterance. Stimulus materials consisted of 20 items selected from the Patterned Elicitation Syntax Test, (PEST), (Young & Perachio, 1983). Sixty stimulus sentences (3 per item) were verbally presented to each of 3 preschool subjects who were instructed to repeat exactly what they heard. The stimulus sentences were presented on two different occasions, with a 5 minute break between each session to reduce the affects of adaption, to elicit corresponding speech samples from each subject. Analysis consisted of digital spectrographic strip measurement of word duration for the words immediately before (BSTUT) and after (ASTUT) a stuttered word. These measurements were then compared to word duration measurements for the exact corresponding words immediately before (BNSTUT) and after (ANSTUT) the same nonstuttered words produced by the same speaker. The results of two-tailed t-tests for paired samples calculated for BSTUT vs. BNSTUT (p=.998) and ASTUT vs. ANSTUT (p=.076) indicate no significant differences exist between the word durations of both data groups at the p=.05 level of confidence. The findings of the present study do not support the theory that stuttering effects the production of words immediately before and after a stuttered word in children's speech.

TEMPORAL CHARACTERISTICS OF FLUENT SPEECH IN THE STUTTERED UTTERANCES OF CHILDREN

by

DIXON IRA KIRSCH

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CHAPTER 1

INTRODUCTION

The question of whether stuttering is confined to discrete periods of time during connected speech or whether it affects the fluent speech surrounding the stuttered word has been a point of interest in research for some time (Runyan & Adams, 1978; Viswanath, 1989; Wendahl & Cole, 1961; Williams, 1957). The bases for continued interest in this area stem from questions that are yet unanswered concerning the etiology of the stuttering disorder.

In the past, perceptual-based studies attempting to identify significant differences in the fluent speech of persons who stutter as compared to normal speakers have produced conflicting results which have led to disagreement concerning the reliability of the data. The concern revolving around the reliability of perceptually based observations is underscored by recent published studies that have provided data indicating untrained individuals, as well as recognized authorities in the area of stuttering, cannot reliably identify stuttered events on a perceptual bases (Cordes, Ingham, Frank, & Ingham, 1992; Curlee, 1981; Ingham & Cordes, 1992). It is apparent additional empirically based acoustic studies addressing the nature of stuttered speech are needed.

Only since the onset of digital technology has the desktop technology become available that allow aggressive empirical study of the fluent speech within the stuttered utterances of children and adults. Microcomputers and software designed to analyze speech are currently being combined with improved audio recording and digitizing equipment to provide new insight into this area of study. Procedurally similar to previous adult studies conducted by Young (1994) and Tetnowski, Morris, & Peterson (1995), the present study will employ some of the newly available technology in an effort to maximize the precision of data collection. Increased precision of data collection will serve to provide much needed quantitative information describing the nature of fluent speech within the stuttered utterances of children.

Statement of Purpose

The present study, by means of objective acoustic analysis, looks at word duration (in msec) of words immediately before and after a stuttered word within a child's stuttered speech. The time measurements were then compared to the same words in the same sentences by the same speaker when the stuttering did not occur. These comparisons were performed in an effort to answer the following question: "Is there acoustic evidence, in terms of differences in word duration, of the spread effect on words surrounding (i.e., immediately before and after) the stuttered words of children's stuttered speech?" The null hypothesis states that there will be no acoustic evidence of the spread effect on words surrounding the stuttered words of children's stuttered speech. Should evidence of the spread effect on words surrounding the stuttered moment be observed, continued research aimed at identifying and describing the structure of fluent speech within a stuttered utterances of children is warranted.

Definition of Terms

The following terms used throughout this study are more specifically defined below:

Formant Frequencies: Peaks of resonance in the vocal tract that are displayed as broad amplitude of energy in a wide-band spectrogram. The formant frequencies are labeled F_x where the fundamental frequency is identified by F_0.

Formant Transition: A change in formant frequency for a given speech sample.

Fundamental Frequency: The fundamental frequency (F_0)

is the lowest frequency component of a complex periodic wave.

Perceptual Assessment/Judgement/Evaluation: Non-quantitative methods of obtaining test data. Perceptual methods rely on personal judgements of the examiner.

Prolongations: A stuttering event in which respiratory, phonatory, and/or articulatory movement precedes at a slow, elongated, and usually tense level.

Repetitions: A stuttering event in which alternating contraction and relaxation of speech musculature results in whole-word, part-word, syllable, or phoneme repeats, or repetitive articulatory postures.

Spectrogram: A voice print on which phonemes appear in distinctive patterns useful for acoustic analysis of the speech signal.

Spread Effect: A term used to describe the effect of a stuttered word on surrounding fluent speech. For this study the effect of interest concerned changes in the duration (msec) of words in the immediate vicinity of a stuttered moment.

CHAPTER II

REVIEW OF THE LITERATURE

A stable definition of stuttering that adequately describes the core features of stuttering and its associated behaviors has proven to be as illusive as the disorder itself. Wingate (1964), after examining what he referred to as the speech characteristics of stuttering, provided the following definition.

> The term *stuttering* means: 1.(a) Disruption in the fluency of verbal expression, which is (b) characterized by involuntary, audible or silent, repetitions or prolongations in the utterance of short speech elements, namely: sounds, syllables, and words of one syllable. These disruptions (c) usually occur frequently or are marked in character and (d) are not readily controlled. (p. 488)

Although a very descriptive definition of stuttering that seemingly addresses all of the features that are observable in stuttered speech, this definition, and others like it, have drawn significant criticism.

Van Riper (1982) described Wingate's definition as a listing of phenomena characteristic of stuttered speech behavior that may or may not exist in the speech of some or all persons who stutter. In an effort to account for the variability of the *nature* of stuttered speech both from speaker to speaker and within the same speaker, Van Riper proposed the the following definition, "Stuttering occurs when the forward flow of speech is interrupted by a motorically disrupted sound, syllable, or word or by the speakers's reaction thereto" (p. 15). It appears that Van Riper's definition expands our understanding to include the emotional aspects as well as the behavioral components of stuttering put forth by Wingate. However, Perkins (1990) criticized both definitions proposed by Wingate and Van Riper based on the implication that only motoric disruptions qualify as stuttering.

Perkins's (1990) disagreement stems from his experience with clients who rarely, if ever, were heard to stutter; yet they were among the most fearful of stuttering. To account for silent disruption of the normal flow of speech, Perkins proposed, "Stuttering is the involuntary disruption of a continuing attempt to produce a spoken utterance" (p. 376). It is important to note that Perkins qualified the term *involuntary* using Webster's

(1979) definition, "done contrary to or without choice... not subject to control of the will" (p. 466). In doing so, Perkins (1990) attempted to redefine stuttering in terms of an event in the mind of the speaker that is manifested in a motoric disruption of speech versus a perceptual event in the ear of the listener.

It is apparent in each of the above definitions, important aspects of the nature of stuttering are personified, however, in and by themselves none provide a stable and accepted working definition of stuttering that apply to all who stutter. Hood (1974) provided a possible link between the behavioral aspect proposed by Wingate and VanRiper and the cognitive component proposed by Perkins with the following statement,

> "What the stutterer does at any point of time is in part the behavioral consequence of what he has already done. The stuttering behaviors that we observe are the culmination of certain tensing, speeding, avoiding, postponing, holding back, struggling or escaping that have already occurred" (p. 25).

Given Hood's premise that what we observe overtly as a stutter is really the result of the actual stutter which has already occurred, the primary purpose of this investigation was to quantify, through measurable acoustic data, the resultant effect of a stuttered event in the utterances of children. This quantification of effect was measured in terms of word duration (msec) immediately before and after a stuttered event. The remainder of this chapter will: (a) provide a brief overview of selected historical studies that have addressed the fluent speech of adults and children who stutter and how this fluent speech differs perceptually from those who do not stutter, (b) provide a brief overview of selected historical studies that have investigated the acoustic parameters of stuttered speech as compared to the fluent speech, and (c) provide rationale for investigating word duration in children's stuttered and fluent utterances.

