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Temporal Characteristics of Words Surrounding a Moment of Stuttering in Preschool-age Children

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THESIS APPROVAL

The abstract and thesis of Gregory Keith Lilly for the Master of Science in Speech Communication: Speech and Hearing Science were presented October 1, 1996, and accepted by the thesis committee and the department.

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ABSTRACT

An abstract of the thesis of Gregory Keith Lilly for the Master of Science in Speech Communication: Speech and Hearing Science presented on October 1, 1996.

Title: Temporal Characteristics of Words Surrounding a Moment of Stuttering in Preschool-Age Children.

Until this time, few studies have examined differences in durational characteristics in words surrounding a moment of stuttering for untreated preschool children. It is important to determine whether or not untreated preschoolers' who stutter alter the duration of their speech when they stutter versus when they are fluent to determine what factors influence stuttering behaviors.

The purpose of the present study was to examine the duration of words immediately before and after a stuttered word and the duration of the matched target word in the identical fluent utterance. The following questions were to be addressed:

1) Is there a significant durational difference between a word preceding a stuttered word and the duration of the same word in a corresponding fluent utterance?

2) Is there a significant durational difference

between a word following a stuttered word and the duration of the same word in a corresponding fluent utterance?

Three subjects between the ages of 4 years, 6 months and 6 years, 11 months who had never received treatment participated. Subjects were recorded using a delayed imitation task, elicited from 60 action pictures in the Patterned Elicited Syntax Test,(PEST) two times in succession with a five minute rest period between elicited utterances. Phrases and sentences containing a stuttered word and identical elicited fluent utterances were used for analysis. The duration of the following words in milliseconds (msec.) were calculated using the CSRE 4.2 software program:

1) The duration of the word immediately preceding a stuttered event within the same utterance (BSTUT).

2) The duration of the same word in the identical fluent utterance (BNSTUT).

3) The duration of the word immediately following a stuttered event within the same utterance (ASTUT).

4) The duration of the same word in the identical fluent utterance (ANSTUT).

A total of 44 samples were obtained. A two tailed t-test was completed at the .05 confidence level to determine the significance between the BSTUT vs. BNSTUT and ASTUT vs. ANSTUT word pairs. Results did not find statistically significant differences.

TEMPORAL CHARACTERISTICS OF WORDS SURROUNDING A MOMENT OF STUTTERING IN PRESCHOOL-AGE CHILDREN

by
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INTRODUCTION AND STATEMENT OF PURPOSE

INTRODUCTION

Some researchers suggest that a stuttered event is defined as a single disrupting incidence (Cordes, Ingham, Frank, & Ingham, 1992; Few & Lingwall, 1972). Other investigations have found that stuttering is not an incidence or singular event but a spread effect throughout the utterance (Viswanath, 1989; Williams, 1957). When considering these two opposing views, past and recent investigations contend that it is difficult to perceptually judge the exact moment of stuttering in an utterance: where dysfluencies begin and end (Ingham, Cordes, & Gow, 1995).

Acoustic measures have been suggested as being better equipped to reveal the boundaries between fluent and stuttered speech in sentences. The utilization of spectographic and other acoustic analyses have assisted researchers in identifying where dysfluent disruptions start and when the effects cease in the continuum of running speech (Onslow, 1995; Pindzola, 1987; Viswanath, 1989; Young, 1994).

Acoustic, as well as perceptual investigations, have also demonstrated that stutterers' fluent speech is

distinguishable from nonstutterers' fluent speech (Adams, 1987; Pindzola, 1987; Viswanath, 1989). A group of studies for example, has analyzed temporal measures in voice onset times (VOT) of individuals who stutter and VOT of individuals who do not stutter. The results from these studies suggested stutterers are slower than nonstutterers in initiating voicing in conjunction with supraglottic (above the level of the vocal folds and larynx) articulatory movements. According to these investigations, individuals who stutter may present difficulties in speech-timing control and coordination of their articulators (Hillman & Gilbert, 1977; Metz et al., 1978; Pindzola, 1987). Perceptual investigations (listener judgements), although less reliable and inconclusive, have also detected differences between persons who stutter and nonstutterers' fluent speech (Cordes, Ingham, Frank, and Ingham, 1992; Few & Lingwall, 1972). Results from a few sophisticated (speech-language pathologists) and naive listener investigations have suggested stuttering groups as exhibiting slower speech rates, longer pause times, atypical prosody and abnormal naturalness of discourse when compared to nonstuttering groups (Ingham & Packman, 1978; Runyun & Adams, 1979).

STATEMENT OF PURPOSE

The purpose of this study is two fold. The first purpose of this study is to measure differences in durations between a word prior to a moment of stuttering and compare the duration of the same word when no stuttering is observed in the same speaking context. The second purpose is to examine the durational differences between a word following a moment of stuttering and compare the duration of the same word when no stuttering is observed in the same speaking context.

This study poses two research questions. The first question is: Are there durational differences between a word prior to a moment of stuttering when compared to the exact word in the same speaking context when no stuttering is observed? The second question is: Are there durational differences between a word following a moment of stuttering when compared to the exact word in the same speaking context in the absence of stuttering?

The null hypothesis states that there will not be a significant difference between a word prior to a moment of stuttering and the same word in the fluent speaking context. The null hypothesis for the second research question states that there will not be a significant difference between a word following a moment of stuttering and the same word in the fluent speaking context.

DEFINITION OF TERMS

The following operational definitions are given to help clarify the terms used in this study.

1. Fluency: Refers to speech that is produced effortlessly with normal rate and rhythm or flow.

2. Moment of stuttering: refers the word or time when an individual is dysfluent (stutters). These dysfluencies may include the following:

   a. Part word repetitions: Refers to repetitions of sound and syllable units which are less than the entire word. Example: s-s-s-s-sit is a sound repetition and kuh-kuh-kuh-car is a syllable repetition.

   b. Prolongations: Refers to any sound or syllable produced that is continued beyond that which is considered normal in length. Example: "She has a compu---ter."

   c. Fixations: Refers to stopping the flow of air and voice at one or more places of the speech mechanism (vocal folds of the larynx, mouth, and lips (Van Riper, 1982).

3. Duration: Refers to the time taken or utilized for an individual to express a syllable, word, or utterance. Duration of words in the context of this study were measured using milliseconds (msecs) (Baken, 1987).

4. Prolonged Speech: Refers to slowing down or reducing the rate of speech. Prolonged speech may also include stretching out or lengthening syllables of each word in the individual's utterances, and controlling the airstream

5. Voice Onset Time (VOT): The interval from release of intraoral pressure to the onset of glottal pulsing (Baken, 1987).

6. Anticipation: Used descriptively in the context of this study to denote objective changes which may occur before (i.e., anticipate) a moment of stuttering (Viswanath, 1989).

7. Carryover: Used descriptively in the context of this study to denote objective changes which may occur immediately after a moment of stuttering (Viswanath, 1989).

8. Adaptation: Refers to the decline in stuttering frequency which accompanies consecutive oral readings of the same written material.

9. Spread or Vicinity Effect: Used to describe the effect of a stuttered word on surrounding fluent speech.

10. Spectrogram: A voice print (the monitor's output of the spectrograph) on which the smallest units of speech (phonemes) appear in particular patterns useful for acoustic analysis of the speech signal.

CHAPTER II

REVIEW OF THE LITERATURE

INTRODUCTION

Stuttering does not have a universal means of identification and definition. Some researchers and/or speech clinicians believe it consists of defining elements such as with-in word (sound/syllable) repetitions, revisions, and prolongations, (Curlee, 1991, Riley, 1994). Others suggest fixations are also an important part of the definition, particularly in preschool children (Peters & Guitar, 1991; Van Riper, 1982).

