Rhythmicity, Rate, and Perceived Effort Level of Fluent and Disfluent Children and Their Parents

Lorraine DeStefano Proctor

Western Michigan University
RHYTHMICITY, RATE, AND PERCEIVED EFFORT LEVEL OF FLUENT AND DISFLUENT CHILDREN AND THEIR PARENTS

by

Lorraine DeStefano Proctor

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RHYTHMICITY, RATE, AND PERCEIVED EFFORT LEVEL OF FLUENT AND DISFLUENT CHILDREN AND THEIR PARENTS

Lorraine DeStefano Proctor, M.A.

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Finger tapping and CVC syllable repetition measures of 7 four to eight year old fluent and disfluent children and their mothers were evaluated. Perceptual ratings of speech rate and effort level were also completed by the children, their mothers, and nine graduate students. These procedures were used to test hypotheses that mean interval durations for tapping and for speech, and perceptual ratings of speech rate and effort level are individual in nature.

Results indicated that the subjects' measures of mean interval durations for tapping and for speech as estimates of rhythmicity, and perceptual ratings of speech rate and effort level were individual in nature for the subjects in this study.

These results were discussed in terms of theoretical and clinical implications, and of the hypotheses which may be generated and tested concerning the individual effects that different production and perception variables may have on communication for the disfluent child.
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Lorraine DeStefano Proctor
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CHAPTER I

BACKGROUND AND PURPOSE

Introduction

Numerous theories pertaining to the onset and development of disfluent speech in children have been developed. Focus has shifted among genetic predisposition, language development/disorder, learning, attitudes, and interpersonal interaction. While each of the foregoing areas has provided potentially useful information, effort has often been made to establish a "causal" relationship between a certain "impairment" and the onset and development of stuttering within the philosophical domain of each framework. In order to discuss the necessity for pooling the ideas of previous researchers into a more ecological perspective, a brief discussion of the background from which current information has been obtained is appropriate.

Physiological orientations have included reference to a genetic predisposition to stutter which is triggered by stress, fatigue, or illness; to "laterality" or sidedness as a causal factor; and to specific organ deficiencies as evidenced by recent experimental emphasis on laryngeal behaviors, phoneme and syllable voice onset
time, voice and finger reaction time, duration measures, and speech rate. While any or all of the suggested and measured physiological correlates mentioned may be of import with regard to fluency breakdown, consideration of such variables as "causal" elements may be premature, especially in light of extant data which indicate that environmental, psychological, and linguistic variables may also comprise significant elements of speech control mechanisms.

In contrast to those more "organic" perspectives of stuttering, some researchers have focused on the linguistic aspects of speech. Since Brown (1945) noted that attributes of words, sentence position, word length, and phoneme type may be accurate predictors of the "loci of disfluencies," subsequent researchers have gathered data which indicate that vocabulary deficits (Brown, 1945), word finding problems (Bloodstein and Gantwerk, 1967), and lack of language experience (Gottfried, 1976), are related to the onset and development of disfluent speech.

Learning theorists have presented stuttering as a conditioned behavior. Historically, researchers across the centuries have discussed stuttering as a "bad habit." More recently, researchers have developed more sophisticated paradigms of learning, such as the
two-factor theory of learning proposed by Dollard and Miller (1950), or the instrumental learning model developed by Skinner (1957). These researchers regarded stuttering as a behavior which is possibly controllable by "ensuing consequences." Others have postulated that disfluent speech could be classically conditioned by stimulus association which promotes the gradual conditioning of emotional and physiological aberrancies through experiences of communicative failure.

Other psychological orientations have focused on neurotic etiology of stuttering. These theorists have described the core of stuttering as being emotionally based characteristics of the speaking situation which are often perpetuated by fear or anxiety (Sheehan, 1958; Wischner, 1952). Some have attributed disfluent speech to neurotic fixations (Coriat, 1931), and others have spoken of physiological substrates of internal psychological conflicts (Sheehan, 1958), as possible causal elements. Recently, some researchers who previously followed a traditional psychological perspective have abandoned the assumption that stuttering may be solely psychologically based. They have opted for a more psychosocial orientation, suggesting that the stutterer's behavior may be specifically influenced by the unique social/environmental interactions in which
he/she partakes.

The psychosocial orientation has shifted focus from individual psychoneuroses and toward consideration of individual characteristics which emerge as dynamic products of various verbal interactions. Study of the stutterer's attitude toward his speech and toward specific communicative situations has been investigated as a particularly interesting psychosocial phenomenon correlated with stuttering. The dynamics of the parent-child interaction have also received much attention, especially in relation to the development of diagnosogenic and semantogenic theories of Wendell Johnson (1959), which suggest that the label of stuttering or the evaluations of parents during the social interactions with their children may be responsible for the development of the disorder.

While all of the perspectives described above (physiological, linguistic, learning, psychological, and psychosocial) have yielded information about variables which may be potentially useful for understanding stuttering, they may be of limited value because they have been designed to instigate search for the critical variable which is responsible for the onset and development of stuttering. The resulting failure to define the critical variable may be related to the
failure by researchers to consider each variable as part of a dynamic interaction of communicative events rather than as an isolated variable which has some discrete causal relevance. Based upon current thought on movement control (Kelso, Tuller, and Harris, 1983), it seems reasonable to consider an alternative to the foregoing perspectives by considering speech, language, and perceptual variables as conditions comprising a dynamic interaction of the organism and environment. The relevance of each variable may be understood only in terms of organismic and environmental conditions determined, in part, by the context in which they occur.

Recent researchers (Zimmermann, 1980; Zimmermann, Smith, and Hanley, 1981; Hanley, 1982) have called for a unified perspective of stuttering based on the study of the interaction of the foregoing variables in terms of their effects on speech motor control. In the discussion that follows, it will be assumed that the disfluent child must be viewed in terms of the effects of his physiological, psychological, linguistic, learning, and psychosocial makeup on the individual's speech motor patterns and/or the breakdown of critical mechanisms underlying these patterns. An ecological perspective does not represent an attempt to search for yet another causal element. Rather, it seeks to describe the
differential effects of the foregoing variables on the physiological processes associated with speech fluency. This rationale suggests the import of description and measurement of physiological, psychological and psychosocial variables and their relationships during social interactions. The specific variables of rhythmicity, rate, and effort level, and the child's perception of these variables have been proposed as variables related in some way to alteration of the speech motor control mechanism(s) and/or speech breakdown (Kelso, Tuller, and Harris, 1983). These variables will be studied and discussed in the present study in terms of their effects on the disfluent child while interacting with his/her parent. Results are interpreted from an ecological perspective, and implications of these results are discussed in terms of traditional and current theoretical and therapeutic issues.

Review of Pertinent Literature

The study of the onset and development of disfluent speech in children has been undertaken by numerous researchers who were motivated by various philosophies and biases. As a result, several perspectives have differentially emphasized physiological, language, learning, emotional, and psychosociological elements as
causes of stuttering. While these specific areas may not harbor a specific causal element of stuttering, they each have provided bits of information which may eventually enhance our understanding of stuttering. These perspectives are briefly discussed below in terms of the variables thought to be potentially related to speech motorics and the breakdown of the speech process.