Historical Studies Based on Subjective Perceptual Judgment

Adults

Working from Williams's (1957) theory that stuttering affects all the speech in an utterance, Wendahl & Cole (1961) were first to provide evidence that differences do exist between the fluent speech of those who stutter as compared to those who do not. Findings from their study indicate that listeners could in fact perceive a difference in the recorded fluent speech produced by individuals who stutter even when all traces of the stuttered moment were removed from the samples. The oral readings of 16 subjects (8 adult males who stutter and 8 who did not, matched for age and reading proficiency) were tape recorded. Four sentences for each person who stutters were selected and edited to replace all instances of stuttering with two-second silent intervals of blank tape. Tapes for the matched control subjects were similarly edited resulting in matched pairs of speech samples. Eighty-six undergraduate students in psychology severed as untrained judges for the study. The judges were divided into four groups and were independently presented the speech samples via the sound field. Prior to the presentation of the speech samples, each group was instructed concerning decisions they were to make in the areas of stuttering (group #1), speech rate (group #2), the amount of force or strain in the voice (group #3), and rhythm patterns (group #4). Based on the t-test analysis of the pooled data, it was concluded that: (a)fluent speech of individuals who stutter is significantly different from that of individuals who do not stutter, and (b) the fluent speech of the person who stutters is affected by the stuttered moment within an utterance.

The results of Wendahl and Cole's (1961)investigation have subsequently been supported by Ingham & Packman (1978), Runyan & Adams (1979), and Howell & Wingfield (1990). Ingham & Packman(1978), while investigating the perceptual assessment of speech normalcy following stuttering inter-vention, asked listeners to distinguish between intermingled matched pairs of speech samples obtained from 9 individuals who had been treated for stuttering and their sex- and age- matched fluent speaking peers. The listeners were unable to judge perceptually significant differences between the matched samples in the areas of prosody, rate, fluency, and naturalness. However, when a second group of listeners were asked to determine if a speech sample was obtained from a treated stutterer or a normal speaking individual, the individuals who stutter were judged as abnormal significantly more often than the control group. As a result, Ingham and Packman concluded that, "...[it is significant] that no stutterer's speech sample was confidently described as the speech of a normal speaker; even though subjects had achieved the therapy goal of stutter-free speech within the target speech-rate change" (p. 71).

Using similar methods to those employed by Wendahl and Cole (1961), Runyan and Adams (1979) took recorded samples of fluent speech extracted from the speech of successfully and partially successfully treated individuals who stutter and paired them with the fluent speech of matched normal speakers. The experimental recorded tapes were then presented to 20 "unsophisticated" judges (employed as secretaries, laborers, businessmen, housewives, and nurses) who had no previous formal training in the area of speech production and stuttering. The purpose of the study was to determine if perceptual differences exist in the fluent speech of stutterers as compared to nonstutterers when judged by the untrained ear. It was concluded that the fluent speech of those who stutter was different from the fluent speech of normal speakers at levels significantly above chance.

Similar findings were reported by Howell and Wingfield (1990) in a two-part study in which they looked at the relationship between perceptual evaluations and acoustic properties of fluent speech within a stuttered utterance. For this investigation, recordings were made of seven males who stuttered (ranging in age from 20 to 35 years) while engaged in conversation with a speech-language pathologist on a variety of topics. Experimental clauses were extracted from the tapes that began with a fluent section of speech, contained a stuttered event (i.e., part-word repetition or prolongation) in the middle of the clause, and was completed with a fluent section of speech. The sample clauses were paired with control samples and presented to five groups of 14 listeners identified as speech science students who had completed an introductory course in phonetics. The groups were assigned and instructed concerning rating and discrimination tasks associated with identifying the proximity of a fluent word to that of the stuttered event within the utterance. Specifically, groups 1-3 were instructed to rate each of the paired clauses on a seven-point rating scale where 1 indicated the listener was sure the clause was produced adjacent to a stuttered moment while 7 indicated the listener was sure the clause was produced elsewhere in the utterance away from the stuttered moment. Groups 4 and 5 were instructed to listen to the prepared sample tapes and determine: (a) which sample came from near a stuttered moment, (b) whether the adjacent stuttered moment was a repetition or a prolongation, and (c) whether the adjacent stuttered moment preceded or followed the section they (judges) heard. The results of the study indicated that, although listeners could not perceptually judge the proximity of fluent speech with respect to the stuttered event, they could distinguish between experimental and control samples. In addition, listeners could, based on differences in vocal intensity (loudness), identify the type of stuttering event that occurred in the experimental samples at a level higher than would be expected due to chance.

The results of Wendahl and Cole's (1961) study have, on the other hand, been questioned as a result of contradictory findings (Few & Lingwall, 1972; Young, 1964). Findings of these studies indicate that the perceptual differences between the fluent speech of an individual who stutters and the fluent speech of those who do not are insignificant to the listener. Young (1964), after questioning the procedures used by Wendahl and Cole, replicated the study using the original tapes. It was discovered the original study presented the paired speech samples in the same sequence, thereby, allowing the listener a 50% chance of labeling each speaker as either a person who stutters or as a normal speaker. To alleviate this problem, Young gave the same instructions to the 43 listeners; however, they were told to listen to all the presented speech samples for each pair of speakers before making a judgment as to whether the individuals were stutterers or nonstutterers. The resulting data were evaluated using an alternative mode of analysis that placed confidence limits at 13 and 30 (based on the guess factor of .5 for the binomial probability model). Using this method of analysis, Young was unable to conclude the fluent speech of individuals who stutter is significantly different from that of normal speakers when perceptually judged by the listener.

Few and Lingwall (1972) conducted a similar study that required a group of 20 graduate students in speech pathology and audiology to listen to and judge 34 randomly ordered, 10-second fluent speech samples taken from 28 subjects (14 adult males who stutter and 14 adult males evaluated to be normal speakers who exhibited no stuttering behaviors). The judges were presented the speech samples on two different occasions. During the first presentation, the judges were instructed to indicate the perceived rate of speech on a scale of 1 to 7 (1 being slow and 7 being fast). During the second presentation, the judges were asked to identify whether each of the 10-second speech samples were produced by a person who stutters or a normally speaking individual. Based on the perceptual judgments of the 20 listeners, the findings indicate that, although the listeners perceived the fluent speech of persons who stutter to be slightly slower, the accompanied *t*-test results did not reach significance at the 0.05 level. Additionally, the total number of individuals correctly identified as nonstutterers was 81.7% while the correct identification of persons who stutter only reached 31%. As a result of these findings, Few and Lingwall concluded that, based on listener judgments of speech rate and speaker identification, there was no evidence to support the finding reported by Wendahl and Cole which suggests perceptual differences exist in the fluent speech of persons who stutter and those who do not.

Children

Studies investigating the perceptual judgment of fluent speech in children who stutter are fewer in number as compared to those concerning adults. This is notable in light of the fact stuttering is many times thought of as a disorder of childhood that may be related to the development of language. In an effort to extend the research of fluent speech produced by individuals who stutter to children, Krikorian and Runyan (1983) conducted a comparison study of the fluent speech of children who stutter and the fluent speech of childeren who do not stutter as perceptually judged by 10 sophisticated listeners. Fifteen subjects (14 male and 1 female) diagnosed as children who stutter were age-, sex-, and grade-matched with 15 normal speaking children. The children ranged in age from 4 years 2 months to 6 years 11 months. Audiotape recordings for each of the 30 subjects were collected during the spontaneous retelling of two different stories. From the recordings, 4 nonstuttered speech samples were collected from each of the experimental subjects and paired with samples obtained from the control group. After matching each pair of utterances for fluency, content, and length, 60 pairs of speech samples were available for construction of a master tape. The paired speech samples were then randomly ordered with selected samples from the children who stutter and samples from the control group occupying the initial position an equal number of times. The tapes were presented to the judges and resulting data were analyzed using a binomial probability model. Confidence limits were set at 331.58 and 268.42 based on a 50% guess factor and a total possible score of 600 correct identifications of the speaker who stutters. The results of the study indicated the sophisticated judges did not identify the children who stutter from the normally speaking children at a level greater than would be expected due to chance. The total number of correct identifications equaled 299 out of the 600 possible.

In summary, the research to date addressing the existence of perceptual differences in the fluent speech of those who stutter as compared to normal speakers has generated conflicting results. The findings have both supported and contradicted Williams's (1957) theory that a stuttered event influences the entire utterance. The body of evidence presented makes it clear the study of stuttering cannot rely on perceptual judgment of speech produced by persons who stutter as the only means of collecting data. Investigators who engage in the study of stuttering must continue to expand their research methodology in the area of acoustic and durational data collection.