According to the literature, there are two major investigative methods in the identification of a moments of stuttering: perceptual and acoustic. In perceptual investigations, researchers have been shown to disagree on whether the fluent speech of stutterers differs from the fluent speech of nonstutterers (Few & Lingwall, 1972; Ingham, Cordes, Ingham, & Gow, 1995; Ingman & Packman, 1978; Runyun & Adams, 1978, 1979). Listener judgment (naive and expert: speech-language pathologists) studies have discovered both supportive and inconclusive evidence on whether differences in fluent speech exists. A few perceptual studies (Runyun & Adams, 1978, 1979; Ingman & Packman, 1978) utilizing naive and sophisticated listeners

have supported perceived differences between the fluent speech of nonstutterers and subjects who do stutter. Subjects who stuttered were identified as having slower speaking rates, longer pause times, and atypical prosody and naturalness during fluent samples. In contrast, other perceptual research (Cordes, Ingham, Frank, and Ingham, 1992; Few & Lingwall 1972; Ingham, Cordes, Ingham, & Gow, 1995) has not found conclusive evidence on whether listeners could successfully differentiate between the fluent speech of subjects who stutter and nonstutterers. Listeners in these studies failed to agree on whether the fluent speech of individuals who stuttered was unique in comparison to nonstutterers. Acoustic investigations have an advantage over perceptual studies in that specific units (i.e., phonememes) of speech can be analyzed in which even expert listeners may not have detected. Relying completely on perceptual data appears to be insufficient in the identification of differences between the fluent speech of individuals who stutter and nonstutterers (Ingham, Cordes, Ingham, & Gow, 1995; Runyun & Adams, 1978, 1979). This is why acoustic analysis rather than listener judgments (perceptual data) was chosen for the present research. This literature review will: 1) Discuss acoustic investigations relating to differentiations and characteristics of fluent and nonfluent adult and preschool-aged subjects and, 2) Describe five

investigations in which are closely related to the present study.

ACOUSTIC INVESTIGATIONS

Adult Subject Temporal Studies

The following studies described briefly demonstrate that there are temporal changes in the fluent speech of adult subjects who stutter when compared to matched (for age and gender) nonstuttering subjects. In 1971, Agnello and Wingate examined consonant-vowel (CV) syllable productions of stutterers and nonstutterers and found that the stuttering group were slower in terminating phonation in their fluent productions. Individuals who stutter have been found to demonstrate slower timing or phonatory lags in the onset of fluently uttered syllables (Agnello, Wingate, & Wendell, 1974; Agnello, 1974; Van Riper, 1982). Other research has suggested consonants and vowels are longer in duration in the fluent speech of adults who stutter as compared with nonstutterers (DiSimoni, 1974; Prosek & Runyun, 1982). When voice onset times (VOT) values were compared for stop consonants of similar place of articulation in connected speech, the stuttering group were discovered as having longer temporal values (Hand & Luper, 1980; Hillman & Gilbert, 1977; Metz, Conture, & Caruso, 1979; Young, 1994).

Vowel Durations

Many studies have shown the fluent speech of individuals who stutter are longer in the durations of vowels with longer transition times when compared to nonstutterers (DiSimoni, 1974; Hand & Luper, 1980; Prosek & Runyan, 1982). DiSimoni (1974) for example, found vowel durations of adults who stuttered to average 137 milliseconds (msecs.) longer than nonstutterers in plosive contexts (the /p/ and /b/ phonemes in consonant-vowel-consonant words, respectively). Prosek and Runyan (1982) also found the vowel durations of adults who stuttered were significantly longer than nonstutterers (about 27 msecs longer). The difference in vowel durations may not be valid however, because these results were obtained after successful stuttering treatment. The use of rate control methods could have been a contributing factor to the lengthened durations. If the transitional speech movements of vowels are inheritantly slower in pretreated adults who stutter, then this finding may contribute to the proposition that fluent speech is different between the two groups.

Physiological Basis

Zimmerman (1980) used high-speed cineradiography to study the positions, movements, and timing of lip and jaw structures in the production of the syllables /pap/,

/bab/, and /mam/. Only the fluent syllables of the stutterers were examined in order to examine whether a difference between nonstutterers fluent productions could be found. As with the previously discussed acoustic studies, the stuttering group in Zimmermann's research also revealed marked differences on fluently spoken syllables. The adults who stuttered demonstrated longer durations of movement onset, slower voice onset times, and lip and jaw movements were slower in attaining peak velocities. The transition times and articulatory postures were also held longer. The final results in this study suggested that the stuttering group had more dysynchronies between lip and jaw movements than the nonstuttering group (Zimmermann, 1980). From a physiological standpoint, this study supports the theory that adults who stutter have slower transitional speech movements than adults who do not stutter.

Many studies have utilized adults who stutter as subjects but there have been a few studies which have incorporated school-age and preschool-age children (Adams, 1987; Healey & Adams, 1981; Zebrowski, Conture, & Cudahy, 1985). Acoustic investigations (i.e., durational measures) are reasonable and warranted in subjects who are preschool age or beginning stutterers. These investigations are advisable since this is the age group associated with the onset of stuttering.

Child Subject Studies

Speech Timing and Pauses.

Healey and Adams (1981) were the first to include children who stutter in any temporal study. They analyzed the speech-timing skills of school-aged children and adults who stutter and of those who are normally fluent. The purpose of their research was to observe when, the discoordination of speech-timing abilities originated, in relation to the development of stuttering. The researchers failed to find any consistent differences between children who stutter and those who do not stutter on temporal variables. It was hypothesized that the lack of significant results may have resulted from the speech tasks being too simplistic. For example, the sentences used were composed of five monosyllabic words and the repetitious nature of each test sentence was also simple (10 times per sentence).

In a related study, Winkler & Ramig (1986) found that children who stutter exhibit more frequent and longer pauses in between words in complex speech tasks. These researchers evaluated two groups of nine school-aged male stutterers (ages 6 to 12 years and a mean age of 8 years, 6 months) and nine from a matched nonstuttering control group. The first part of this study replicated Healey and Adams (1981) project and results suggested that children

who stutter have similar speech-timing abilities on simple speech tasks when compared to the nonstuttering group. The second part of this study however, found the children who stuttered had more frequently occurring and longer interword pauses than the nonstuttering group in a more complex speech task. The complex speech task was for the subjects to repeat a narrative accompanied by a picture depicting the story presented twice initially. Subjects were also instructed to use as many of the same words they heard in which they could remember when repeating the story. The target words produced fluently and articulated correctly by the subjects were the only words analyzed. One implication the researchers suggested was that children who stutter may anticipate having difficulty and thus insert pauses to delay a moment of stuttering.

Onslow (1995) argued "early stuttering involves complex speech events that are not described adequately by a single term (p.586)." He expressed that acoustic measurements assist in analyzing moments of stuttering more thoroughly than what can be perceived and categorized (e.g., repetitions, prolongations, fixations) by listeners (perceptual analysis). In illustrating this conclusion, a speech sample segment of a 4-year-old boy stuttering on "Well I like" was examined. The phonemic transcription of this segment was perceived as /wəwɛəwəwəwəwəwlaɪlaɪk/. In perceptual analysis, Onslow contended that the listener,

may describe the dysfluency as a part word repetition. The utilization of wideband spectrogram and waveforms (acoustic analysis) however, defines the disfluency further. Onslow demonstrated that when using curser placement procedures on each repetition (on screen), the results also indicated that "tense pauses'' or fixations were evident. The first "wuh" was 150 msec, followed by a pause period of 998 msec. The following /wɛ∂/ was 500 msec, followed by a pause period of 1,380 msec. "Then there is a sequence of three /w∂/ repetitions of respective durations 150 msec, 188 msec, and 88 msec, each of which is followed by silences of respective durations 388 msec, 175 msec, 137 msec (p.587)." There was further evidence of fixations occurring in that a reduction in acoustic energy of the entire segment accompanied a decline in the duration of pauses between repetitions. The last four silent periods/pauses in particular became systematically shorter, from 1,380 msec, to 388 msec, then 175 msec, and finally 137 msec. indicating that something in the child's speech production seems to be halting the fluent flow of speech (Onslow, 1995).

In sum, acoustic investigations may identify other categories of dysfluency in which perceptual analysis cannot adequately distinguish. Acoustic analysis of the insertion and duration of pauses relative to fluent words

prior to and/or following a moment of stuttering was considered in the present study.