**Physiological Perspectives**

Physiological perspectives have shared a common objective, to ascertain what underlying physiological event(s) may be responsible for fluency breakdown. West and his students (1958) postulated a predisposition theory, suggesting an inherent physiological dysfunction of the speech production system. They proposed that certain persons possess an innate abnormality or "dysphemia" which is triggered by stress, illness, or other disturbances. West also suggested that stuttering could be related to pyknolepsy, a form of epilepsy which occurs in children. Similarly, Bryngelson (1935) and others observed that stutterers were less likely to be left-handed than nonstutterers, but were more likely to have had their handedness switched. Sidedness, he suggested, was a possible etiologic factor in stuttering. Travis and his co-workers (1931; Travis and Orton, 1929;
Travis, Tuttle, and Cowan, 1936) made experimental observations which later supported Bryngelson's reasoning, and they proposed that a lack of cerebral dominance caused a dysfunction of the speech mechanism and hence, a predisposition to speech breakdown. The work of Johnson (1955), Johnson and King (1942), Van Dusen (1939), Heltman (1943), Daniels (1940), and Spadino (1941) contradicted the earlier findings on laterality and handedness. This group of researchers found no significant differences in the laterality of stutterers and nonstutterers. In spite of a mass of contradictory data, the laterality question later resurfaced with the advent of more advanced tests of cerebral dominance. The intracarotid sodium amytal (Wada) test has been used to determine lateral dominance (Jones, 1966; Walle, 1971; Andrews and Quinn, 1972), but again the results have been equivocal. The contradictory results of these tests may possibly be due to attempts to prove that a correlation-causation link between laterality and stuttering was a group rather than an individually determined characteristic. Studies persist in the search for a link between cerebral dominance, laterality, and genetic predisposition, as group characteristics related to the onset and development of stuttering. While the foregoing researchers have provided information and
speculation concerning organism dysfunction as a possible critical variable underlying disfluent speech in some individuals, other physiological research perspectives have alluded to more specific organ deficiencies.

A body of current research has emphasized laryngeal behavior as a specific area of dysfunction in stutterers. Wingate (1966) found that prosodic features of speech and adaptation may be contributing factors in fluency control and he proposed the process of vocalization as a specifically disrupted process in stutterers. Later, Adams and Reis (1971) found that the stutterers in their sample experienced fewer disfluencies and more rapid adaptation (resumption of fluency over repeated readings) when asked to read "all-voiced" material, than when asked to read material which combined voiced and voiceless phonemic speech patterns. Adams and Hayden (1976) compared stutterers and nonstutterers on measures of voice onset time and voice termination time for production of isolated vowels. They found that stutterers as a group were slower on both measures, even when adaptation was taken into consideration. These authors also suggested that alterations in laryngeal adjustment could be implicated in the onset of disfluency. Wingate (1976) later postulated that all fluency enhancing conditions, such as whispering or
choral reading, share a common trait, reduced rate of speech. This observation implied that physiological limitations characterized the speech of stutterers. It should also be noted, however, that speech rate may be systematically altered by changing pause time, rate of movement, displacement of articulator structures, or some combination of these. Thus, an observation of "rate" change alone does little to elucidate the more critical physiological alterations which determine rate change. Recently, Starkweather, Franklin, and Smigo, (1981), Cross and Luper (1979), and Till, Reich, Dickey, and Seiber, (1983) have reported that stutterers' voice and finger reaction times were slower than those of nonstutterers. These researchers attributed this difference between groups to coordination difficulty which characterizes stutterers even during episodes of fluent speech. Studies implying organ and organism deficiencies of stutterers may have erred by portraying their observed physiological differences as causal agents. In each of the preceding studies, effort has been made to attribute import of these variables in a "determining" rather than a "contributing" framework. However, they have described variables which may later be portrayed as significant.
Linguistic Perspectives

In contrast to the aforementioned "organic" perspectives, some researchers have focused on the language process of stutterers in their search for the cause of stuttering. Linguistic determinants of the "loci of disfluencies" were measured as early as 1935 by Johnson and Brown. They determined that the likelihood of stuttering on a given word was strongly influenced by the sound with which it began, but that specific sounds on which the disfluency occurred varied widely among stutterers. Brown's additional investigations culminated in 1945 with his announcement of four principle attributes of words that determined the "loci of stuttering" in oral reading: the initial sound of the word, the grammatical function of the word, the position of the word in the sentence, the length of the word, and the informational value of the word (content versus functional).

Subsequent researchers have drawn on Brown's four factors as bases for investigation of other linguistic determinants of stuttering. Brown (1945), Oxtoby (1955), Trotter (1956), and Silverman and Williams (1967) indicated that longer, more unfamiliar words were more frequently disfluent than were shorter, more common
words. The authors used their data to suggest that vocabulary deficits may be related to the onset and development of stuttering as a developmental attribute. Gottfried (1976) found an increase in the quantity of language usage and the lack of experience with emerging forms as possible factors which correlate highly with sharp increases in the frequency of occurrence of disfluencies between the second and third years.

Bloodstein and Gantwerk (1967) observed that the disfluencies of young stutterers occurred primarily on pronouns and conjunctions, especially as a function of being the first words in a sentence. More recently, Silverman (1974) noted that the disfluencies on these pronouns and conjunctions were just as likely to be found within the sentence unit as they were at sentence initiation. Silverman, however, did not consider the issue of syntactic units as initiation points for disfluency, as Bloodstein did. Bloodstein (1975) reported the results of one of his earlier studies which showed that in speech of young stutterers, all of the word repetitions occurred at the beginning of syntactic units such as sentences, clauses, verb phrases, noun phrases, or prepositional phrases. Based on these findings, he concluded that stuttering had its origin in an early stage of fragmentation of larger syntactic
units. Bloodstein suggested that the programming of these larger units could reflect the child's inadequacy in carrying out speech as a motor task. Bloodstein (1975) later stated that since males are slower in language acquisition, this may explain the higher incidence of stuttering in males as compared to females. The theme of inadequate language has been further developed by Wall, Starkweather and Cairns (1981). They cited an earlier study by Wall, in which he suggested stutterers tend to use fewer complete clauses and less complex syntax than do nonstutterers. In addition to the preceding discussion of physiological and linguistic perspectives which have searched for a specific and inherent source of breakdown within the child, psychological perspectives have also searched for a causal element within the child.

Psychological Perspectives

Abandoning an inherent organic or genetic causal basis for dysfunction as a possible cause for disfluent speech in children, learning theorists have looked to stuttering as a conditioned behavior which evolves according to the principles of learning. Van Riper (1982) reviewed the history of learning theory as beginning in the early 18th century, when stuttering was
referred to as a "bad habit." Learning theories have become more sophisticated, and ultimately protagonists of learning have evolved into two camps. The operant or instrumental theorists have based their speculations on the belief that when normal disfluencies are punished, or when abnormal behaviors are reinforced, stuttering behavior develops. Flanagan, Goldiamond, and Azrin, (1959) suggested that nonfluencies may represent responses which are controllable by ensuing consequences. The consequences of the disfluency are, in effect, reinforcing to aberrant speech behaviors, and cause the recurrence of those behaviors. Shames and Sherrick (1963) suggested that when normal disfluencies have no rewarding consequences, the child becomes a normal speaker, but when disfluencies serve to gain the attention of parents, allow the child to speak without interruption, etc., the reinforced disfluencies increase in number until they comprise the majority of the child's speech. Ayllon and Azrin (1965) suggested that the secondary stuttering behaviors are maintained because, though punishing in themselves, they serve to escape the listener's surprised or shocked reaction. Thus, according to operant theorists, stuttering is both caused and maintained by its reinforcing consequences.

Other learning theorists were proponents of the role...
of classical conditioning (respondent learning) in stuttering. These individuals portrayed stuttering as a behavior caused and maintained by the respondent association of speech with a negative experience. The child becomes most disfluent in those situations which are associated with negative emotions. Brutten and Shoemaker (1967) proposed a "two factor" explanation of the onset and development of stuttering. Based on models designed by Hull (1955), and Mowrer (1950), Brutten and Shoemaker suggested that classically conditioned emotional responses interact with behaviors acquired instrumentally to promote fluency breakdown.