Historical Studies Based on Objective Parameters

Various studies have used acoustic measures as a means of comparing the fluent speech of persons who stutter with that of normal speakers. As in the perceptual study of fluent speech, the majority of objective investigations have concentrated on the differences in adult speech as opposed to fluent speech of children who stutter.

Adults

Love & Jeffress (1971) investigated the differences in accumulated pause time in the fluent speech of those who stutter as opposed to those who do not. The findings of this study have become a quasi-benchmark in opposition to Wendahl and Cole's (1961) findings. Fifty subjects (25 clinically diagnosed as stuttering disordered and 25 normal speakers) matched for age and sex were audiotape recorded during the oral reading of three different passages. Defining a brief pause as 25 to 2500 msec, the accumulated pause time for each sample was determined using a simple counting device designed to sum the duration (in msec) of brief pauses present in the speech waveform. Results of the data analysis indicated the accumulated pause time in the fluent speech of a stuttered utterance is significantly higher than that of the non-stuttered utterance. However, the difference generally fell within a time duration range of 125 to 150 msec. It was Love and Jeffress's belief that even at 150 msec, the additional pause time could not be perceived by the listener as different than that of normal speech.

Klich and May (1982) used spectrographic analysis to study the formant frequencies and formant transitions of the vowels /i/, /æ/, and /u/ produced in consonant-vowel (CV) sequences during fluent speech of persons who stutter. Seven male subjects identified as stuttering disordered were audiotape recorded during isolated productions of

/h+vowel+d/ sequences and 5-minute oral readings of selected materials under five different conditions. The conditions identified by the procedure included: normal, noise, delayed auditory feedback (DAF), rhythmic pacing, and whisper. Fluent speech segments of the resulting recorded speech samples were marked and spectrograms made of fluently produced words containing the target vowels. The results indicate the first and second formant frequencies in an isolated /h+vowel+d/ production were more centralized than those previously reported for nonstuttering individuals. Formant frequency centralization occurred even more during the reading of the passages with little variance across conditions. Duration and rate of formant transitions remained essentially the same across all conditions as well. The findings of this study indicate vowel production by persons who stutter are more restricted than that of nonstuttering individuals.

Metz, Samar, and Sacco (1983), while investigating the fluent speech of persons who stutter before and after intervention, performed acoustic analysis on nine different variables: voice onset time (VOT), selected intervocalic interval acoustic parameters (voicing, friction and silence of voiced and voiceless stop consonants), and vowel duration. On the first and last day of a 5-week treatment program, 14 adult subjects (12 male and 2 female) were audiotape recorded while reading a 1,000 word passage and a list of 24 monosyllabic (CV) English words. The resulting target words that met the fluency criteria were sectioned, digitized, and stored on magnetic tape for analysis. The findings of this study present acoustic evidence in support of the existence of perceptual differences in the fluent speech of individuals who stutter. The authors concluded at least one perceptually subliminal acoustic event (silence in the intervocalic interval) varies as a function of dysfluency.

The findings of Pindzola's (1987) investigation suggest that temporal differences do exist in the fluent speech of stutterers as compared to nonstuttering individuals. Spectrograms derived form the recorded fluent speech samples (4 symmetric and 4 asymmetric VCV sequences) of 10 experimental subjects identified as stuttering disordered and 10 nonstuttering control group subjects were analyzed for duration of vocalic transitions, steady states, and total vowel durations. Two-factor analysis of variance with repeated measures on one factor were used to evaluate the durational differences between the two groups of subjects and among the VCV stimuli. Results of the analysis indicate (a) the steady-state duration of vowels produced by the persons who stutter were significantly different than those produced by the nonstuttering control group, (b) the duration of vowel-to-consonant transition was significantly different, (c) the duration of consonant-to-vowel transition was not significantly different, and (d) total vowel durations were not significantly different between the two groups. Pindzola not only concluded that temporal differences exist between the fluent speech of persons who stutter and normal speakers, but these temporal differences are not confined to isolated speech subsegments (i.e., only during transitions or steady states).

Viswanath (1989) conducted a two-part study to investigate (a) the global relationship of total articulation time (TAT) and total pause time (TPT) with the frequency of stuttering events during adaptation, and (b) the duration of words in various locations in the immediate vicinity of the stuttered event within clausal utterances. As the second purpose of this study is closely related to the present study, it will be addressed in greater detail than previous studies presented.

Viswanath (1989) analyzed the acoustic-temporal aspects of clausal utterances in two ways, globally and locally. In the global analysis, the differences in temporal reorganization associated with adapting clausal utterances produced by individuals who stutter as opposed to the productions of nonstutterers was examined. This portion of the study intended to answer the following questions: (a) Are there differences in the fluent oral readings produced by persons who stutter and controls with respect to TAT and TPT, (b) Are there differences in the TAT and TPT of persons who stutter and controls when the experimental subject's reading contains a stuttered event, and (c) Are there differences in the TAT and TPT of persons who stutter when producing a stuttered event in one reading with the other readings being fluent, as compared to no dysfluency over the course of five readings?

The analysis examines the effects of a stuttering event on the duration of words immediately before and after the stuttered event. This portion of the study was intended to answer the following questions: (a) Are there anticipatory and carryover effects that influence the duration of words at various locations in the immediate vicinity of a stuttered event, (b) What are the limits of these effects with respect to the entire clausal utterance, and (c) Do the duration changes reflect an overall durational constraint to the speaker planning an utterance?

To provide evidence in support or opposition to these questions, Viswanath (1989) employed 8 subjects (4 persons who stutter and 4 normal speakers) matched for age, sex, education, and social background. Each subject read two short stories five times in succession with a 2 minute rest period between readings. The oral readings were audiotape recorded, then reviewed to isolate stuttering events (defined as repetitions and prolongations of sound and syllables) and clausal-utterances. A clause produced by an experimental subject was selected for analysis if the associated five readings met the following criteria: (a) the first reading of the clause contained a stuttered event while the remaining four readings were judged to be fluent, (b) the speaker fluently produced the last word in the preceding clause and the first word in following clause in five readings, and (c) the matched control speaker's utterance were produced fluently and without distortion.

Forty utterances produced by the experimental group met criteria (a) and (b) above (8 clauses x 5 readings) and therefore were identified as the dysfluent corpus, labeled (SD). Additionally, 40 matched utterances produced by the nonstuttering subjects made up the control group corpus, labeled (CD). The speech samples obtained from the 8 subjects were then reviewed a second time to identify two clauses produced by each subject where the last word of the preceding utterance and first of the following utterance was produced fluently and without distortion. This provided two additional corpi consisting of 40 fluent utterances produced by the experimental group, labeled (SF), and 40 matched fluent utterances produced by the control group, labeled (CF).

To facilitate data analysis, broadband spectrograms were produced which segmented each utterance into words and pauses. The segmentation of the stuttered events were completed using the following procedure. Repetitions of sounds and syllables were identified as the first fragment of the attempted word through the subsequent repetitions of the fragment. Audible prolongations were identified by steady-state formant patterns with the end of the prolongation being identified at the first formant transition.

For the global analysis, TAT (defined as the sum of duration of words constituting the clausal utterance) and TPT (defined as the sum of duration of pauses within the clausal utterance and the syntactic pauses at their boundaries) were calculated for each utterance in the four corpi (SD, CD, SF, and CF). An ANOVA was performed to compare trends between the data groups using group as one factor and readings as the other. The results of this analysis indicate the experimental group, as compared to the control group, demonstrated considerable durational reorganization (i.e., durational changes to various words at different locations in the utterance) of utterances as a result of reducing the TAT and TPT across the five readings. Furthermore, the reorganizations occurred whether or not the stuttered event occurred in the series of corresponding utterances.

With respect to the local analysis, word locations were designated within and exterior to the target clause. X- location identified the words that were produced fluently after having been stuttered in the first reading. The remaining locations within and external to the target clause were identified with respect to the X-location. Specifically, X-1 identified the location immediately before the stuttered word, X+1 identified the location immediately following the stuttered word, X-2 identified the location one word removed prior to the stuttered word, X+2 identified the location one word removed following the stuttered word, Xp referred to the last word-location of the previous clause, and Xf identified the first word-location in the following clause.