Voice Onset Time/Segment Durations

In 1987, Adams found that children who stuttered had significantly slower voice onset times and longer segment durations of words in isolation, in elicited sentences, and in conversation. Adams explored the possibility that some past temporal results with preschool incipient/beginning stutterers may not be completely justifiable since most of the subjects in the prior studies (Kent, 1976; Adams et al., 1984; and Adams, 1985) had already been stuttering for a while. The purpose of this investigation was to compare VOT and segment duration of nonstuttering preschool speakers with preschoolers whose fluency development had become a matter of concern to parents recently (2-5 months). Five children out a total of 17 were diagnosed as being incipient stutterers. This diagnosis was based on subjects exhibiting at least four of the five danger signs of incipient stuttering (Adams, 1977) and were no longer than six months beyond the onset of their parents' initial concern about their fluency. The five children were then paired with a nonstuttering control group matched closely to sex and age. Word and sentences were elicited by the examiner showing an object, animal, or action picture to the

children. "What is this?" and "Can you tell me a little story about what the cat is doing?" (p. 136) were the types of questions used to obtain the words and sentences, respectively. The objects, animals, and action pictures consisted of initial stop consonants (i.e., /b/, /p/, /t/, /k/) to obtain durational measurements of VOT, and voiceless fricatives (i.e., /s/,/f/) to obtain measurements of initial consonant durations. All identical and analyzable utterances were then matched for the target word and the words position. For example, an acceptable match for position was selected when the two subjects in the pair responded with identical sentences (i.e., The cat is sleeping). For comparison purposes, matching for position in the sentences was considered essential. Both experimental (stuttering group) and control subjects' duration of target words needed to be measured in the same syntactical environment. Results demonstrated that the preschool-age children who stuttered had slower mean VOTs, and longer mean initial consonant and vowel durations (segment durations). For example, the mean VOT for initial /b/ words in the stuttering group was 22.67 milliseconds (ms) while 16.67 msecs was the nonstuttering group's VOT mean value. The stuttering group's standard deviation values were also all larger than those for the controls indicating that they were more variable in managing these temporal speech elements (VOTs and segment durations).

Adams (1987) suggested that if follow-up studies support the findings in this study then slower VOTs and longer segment durations could be an inherent feature in the beginning stutterers' speech-timing control.

To summarize, Adam's (1987) results indicated preschool-age children who stutter use considerably longer segment durations and slower VOTs in words, sentences, and in conversation when compared to nonstutterering preschoolers. This investigation supports the theory that preschoolers who stutter may have slower transitional speech movements than preschool-age children who do not stutter.

The findings of all the formerly discussed acoustic investigations lead to the theory that individuals who stutter demonstrate distinct temporal differences in their fluent speech as compared nonstutterers. Acoustic investigations have an advantage over perceptual studies in that specific units of speech can be analyzed in which even expert listeners may have not detected. Young (1994) summarizes this point well: "The advantages of acoustic analysis include the capabilities of storing the speech signal, displaying it as an oscillographic trace, performing and recording mathematic calculations of exact word durations. These advantages promote the capture of extremely accurate data (p.26)."

RELATED STUDIES

A review of literature revealed five studies in which were closely related to the present investigation. Two studies completed by Viswanath (1989) and Howell and Wingfield (1990) will be reviewed first and a critique of how they differ from the present study will follow. Two investigations (Young, 1994; Peterson, 1995) were thesis projects utilizing adults and one adolescent who stuttered. The other investigation (Tetnowski, Morris, & Peterson, 1996) was a research paper which also utilized subjects between the ages of sixteen to adult.

Viswanath (1989), using spectrographic durational measurements, found that adults who stutter prolonged or lengthened the word immediately preceding the moment of stuttering when compared to the matched control group of nonstutterers. There were no significant statistical differences in the average duration of words immediately following the moment of stuttering.

There were two purposes involved in Viswanath's (1989) research. The first purpose was to relate Total Articulation Time (TAT) and Total Pause Time (TPT) to the frequency of moments of stuttering during adaptation. The second purpose was to "examine the duration of words in various locations in the vicinity of stuttering events in

the context of clausal utterances (p. 245)." Since the present study is primarily concerned with with duration of words prior to and following the moment of stuttering, the second purpose relating to the spread or vicinity effect of Viswanath's investigation was examined and given attention.

Four adults who stuttered were matched with four nonstuttering adults for age, sex, educational, and social background to form the subject sample for this study. Two short stories from a collection of Thurber stories were read by each subject five times in succession. Instructions were to read the passages aloud in a "normal" way. The samples were recorded on a (Sony TC-270) reel to reel tape recorder in either a sound treated room or a room with quiet ambient noise. Forty clausal utterances (8 clauses x 5 readings) were chosen for analysis for both stuttering and nonstuttering groups. Clauses were analyzed only when they met the following criteria:

1. The first reading required at least one moment of stuttering with the four remaining readings of the clause being fluent and free from distorted sounds or words.
2. "The last word of the previous clause and the first word of the following clause must have been produced fluently and without distortions in the five readings (p.249)."

3. The matched control (nonstuttering group) speaker's utterances were required to be fluent and free from distorted sounds and words.

A major result of this study was that significant anticipatory and carryover effects were observed within the clausal utterances. These effects were limited to immediate vicinity of the moment of stuttering. In other words, the individuals who stuttered demonstrated a marked tendency to increase the duration of words closest to (or surrounding) the stuttered word. Specifically, the adults who stuttered demonstrated a tendency to increase the duration of the stuttered word significantly once they produced the word fluently. In addition, this tendency persisted into the second reading of the clause. In sum, Viswanath (1989) suggested that individuals who stutter are likely to have longer durations than normal in various locations around a moment of stuttering. This increase in duration is accentuated in the word prior to a moment of stuttering and the stuttered word itself. According to these results, the author suggested that a moment of stuttering is not an interruption in the fluent flow of speech, but seems to emerge and decline in the overall context of a planned utterance. Viswanath further explained that there was a significant durational difference between the two groups in the second through fifth readings, even though the clauses were produced

fluently. The differences in duration may suggest evidence of an extra processing load developed by the stutterer. This extra processing load could be an internal anticipatory effect (within the stutterer himself) prompted by the knowledge that stuttering occurred previously in the upcoming clause (Viswanath, 1989).

Howell and Wingfield, (1990) did not find significant differences between an adult stuttering (presumably receiving treatment) and nonstuttering group in the overall duration, speech rate, number of pauses, and intensity of fluent speech averaged over a section of conversational speech. According to the researchers however, the effects of duration and rate did approach a significant mark. In this investigation, pauses and modulations in the intensity-time profile were measured from recordings of interviews between subjects and speech language pathologists lasting from 30 to 90 minutes. Results indicated that the stuttering groups' mean durations of utterances were slightly longer. These durations were collected directly from the digital recordings and were 2.46 seconds for the stuttering group and 2.09 for the nonstutterers. The main findings of the acoustic section of this study demonstrated that speech near a moment of stuttering "breaks down" (p.44). These break downs depend on whether a repetition or prolongation is about to occur or has previously occurred. When fluent

speech is near a repetition, there is a large modulation in intensity or (in other words) a large separation between syllables. The speakers who stuttered tended to speak slower in this context. When fluent speech is near a prolongation, there is also large separations between syllables when compared to nonstutterers. Fluent speech surrounding a repetition however is slower and longer in duration than fluent speech around a prolongation. Finally, the overall speech rates were slower when moments of stuttering: repetitions and prolongations were evident in the stuttering groups utterances. These investigations (Howell & Wingfield, 1990) and Viswanath (1989) support the theory that stuttering groups' transitional speech movements/speech timing are typically slower in duration than nonstuttering groups. A critique discussing how the present investigation differs from these studies follows.

Critique

The present investigation will differ from the investigations of Viswanath (1989), Young (1994), Peterson (1995), and Tetnowski, Morris, and Peterson (1996) in three important variables. These three variables include: 1) the age of the subjects; 2) the controlled context in which the samples will be collected and; 3) the time in treatment variable.

The first variable is age. Differences between

the durations of words surrounding a moment of stuttering when compared to duration of words in fluent utterances have been found with adults who stutter (Howell & Wingfield, 1990; Viswanath, 1989; Young, 1994). To the knowledge of this investigator, this same kind of durational research (duration of words immediately surrounding a moment of stuttering) has not been investigated with preschool-age children. Since this population is the age group associated with the onset of stuttering (incipient/beginning stutterers), an acoustic investigation in the duration of words surrounding stuttered events appears warranted.

Controlling the context in which only identical utterances containing a moment of stuttering and comparing identical fluent utterances may maximize confidence in results. The variables in the two prior investigations did not control for context in this manner. In addition, utterances will be elicited using action picture identification which may provide useful information and perhaps a larger sample size.

Finally, Viswanath gave no information regarding the history of treatment for his subjects. Howell & Wingfield mentioned that several of their subjects had been treated unsuccessfully with various treatments prior to the study. Treatment has been found to result in longer voice onset times (Ramig, 1984) and longer vowel durations (Prosek &

Runyun, 1982). For this reason, keeping the treatment variable constant in acoustic investigations appears to be of value. The studies of Young (1994), Peterson (1995), and Tetnowski, Morris, and Peterson (1996) will be discussed next.