In contrast to the learning perspective of stuttering as a response to its consequences, other theorists focused on the stutterer's feelings about his speech. Sheehan (1958) applied an earlier concept of approach-avoidance learning to stuttering. The stutterer, according to Sheehan, could speak at the risk of the shame and guilt his speech causes him, or remain silent and suffer the frustration of being unable to communicate his thoughts. In addition to the learning perspective view of stuttering as a conditioned reaction, the psychological perspective of Sheehan also dealt with the emotionality of the stutterer. Other theorists (Coriat, 1931; Fenichel, 1945; Glauber, 1958; Barbara,
1946) spoke of internal conflict between id and superego or fixations at either the oral or anal stage. These earlier views have been largely discarded, and more recent writers have focused on the attitudes of the stutterer to implicate psychodynamics in the phenomenology of stuttering. Erickson (1969) derived a scale of communication attitudes which differentiated stutterers from nonstutterers based on the degree of difference in attitudes between the two groups. Andrews and Cutler (1974), using an adaptation of the Erickson scale, found that the lack of normalization of stutterers' attitudes after therapy may affect their long-term maintenance of fluency. Guitar and Bass (1978) also used adaptations of Erickson's scale in a follow-up study of posttherapy attitudes, and found that the stutterers whose attitudes concerning speech had not been normalized were more frequently disfluent one year post therapy. The findings of these studies indicate that the stutterer's attitudes concerning speech are an important component of disfluency. However, attitudes cannot be considered as a sole causal component. Rather, they might be viewed as significant conditions associated with the breakdown of speech.

While traditional psychological paradigms focused on the stutterer's individual reaction to his speech, recent
theorists have placed more emphasis on the interaction of psychological with social variables.

**Psychosocial Perspectives**

The development of the diagnosogenic, semantogenic, and interaction hypotheses of Johnson (1955) typify an environmental emphasis. Johnson suggested that children's speech is initially characterized by normal disfluencies, and that the development of a stuttering problem resulted from inappropriate interactions between the parent and child. Johnson implied that parents used evaluative judgments of disfluency as a basis for reaction. This reaction, often culminating in a parental diagnosis of stuttering, was described as the critical causal factor in the onset and development of stuttering. Johnson observed that:

1. Practically every case of stuttering was originally diagnosed as such not by a speech expert, but by a layman – usually one or both of the child's parents.
2. What these laymen had diagnosed as stuttering was, by and large, indistinguishable from the hesitations and repetitions known to be characteristic of the normal speech of young children.
3. Stuttering...as a definitive disorder was found to occur not before being diagnosed, but after being diagnosed.

In Johnson's diagnosogenic view, the label applied to the child caused the child's abnormal speaking
behavior because the child was responding and reacting emotionally to the parent's worries, anxieties, and pressures. It may be that Johnson's observations were critically important. However, it is also quite possible that the import of parent reactions is varied depending on specific characteristics of the child's motoric, linguistic, perceptual, and emotional abilities at any given time or under certain specific environmental conditions.

Bloodstein's (1958) view was similar to Johnson's. Bloodstein suggested that those disfluencies first identified as stuttering began as responses of tension and fragmentation which were initially identified as normal disfluency, and later developed into stuttering because of continued or severe communication failure in pressured communicative situations. Cleazy (1978) designed a program for the modification of the parent-child social and verbal interaction based on Johnson's and Bloodstein's contention and further suggested that psychological or behavioral parental characteristics may have a profound global effect on even an infant's behavior.

Given the implications of parent-child interactions as discussed by Johnson (1955), Gregory (1974) and Gregory and Hill (1980) in the onset and development of
stuttering, Brown (1970), Retherford, Schwartz, and Chapman, (1980), and Ervin (1964) speculated that certain parent speech characteristics and speech or nonspeech models may be correlated with different levels of fluency or speech competency in children. While the speculations of these psychosocial researchers suggest that the interactions of parents and children may be critically related to the onset of disfluent speech, no definitive evidence has been gathered which specifies those critical interaction variables involved, or the impact of those variables which may be important in the development of stuttering.

Frequent reference has been made to other specific listener characteristics during verbal interaction (Williams and Kent, 1958) and to speaker and listener emotionality (Goldman-Eisler, 1958, 1961a, 1961b) as concomitants of stuttering in children. A common factor which is implicit in speech, and which is often described by clients, parents, and clinicians as a "potentially important speech variable" at speech initiation is perceived effort level, as manifested by muscle tension, force, or anxiety of the child during communicative attempts. Less obvious in the literature is discussion of the child's perception of the other speakers, perceptions of more subtle verbal and nonverbal
characteristics, or perceptions of differing environmental settings. As the child's effort level increases, or as his perception of the speech or emotional characteristics of the listener or situation changes, it is possible that the number of disfluencies increases (Adams, 1980). However, while each of these variables may be pertinent to the understanding of speech breakdown, their relevance has not been adequately determined. Our failure to determine their relevance may be related, in part, to our inability to define which constructs and variables may be relevant for a particular person, at a particular time, in a particular situation, and at a particular stage of language development. At a psychological or linguistic level, perceptions of the prosodic variables or listener verbal or nonverbal behaviors may be relevant. At the speech production level, perceptions of "effort level," speech rate, length of utterance, and other physical elements may be intimately related to alterations of the child's speech-motor patterns. Failure to establish the critical variable may be related to a lack of consideration of each variable as a part of a dynamic interaction of variables rather than as a variable which has some discrete causal relevance. Considered as an isolated discrete event, any of the variables discussed
in the preceding review may be meaningless.

Statement of the Problem

In light of the need for a unified perspective which has been stressed by recent writers (Zimmermann, 1980; Zimmermann, Smith, and Hanley, 1981; Hanley, 1982), and which is based on the interaction of various types of variables and their effects on speech motor control, it seems reasonable to assume that a more ecological perspective of stuttering may provide a reasonable model for descriptive research on stuttering in four to eight year old children. Such descriptive research does not propose to search for yet another causal factor in the onset and development of stuttering. Rather, it intends to describe variables or patterns of variables which are potentially relevant for individual disfluent children while they engage in verbal interaction with their parents. These variables may represent significant conditions associated with fluency or speech breakdown for a particular child, and thus may lead to increased understanding of organismic/environmental interactions related to speech motor breakdown and to the development of more efficient therapeutic strategies to manage fluency disorders.

Research has established the interrelationship of
rhythmicity variables for a number of motor tasks. Various studies (including Zaleski, 1965; Starkweather, Franklin, and Smigo, 1981; Kelso, Tuller, and Harris, 1983) have demonstrated correlations between finger tapping and speech motor movement. Kelso, Tuller, and Harris, (1983) suggested that patterns of background neural activity were correlated with measures of rhythmicity and rate. Kelso et al. explained that the frequency of neuronal firing may be controlled by a central process. The central process may control a system of coupled oscillators engaged in performing seemingly unrelated activities (e.g., tapping and speech) simultaneously, or at ratio-related cycles. Thus, rhythmicity was shown to operate at low-integer sub- or superharmonics among anatomical and physiological systems that share little or no apparent common structural similarity. For example, when subjects were asked to speak at a different rate from their preferred finger tapping rate, they did so by establishing syllable to tapping ratios such as 2:1 or 3:1. Rate of tapping was similarly implicated as an associated condition emerging from critical neural coordination patterns. The organism performs most efficiently at an optimal rate, or "resonant" rhythmicity, concordant with the biomechanical constraints of his/her individual system (Kelso, Tuller,
and Harris, 1983). Therefore, if a child attempts to imitate a rate or rhythmicity which is discordant with his/her optimal level, he/she may be inducing a coordinative condition which promotes breakdown.

Effort level was also considered to be of potential import as an individual characteristic related to optimum movement control of the organism. Kelso observed that as the subject's perception of effort level during interaction increased, or as a situation became more stressful to the individual, a point of system "overload" was concurrently observed in the speaker, and a malfunction or change in coordinative patterns ensued.

The preceding discussion suggests that variables which are perceptually relevant for the child, especially those motor, linguistic, and individual nonverbal communicative behaviors, must be considered. What one child may see as perceptually relevant at a particular time, in a particular situation, may be of no importance to another child in a different situation. Thus, the perception of rhythmicity, rate, and effort level, as well as the performance described with these variables may possibly be implicated in speech motor breakdown and may provide correlative evidence of significant conditions underlying speech motor breakdown. However, these conditions may not express themselves as group
characteristics. Thus, it was hypothesized that the
design of experimental procedures to determine the
existence of such variables should be of a descriptive
rather than an inferential nature at this point.