An ANOVA with repeated measures was performed for the corpi SD and CD with the analysis limited to the five locations mentioned. Per Viswanath (1989), few clauses contained locations beyond the X-2 and X+2 locations. Results of the analysis provided the following findings concerning the possible anticipatory and carryover effects that influence the duration of words at various locations in the immediate vicinity of a stuttered event.

With respect to the X-location, no significant difference was observed between the experimental and the control groups for the average duration of the words in the X-location over the course of the five readings. Similarly, there was no significant difference noted in the average duration of words in the X-1 location over the course of the five readings; however, although the experimental and control groups demonstrated similar trends, the greatest difference between the groups was exhibited in the first reading. This would indicate that persons who stutter lengthen the word immediately preceding a stuttered event.

There was no indication of significant differences at location X-2 for all five readings; indicating changes one word removed prior to a stuttered event do not exist. The results associated with location X+1 indicate there is no significant difference in the average duration of words, therefore carryover effects do not appear to influence the words immediately following a stuttered event. Similar to location X-2, location X+2 demonstrated no significant difference in durational measures over the five readings. The data associated with the Xp location, on the other hand, indicates a significant difference in average word duration for this location across all readings in the absence of identifiable differences for the other locations analyzed. Finally, the experimental and control groups demonstrated significant nonparallel trends for word duration in the Xf location. The subjects who stutter increased the duration of words in this location from reading one to reading two while the control group decreased the duration of Xf-location words between reading one and readings two, then stabilized the durations for reading three and four.

Viswanath's (1989) study of global and local temporal effects of stuttered events in the context of a clausal utterance provides evidence that indicate differences in the fluent speech of persons who stutter do exist in the immediate vicinity of the stuttered word. These findings are pertinent to the present study and will be discussed in a following chapters. At this point, it is important to note that it is not clear as to whether any or all of the experimental subjects had undergone treatment for stuttering prior to the time of the study. This should be considered as an important factor as other studies have indicated that treatment for stuttering can influence the naturalness of the client's speech (Metz, Schiavetti, & Sacco, 1990).

Children

Hall and Yairi (1992) provided one of the few studies investigating the acoustic correlates of phonatory control in the fluent speech of children who stutter. The purpose of this study was to investigate the fundamental frequency, jitter, and shimmer in the fluent speech of young children who stutter. Ten preschool-aged boys who were identified as stuttering disordered by both their parents and the investigators, and 10 normally speaking boys served as subjects. Spontaneous conversational speech (approximately 1000 words) was audiotape recorded during verbal interaction with their respective parents. Thirty fluent target utterances from each subject's speech sample (consisting of CV, VC, CVC, and CCVC utterances) were selected via orthographic transcription for analysis (total of 600 speech segments; 30 segments x 20 subjects). Acoustic measurements were made of the middle 100 msec of each speech segment using CSpeech (a speech analysis computer program). The mean for the 30 values for each of the four acoustic parameters were calculated for each subject and used to determine groups means. The results indicate the boys who stuttered demonstrated a slightly lower overall fundamental frequency; however, the fundamental frequency range for both groups was similar. There were no significant differences in the mean jitter values produced by the experimental group as compared to the control group. On the other hand, the acoustic measures for shimmer produced by the experimental group appeared to be significantly higher than those demonstrated by the control group. As Hall and Yairi (1992) attempted to quantify the acoustic correlates of phonatory control through empirical measurement, Lilly (1995) attempted to quantify potential differences in the duration of words immediately before and after a stuttered event in children's speech.

Three preschool children were tape recorded during two separate sessions during which time they provided a delayed repeated response elicited from predetermined stimulus materials. The resulting recordings were analyzed to identify target words that were stuttered in one session and not in the other. The word durations of the words immediately before and after the target words (a stuttered word and its corresponding nonstuttered word) were measured in msec. and compared to determine if there were significant differences in the word durations. Two tailed t-tests were run to identify significant differences between the paired word durations. The results indicate there is no significant statistical difference at the p=.05 level.

In summary, data collection via objective measurement methodologies have provided much needed data to support the ongoing study of the stuttering disorder. Although subject to continued discussion, the quantitative data produced as the result of the above described studies (and others not mentioned) is helping to provide further understanding into the nature of stuttering. Similarly, the present study uses acoustic analysis to investigate the durational differences in the fluent speech of children who stutter.

Rationale for Investigating Word Duration in Children's Stuttered and Fluent Utterances

Viswanath,(1989) provided valid rationale for conducting studies based on changes in acoustic parameters associated with portions of the utterance that are not perceptually dysfluent when stating:

> Data from studies that examine acoustic changes preceding and following stuttering events, in effect, contextualize stuttering events, as they will give a more complete account of the problem by showing (a) whether [persons who stutter] plan and produce utterances with stuttering events differently from utterances that are judged to be totally fluent, and (b) whether there is a localized buildup of change around the stuttering event. (p. 246)

This rationale for acoustic study is strengthened when consideration is given to the desktop technology currently available for the study of the human speech signal. Digital waveform sampling rates that exceed 100,000 samples per second make precision of measurement not only accessible, but mandatory, in today's research. The study of stuttering and other speech-related disorders can no longer rely on perceptual judgment as the preferred method of data collection for research, diagnostics, and treatment evaluation.

To further our understanding of these disorders, investigators must move toward the use of instrumentation that will allow examination of factors that are not readily perceived at the level of human sensory perception. This need becomes ever more apparent when consideration is given to the statistical data currently being published that rate observer agreement on perceptual judgment at 70% or less (Cordes & Ingham, 1995). The combined need for acoustic-based studies to support perceptual findings, the availability of desktop technology in the form of personal computers and software, and the unreliability of perceptual observation are valid rationale for conducting this study using the methodology described in the next chapter. However, these are not the only rationale for a study of this nature.

The surprising lack of investigations addressing the fluent speech of children who stutter becomes obvious when time is spent researching this area. Krikorian and Runyan, conducted the first study concerned with the fluent speech of children in 1983, 20 years after Wendahl and Cole (1964) conducted the their research in area of fluent speech produced by adults who stutter. Recognizing the need for empirical data describing the fluent speech of children who stutter, the goal of the present study is to investigate, using acoustic measures, the temporal effects on the duration of words immediately before and after the stuttered event in children's speech.

CHAPTER III

METHODS

In this chapter, the criteria used for subject selection, equipment used to collect and analyze data, and the procedures used to elicit and analyze speech samples are described.

Subjects

Subject Selection

Subjects were solicited from all clients enrolled in the Portland State University Stuttering Clinic. Each of the 3 subjects employed in this study met the following criteria: (a) 3 years 6 months to 7 years 11 months of age, (b) diagnosed as stuttering having a moderate to severe level of severity as scored on the Stuttering Severity Index-3 (SSI-3) (Riley, 1994), (c) no prior treatment for stuttering, (d) no language disorder demonstrated on the administration of the Utah Test of Language Development-Revised (Mecham & Jones, 1967), (e) free of any physical limitation that would preclude their participation in the study, and (f) signed permission from the child's parent or legal guardian; refer to Appendix A. Table 1 summarizes subject information according to various categories.

Table 1.
Subject information

Subject	Gender	Age	Severity	Language
#1	Male	4.5	Severe	**
#2	Male	5.3	Moderate	**
#3	Female	3.8	Severe	**

**: Within normal limits for age group.

Procedures

Speech Sample Collection

Speech samples were collected from each subject using a high quality multi-track digital audio tape (DAT) recorder (Sony PCM 2300 with a sampling rate of 48K), recording in the analog mode, in conjunction with an appropriate uni-directional condenser microphone (Audio Technica AT813), Mackie Micro Series 1202 mixer, and a Harman/Kardon HK-3350 amplifier (Figure 1).

In order to calibrate the input signal, a 1000 Hz reference tone was laid down on track #1 of the recording using a function generator (WaveTech, Model 19) in combination with a Tectronix CMC-250 frequency counter.The signal was then measured again at the time of analysis to ensure calibration of the audio signal.