The research completed by Young (1994), Peterson (1995), and Tetnowski, Morris, and Peterson (1996) was similar to the present investigation in that identical fluent words immediately proceeding and following the stuttered moment were examined in identical stuttered and fluent contexts. The two major differences between these past investigations and the present study include the ages of the subjects and the stimulus materials used to elicit responses. The past studies employed adults who read 83 sentences (twice in succession for the data corpus) while the present study utilized preschool children who responded to delayed imitations provided by the examiner from 60 action picture elicitations (twice in succession for the data corpus). The results of these prior investigations indicated that significant durational differences were determined prior to stuttering. Only one study (Young, 1994) found significant durational differences in fluent words immediately following the stuttered word. Therefore, the anticipation effect appears to be a greater factor than the carryover effect in the

past studies. These studies are discussed in greater detail next.

Young (1994) utilized spectrographic analysis on 40 of 83 phonetically balanced sentences read twice in succession (30 minute rest period between readings) by two adult male subjects who stuttered. In combined analysis of both subject's samples (N = 40), Young found significant durational differences between target words immediately before and after stuttered moments in the identical stuttered and nonstuttered sentences. The difference of fluent words immediately proceeding the stuttered word (BSTUT) averaged 50.5 msec. longer in duration than those measured before the nonstuttered word (BNSTUT) in the matched samples for the two adults who stuttered. Young reported significant differences in fluent target words (N = 40) occurring immediately after stuttered moments in the identical stuttered and nonstuttered sentences. The differences of fluent words occurring immediately after the stuttered word (ASTUT) averaged 23.5 msec. longer in duration than those measured after the nonstuttered word (ANSTUT) in the matched samples. According to Young, both anticipation and carryover effects appeared to have existed in the sample of two adults who stuttered. This indicated that these two adults prolonged the words before and after stuttered words. Using an expert (Ph.D. level speech-language pathologist) in stuttering and

spectrographic analysis as a reliability judge, close correlations between the examiner's and judge's (inter-judge) duration calculations were found: ($r = .961$) and shared variance r^2 was high at 92%. Young concluded that results in her research support the theory that the stuttered word in read sentences appears to influence the duration of words immediately surrounding its occurrence: the spread or vicinity effect.

Following the same procedures as Young (1994), Peterson (1995) also found significant differences between fluent target words before the stuttered event (BSTUT) but not after it (ASTUT). In her study, Peterson (1995) utilized three subjects who stuttered, ages 16, 48, and 53 (two males and one female) who read 83 phonetically balanced sentences twice in succession with a 30 minute rest period between readings. The difference of fluent words ($N = 36$) immediately proceeding the stuttered word (BSTUT) averaged 57.5 msec. longer in duration than those measured before the nonstuttered word (BNSTUT) in the matched samples for the three subjects who stuttered. The difference of fluent words ($N = 36$) immediately following the stuttered word (ASTUT) averaged only 7.7 msec. longer in duration than those measured after the nonstuttered word (ANSTUT) in the matched samples. These results suggested anticipation effects occuring in her sample of adults and one adolescent who stuttered. Peterson applied

intra- and inter-rater reliability and findings were high in correlation. For intra-rater reliability measures, Peterson repeated durational analysis on 10% of the sample. The Pearson-Product Moment correlational coefficient delineated a value of .943 indicating high test-retest reliability. Utilizing a Ph.D. level inter-rater reliability judge on 10% of the sample words, close correlational results between the examiner's and judge's duration calculations were found ($r = .854$). According to these temporal results, Peterson (1995) reported fluent words occurring immediately before stuttered words in sentences were on average longer in duration than those occurring before the matched nonstuttered word. She further suggested that individuals who stutter appear to have the ability to anticipate a stuttering event and in turn prolong the proceeding word. In contrast, no significant differences between the fluent target words following the stuttered event and the matched target words in the identical nonstuttered contexts were found.

Tetnowski, Morris, and Peterson, (1996) employed eight individuals who stuttered between the ages of 16 and 35 years as subjects. Like Young's (1994), and Peterson's (1995) research design, this investigation also required the subjects to read 83 phonetically balanced sentences twice in succession with a 30 minute rest period between the two readings. Through the use of oscilloscopic

tracings, these investigators found significant differences between the duration of fluent words prior to stuttering but not in the fluent words following stuttered words. The difference of fluent words (N = 63) immediately preceding the stuttered word (BSTUT) averaged 92.6 msec. longer than the same words measured before the nonstuttered word (BNSTUT) in the matched samples. The difference of fluent words (N = 63) immediately following the stuttered word (ASTUT) averaged only 37.3 msec. longer in duration than those measured after the nonstuttered word (ANSTUT) in the identical samples (not statistically significant). Anticipation effects, like the results of Viswanath (1989), Young (1994), and Peterson, (1995) were cited as being a possible contributing factor for these eight individuals who stuttered. Tetnowski, Morris, and Peterson (1996) applied intra- and inter-rater reliability on temporal measurements and findings were high in correlation. For intra-rater reliability, the investigators repeated durational analysis on 10% of the sample. The Pearson-Product Moment coefficient delineated a value of .943 indicating high test-retest reliability. In addition, the authors reported that most (all but two) of the intra-rater reliability measures were within 50 msec. of the original measure. The first and second authors completed inter-rater reliability measurements on 10% of the sample words. Close correlational results

between the first and second author's duration calculations were found (r = .854). The researchers reported that the msec. durational measures between the first and second examiner were less impressive. Sixty-five percent of the inter-rater reliability measures were within 50 msec. of the original measure. According to the overall temporal results, the investigators reported fluent words occurring immediately before stuttered words in sentences were on average longer in duration than fluent words occurring before the matched nonstuttered word. "Observation of the mean differences indicate that a word spoken prior to a moment of stuttering was approximately 50 milliseconds longer than when the same word was spoken in a non-stuttering context (p. 15)." They further suggested that individuals who stuttered in this investigation seemed to anticipate an upcoming stuttered event and in turn prolonged the proceeding word, i.e., an anticipatory effect.

In sum, durational differences of fluent words occurring immediately before the stuttered event have been found in the three studies previously discussed. Young (1994), in contrast with Peterson (1995) and Tetnowski, Morris, and Peterson (1996), reported fluent words immediately following the stuttered events were also significantly longer in duration than the matched

nonstuttered words. These studies support the theory that stuttering groups' transitional speech movements and speech timing control may be slower in duration when moments of stuttering occur.

SUMMARY

In this chapter, acoustic investigations relating to characteristics and differentiations of fluent and nonfluent adults and preschool-aged children was reviewed, and four investigations related to the present investigation were discussed. There have been many studies describing the perceptual and acoustical characteristics of stuttered utterances, but fewer regarding the durational differences in stuttered speech. Although Viswanath (1989) and Howell and Wingfield (1990) found durational differences in the fluent words surrounding a stuttered word, they did not control the context in which the samples were collected and the time in treatment variable. Controlling the context in which only identical utterances containing a moment of stuttering and comparing identical fluent utterances may maximize confidence in results and provide useful information. Controlling the treatment variable also appears to be of value. Ramig (1984) found that stuttering treatment results in longer voice onset times and Prosek & Runyun (1982) discovered longer vowel durations in their treated subjects. In 1994,

the subjects in Young's study had (on average) significantly longer fluent word durations immediately before and after stuttered moments when identical stuttered and nonstuttered sentences were compared. Peterson (1995), Tetnowski, Morris, and Peterson (1996) found significant differences, as Young (1994), in fluent words before the stuttered moment but not in the words immediately following. The results from these durational studies suggest and support the two following theories:

A. Stuttered words in sentences appear to influence the duration of fluent words immediately surrounding its occurrence: the spread or vicinity effect.

B. Stuttering groups' transitional speech movements and speech timing control may be slower in duration when moments of stuttering occur.

The present acoustical study will focus on determining whether or not the duration of fluent words immediately surrounding a moment of stuttering differ from the same fluent words immediately surrounding identical nonstuttered utterances. Therefore the research questions are:

1. Are there durational differences between a word prior to a moment of stuttering when compared to the exact word in the same speaking context when no stuttering is observed?

2. Are there durational differences between a word following a moment of stuttering when compared to the exact word in the same speaking context in the absence of stuttering?