The present study was designed to ask several
questions with regard to four to eight year old children.
For each child:

1. are the mean interval durations of tapping and
   of speech individual in nature;
2. are the ranges of tapping and of speech mean
   interval durations across rate conditions
   individual in nature;
3. are low integer sub- or superharmonic interval
   ratios established from tapping to speech when
   tapping and speech mean interval durations are
   compared at slow, at comfortable, and at fast
   rate conditions;
4. are the mean interval durations, harmonic
   ratios between intervals, and ranges of
   interval durations comparable to those of other
   children, of the child's parent, and of other
   parents;
5. are the perceptual ratings of spontaneous
   speech rate and effort level similar to those
   of other children and parents;
6. are the graduate students' perceptual ratings of spontaneous speech rate and effort level comparable to those of the children and parents in this study?
CHAPTER II

PROCEDURES

Speakers

The participants in this study were stuttering and nonstuttering children, their mothers, and a group of graduate students.

Children

Seven children, aged four years, three months to eight years, two months (mean age five years, five months) were selected for participation in this study. Three of the children were chosen because they were considered normal speakers by their parents and by a certified speech/language pathologist. The other four children were selected from a group of children who had been diagnosed as having fluency problems following referral by their parents to a speech and hearing clinic. Each "stutterer" was judged by two speech/language pathologists to be in the mild to moderate range of severity. Screening procedures were used to insure that all subjects had normal hearing, speech articulation, history of language development, and voice quality.
Stuttering children were coded S0_C for the present study, and nonstuttering children were coded NO_C.

Parents

The mother of each subject (N=6) also participated in the study. One parent was the mother of two of the participating children. Thus, data are presented for seven children and six parents throughout the study. Parents were also screened to insure that hearing and speech articulation were within normal limits.

Graduate Students

Graduate students (N=9) studying Speech/Language Pathology served as judges in the investigation. All judges had acquired clinical experience working with stutterers and had completed at least one course in stuttering.

Experimental Procedures

Three experimental procedures were implemented for the present study: a finger tapping procedure, a syllable repetition task, and a parent/child interactive speaking session. The finger tapping and syllable repetition tasks were used to estimate rhythmicity across speech rates. The speech interaction sessions were
videorecorded for later use as stimuli for the perceptual portion of the experiment.

Preliminary Procedures

Prior to the experiment, each parent was asked to review and sign an Instructions for Speakers Form (Appendix A), and an Informed Consent Release Form (Appendix B). The experimenter also provided verbal instructions prior to each portion of the experiment. After the verbal instructions were given, each parent was asked to remain in an outer room while her child entered the recording room. The investigator spoke with the child about hobbies, friends, etc., in order to determine that the child's language development was sufficient for the experiment. Afterwards, the child was shown six plastic doughnut shapes, arranged according to size. The child was asked to study the size and arrangement of the shapes. Then the subject was asked to hide his/her eyes while the experimenter removed one of the doughnuts. The child was asked to determine which of the shapes had been removed by stating the number of the shape. This simple test was performed three times in order to increase the likelihood that the child would be able to generalize from six degrees of size to six degrees of magnitude during the perceptual portion of the experiment.
Recording of Tapping and Speech Samples

Upon completion of the preliminary tests, each child was instructed to tap on a plastic surface for approximately 30 seconds at a "comfortable" rate. The child was instructed when to start tapping and when to stop tapping. The taps were converted to electric pulses and stored on magnetic tape. The "comfortable" tapping condition was followed by a 30 second "slow" tapping condition, and then by a 30 second "fast" tapping condition. It was originally intended to determine a reasonable number of 30 second production measures which could be expected of each child. Perusal of pilot data revealed that the children became fatigued and very inconsistent as the duration of the session progressed. Therefore, while measures of reliability for the tapping and speech interval data may have been sacrificed, the children were able to complete the experiment with minimum fatigue and stress. Responses were evaluated by the experimenter and by an independent judge to be consistent and valid.

After the tapping activities were completed, each child was instructed to repeatedly produce the consonant-vowel-consonant (CVC) syllable /pæt/ for 30 seconds at a "comfortable" rate. Again, the child was instructed when to start speaking and when to stop speaking. These CVC
syllable productions were audiotaped. The "comfortable" syllable rate condition was followed by a 30 second "slow" syllable rate condition, and then a 30 second "fast" syllable rate condition.

When each child completed the tapping and speech sections of the experiment, his/her mother was asked to enter the recording room. The child was permitted to play in the outer room, or stay with his/her mother during her production session.

Following directions similar to those given the child, each mother was instructed to tap on the plastic surface for 30 seconds at a "comfortable" rate, then for 30 seconds at a "slow" rate, and then for 30 seconds at a "fast" rate. Again, the subjects were instructed when to start tapping and when to stop tapping.

Following the tapping procedures, each mother was instructed to repeatedly produce the CVC syllable /pæt/ for 30 seconds at a "comfortable" rate, then for 30 seconds at a "slow" rate, then for 30 seconds at a "fast" rate. These CVC syllable productions were also audiotaped.

No experimenter models were presented to any of the subjects as antecedents for the tapping and syllable conditions. Thus, each participant determined his/her response patterns independently.
Recording of Spontaneous Samples

Following the tapping and speech production tasks, each child and his/her parent were taken to a small room equipped with videotape cameras. Equipment was controlled from an adjacent room. The parent/child pair was asked to sit at a table and to talk together for a period of not more than 30 minutes. A set of ten pictures was presented by each mother to help elicit spontaneous speech from the child. The pictures were selected to present a variety of thematic complexities (e.g. object description versus activity description) in order to enhance the likelihood that linguistic formulation might vary during the speech interaction session. Any correlations of dependent variables (i.e. perceived spontaneous speech rate and effort level) across communicative conditions of varied complexity might suggest critical variables underpinning those patterns which are conducive to fluency or speech motor breakdown.

Each child was instructed by his/her mother to "Tell a story about this picture." If the child was hesitant or reluctant to speak, his/her parent would say, "Tell me more about this picture." When each child/parent pair completed the picture description task, the parent attempted to engage the child in discussion about one of
several topics familiar to the child (e.g. going to the circus, going to the movies, watching a favorite cartoon). This speaking alternative was presented to further increase the likelihood that linguistic complexity might be altered to provide a different set of communicative circumstances.

During the parent/child speech interaction session, no other attempt was made by the investigator to control or manipulate the type or amount of communication which would take place. Any such manipulations might have imposed experimental limitation or alteration of the motoric events related to the child's speech.

Procedures for Rating Videotaped Speech Samples

The second experimental session for each child/parent pair was the perceptual portion of the experiment. During this session, each child was instructed to view segments of randomized videotaped samples of each participating parent and child, including his/her own sample. Each sample of spontaneous speech was approximately 15 to 30 seconds in duration. All perceptual ratings were made by comparison of samples to a standard referent, a videotaped sample of an adult female producing four spontaneous sentences. The child, serving as a judge, was instructed to rate the videotaped
sample of the subject on four perceptual continua: slow versus fast rate of speech; relaxed versus tense; comfortable versus uncomfortable; and effortless versus effortful. Ratings were made using a 1 (low) to 6 (high) scale for each of the above perceptual continua.

Upon entering the room, each child was instructed to sit at a table positioned so that two video monitors were visible. The child was provided with a response sheet for each subject he/she viewed (See Appendix C). The experimenter presented the referent speech sample to the child, and asked the child to pay attention to how the referent looked and sounded. Then the child was presented with a section of a videotaped interaction of a parent and child engaged in verbal interaction. The child was instructed to look and listen to the parent in the tape. Afterwards, the experimenter asked the child to tell whether the mother was faster or slower than the referent. When the child responded, the experimenter wrote a check mark on the appropriate line ("faster"-"slower") of the child's response sheet. Then the experimenter asked the child whether the mother was a little slower/faster, somewhat slower/faster, or very much slower/faster than the referent. The experimenter pointed to six different circles on the response sheet as the question of degree was addressed. When the child
decided on the appropriate degree, the child placed a glue-on cartoon character on the circle chosen. Next, the experimenter asked the child whether the mother was more relaxed than the referent or more tense than the referent. Again, the child first made the dichotomous decision, then the decision regarding degree. Third, the child made a similar decision based on comfortability. The phrases "Like she is sitting on a rock" or "Like she is sitting on a pillow" were used as descriptors of uncomfortable/comfortable. The last decision for each view was based on whether the mother was more effortless or more effortful than the referent. The phrases "Harder for the mother to talk" or "Easier for the mother to talk" were used as descriptors of effortless/effortful. These descriptors of comfortability and effort were used to enhance the likelihood that they would be more cognitively relevant for the children.