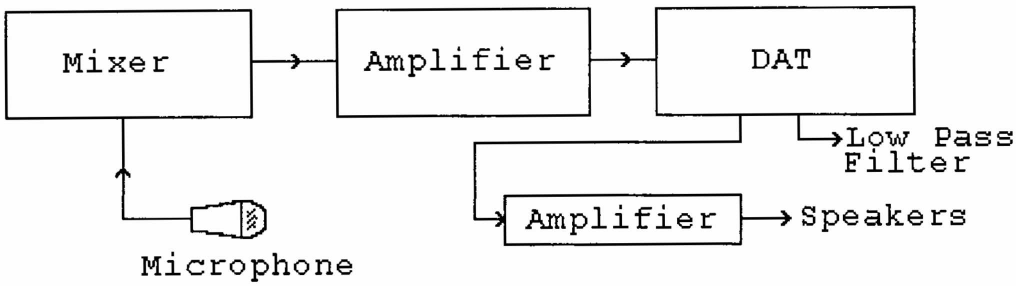

Figure 1. Speech Sample Collection Equipment

All speech samples were then recorded on track #2 of the audio tape while maintaining a mouth-to-microphone distance of approximately 20 cm.

The subjects were placed in a soundproof room and instructed concerning how to respond to each of the first 20 items from the Patterned Elicited Syntax Test (PEST; Young & Perachio, 1993) when presented by the clinician. Additionally, each subject was instructed to use their normal speaking voice. The selected PEST items were presented two times with a 15-minute rest period between each administration. Refer to Appendix B for a listing of the stimulus items.

Determination of which words within the utterances had been stuttered by each subject was made using the following procedure. The recorded speech samples for each administration of the PEST were displayed via the sound field using the amplified portion of the DAT output signal to drive two standard audio speakers. The stuttered utterances from one session were compared with the utterances collected during the other session to determine which of the corresponding words were not stuttered. If a word from one sample was determined to be stuttered and the same word in the remaining sample was determined not to be stuttered, then the two utterance samples were marked for analysis. The decision as to whether a given word had been stuttered required the consensus of two judges, that is, this examiner and another individual experienced in the area of stuttering (i.e., a graduate student in the area of Speech-Language Pathology). Any stuttered words that did not obtain consensus between the judges were eliminated (approximately 3% of potential target words were eliminated based lack of consensus of the judges). Additional words not included in the data corpus consisted of stuttered words occurring immediately before or after another stuttered word, thereby, 2 stuttered words could not appear in succession.

Speech Sample Analysis

To facilitate the speech sample analysis, the output signal of the DAT recorder (refer to figure 2) was split to accommodate input signals to both a signal amplifier (for display via the sound field) and a WavTech Brickwall low pass filter. The low pass filtering unit (WavTech Brickwall, Model 752A) was set to filter frequencies greater than 10,000 Hz, thereby conditioning that portion of the DAT output signal to remove any unwanted noise. The output of the low pass filter was digitized at 20,000 Hz via an analog-to-digital (A/D) converter (Tucker-Davis Technology DD1).

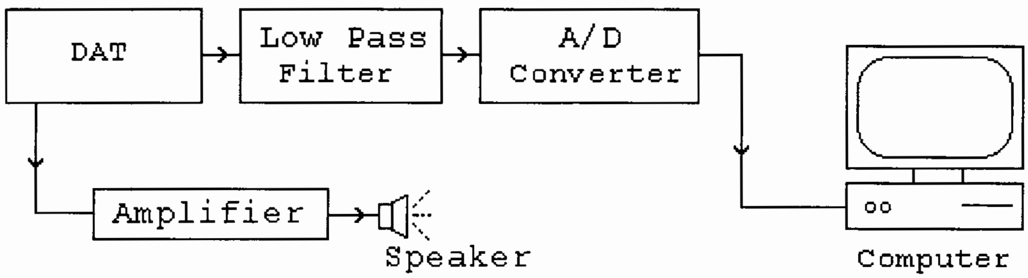

Figure 2. Speech Sample Analysis Equipment

The digitized output was then sent to the computer (486/66MHz IBM compatible PC) for analysis using the Computer Speech Research Environment (CSRE), Version 4.2 (Jamieson, Ramji, Nearey, & Baxter, 1990) software package.

The following procedure (Tetnowski, Morris, & Peterson, 1995; Young, 1994) was used in conjunction with the CSRE oscillographic trace display to locate, mark, and analyze target words of interest within the speech sample. Location of word initial and word final sounds for target words were determined using the following criteria: (a) onset of voiceless sounds were identified by a doubling of the signal voltage from baseline, (b) offset of voiceless sounds were identified by a halving of the voiceless sound signal voltage, (c) onset of voiced sounds in word initial and medial positions were identified by the first negative peak of the quasi-periodic wave form, and (d) the offset of voiced sounds ending the word were identified using the last negative peak of the quasi-periodic wave form. Once a stuttered word from one sample was identified and paired with a corresponding non-stuttered word in the other sample, three-word clusters consisting of the word immediately proceeding the stuttered word (BSTUT), the target stuttered word, and the word immediately following the stuttered word (ASTUT) were marked. The three-word cluster was then played back via the sound field to ensure the entire cluster was captured and stored on 3.5" floppy disk for future analysis of word duration using the CSRE software package. Similarly, three-word clusters consisting of the word immediately proceeding the corresponding non-stuttered word (BNSTUT), the non-stuttered target word, and the word immediately following the corresponding non-stuttered word (ANSTUT) were marked, played back, and stored on 3.5" disk for future analysis using CSRE 4.2. The three-word clusters for both the targeted stuttered and non-stuttered words were stored using a 7 digit alpha-numeric filename (Young, 1994). Refer to Appendix C for an explanation of the filename coding.

Reliability

Time measurements were grouped as BSTUT, ASTUT, BNSTUT, or ANSTUT and entered on a spread-sheet for statistical evaluation. The time duration measurements were then analyzed for significant differences using a two-tailed t-test for paired samples, pairing BSTUT with BNSTUT and ASTUT with ANSTUT.

The reliability of the data analysis was checked by reanalysis of 10% of the time-based measurements (Hall & Yairi, 1992). The time-based measurements were randomly selected using a random number generator and reanalysis was performed by the qualified speech-language pathologist as this individual was familiar with the procedure. A Pearson-Product Moment coefficient was preformed on the resulting measurements with a resulting correlation coefficient of r=0.83. Interexaminer reliability between the examiner's duration calculations and those of the reliability judge were checked when both the examiner's and the reliability judge's observations were judged to be within 50 msec for 70% of the reliability sample. Intrajudge reliability was checked by reanalysis of the same randomly selected time-based measurements by the primary investigator. A Pearson-Product Moment coefficient was preformed on the resulting measurements with a resulting correlation coefficient of r=0.89. Intrajudge time duration measurements were observed to be within 50 msec for 80% of the reliability sample.

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS

The purpose of this study was to determine, by means of objective acoustic analysis, if the word duration (in msec) of words immediately before and after a stuttered word were significantly different than the word duration of the same words, produced by the same child, immediately before and after the same nonstuttered word. More specifically, the purpose this study was to determine if a stuttered event in a child's utterance has an effect on word duration of words immediately before and after the stuttered word.

Duration Analysis

Words stuttered in the first sample and produced fluently in the second sample were identified and marked for further analysis. Stuttered words that occurred immediately before or after another stuttered word were not considered for further analysis. Words preceding the stuttered word (BSTUT) in an sample utterance were paired with the same word (BNSTUT) in the same utterance when spoken fluently and analyze for word duration. The same procedure was used to determine the word durations of words after a stuttered word (ASTUT) and the same word in the same utterance (ANSTUT) when spoken fluently. Appendix E contains the raw data for each subject listed by filename and data group.

Two tailed t-tests for paired samples were calculated for the paired data groups (BSTUT and BNSTUT, ASTUT and ANSTUT). Results of the calculations indicate there were no significant statistical differences between the associated data groups at the $p=.05$ level. The t-test calculation for BSTUT vs. BNSTUT resulted in $p=.998$ (see Table 2) and the calculation for ASTUT vs. ANSTUT resulted in $p=.076$ (see Table 3). This analysis provides evidence that the mean duration of words immediately before and after a stuttered word in children's stuttered speech is not significantly different than the mean duration of the same words produced in the same fluent utterance. As noted in Table I, the high p-value of .998 is indicative of a small mean for the paired differences (Mean =.05 msec. with a standard deviation of 98.62 msec). This would indicate that, for the 3 subjects sampled, there is essentially no difference in the word durations of words immediately before a stuttered word as compared to the same word in the same utterance that is produced fluently when analyze at the p=.05 level.