CHAPTER III

METHODS AND PROCEDURES

Subject Selection

The subjects for this study were chosen from a list of potential clients (preschool-age) with a referring complaint of "stuttering" to the Portland State University Speech and Hearing Clinic. All of the three subjects employed in this study met the following criteria: a) between the ages of 4 years, 6 months to 6 years, 11 months of age, b) diagnosed as being at least "moderate" to "severe" in stuttering severity as scored on the Riley Stuttering Severity Index-3 (SSI-3) (Riley, 1994), c) had never received treatment for stuttering, d) signed consent from the child's parent or legal guardian, e) free from any other major speech, language, hearing disorder, and physical limitations that would hinder their participation in the study. Subjects utilized in this study were required to achieve "within normal limits" scores on language content, use, and form when screened using the Test of Early Language Development 2 (TELD-2) (Hresko,Reid, & Hammill, 1991).

Subject Description

Three subjects with written and signed permission from their parents/legal guardians agreed to participate

in the study. Information regarding the subject's ages, gender, previous treatment, and stuttering severity as determined by the SSI-3 are listed in Table I.

TABLE I
BIOGRAPHICAL INFORMATION FOR EACH SUBJECT

Subject	Age	Gender	Previous Treatment	Suttering Severity
#1	6	Male	Never	Moderate
#2	5	Male	Never	Moderate
#3	5	Male	Never	Severe

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 analog mode, in conjunction with a uni-directional condenser microphone (Audio Technica AT813), Mackie Micro Series 1202 mixer, and Phillips amplifier, and low pass filter set at a sampling level of 10,000 Hz.

In order to calibrate the input recording signal, a 1000 Hz reference tone was utilized 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. All speech samples were then recorded in a sound treated room on track #2 of the audio tape while maintaining a mouth-to-microphone distance of approximately 20 cm.

Stimulus Materials

The subjects were instructed to repeat each of the first twenty items (60 utterances) from the Patterned Elicited Syntax Test,(PEST) (Young & Perachio, 1983) when presented by the examiner. The selected items from the PEST were presented two times in succession with a 5 minute rest period between each administration. Refer to Appendix I for a listing of the stimulus items.

The PEST was utilized to obtain two to five word elicited utterances. This assessment instrument, in its evaluative design, is used for providing information on a broad range of grammatical structures which usually occur in children's language. Delayed imitation is the means for eliciting responses. The age range is from 3 to 7.5 years and can also be used with older children who have expressive language deficits. "The final version of the PEST consists of 44 items of increasing complexity that ranges in sentence or phrase length of three to eight words (Young & Perachio, 1983, p. 1)." The PEST is reported by the authors as having excellent reliability

and validity. The following reliability and validity measures are as follows:

1) *Temporal stability* was assessed using the test-retest method of Pearson product moment which established a high correlation of .94,

2) *Internal Consistency* was tested using split-half reliability with the Spearman-Brown Formula. Reliabilty coefficients ranged from .93 to .99,

3) *Item Validity* was completed by using t-tests of group means by each age level. The tests showed statistically significant differences between group means at each age level,

4) *Content Validity* was assessed using the test-retest method of Pearson product moment which established a correlation of .88 for a language-impaired group and a correlation of .86 for the normal language group, and

5) *Predictive Validity* was determined by comparing results from a full battery of diagnostic language tests administered by qualified speech-language clinicians with PEST results on thirty-five children judged as having expressive language impairments. The PEST identified thirty-four of thirty-five children with expressive language impairments in the area of morphology and syntax which indicated high predictive validity. With these high measurements of reliability and validity, the PEST was

determined as being a suitable instrument for collecting samples in the present investigation.

The test's protocol was followed by using delayed imitation on the first twenty items. The action pictures were placed in front of the subjects and the examiner presented verbal models while pointing to each picture in groups of three on each page. In other words, the examiner pointed to each picture in sequence and verbally modeled the stimulus phrases and sentences three at a time (e.g., *"a baby playing," "a boy sitting," "a girl combing"*). The subjects were then required to repeat the three utterances previously modeled by the examiner. One item is equivalent to three phrases or sentences per stimulus page. Therefore, 20 items or 60 utterances (20 x 3, respectively) were collected for analysis and subsequent selection for the data corpus (See Appendix I).

Identification of Stuttered Events.

Two judges (two second year graduate Speech-Language Pathology students) made a data corpus by listening to all 60 picture-elicited utterances and identifying each moment of stuttering in the first and/or second elicitation of the samples. Moments of stuttering were judged to occur according to governed rules of the Riley Stuttering Severity Instrument-3 (SSI-3) (Riley, 1994) definition of stuttering behaviors. Prolongations (including silent

prolongations) or repetitions of sounds or syllables were considered moments of stuttering. Rephrasing and repeating words of more than one syllable were not identified as moments of stuttering. Criteria for inclusion in the data corpus were moments of stuttering in one of the stimulus-picture elicited utterances and no incidence of stuttering in the identical fluent context. Inclusion of data in the corpus for subsequent analysis was dependent upon unanimous agreement among the two judges. When unanimous agreement was not reached between the two judges, the sample was simply omitted from the data corpus. Criteria for the exclusion included any stuttered word occurring immediately before or following another moment of stuttering. This was done to ensure control over the utterance context of analyzing only fluent words before and after the stuttered words and matched nonstuttered target words.

Speech Sample Analysis

The Tucker-Davis Technologies System II (AT&T DSP-32 based) configuration was utilized in acquiring data and was supported by Computerized Speech Research Environment 4.2 (CSRE 4.2) (Jaimeson, D.G., Ramji, K.V., Neary, T., & Baxter, T., 1990). The signal was digitized through a 2 channel, 16 bit A/D and D/A board to a Gateway 2000 Local

Bus Computer System with an 80486 processor. Components of the System II hardware configuration (Young, 1994) are composed of:

TABLE II

COMPONENTS INCLUDED IN THE CONFIGURATION OF THE SYSTEM II HARDWARE

AP2	50 Mhz Array Processor w/Optical Interface
DD1	2 Channel, 16 bit A/D and D/A
PA4	Programmable Attenuator
P12	Enhanced Parallel Interface Adapter Module
HB5	Stereo Headphone Buffer/Driver
MS1	Monitor Speaker with Two Watt Amplifier
MA1	Microphone Amplifier with LED meter
XB1	Quad Device Caddie
OT1	XBUS--Optical Interface
PWS25	25 Watt Rack-Mount Power Supply

Figure 1 (Young, 1994) illustrates the configuration of the System II hardware. The speech signal was delivered via digital audiotape recording input to the amplifier, filter, and XBUS Interface to the Gateway 2000 PC on which the oscillographic trace was displayed and analyzed.

Time analysis was performed on the selected words occurring immediately prior to (BSTUT) and/or following the moment of stuttering (ASTUT) in each stuttered speech samples and in the identical fluent context or counterpart

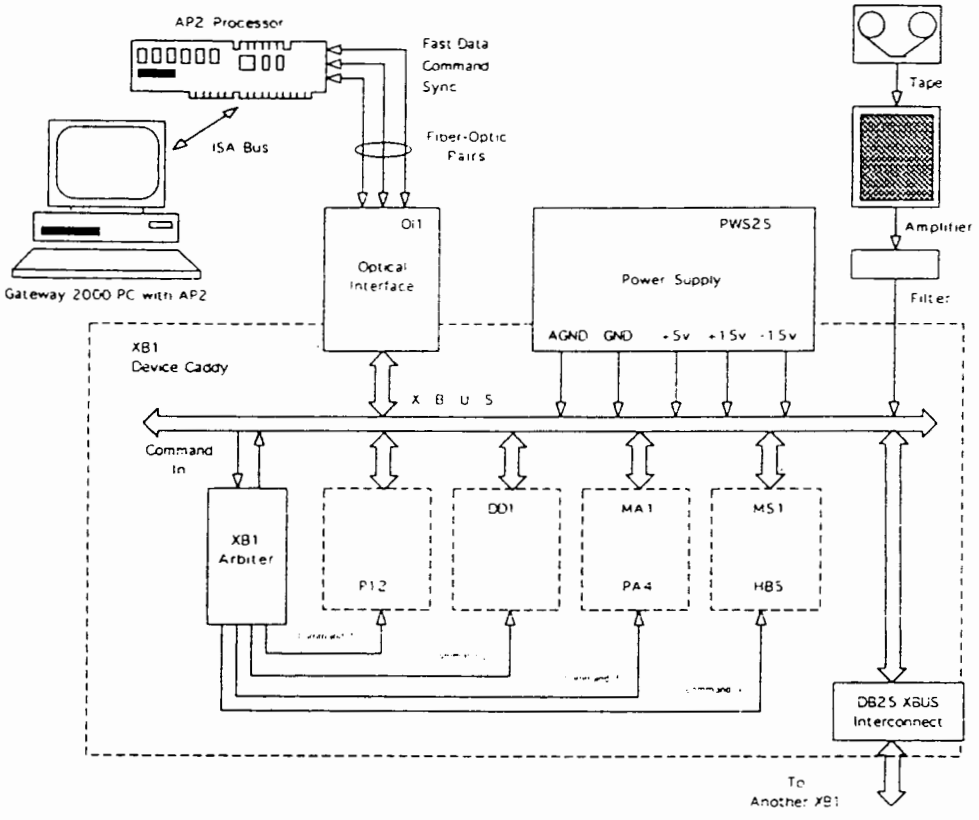

Figure 1. Diagram illustrating the configuration of the System II Hardware.