When the child completed the comparison of the mother to the referent, the child was again shown the referent, then the videotaped segment. The child was then asked to rate the child's speech as presented in that sample. After the child had completed the response sheets of a child/parent pair, the child continued to view each videotaped segment of child/parent pairs in the order described above. The session concluded with the
child viewing his/her mother, and then him/herself, making similar comparisons.

When the child had made perceptual ratings of every subject (N=13), his/her mother was instructed to enter the room. The mother was given the same instructions as her child and was asked to make perceptual ratings by writing check marks in the appropriate spaces. The mother was told of the descriptors used with her child to insure that consistent directions were provided.

A group of nine graduate students also participated in the perceptual portion of the experiment during a different session. The graduate students viewed the referent, then the mother or child, and then made their independent perceptual estimations on the response sheets provided. The same order of presentation was followed for children, parents, and graduate students.

Dependent Variables

The dependent variables chosen for this study were mean interval duration for tapping and syllable repetition and perceptual ratings of speech rate and effort level. These variables were chosen in light of the recent research suggesting a correlation among alterations in background neural activity and movement coordination with measures of speech rate, perceived
effort level, and tapping patterns as estimates of rhythmicity (Kelso, Tuller, and Harris, 1983).

Estimates of Rhythmicity

To estimate a rhythmicity referent for tapping, the tapping samples from each child and each parent were recorded and analyzed to determine the mean interval duration (in milliseconds) between successive tapping onsets, and the variability of those tapping interval durations for each subject.

Similarly, a speech rhythmicity estimate was obtained for each child and each parent from samples of CVC syllable productions to determine the mean interval duration (in milliseconds) between successive bursts of initial plosive energy for CVC syllable productions and the variability of speaking "rhythmicity" intervals for each subject.

Comparisons were used to describe similarities of the means and variability of measures between tapping and speech, and between parent and child.

Mean Interval Durations

Measures of interval durations (mean interval duration in milliseconds between successive tapping or speech gestures) were similarly obtained for each child.
and each parent from the tapping and CVC syllable productions. Comparisons were used to describe similarities of the mean tapping and syllable interval durations and the variability of those interval durations. Parent interval durations and child interval durations for tapping and for speech were compared within and between subjects.

**Perceived Effort Level**

Based on the preceding review, it is assumed that children may perceive different environmental events individually. The work of Johnson (1959) and other descriptive reports (e.g. Bloodstein, 1975) suggests that parents are often described as "effortful." These findings, taken in context with the work of Kelso, Tuller, and Harris (1983), suggest that children's perceptions of communicative phenomena as effortful or stressful should be described.

Measures of perceived effort level were obtained by the students', the children's, and the mothers' evaluations of randomized videotaped samples of "fluent" and "disfluent" children and their parents. Evaluations were based on a scale of 1 (low) to 6 (high) for estimates of "rate," "tenseness," "comfortability," and "effort." These perceptual ratings were compared to
sylable and tapping interval duration measures previously gathered from each parent and each child.

Apparatus

Tapping Equipment

A transient motion detector was constructed to transduce the children's and parents' finger taps to an equivalent electrical voltage. This device consisted of a piezoelectric transducer affixed to the underside of a semi-rigid plastic plate, on which each subject tapped. No attempt was made to determine the latent period for this investigation, since piezoelectric transducers are generally responsive within one millisecond. Tapping and syllable signals were fed into a Challenger Mixer (Model MX 6). The output of the mixer was interfaced with a Sony stereo tape recorder (Model TC-650), and the tape speed was adjusted to 19 centimeters per second.

Video Equipment

During the spontaneous interchange between children and parents, speech samples were recorded using a Videocorder (Model number AV-3600), a Magnavox monitor (Serial number 3913T141B), a Sony special effects generator (Model number SEG 1), and a Shure professional microphone mixer (Model number M-67). Three Sony video
cameras (Model number AVC-3202) were used interchangeably throughout the taped sessions. Audio output of this equipment was adjusted to approximate a 70 to 75 decibel sound intensity level at the listener's ear.

Mingograf Recorder

A Hewlett Packard mingograf recorder, with a 350D attenuator (set 5W-55V, 600 DCMC), was used to process the audiotaped samples of tapping and speech for each subject. The paper speed was individually set at 25, 50, or 100 millimeters per second to promote ease of calculation of each subject's tapping or speech rate.

Data Reduction Procedures

Audiotaped samples of tapping and speech were processed through a mingograf recorder for analysis. Intervals between successive taps and CVC (intervals between successive syllable productions) were calculated for each subject. Means and standard deviations were derived within each condition ("comfortable," "fast"," and "slow"), for each measure (tapping and speech), and for each subject (child and parent). Inter- and intrajudge reliability of interval duration measurements indicated agreement to within three milliseconds in a randomly selected sample of 50 recordings. Portions of
each tapping and speech sample were purposely eliminated from analysis to enhance the likelihood that ongoing patterns of responses would be measured without the biases of starting and stopping. Additionally, comparisons of mingograph recordings and audiotaped samples were used to exclude perceptible inhalations from the data measured. The number of taps or syllable repetitions eliminated from the beginning and end of each sample varied. The criterion for elimination was the subjective estimation of the first evidence of tapping or speech stability. The experimenter and one independent judge were in perfect agreement on all segmentation decisions.
CHAPTER III

RESULTS

As stated in the previous chapter, the tapping and syllable repetition samples of the children and their mothers provided the raw data for the production portion of the experiment. The parent-child speech interaction samples were used as stimuli for the perception portion of the experiment. Children, mothers, and graduate student clinicians served as judges by recording their perceptual ratings of each subject on answer sheets (see Appendix C).

No attempt was made a priori to suggest that certain attributes of organismic and environmental conditions in this study would prove significant for any subject. Relationships of potential relevance were determined for each parent-child situation. Inter- and intra-subject descriptions and comparisons were completed for mean interval duration of tapping and of speech as estimates of rhythmicity. Similarly, children's, parents', and graduate students' perceptions of speech rate and effort level were analyzed.

From such analyses, results are presented in terms of both individual and group data for production
comparisons and perception comparisons. Since the intent of the present study was to describe individual data, those individual data are initially discussed in detail, and are subsequently summarized at the conclusion of the chapter.

Production Comparisons

**Tapping and Syllable Comparisons**

Mean interval durations were calculated for each subject for tapping and for syllable repetition at comfortable, fast, and slow rates (see Table 1). Mean ($\bar{X}$) durations of tapping and speech intervals were unique to each subject. As a matter of fact, an increase in duration (decrease in rate) was noted from a) slow to comfortable tapping in one nonstuttering child (NO1C), and in two stuttering children (S03C, S05C); b) from comfortable to fast tapping in one nonstuttering child (NO2C), and in two stuttering children (S02C, S03C); c) from slow to comfortable speech in one stuttering child (S05C); and d) from comfortable to fast speech in two stuttering children (S03C, 504C).

As a rule, on both tapping and syllable measures, all children (stutterers and nonstutterers) were faster (had smaller mean interval durations) than their parents in the slow and comfortable conditions but slower than
Table 1
Means (\(\bar{X}\)) and Standard Deviations (SD) of Interval Durations in Milliseconds at Slow (S), Comfortable (C), and Fast (F) Tapping and Syllable Repetition Rates for Each Subject.