Table 2.
T-test results for paired samples comparing words before a stuttered word (BSTUT) with words before the same non-stuttered word

Variables	# of Pairs	Corr	2-Tail Sig	Mean	SD	SE of Mean
A: (BSTUT)				253.81	115.2	28.8
	16	.638	.008			
B: (BNSTUT)				253.76	116.5	29.1

Paired Difference

Mean	SD	SE of Mean	T-value	df	2-Tail Sig
.05	98.6	24.7	.00	15	.998

Similar results are summarized in Table 3 for the ASTUT vs. ANSTUT pairing.

Table 3.
T-test results for paired samples comparing words after a stuttered word (ASTUT) with words after the same non-stuttered word

Variables	# of Pairs	Corr	2-Tail Sig	Mean	SD	SE of Mean
C: (ASTUT)				284.64	194.2	32.8
	35	.862	.000			
D: (ANSTUT)				254.08	160.1	27.1

Paired Difference

Mean	SD	SE of Mean	T-value	df	2-Tail Sig
30.5	98.7	16.7	1.83	34	.076

Although the mean for the paired differences (Mean = 30.5 msec with a standard deviation = 98.7 msec) is higher for the ASTUT vs. ANSTUT pairing, the p-value = .076 is not statistically significant at the p=.05 level. Therefore, as for the BSTUT vs. BNSTUT pairing, there are no significant differences in the word durations of words immediately following a stuttered word as compared to the same word in the same utterance that is produced fluently.

Reliability

To ensure reliability of the examiner's word duration measurements, 10% of the time-based measurements were randomly selected for reanalysis of the duration calculations by a reliability judge. A reliability check was computed using a Pearson Product-Moment with a resulting correlation coefficient (r) of 0.83 (total agreement would be indicated by a correlation coefficient of r=1.00). Additionally, as a interexaminer reliability check, at least 70% of the randomly selected measurements performed by the examiner were found to be within 50 msec of the reliability judge's independent measurement. Intrajudge reliability was checked by reanalysis of the same randomly selected time-based measurements by the primary investigator. A Pearson-Product Moment coefficient was preformed on the resulting measurements with a resulting correlation coefficient of r=0.89. Intrajudge time duration measurements were observed to be within 50 msec for 80% of the reliability sample.

Discussion

When interpreting the findings of this study it becomes important to address three areas of potential concern, including: (a) limited data in the area of child stuttering to compare results, (b) the relative small size of the data corpus, and c) potential for p-value error in t-test calculation if large variance across subjects exists.

There are very limited data available in the child stuttering literature to which the results of this study can be directly compared. The present study does however support the findings of an investigation conducted by Lilly (1996) who used comparable methods and procedures. Concurrent with the present study's results, Lilly concluded that no significant acoustic evidence exists to support the idea of a spread effect on words surrounding a moment of stuttering in the stuttered speech of children. The findings of these child studies are markedly different than the findings presented by Tetnowski et al. (1995), Viswanath (1989), and Young (1995) which focused on adult subjects. The results of these studies support the idea that there is a spread effect on words surrounding a moment of stuttering in adult stuttered speech. However, to compare the results of child and adult studies would be somewhat questionable. This statement is possible as it is common knowledge within the field of speech-language pathology that children who are beginning to stutter exhibits characteristically different traits of stuttering than those of adults who have stuttered for significantly longer periods of time.

The second area of concern deals with the relatively small sample size associated with this study. Speech samples obtained from 3 subjects resulted in a total of 102 data points available for analysis. It must be concluded that this is much too small a sample to warrant generalization of the finding to the total population of children who stutter. Additionally, the results from a small sample size can become questionable if the potential for p-value error in the t-test calculations exists due to a large variance across subjects. To address this concern, Figures 3 & 4 present scatter diagrams for the grouped matched data points for both BSTUT vs. BNSTUT and ASTUT vs. ANSTUT data.

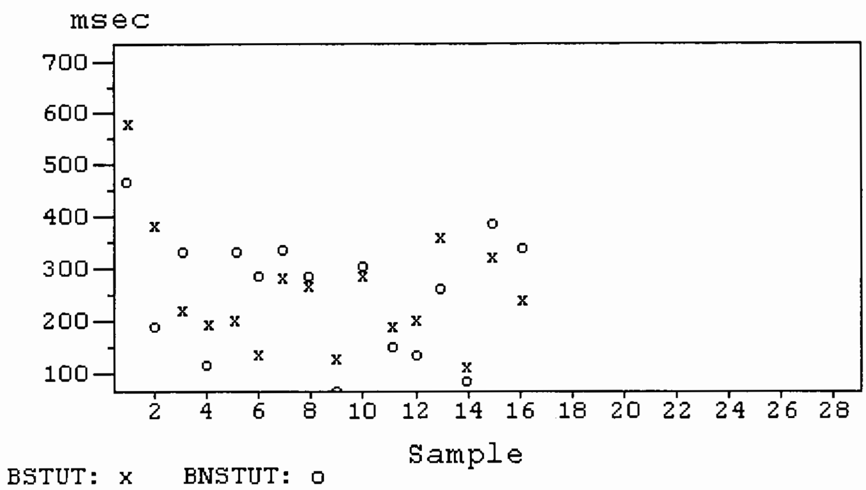

Figure 3. BSTUT vs. BNSTUT

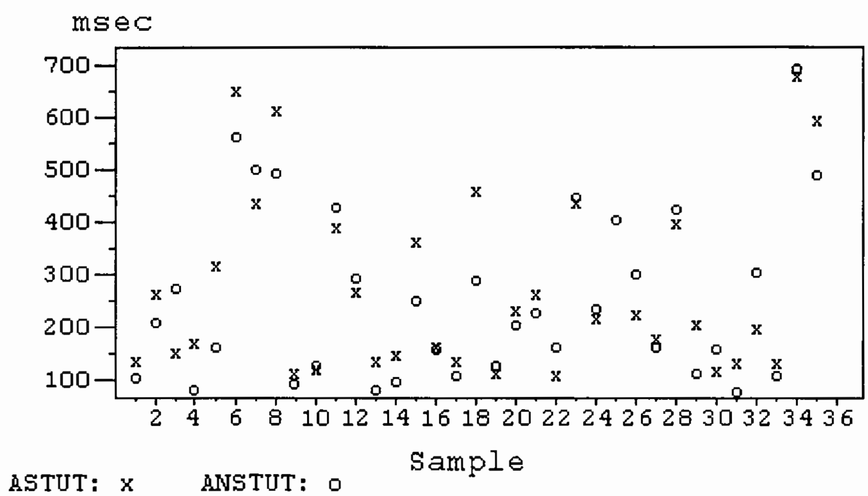

Figure 4. ASTUT vs. ANSTUT

Inspection of the scatter diagram presented in Figure 3 indicates that, with the exception of one out-lying data point, all data points show little variance across all three subjects for the production of single syllable words. The one out-lying data point was the result of a multi-syllable word and would be expected to have a longer duration.

Again, the scatter diagram presented in Figure 4 shows little unexpected variance across the word durations for all three subjects. As in figure 3, the extreme out-lying points on the scatter diagram can be accounted for as the longer word durations associated with multi-syllable words. In summary, the scatter diagrams have provided visual evidence that the large variance across subjects needed to produce the potential p-value error of concern does not exist in the present study's data set. Additionally, the scatter diagrams indicate there is no consistent pattern that identifies BSTUT vs. BNSTUT or ASTUT vs. ANSTUT as higher or lower in magnitude (approximately 50-400 msec across the data base) than the other. This result adds validity to the findings of this small sample size study. Given the three concerns and associated rationale discussed above, the results of the this study are supported by previous studies and sound methods and procedures.