(BNSTUT and ANSTUT). The CSRE 4.2 program was used to perform durational analysis of the speech signal which displayed the utterances as oscillographic traces. Using auditory and visual cues, the target words were identified and packeted into triplet units. Each three word packet was then saved on 3.5'' disk for future analysis using CSRE 4.2.

In the analysis procedure (Young, 1994; Peterson, 1995), onset of the voiced target words was accomplished by zooming in, editing and marking the first and last negative peak of the quasiperiodic vocal wave. For voiceless sounds, the point at which the amplitude doubled or halved from the level of background noise defined onset and offset locations. By moving the cursors to these locations and playing back the sound between them, it was determined if the entire word had been marked without omitting any sounds or including adjacent ones. With the end points determined, the CSRE program then calculated the duration of the selected words in msec. and displayed it on the screen.

STATISTICAL ANALYSIS

Speech samples for each of the four subjects were assigned 7 digit numeric-alpha filenames (Young, 1994). For example, the number 01/02/02/(S1) demonstrated that the word was from the first utterance (01), the second

word (02), in the second sentence (02) from the sample of the specified subject (S1). A minimum of two iterations of the duration calculations were performed on each numeric-alpha word file for inter- and intra-judge reliability. Duration calculation scores were then subjected to inter- and intra-judge reliability checks on 10% of the time based measurements as described by Hall and Yairi, 1992.

Duration measurements were grouped according to the following categories:

1. word duration or length of the preceding word within the same sentence prior to a stuttered word BSTUT),

2. word length of that same word taken from the corresponding nonstuttered sentence (BNSTUT),

3. word duration or length of the word following a moment of stuttering within that same sentence (ASTUT), and

4. word length of that same word from the corresponding nonstuttered sentence (ANSTUT).

These msec. durational measurements were entered on a spreadsheet and subjected to one sample, two-tailed t-tests pairing the two matched samples (BSTUT with BNSTUT; ASTUT with ANSTUT). The level of confidence was set at $p < .05$.

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS

The purpose of this study was to determine whether there was a significant difference between the duration of words surrounding a stuttered moment with preschool-age children who stutter having never received treatment. Specifically, this study examined the duration of words immediately preceding and following a stuttered word and the duration of the matched fluent words in identical nonstuttered contexts.

Duration Analysis Before Stuttering

Words immediately preceding the stuttered words (BSTUT) paired with their nonstuttered counterparts (BNSTUT) were identified and analyzed for determining durations in milliseconds (msec.). The data corpus for the three subjects are listed in Appendix II.

One sample, two-tailed t-tests were completed to determine if a significant difference existed between the words immediately preceding stuttered events (BSTUT) in one sample and the words produced fluently in the corresponding match (BNSTUT). The level of confidence was set at .05.

The t-test results did not show significant differences between the word pairs BSTUT vs. BNSTUT ($p = 0.399$). This analysis indicated the mean duration of words immediately preceding the stuttered word (BSTUT) was not significantly different from those of the corresponding fluent samples (BNSTUT) (See Table III). Standard deviation results were also insignificant in that variability of duration in this sample was comparable to adults who stutter (Peterson, 1995; Tetnowski, Morris, & Peterson, 1996; Young, 1994). These preschool children did not vary their durations before stuttering (range: 13 msec. to 67.6 msec.) any more than adults have in the past studies above.

TABLE III

RESULTS OF A T-TEST COMPARING WORD PAIR DURATIONS IN MILLISECONDS FOR BSTUT/BNSTUT AND ASTUT/ANSTUT POSITIONS

Variable	N	Mean	StDev	SE Mean	T	P-Value
BSTUT/BNSTUT	26	13.65	56.29	15.61	0.87	0.399
ASTUT/ANSTUT	62	0.83	60.05	10.79	0.08	0.939

Duration Analysis After Stuttering

Words immediately following the stuttered words (ASTUT) paired with their nonstuttered counterparts

(ANSTUT) were identified and analyzed for determining durations in msec. The data corpus for the three subjects are listed in Appendix III.

One sample two-tailed t-tests were then completed to determine if a significant difference existed between words immediately following stuttered events (ASTUT) in one sample and produced fluently in the corresponding match (ANSTUT). The level of confidence was set at .05.

The t-test results did not show significant differences between the word pairs ASTUT vs. ANSTUT ($p = 0.939$). This analysis indicated the mean duration of words immediately following the stuttered word (ASTUT) was not significantly different from those of the corresponding fluent samples (ANSTUT). In the analysis of all samples, fluent words following the stuttered moments averaged only 0.83 msec. longer in duration than those calculated after the nonstuttered word in the matched samples (See Table III).

Intra-judge Reliability

Intra-judge reliability calculations were obtained by the examiner through random selection of the data and repeating the measurements for a second time on ten percent of the samples illustrated in Table III. A Pearson-Product Moment correlation coefficient found a value of $r = .988$ indicating high intra-judge test-retest

reliability. The amount of shared variance between the examiner's first and second measurements was calculated with r^2. The shared variance was high, at 97%. For the purpose of providing an additional intra-judge reliability check, two separate duration calculations completed by the examiner were observed to be within 50 msec. for 90% of the reliability sample (Tetnowski, Morris, & Peterson, 1996). Eleven of twelve or 92% of the randomly selected samples were within 25 msec. of each other which indicates high reliability. One word ("he") did not meet this criterion-referenced procedure with a difference of 77.3 msec. Durational results for intra-judge reliability are listed in Table IV.

TABLE IV

INTRA-JUDGE RELIABILITY RESULTS
OF 10% OF THE OBTAINED SAMPLES

Subject #	Utterance #	Word Analyzed	Duration-1	Duration-2
1	2	boy	376.6	388.4
1	17	what	240.0	288.2
1	17	in	275.6	270.8
1	47	a	100.7	85.6
2	52	wants	400.6	378.9
2	54	wants	489.7	496.2
3	5	fall	475.5	455.3
3	27	is	125.5	138.0
3	40	are	149.2	144.7
3	42	are	141.6	137.5
3	52	he	150.6	77.3
3	56	is	218.2	216.7

Inter-judge Reliability

Inter-judge reliability measures were obtained with assistance from a Ph.D. level speech-language pathologist (Professor) with extensive experience in spectrographic analysis and stuttering diagnosis and treatment. The judge/professor measured durations on ten percent of randomly selected words in the sample. A Pearson-Product Moment correlation coefficient yielded a value of $r = .990$ indicating high intra-judge test-retest reliability. The amount of shared variance between the examiner's and professor's measurements was calculated with r^2. The shared variance was high, at 98%. For the purpose of providing an additional inter-judge reliability check, duration calculations completed by both the examiner and the reliability judge were observed to be within 50 msec. for 90% of the reliability sample (Tetnowski, Morris, & Peterson, 1996). Ten of twelve or 84% of the randomly selected samples were within 25 msec. of each other which indicates high reliability. Two words ("is" and "wants") did not meet this criterion-referenced procedure with a difference of 66.5 and 44.1 milliseconds, respectively. The context of the surrounding words accounted for these differences in duration. For example, the BSTUT word "wants" in utterance #52, "He wants to ride." was variable for exact curser placement on the oscillographic trace

since the coarticulation on final /s/ of "wants" and initial /t/ of "to" are both high frequency voiceless sounds. Durational results for inter-judge reliability are listed in Table V.