<table>
<thead>
<tr>
<th></th>
<th>Tapping</th>
<th>Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>C</td>
<td>F</td>
</tr>
<tr>
<td>NO1C</td>
<td>(\bar{X}=410)</td>
<td>(\bar{X}=450)</td>
</tr>
<tr>
<td></td>
<td>SD=40</td>
<td>SD=40</td>
</tr>
<tr>
<td>NO1A</td>
<td>(\bar{X}=1400)</td>
<td>(\bar{X}=940)</td>
</tr>
<tr>
<td></td>
<td>SD=80</td>
<td>SD=40</td>
</tr>
<tr>
<td>NO2C</td>
<td>(\bar{X}=340)</td>
<td>(\bar{X}=270)</td>
</tr>
<tr>
<td></td>
<td>SD=40</td>
<td>SD=20</td>
</tr>
<tr>
<td>NO2A</td>
<td>(\bar{X}=1140)</td>
<td>(\bar{X}=710)</td>
</tr>
<tr>
<td></td>
<td>SD=120</td>
<td>SD=30</td>
</tr>
<tr>
<td>NO3C</td>
<td>(\bar{X}=900)</td>
<td>(\bar{X}=550)</td>
</tr>
<tr>
<td></td>
<td>SD=90</td>
<td>SD=110</td>
</tr>
<tr>
<td>NO3A</td>
<td>(\bar{X}=1510)</td>
<td>(\bar{X}=580)</td>
</tr>
<tr>
<td></td>
<td>SD=300</td>
<td>SD=20</td>
</tr>
<tr>
<td>S02C</td>
<td>(\bar{X}=730)</td>
<td>(\bar{X}=260)</td>
</tr>
<tr>
<td></td>
<td>SD=60</td>
<td>SD=20</td>
</tr>
<tr>
<td>S02A</td>
<td>(\bar{X}=1250)</td>
<td>(\bar{X}=730)</td>
</tr>
<tr>
<td></td>
<td>SD=60</td>
<td>SD=70</td>
</tr>
<tr>
<td>S03C</td>
<td>(\bar{X}=380)</td>
<td>(\bar{X}=390)</td>
</tr>
<tr>
<td></td>
<td>SD=40</td>
<td>SD=30</td>
</tr>
<tr>
<td>S03A</td>
<td>(\bar{X}=1110)</td>
<td>(\bar{X}=450)</td>
</tr>
<tr>
<td></td>
<td>SD=50</td>
<td>SD=30</td>
</tr>
<tr>
<td>S04C</td>
<td>(\bar{X}=330)</td>
<td>(\bar{X}=250)</td>
</tr>
<tr>
<td></td>
<td>SD=20</td>
<td>SD=20</td>
</tr>
<tr>
<td>S05C</td>
<td>(\bar{X}=330)</td>
<td>(\bar{X}=390)</td>
</tr>
<tr>
<td></td>
<td>SD=10</td>
<td>SD=30</td>
</tr>
<tr>
<td>S04-5A</td>
<td>(\bar{X}=250)</td>
<td>(\bar{X}=250)</td>
</tr>
<tr>
<td></td>
<td>SD=20</td>
<td>SD=20</td>
</tr>
</tbody>
</table>

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their parents in the fast conditions. Inconsistencies were noted in eleven out of the forty-two comparisons of cases. That is, one nonstuttering child (N02C) and one stuttering child (S03C) were slower than their parents in the comfortable speech condition; one stuttering child (S02C) and his parent had equal rates in the fast speech condition; one stuttering child (S04C) was slower than his parent in the slow speech condition, equal to his parent in the comfortable tapping condition, and faster than his parent in the fast tapping condition; and one stuttering child (S05C) was slower than her parent in the slow and comfortable tapping conditions and in the comfortable and fast speech conditions, but faster in the fast tapping condition.

Standard deviations were also calculated for each subject for tapping and speech, at comfortable, fast and slow rates (Table 1). The relationships of the standard deviations and absolute magnitude of mean interval durations were not formally evaluated in this study. However, the need for post hoc analysis of these relationships is indicated. Cursory examination of variability of tapping measures for individual children showed that children were consistent across conditions. For example, N01C showed calculated standard deviations ranging from 20 milliseconds at "fast" tapping and
speech, to 40 milliseconds at "slow" and "comfortable" tapping. There were two exceptions, a nonstuttering child (N03C) and a stuttering child (S02C). Variability of speech measures for children seemed generally inconsistent across conditions with the exceptions of two nonstuttering children (N01C, N03C) and one stuttering child (S04C). Variability of parents seemed inconsistent across conditions for tapping and for speech, with the exception of one subject. Again, however, variability was not formally evaluated in this study.

Rhythmicity ratios based on comparisons of tapping and syllable rates were estimated for each subject. To study these relationships, mean interval durations for tapping and for speech at each condition were placed side by side as shown in Table 2. The experimenter and an independent judge agreed that the subjects showed low-integer relationships from tapping to speech. For example, NO1C's mean interval duration for slow tapping of 410 milliseconds was compared to his mean interval duration for slow speech of 400 milliseconds. The rhythmic relationship of 1:1 between tapping and speech rates was determined. Every subject showed low-integer ratios from tapping to speech (e.g. 1:1, 2:3, 1:2, 2:5, and 1:3, as shown in Table 2). One child (N03C) and two parents (N01A, N02A) showed a ratio of 3:2 from tapping.
Table 2
Approximate Ratio Relationships of Mean Interval Durations Between Tapping and Speech for Each Subject At Slow, Comfortable, and Fast Rates

<table>
<thead>
<tr>
<th>Subject</th>
<th>Condition</th>
<th>Ratio</th>
<th>Means-Tapping</th>
<th>Means-Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01C</td>
<td>Slow</td>
<td>1:1</td>
<td>410</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>1:1</td>
<td>450</td>
<td>340</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:1</td>
<td>300</td>
<td>280</td>
</tr>
<tr>
<td>N02C</td>
<td>Slow</td>
<td>1:3</td>
<td>340</td>
<td>1070</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>1:3</td>
<td>270</td>
<td>920</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>2:5</td>
<td>320</td>
<td>810</td>
</tr>
<tr>
<td>N03C</td>
<td>Slow</td>
<td>3:2</td>
<td>900</td>
<td>640</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>1:1</td>
<td>550</td>
<td>570</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:1</td>
<td>500</td>
<td>550</td>
</tr>
<tr>
<td>S02C</td>
<td>Slow</td>
<td>2:3</td>
<td>730</td>
<td>1140</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>1:2</td>
<td>260</td>
<td>630</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:1</td>
<td>270</td>
<td>270</td>
</tr>
<tr>
<td>S03C</td>
<td>Slow</td>
<td>1:3</td>
<td>380</td>
<td>1070</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>1:2</td>
<td>390</td>
<td>770</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:2</td>
<td>330</td>
<td>930</td>
</tr>
<tr>
<td>S04C</td>
<td>Slow</td>
<td>2:5</td>
<td>330</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>2:3</td>
<td>250</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:2</td>
<td>220</td>
<td>450</td>
</tr>
<tr>
<td>S05C</td>
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<td>1:2</td>
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<td>560</td>
</tr>
<tr>
<td></td>
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<td>2:3</td>
<td>390</td>
<td>570</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
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<td>170</td>
<td>540</td>
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<tr>
<td>N01A</td>
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<td>1260</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>3:2</td>
<td>940</td>
<td>650</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>2:3</td>
<td>180</td>
<td>250</td>
</tr>
<tr>
<td>N02A</td>
<td>Slow</td>
<td>1:1</td>
<td>1140</td>
<td>1310</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>3:2</td>
<td>710</td>
<td>470</td>
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<tr>
<td></td>
<td>Fast</td>
<td>1:1</td>
<td>220</td>
<td>200</td>
</tr>
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<td>1:1</td>
<td>1510</td>
<td>1600</td>
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<td>Comfortable</td>
<td>1:2</td>
<td>580</td>
<td>970</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>2:3</td>
<td>200</td>
<td>280</td>
</tr>
<tr>
<td>S02A</td>
<td>Slow</td>
<td>2:3</td>
<td>1250</td>
<td>2040</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>2:3</td>
<td>730</td>
<td>1180</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:1</td>
<td>240</td>
<td>270</td>
</tr>
<tr>
<td>S03A</td>
<td>Slow</td>
<td>1:1</td>
<td>1110</td>
<td>1340</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>1:2</td>
<td>450</td>
<td>740</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:1</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>S04-5A</td>
<td>Slow</td>
<td>1:3</td>
<td>250</td>
<td>660</td>
</tr>
<tr>
<td></td>
<td>Comfortable</td>
<td>1:2</td>
<td>250</td>
<td>510</td>
</tr>
<tr>
<td></td>
<td>Fast</td>
<td>1:1</td>
<td>240</td>
<td>250</td>
</tr>
</tbody>
</table>
to speech, indicating that the direction of the ratio relationship was different.