CHAPTER V

SUMMARY AND IMPLICATIONS

Summary

The present study, by means of objective acoustic analysis, looks at word duration (in msec) of words immediately before and after a stuttered word within a child's stuttered speech was investigated. The time measurements were then compared to the same words in the same sentences by the same speaker when the stuttering did not occur. These comparisons were performed in an effort to answer the following question: Is there acoustic evidence, in terms of differences in word duration, of the spread effect on words surrounding (i.e., immediately before and after) the stuttered words of children's stuttered speech?

This study employed 3 subjects, 2 males and 1 female, ranging in age from 3.8 to 5.3 years of age. Each subject demonstrated language skills within the normal limits for their age group and no subject was physically limited in such a way as to preclude them taking part in the study.

On two separate occasions, the subjects were placed in a soundproof room and instructed to repeat each of the first 20 items from the Patterned Elicited Syntax Test(PEST)(Young & Perachio, 1993) in their normal speaking voice when presented by the clinician. The stuttered utterances from one session were compared with the utterances collected during the other session to determine which of the corresponding words were not stuttered. If a word from one sample was determined to be stuttered and the same word in the remaining sample was determined not to be stuttered, then the two utterance samples were marked for analysis. Stuttered words that immediately preceded or followed another stuttered word were eliminated from the data base and not considered for analysis.

Analysis consisted of digital spectrographic strip measurement of word duration for the words immediately before (BSTUT) and after (ASTUT) a stuttered word. These measurements were then compared to word duration measurements for the exact corresponding words immediately before (BNSTUT) and after (ANSTUT) the same nonstuttered words produced by the same speaker. To determine if significant differences existed between the duration of words immediately before (BSTUT vs. BNSTUT) and after (ASTUT vs. ANSTUT) stuttered and the corresponding nonstuttered words, two-tailed t-tests for paired samples were calculated at the .05 level of confidence. The results indicate no significant differences exist between the word durations of both data groups (i.e., before p=.998 and after p=.076). The findings of the present study do not support the theory that stuttering effects the production of words immediately before and after a stuttered word in children's speech.

Research Implications

It is interesting to note the results of this study indicate that, for children, no significant differences exist in the duration of paired target words while these significant differences do exist in adult stuttered speech as compared to fluent speech. The combined results of this study and the findings of Lilly (1996) suggest it may be possible to speculate concerning the different characteristics which describe child stuttering as opposed to adult stuttering. As an example, what effect and when does the emotional factors associated with adult stuttering become empirically measurable. This investigator recognizes that various obstacles have to be overcome in order to perform empirical observations in the area of emotional effect on speech production. However, if these observations could be reliably collected and analyzed through the use of stuttering profiles in combination with acoustic measurements, it may be possible to determine if stuttering begins as a developmental disorder that evolves into a powerful learned response to given stimuli. Comparison of the results of these initial child studies and previous adult studies suggest this may be a valid thought-line worthy of continued research.

Clinical Implications

Although child stuttering, like adult stuttering, may be a disorder of timing, it is important to look at the potential reasons for the timing disturbances. Adams, (1990) wrote concerning the "Demands vs. Capacities Model". The basic tenet of the model is that fluency breaks down when environmental and/or self-imposed demands exceed the organism's cognitive, linguistic, motoric, or emotional capacities for responding. The findings of the present study suggest this may be an important consideration when developing intervention programs for the child who stutters. If, as suggested in the previous section, the emotional aspect that characterizes adult stuttering had less impact on child stuttering , then perhaps child stuttering is more a developmental disorder associated with the cognitive, linguistic, and/or motoric aspects of language development. If this were true, then children's intervention programs would want to continue to emphasize fluency techniques that reduce demand on the developing speech and language system and not employ, to a large extent, timing therapies such as rhythmic speech. It has been demonstrated that slight reductions in speech rate increases the fluent speech of many persons who stutter (Andrews, Howie, Dosza, & Guitar, 1982). If this is true, then allowing children more time to development their utterances becomes a function of adult (i.e., parents and teacher) and peer (i.e., siblings and friends) models. If the child who stutters is made to understand there is no need to speak fast, regardless the reason, then it stands to reason the child's fluency will increase. This statement may not be possible when considering therapy programs for the adult who stutters. The major difference between child and adult stuttering appears to be the emotional factor associated with advanced stuttering. Common knowledge suggests adults, for the most part, are much more emotionally attached to their stuttering as a result of learned fears then are children. The differences in the before stuttered vs. before nonstuttered paired words observed by Tetnowski et al. (1995) suggest something is affecting the word duration of words immediately before a stuttered event in adult speech. This "something" may very well be the emotional effects of learned fears impacting the timing of adult speech. The differences noted between adult stuttered speech and the stuttered speech of children may hinge on the emotional aspects of stuttering, however, it must be noted that the differences in stimuli and procedures associated with each study may also be a major contributing factor to the observed differences between adult and child stuttering. Tetnowski et al. (1995) used similar procedures as the present study, however, the stimulus employed consisted of 83 sentences which were read by each adult subject. This type of stimulus will not produce the needed speech sample if used in conjunction with child studies where the subjects are preschool aged.

The stuttered speech of children appears to be different than the stuttered speech of adults. Therefore, continued research that refines both the stimulus and procedures associated with these studies is needed. For it is through refined, well thought out research that the field of speech-language pathology can describe stuttering across all age groups and thus continued to develop more effective clinical procedures for use in treating both adult and child stuttering.

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APPENDIX A

CONSENT FORM FOR PARTICIPATION IN STUTTERED SPEECH STUDY

CONSENT FORM FOR PARTICIPATION

IN STUTTERED SPEECH STUDY

I, ________________________________, agree to allow my child ________________________________, to take part in this research project on stuttering and potential treatment strategies. I understand that the study involves having my child respond to the same sixty action pictures from a standardized test titled the Patterned Elicitation Syntax Test (PEST) for two consecutive administrations. I understand my child will be audio-recorded during the approximate one hour it will take to collect the speech samples. Because of the requirements associated with the study, I also understand there is an inconvenience of waiting a few minutes between the first and second recordings.

Dixon I. Kirsch (examiner) has explained to me the purpose of this study is to examine whether there are differences in the words surrounding a stuttered word as compared to the same words surrounding a non-stuttered word. I understand the recorded speech samples obtained from my child will be analyzed using a computer program designed for this analysis. And, the results of this study may provide information which supports the use of timing therapies (e.g., slowing the rate of speech) in managing child stuttering. I understand my child and I may not receive direct benefit from taking part in this study. However, the study may assist by increasing knowledge which my help others in the future.

Dixon I. Kirsch has offered to answer any questions I have concerning the study and what my child and I are expected to do. Dixon I. Kirsch has informed me that all information received and/or recorded will be kept confidential to the extent permitted by law. The names of

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all individuals involved in the study will be kept confidential.

I understand my child and I do not have to take part in and may withdraw from this study at any time. I understand that choosing not to participate or withdrawing from this study will not affect my relationship with Portland State University or other schools and/or agencies.

I have read and understand the above information and, upon verbal agreement of the child, agree to take part in this study.

Signature: ______________________________ Date: __________

If you have concerns or questions regarding this study, please contact the chair of the Human Subjects Research Review Committee, Research and Sponsored Projects, 105 Neuberger Hall, Portland State University at(503)725-3417. You may also contact the investigator, Dixon I. Kirsch at (503)397-0407.

APPENDIX B

SELECTED STIMULUS ITEMS FROM THE PATTERNED ELICITATION SYNTAX TEST (PEST)

SELECTED STIMULUS ITEMS FROM THE PATTERNED ELICITATION SYNTAX TEST (PEST)

Item#/Sentence

1. a. a baby playing
   b. a boy sitting
   c. a girl combing
2. a. Don't scream.
   b. Don't fall.
   c. Don't drop.
3. a. You eat it.
   b. You throw it.
   c. You read it.
4. a. The cat is hers.
   b. The balloon is hers.
   c. The baby is hers.
5. a. I can talk.
   b. I can read.
   c. I can jump.
6. a. What is in the box?
   b. What is in the basket?
   c. What is in the bag?
7. a. girl brushing teeth
   b. boy eating banana
   c. man reading paper
8. a. I have rabbits.
   b. I have socks.
   c. I have dolls.
9. a. Where is the shoe?
   b. Where is the cat?
   c. Where is the apple?
10. a. This is round.
    b. This is broken.
    c. This is open.
11. a. Take a bath.
    b. Ring a bell.
    c. Hit a ball.