TABLE V

INTER-JUDGE RELIABILITY RESULTS
OF 10% OF THE OBTAINED SAMPLES

Subject #	Utterance #	Word Analyzed	Examiner	Professor
1	3	a	126.2	126.3
1	3	combing	359.5	370.7
1	9	read	238.2	245.7
1	47	a	100.7	101.5
1	47	collar	403.1	410.8
2	28	is	203.6	270.1
2	34	is	212.4	235.9
2	42	wants	400.6	441.7
3	4	scream	670.2	668.1
3	56	the	106.9	98.7
3	56	is	223.9	231.3
3	59	pigs	322.2	318.8

DISCUSSION

The overall data obtained in this study demonstrated that there was not statistically significant differences between word durations both immediately before and immediately after a stuttered word compared to word durations of identical counterparts from fluent samples.

The BSTUT vs. BNSTUT word pairs in particular yeilded a mean durational differance of only 13.65 milliseconds. These results indicate that the preschool children in this sample did not prolong the word before stuttering. Therefore, the anticipation effects of fluent words occurring immediately before stuttering may not be a factor in stuttered utterances of preschool children. This finding is inconsistent from the adolescent/adult temporal studies previously discussed (Peterson, 1995; Tetnowski, Morris, & Peterson, 1996; Viswanath, 1989; Young, 1994). Since these "beginning" or "incipient" stutterers are apparently not anticipating stuttering, the present results may suggest that the anticipation effect is a learned behavior and not an inherent feature in the fluent speech of individuals who stutter. It is suggested however, that the sample size may not be large enough for the contribution of significant results for establishing theory and findings on preschool subjects' BSTUT/BNSTUT durational measures appear to be inconclusive at this time.

In the ASTUT vs. ANSTUT word pairs, the difference did not approach statistical significance. Fluent words following the stuttered moments averaged only 0.83 msec. longer in duration than fluent words measured after the nonstuttered words in the matched samples. These results indicate that the preschool children in this sample did

not prolong the word after stuttering. Therefore, the carryover effect of fluent words occurring immediately after stuttering may not be a factor in stuttered utterances of preschool children. This finding is consistent with the adolescent/adult temporal studies previously discussed (Peterson, 1995; Tetnowski, Morris, & Peterson, 1996; Viswanath, 1989). It is important to note however, that the sample size may have not been large enough in finding statistically significant results and findings on preschoolers' ASTUT/ANSTUT durational measures appear to be inconclusive at this time.

Another reason for the durational differences observed between the adult studies and the present investigation could be a direct result of how the samples were collected. All of previously discussed adolescent and adult studies were collected by requiring the subjects to read. Viswanath's (1989) research design required subjects to read short stories five times in succession, but did not control for context which may have decreased validity in results. Peterson (1995), Tetnowski, Morris, & Peterson (1996), and Young (1994) controlled the context by using same-word,same-speaker comparisons to insure validity of differences found. The subjects' reading rate and stress placed on certain words however, may have influenced the overall speech rates. The present investigation, in contrast, elicited samples through delayed imitation.

Although, this may have not had any influence on stress placed on particular words, it did enhance the naturalness of speech in the samples collected. Therefore, the actual speaking rate may have been more representative in the present study. The next procedure for future studies would then be to examine durational differences in spontaneous speech samples. This could be achieved by incorporating an elicitation task much like the procedure of using the PEST in the present investigation. Young (1994) reported that marking common stress points (intonation) in stimulus materials may reduce the stress variable which has not been controlled in any of the studies discussed.

A final perspective for this study which may have contributed to the differences in results from adult durational studies was the length of each syntactical unit in the sample. In this study, the first twenty items or sixty utterances were used for the collection of speech samples. A majority (N = 36) of the elicited phrases and sentences were three words in length with the rest of the sample contributing two, four, and five word sentences for analysis (See Appendix I). With these short utterances as samples, it may be that it was difficult to visually observe a "spread effect" (if any) in the data. In the adult durational studies previously discussed (Peterson, 1995; Tetnowski, Morris, & Peterson, 1996; Viswanath, 1989; Young, 1994), the sentences were longer (5 - 15

words in length) which allowed examination of words surrounding stuttered events (immediately before and after). In the present investigation, there were twenty-three samples (particularly with subject numbers two and three) where the initial word in the utterance was stuttered and subsequent analysis measured the fluent word in the ASTUT/ANSTUT environments alone (See Appendices I - III). In addition, Peterson (1995), Tetnowski, Morris, & Peterson, (1996), Viswanath (1989), and Young (1994) had exclusion criteria of omitting sentences which began with a stuttered event in order to measure only durational differences in fluent words surrounding (before and after) identical stuttered and nonstuttered sentences. In the present investigation, it was not possible to utilize this exclusion criteria since a large portion (N = 36) of the samples were three words in length. Therefore, it is suggested that the spread effect or the effect of a stuttered word on surrounding fluent speech may have not been completely observed. The PEST utilizes other sentences (items 21 - 44) which range from four to eight words in length. It is recommended that elicited sentences be at least four to eight words in length to measure possible spread effects of fluent words surrounding stuttering events (immediately before and after) in future research with preschool and/or school-age children.

CHAPTER V

SUMMARY AND IMPLICATIONS

SUMMARY

The purpose of this study was to determine if there was a significant difference between the duration of words surrounding a stuttered event and those surrounding a fluent word. Specifically, this study examined the duration of words immediately before and immediately following a stuttered word and the duration of the corresponding words in the matched nonstuttered utterances. The intent of this study addressed the following questions:

1) Are there significant durational differences between a word preceding a moment of stuttering when compared to the matched fluent word in the same speaking context when no stuttering is observed?

2) Are there significant durational differences between a word following a moment of stuttering when compared to the matched fluent word in the same speaking context in the absence of stuttering?

Three subjects ages 5 and 6 who had never received stuttering treatment were selected from a list of potential clients at the Portland State University Speech and Hearing Clinic. Subjects were instructed to repeat

three phrases or sentences at a time after the examiner's model (delayed imitation) in relation to action pictures from the PEST. One hundred twenty utterances were collected in two consecutive administrations (60 each time) of the PEST with a five minute rest period between recordings. Words immediately preceding and following the stuttered words (BSTUT and ASTUT) paired with their nonstuttered counterparts (BNSTUT and ANSTUT) were identified and analyzed for determining durations in milliseconds (msec.). The data corpus for the three subjects are listed in Appendices II and III. The duration of the following word pairs in milliseconds was calculated with the CSRE 4.2 software program:

1) The duration of the word immediately preceding a stuttered word within the same elicited utterance (BSTUT).

2) The duration of the same word in the corresponding nonstuttered elicited utterance (BNSTUT).

3) The duration of the word immediately following a stuttered word within the same elicited utterance (ASTUT).

4) The duration of the same word in the corresponding nonstuttered elicited utterance (ANSTUT).

A total of 44 samples were obtained. A two tailed t-test was completed at the .05 confidence level to determine whether or not there was a significant difference between the BSTUT vs. BNSTUT and ASTUT vs. ANSTUT word pairs. Results demonstrated that there was not

a statistically significant difference between the durations of BSTUT vs. BNSTUT (P = 0.399) and ASTUT vs. ANSTUT (P = 0.939) at the .05 confidence level. In the analysis of the subject's duration of words immediately before the stuttered word, results averaged 13.65 msec. longer in duration than those calculated before the fluent word in the matched sample indicating an insignificant difference. In comparison, the results of the subject's mean duration of words immediately following the stuttered word averaged 0.83 msec. longer than those calculated after the fluent word in the matched sample indicating very little difference.

The present investigation also yielded high intra- and inter-reliability results. Some prior investigations (Howell & Wingfield 1990; Viswanath 1989) did not complete reliability measurements on their data which decreases the reliability of their results. Tetnowski, Morris, and Peterson (1996) reported that defining onset and offset locations of phonemes in durational analysis is the first step towards the standardization of measurement procedures. Eleven of twelve or 92% of the samples re-tested in the intra-judge reliability measures were within 25 msec. of the initial measurement which indicates high reliability. Ten of twelve or 83% of the samples re-tested in the inter-judge reliability measures were within 25

msec. of the original examiner which also indicates high reliability.

IMPLICATIONS

Research Implications

The results of this study, although not significant, suggest the need for further research on acoustic evidence of the spread or vicinity effect on word durations surrounding a stuttered event. As a result of the small sample size, the findings in this study are in need of additional support for establishing theory. Therefore, the following suggestions for future durational studies are given:

1) An increase in the number of preschool-age subjects could also assist in supporting or refuting the results of the present investigation.

2) A spontaneous speech sample could be analyzed in addition to the delayed imitation samples used in this study. This could be achieved through an elicitation task much like the procedure of using the PEST in the present investigation.