**Group Data Results**

When standard deviations were compared on a group basis, cursory examination showed stuttering children were more consistent across conditions for both tapping and speech than were nonstuttering children. Examination of individual standard deviations of mothers of stuttering children suggested that they may be more variable than mothers of nonstutterers for the slow syllable rate, but the groups may be similar in variability for comfortable and fast syllable rates. Variability measures for mothers may be more inconsistent across tapping rates than across syllable rates. Parents of stutterers may be less variable than parents of nonstutterers on slow tapping measures.

The difference in milliseconds between the longest and shortest duration for each task was calculated for each subject. The resultant ranges of interval duration are presented in Table 3. Stuttering children showed a greater range of interval durations for speech across conditions than did nonstuttering children. Differences between child groups were not substantial for tapping. Parents of stuttering children showed smaller ranges of
Table 3
Ranges (milliseconds) of Mean Interval Duration from Slow to Fast for Tapping and speech for Each Subject.

<table>
<thead>
<tr>
<th></th>
<th>Tapping</th>
<th>Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) N01A</td>
<td>1220</td>
<td>1010</td>
</tr>
<tr>
<td>a) N02A</td>
<td>920</td>
<td>1110</td>
</tr>
<tr>
<td>a) N03A</td>
<td>1310</td>
<td>1320</td>
</tr>
<tr>
<td>b) S02A</td>
<td>1010</td>
<td>1770</td>
</tr>
<tr>
<td>b) S03A</td>
<td>930</td>
<td>1100</td>
</tr>
<tr>
<td>b) S045A</td>
<td>10</td>
<td>410</td>
</tr>
<tr>
<td>c) N01C</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>c) N02C</td>
<td>70</td>
<td>260</td>
</tr>
<tr>
<td>c) N03C</td>
<td>400</td>
<td>90</td>
</tr>
<tr>
<td>d) S02C</td>
<td>470</td>
<td>870</td>
</tr>
<tr>
<td>d) S03C</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>d) S04C</td>
<td>110</td>
<td>390</td>
</tr>
<tr>
<td>d) S05C</td>
<td>220</td>
<td>30</td>
</tr>
</tbody>
</table>

a) Parents - Nonstuttering  
b) Parents - Stuttering  
c) Children - Nonstuttering  
d) Children - Stuttering
interval durations for tapping than did parents of nonstuttering children. Differences between parent groups were not substantial for speech.

Tapping and speech mean interval durations were compared within conditions (Table 4). A positive (+) sign indicates an increase in mean interval duration (decrease in rate) from tapping to speech. The Wilcoxon Sign test, which was significant at the .005 level of uncertainty, suggested that stuttering children and their parents uniformly increased durations from tapping to speech for all conditions. Direction of interval duration for nonstuttering children and their parents showed no systematic trend for increment or decrement from tapping to speech (Table 5 and Table 6).

Perception Comparisons

As stated earlier, all perceptual ratings were made with reference to a standard video model.

Individual Data Results

When the children's perceptual ratings were analyzed, all children rated themselves faster than the referent. Three of the four stuttering children and one of the three nonstuttering children rated themselves as more tense. Three stuttering children and two nonstuttering children rated themselves as more
Table 4
Interval Duration Differences (in milliseconds) Between Tapping and Syllable Repetition Tasks (syllable interval minus tapping interval) at Each of Three Rates for Each Subject

For each child.

<table>
<thead>
<tr>
<th></th>
<th>Slow</th>
<th>Comfortable</th>
<th>Fast</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01C</td>
<td>-10</td>
<td>-110</td>
<td>-20</td>
</tr>
<tr>
<td>N02C</td>
<td>+730</td>
<td>+650</td>
<td>+490</td>
</tr>
<tr>
<td>N03C</td>
<td>-260</td>
<td>+20</td>
<td>+50</td>
</tr>
<tr>
<td>S02C</td>
<td>+410</td>
<td>+370</td>
<td>0</td>
</tr>
<tr>
<td>S03C</td>
<td>+690</td>
<td>+380</td>
<td>+500</td>
</tr>
<tr>
<td>S04C</td>
<td>+470</td>
<td>+160</td>
<td>+230</td>
</tr>
<tr>
<td>S05C</td>
<td>+230</td>
<td>+180</td>
<td>+370</td>
</tr>
</tbody>
</table>

For each Parent.

<table>
<thead>
<tr>
<th></th>
<th>Slow</th>
<th>Comfortable</th>
<th>Fast</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01A</td>
<td>-140</td>
<td>-290</td>
<td>+70</td>
</tr>
<tr>
<td>N02A</td>
<td>+170</td>
<td>-240</td>
<td>-20</td>
</tr>
<tr>
<td>N03A</td>
<td>+90</td>
<td>+390</td>
<td>+80</td>
</tr>
<tr>
<td>S02A</td>
<td>+790</td>
<td>+450</td>
<td>+30</td>
</tr>
<tr>
<td>S03A</td>
<td>+230</td>
<td>+290</td>
<td>+60</td>
</tr>
<tr>
<td>S045A</td>
<td>+410</td>
<td>+260</td>
<td>+10</td>
</tr>
</tbody>
</table>
Table 5
Wilcoxon Sign Test of Direction Change of Tapping Versus Speech Interval Durations for Children.

<table>
<thead>
<tr>
<th>NONSTUTTERING CHILDREN</th>
<th>SLOW</th>
<th>COMF</th>
<th>FAST</th>
<th>NONSTUTTERING CHILDREN</th>
<th>SLOW</th>
<th>COMF</th>
<th>FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01C</td>
<td>-10</td>
<td>-110</td>
<td>-20</td>
<td>S02C</td>
<td>+410</td>
<td>+370</td>
<td>0</td>
</tr>
<tr>
<td>SLOW</td>
<td>1</td>
<td>4</td>
<td>2.5</td>
<td>COMF</td>
<td>6</td>
<td>4.5</td>
<td>-</td>
</tr>
<tr>
<td>COMF</td>
<td>4</td>
<td>2.5</td>
<td>4.5</td>
<td>FAST</td>
<td>5</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>FAST</td>
<td>2.5</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N02C</td>
<td>+730</td>
<td>+650</td>
<td>+490</td>
<td>S03C</td>
<td>+690</td>
<td>+380</td>
<td>+500</td>
</tr>
<tr>
<td>SLOW</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>COMF</td>
<td>9</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>COMF</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>FAST</td>
<td>9</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>FAST</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N03C</td>
<td>-260</td>
<td>+20</td>
<td>+50</td>
<td>S04C</td>
<td>+470</td>
<td>+160</td>
<td>+370</td>
</tr>
<tr>
<td>SLOW</td>
<td>5</td>
<td>2.5</td>
<td>3</td>
<td>COMF</td>
<td>7</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>COMF</td>
<td>2.5</td>
<td>3</td>
<td>-</td>
<td>FAST</td>
<td>7</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>FAST</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN RANK OF (-)</td>
<td>12.5</td>
<td>5</td>
<td>3.5</td>
<td>S05C</td>
<td>0</td>
<td>54</td>
<td>0</td>
</tr>
<tr>
<td>DIFFERENCES = 12.5</td>
<td></td>
<td></td>
<td></td>
<td>COMF</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN RANK OF (+)</td>
<td>26.5</td>
<td>54</td>
<td>4.5</td>
<td>FAST</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIFFERENCES = 26.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIRECTION OF CHANGE IS</td>
<td></td>
<td></td>
<td></td>
<td>MEAN RANK OF (-)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOT SIGNIFICANT (P&lt;.05)</td>
<td></td>
<td></td>
<td></td>
<td>DIFFERENCES = 0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>MEAN RANK OF (+)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DIFFERENCES = 54</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>DIRECTION OF CHANGE IS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SIGNIFICANT (P&lt;.005)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6
Wilcoxon Sign Test of Direction of Change of Tapping Versus Speech Interval Durations for Parents.