Item#/Sentence

12. a. She is reading.
    b. He is climbing.
    c. She is drinking.
13. a. We wear boots.
    b. We eat ice cream.
    c. We drink milk.
14. a. They are flying.
    b. They are eating.
    c. They are riding.
15. a. The boy caught the ball.
    b. The girl saw the bird.
    c. The man broke the dishes.
16. a. a boy's jacket
    b. a dog's collar
    c. a girl's hair
17. a. She is sleeping.
    b. She is washing.
    c. She is eating.
18. a. He wants to ride.
    b. He wants to blow.
    c. He wants to swing.
19. a. The ball is on the table.
    b. The rabbit is in the box.
    c. The dog is under the chair.
20. a. The balls are round.
    b. The pigs are fat.
    c. The babies are little.

APPENDIX C

SPEECH SAMPLE FILENAME ASSIGNMENT

SPEECH SAMPLE FILENAME ASSIGNMENT

The following procedure was used to generate individ-ual computer filenames for each three-word-cluster selected for analysis. The eight character format used in this procedure allowed coding of each selected speech sample prior to storage on 3.5" computer floppy disk. The following example describes the function of each character within the filename.

[filename] JS2123NS.adf where:
JS 2 12 3 NS . adf

CHARACTER	DESCRIPTION
JS	Identifies the subjects first and second initials.
2	Identifies the speech sample as collected during the first or second administration of the stimulus materials. For this example, the sample was collected during the second administration.
12	Identifies the Patterned Elicitation Syntax Test (PEST) item number; this number will range from 01 to 20.
3	Identifies the sentence number within the PEST item. This number will range from 1 to 3 as there are three sentences per test item.
NS	Identifies whether the speech sample was stuttered (S) or non-stuttered (NS).
.adf	This is a file extension generated by CSRE 4.2. This extension will appear at the end of all files.

APPENDIX D

RAW DATA LISTED BY SUBJECT

Raw Data For Subject #1

#	Filename	SW	TW	Data Group	mes.
1.	AR1012S	sitting	boy	BSTUT	565.4
2.	AR2012NS		boy	BNSTUT	464.0
3.	AR1033S	read	you	BSTUT	383.4
4.	AR1033S	read	it	ASTUT	129.0
5.	AR2033NS		you	BNSTUT	189.9
6.	AR2033NS		it	ANSTUT	107.8
7.	AR1041S	cat	the	BSTUT	227.8
8.	AR1041S	cat	is	ASTUT	258.4
9.	AR2041NS		the	BNSTUT	337.5
10.	AR2041NS		is	ANSTUT	206.4
11.	AR1043S	baby	the	BSTUT	182.2
12.	AR1043S	baby	is	ASTUT	141.5
13.	AR2043NS		the	BNSTUT	111.9
14.	AR2043NS		is	ANSTUT	268.6
15.	AR1053NS		can	BNSTUT	340.0
16.	AR2053S	jump	can	BSTUT	186.8
17.	AR1063NS		the	BNSTUT	279.2
18.	AR2063S	bag	the	BSTUT	133.2
19.	AR1113NS		a	ANSTUT	79.5
20.	AR2113S	hit	a	ASTUT	161.0
21.	AR1121NS		is	ANSTUT	163.1
22.	AR2121S	she	is	ASTUT	307.3
23.	AR1131S	wear	boot	ASTUT	652.8
24.	AR2131NS		boot	ANSTUT	558.8
25.	AR1132NS		we	BNSTUT	344.4
26.	AR2132S	eat	we	BSTUT	276.0
27.	AR1163NS		hair	ANSTUT	502.0
28.	AR2163S	girl's	hair	ASTUT	443.1
29.	AR1172S	is	she	BSTUT	265.0
30.	AR1172S	is	washing	ASTUT	611.0

31.	AR2172NS		she	BNSTUT	291.7
32.	AR2172NS		washing	ANSTUT	492.7
33.	AR1191NS		the	ANSTUT	89.9
34.	AR2191S	on	the	ASTUT	108.1
35.	AR1192NS		the	BNSTUT	66.0
36.	AR2192S	box	the	BSTUT	131.2
37.	AR1193S	under	is	BSTUT	281.4
38.	AR1193S	under	the	ASTUT	116.8
39.	AR2193NS		is	BNSTUT	286.0
40.	AR2193NS		the	ANSTUT	126.4
41.	AR1201NS		are	BNSTUT	149.6
42.	AR2201S		are	BSTUT	174.9

Raw Data For Subject #2

#	Filename	SW	TW	Data Group	mes.
1.	AB1011S	a	baby	ASTUT	389.5
2.	AB2011NS		baby	ANSTUT	425.9
3.	AB1031NS		eat	ANSTUT	289.8
4.	AB2031S	you	eat	ASTUT	255.3
5.	AB1111S	take	a	ASTUT	133.9
6.	AB2111NS		a	ANSTUT	80.7
7.	AB1112NS		a	ANSTUT	92.4
8.	AB2112S	ring	a	ASTUT	141.2
9.	AB1121S	she	is	ASTUT	354.4
10.	AB2121NS		is	ANSTUT	249.6
11.	AB1132NS		eat	ANSTUT	160.0
12.	AB2132S	we	eat	ASTUT	151.7
13.	AB1141NS		are	ANSTUT	109.9
14.	AB2141S	they	are	ASTUT	143.3
15.	AB1142S	eating	are	BSTUT	199.7
16.	AB2142NS		are	BNSTUT	145.6

17.	AB1151S	the	boy	ASTUT	415.4
18.	AB2151NS		boy	ANSTUT	286.8
19.	AB1152NS		girl	BNSTUT	261.4
20.	AB1152NS		the	ANSTUT	129.7
21.	AB2152S	saw	girl	BSTUT	365.0
22.	AB2152S	saw	the	ASTUT	111.5
23.	AB1153NS		the	BNSTUT	80.3
24.	AB1153NS		broke	ANSTUT	203.9
25.	AB2153S	man	the	BSTUT	119.1
26.	AB2153S	man	broke	ASTUT	232.1
27.	AB1191NS		ball	ANSTUT	224.1
28.	AB2191S	the	ball	ASTUT	256.8
29.	AB1192NS		rabbit	BNSTUT	370.2
30.	AB1192NS		the	ANSTUT	165.6
31.	AB2192S	is'n	rabbit	BSTUT	318.0
32.	AB2192S	is'n	the	ASTUT	108.8

Raw Data For Subject #3

#	Filename	SW	TW	Data Group	mes.
1.	LT1032NS		throw	ANSTUT	442.5
2.	LT2032S	you	throw	ASTUT	438.0
3.	LT1033NS		read	ANSTUT	229.2
4.	LT2033S	you	read	ASTUT	211.8
5.	LT1051S	I	talk	ASTUT	856.6
6.	LT2051NS		talk	ANSTUT	405.9
7.	LT1053NS		play	ANSTUT	300.7
8.	LT2053S	I	play	ASTUT	220.1
9.	LT1061S	what	in	ASTUT	176.0
10.	LT2061NS		in	ANSTUT	163.5
11.	LT1071S	boy	brushing	ASTUT	395.0
12.	LT2071NS		brushing	ANSTUT	419.2
13.	LT1091S	where's	the	ASTUT	205.4

14.	LT2091NS		the	ANSTUT	112.6
15.	LT1092NS		the	ANSTUT	160.0
16.	LT2092S	where's	the	ASTUT	115.4
17.	LT1112NS		a	ANSTUT	78.9
18.	LT2112S	ring	a	ASTUT	132.8
19.	LT1141S	they	are	ASTUT	194.2
20.	LT2141NS		are	ANSTUT	302.0
21.	LT1143S	they	are	ASTUT	133.2
22.	LT2143NS		are	ANSTUT	107.7
23.	LT1161S	a	boy's	ASTUT	670.9
24.	LT2161NS		boy's	ANSTUT	676.9
25.	LT1183S	to	wants	BSTUT	251.9
26.	LT1183S	to	swing	ASTUT	590.1
27.	LT2183NS		wants	BNSTUT	342.5
28.	LT2183NS		swing	ANSTUT	480.4