3) Include all age groups in this investigation. Up until this time, the age groups have been adults, adolescents, and with the present study, preschool-age children. According to the literature review, school-age children who stutter have not been used as subjects in

this research design. Significant durational differences were not found in the present investigation but were found in the adolescent and adult studies. This could indicate that the durational differences are a learned behavior and perhaps not a naturally occurring characteristic of the fluent speech of individuals who stutter. In addition, if results were to reveal significant durational differences in school-age children who stutter, then perhaps future investigations may be able to support these temporal changes as a learned behavior.

4) The utilization of longer phrases and sentences may assist in observing a spread effect (if any) in the subject's samples. A majority of the phrases and sentences in the data corpus were only three words in length which may have contributed to an incomplete visual observation of the spread effect. In other words, the spread effect or the effect of a stuttered word on surrounding fluent speech may have not been completely observed. There were twenty-three samples (particularly with subject numbers two and three) where the initial word in the utterance was stuttered and subsequent analysis measured the fluent word in the ASTUT/ANSTUT environments alone (See Appendices I - III). In order to observe possible spread effects, future durational investigations employing preschool-age children may need an equal amount of BSTUT/BNSTUT and ASTUT/ANSTUT samples. The PEST utilizes other sentences (items 21 - 44)

which range from four to eight words in length. It is recommended that elicited sentences be at least four to eight words in length to measure possible spread effects of fluent words surrounding stuttering events (immediately before and after) in future investigations with preschool-age children.

Clinical Implication

This study indicates that the young subjects did not anticipate stuttering. Peters and Guitar (1991) reported children who are beginning to stutter may not have developed a fear or anticipation of stuttering. They usually do not interpret their speech as disordered at this time of their development and therefore do not show the anticipation differences in which adolescents or adults show (Peterson, 1995; Tetnowski, Morris, & Peterson, 1996; Viswanath, 1989; Young, 1994). Van Riper (1982) suggested that children observe stuttering as "episodic." They will sometimes observe and may be annoyed by stuttering and at other times are fluent and unaware of difficulties with their speech. Since spread effects were not found in the preschool subjects' results, clinical strategies should not focus on prolongation or rate control as reported as effective therapy for adolescents and adults who stutter (Tetnowski, Morris, & Peterson, 1996; Viswanath, 1989; Young, 1994). Clinical strategies

should concentrate on treatment options such as easy onset of the initial word in utterances, parental consultation and education for promoting fluency in the home, and relaxation techniques.

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APPENDIX I

CONSENT FORM

&

LIST OF 60 STIMULUS PHRASES AND SENTENCES (20 ITEMS) FROM THE PATTERNED ELICITED SYNTAX TEST (PEST) USED IN COLLECTION OF SUBJECT'S SPEECH SAMPLES

CONSENT FORM

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 called the Patterned Elicitation Syntax Test (PEST) for two consecutive times. I understand my child will be audio-recorded and that because of this study, there is an inconvenience of waiting five minutes between the first and second recordings.

The examiner has told me that the purpose of this study is to examine whether there are any differences in the duration of words surrounding moments of stuttering (the words immediately before and immediatly after? and the duration of the same words in identical fluent utterances. I understand that the goal of the project is to observe two conditions in which the above words (duration) will be evaluated: sixty fluent (no stuttering) utterances and sixty identical utterances with a stuttered event. The examiner explained that the duration of these words (in the stuttered and fluent contexts) will be examined using a "voice print" or spectrographic analysis

of my child's speech on a highly accurate computer program. The examiner explained this investigation is about examining whether there are any distinct changes in the nonstuttered words surrounding the stuttered word or moment.

My child and I may not receive any direct benefit from taking part in this study. But the study may assist by increasing knowledge that may help others in the future.

The examiner has offered to answer any questions I have aobut the study and what my child and I are expected to do. He promised that all information received wil be kept confidential to the extent permitted by law. The names of all people in the study will be kept confidential.

I understand that 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 other agencies.

Date: _____ Signature: _____

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, (503) 725-3417.

SENTENCES AND PHRASES FROM THE PEST

Item #1
1. a baby playing
2. a boy sitting
3. a girl combing

Item #2
4. Don't scream.
5. Don't fall.
6. Don't drop.

Item #3
7. You eat it.
8. You throw it.
9. You read it.

Item #4
10. The cat is hers.
11. The balloon is hers.
12. The baby is hers.

Item #5
13. I can talk.
14. I can read.
15. I can jump.

Item #6
16. What is in the box?
17. What is in the basket?
18. What is in the bag?

Item #7
19. girl brushing teeth
20. boy eating banana
21. man reading paper

Item #8
22. I have rabbits.
23. I have socks.
24. I have dolls.

Item #9
25. Where is the shoe?
26. Where is the cat?
27. Where is the apple?

Item #10
28. This is round.
29. This is broken.
30. This is open.

Item #11
31. Take a bath.
32. Ring a bell.
32. Hit a ball.

Item #12
34. She is reading.
35. He is climbing.
36. She is drinking.

Item #13
37. We wear boots.
38. We eat ice cream.
39. We drink milk.

Item #14
40. They are flying.
41. They are eating.
42. They are riding.

Item #15
43. The boy caught the ball.
44. The girl saw the bird.
45. The man broke the dishes.

Item #16
46. a boy's jacket
47. a dog's collar.
48. a girl's hair.

Item #17
49. She is sleeping.
50. She is washing.
51. She is eating.

Item #18
52. He wants to ride.
53. He wants to blow.
54. He wants to swing.

Item #19
55. The ball is on the table.
56. The rabbit is in the box.
57. The dog is under the chair.

Item #20
58. The balls are round.
59. The pigs are fat.
60. The babies are little.

APPENDIX II

DURATION IN MILLISECONDS (MSEC) OF WORD PAIRS BEFORE STUTTERING (BSTUT) AND BEFORE NON-STUTTERING (BNSTUT) FOR ALL SUBJECTS

TABLE VI

DURATION OF WORD PAIRS BSTUT/BNSTUT IN MSEC
FOR ALL SUBJECTS

Subject #	Utterance #	Stuttered Sample #	Word Analyzed	Duration	
				BSTUT	BNSTUT
1	2	2nd	boy	262.1	376.6
1	3	1st	a	126.2	178.7
1	14	1st	I	171.9	158.9
1	17	2nd	what	240.0	172.4
1	38	1st	we	341.3	395.5
1	40	1st	are	140.6	110.2
1	43	1st	the	163.1	108.8
1	47	2nd	a	114.0	100.7
1	48	1st	girl's	561.2	509.1
2	28	1st	is	203.6	148.3
2	54	2nd	wants	542.2	489.7
3	52	2nd	he	150.6	85.1
3	56	2nd	the	106.9	112.2

APPENDIX III

DURATION IN MILLISECONDS (MSEC) OF WORD PAIR AFTER STUTTERING (ASTUT) AND AFTER NON-STUTTERING (ANSTUT) FOR ALL SUBJECTS

TABLE VII

DURATION OF WORD PAIRS ASTUT/ANSTUT IN MSEC
FOR ALL SUBJECTS

Subject #	Utterance #	Stuttered Sample #	Word Analyzed	Duration	
				ASTUT	ANSTUT
1	3	1st	combing	359.5	484.7
1	7	2nd	eat	206.3	150.3
1	9	2nd	read	243.2	238.2
1	14	1st	read	154.5	235.0
1	17	2nd	in	275.6	150.5
1	34	1st	is	235.8	183.1
1	36	2nd	is	236.2	258.2
1	38	1st	ice	265.2	210.3
1	43	1st	caught	256.0	210.0
1	47	2nd	collar	460.3	403.1
2	2	1st	boy	270.2	245.7
2	33	1st	the	57.9	80.1
2	34	2nd	is	212.4	268.4
2	52	2nd	wants	281.5	400.6
2	53	1st	wants	598.5	539.4
2	54	2nd	swing	650.4	588.8
3	4	1st	scream	691.8	670.2
3	5	1st	fall	475.5	414.6
3	6	1st	drop	522.3	634.9
3	9	2nd	read	257.0	301.4
3	22	1st	have	166.1	172.1
3	27	2nd	is	125.5	109.5
3	29	1st	is	120.0	157.8
3	30	1st	is	193.3	192.9
3	32	1st	a	37.3	68.1
3	33	1st	a	34.3	35.9
3	40	1st	are	176.6	149.2
3	42	2nd	are	141.6	171.5
3	52	2nd	to	27.2	61.7
3	56	2nd	is	223.9	218.2
3	59	2nd	pigs	322.2	248.0