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>DIFFERENCE</th>
<th>RANK</th>
<th>SUBJECT</th>
<th>DIFFERENCE</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01A</td>
<td></td>
<td></td>
<td>S02A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLOW</td>
<td>-140</td>
<td>5</td>
<td>SLOW</td>
<td>+790</td>
<td>9</td>
</tr>
<tr>
<td>COMF</td>
<td>-290</td>
<td>8</td>
<td>COMF</td>
<td>+450</td>
<td>8</td>
</tr>
<tr>
<td>FAST</td>
<td>+70</td>
<td>2</td>
<td>FAST</td>
<td>+30</td>
<td>2</td>
</tr>
<tr>
<td>N02A</td>
<td></td>
<td></td>
<td>S03A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLOW</td>
<td>+170</td>
<td>6</td>
<td>SLOW</td>
<td>+230</td>
<td>4</td>
</tr>
<tr>
<td>COMF</td>
<td>-240</td>
<td>7</td>
<td>COMF</td>
<td>+290</td>
<td>6</td>
</tr>
<tr>
<td>FAST</td>
<td>-20</td>
<td>1</td>
<td>FAST</td>
<td>+60</td>
<td>3</td>
</tr>
<tr>
<td>N03A</td>
<td></td>
<td></td>
<td>S045A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLOW</td>
<td>+90</td>
<td>4</td>
<td>SLOW</td>
<td>+410</td>
<td>7</td>
</tr>
<tr>
<td>COMF</td>
<td>+390</td>
<td>9</td>
<td>COMF</td>
<td>+260</td>
<td>5</td>
</tr>
<tr>
<td>FAST</td>
<td>+80</td>
<td>3</td>
<td>FAST</td>
<td>+10</td>
<td>1</td>
</tr>
</tbody>
</table>

MEAN RANK OF (−) DIFFERENCES = 21
MEAN RANK OF (+) DIFFERENCES = 24

DIRECTION OF CHANGE IS NOT SIGNIFICANT (P<.05)
DIRECTION OF CHANGE IS SIGNIFICANT (P<.005)
uncomfortable. Three stuttering children and all three nonstuttering children rated themselves as less effortful.

All parents rated themselves as faster, more tense, and more uncomfortable than the model. No trends were noted for effort.

Differences in perceptual ratings between mothers and children were calculated to establish comparisons of agreement between parent and child ratings of each other (see Table 7 and Table 8). Parents and children were not in agreement on their perceptions of each other. Only one nonstuttering child-parent pair (N02C, N02A) and one stuttering child-parent pair (S04C, S045A) were in almost complete agreement with each other.

**Group Data Results**

When stuttering children and their parents were compared to nonstuttering children and their parents, it was observed that parents of stutterers rated their children as faster, more tense, more uncomfortable, and more effortful than the referent. Only one parent (S03A) rated her child as more comfortable than the referent. All parents of nonstutterers rated their children as faster and more comfortable than the referent. Two of the three parents of nonstutterers rated their children
Table 7
Comparison of Agreement (numerical difference between child's rating and parent's rating)
Regarding Perceptions of the Child's Rate, Tension, Comfort Level, and Effort

<table>
<thead>
<tr>
<th>Child</th>
<th>Rate</th>
<th>Tension</th>
<th>Comfort</th>
<th>Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01C</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>N02C</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>N03C</td>
<td>3</td>
<td>8</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>S02C</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>S03C</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>S04C</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>S05C</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 8
Comparison of Agreement (numerical difference between child's rating and parent's rating)
Regarding Perceptions of the Parent's Rate, Tension, Comfort Level, and Effort

<table>
<thead>
<tr>
<th>Parent</th>
<th>Rate</th>
<th>Tension</th>
<th>Comfort</th>
<th>Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>N01A</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>N02A</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>N03A</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>S02A</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>S03A</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>S04A</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S05A</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
as more relaxed and more effortful.

Three of the four stuttering children and two of the three nonstuttering children rated their parents as faster, more tense, more uncomfortable, and more effortless than the referent.

Graduate student ratings were compared to parents' and children's ratings of each other. Graduate clinicians agreed with parents' and children's ratings of each other as faster than the model in all but one case (N03A). Graduate clinicians disagreed with parent's and children's ratings of each other on: a) measures of tension with one exception (N03A); b) measures of comfortability with one exception (N01A); and c) measures of effort with three exceptions (N02A, S04C, S02A).

Summary

To summarize individual production comparisons, means for tapping and speech interval duration were unique for each subject. Most children were faster than their parents in the slow and comfortable tapping and syllable rates, but slower than their parents in the fast tapping and syllable conditions. For all children, cursory examination of standard deviations as measures of variability showed greater consistency in tapping than in syllable repetition.
When production data were compared across groups, stuttering children showed more consistency across rate conditions for both tapping and speech measures than did nonstuttering children. For all parents, tapping measures were more consistent than were syllable measures. As a group, stuttering children and their parents showed a greater range of syllable interval durations than of tapping interval durations. Similar trends were not found in nonstuttering children and their parents. Stuttering children and their parents uniformly showed increases in interval duration from tapping to speech in all rate conditions. No trend of increment or decrement of interval duration from tapping to speech was observed for nonstuttering children and their parents. Low integer sub- or superharmonics were observed from tapping to speech for all subjects. (For an abbreviated summary of production results, see Table 9.)

To summarize perception data, with reference to a standard video model, all mothers rated themselves as faster, tenser, and more uncomfortable than the referent. Parents of stutterers rated their children as faster, more tense, more uncomfortable, and more effortful than the referent. Parents of nonstutterers rated their children as faster and more comfortable than the referent. All children rated themselves as faster than
the referent. Mother ratings of children did not agree with self-ratings by the children, nor did child ratings of mothers agree with mothers' self ratings. In addition, graduate student clinicians agreed with parents' and children's ratings of each other on perceived rate of speech, but they disagreed with parents' and children's ratings of tension, comfortability, and effort. (For an abbreviated summary of perceptual results, see Table 10.)
Table 9

Summary of Group Trends

Production Comparisons

1. Means (X) for tapping and speech interval durations were unique for each subject.

2. Stuttering children and their parents uniformly showed increases in interval duration from tapping to speech in all rate conditions. No trend of increment or decrement of interval durations from tapping to speech was observed for nonstuttering children and their parents.

3. On both tapping and speech measures, children (stutterers and nonstutterers) tended to be faster than their parents in the slow and comfortable conditions, but slower than their parents in the fast condition.

4. For children, variability of tapping measures was consistent across rate conditions. Variability of speech measures was inconsistent across rate conditions.

5. Stuttering children were more consistent across rate conditions for both tapping and speech measures than were nonstuttering children. Parents showed more consistency for speech measures than tapping measures.

6. As a whole, stuttering children and their parents showed a greater range of speech intervals than tapping intervals. Similar trends were not found in nonstuttering children and their parents.
Table 10

Summary of Group Trends

Perception Comparisons
With reference to the standard video model:
1. All parents rated themselves as faster, tenser, and more uncomfortable. No trends were noted for perceptions of effort.
2. Parents of stutterers rated their children as faster, tenser, more uncomfortable, and more effortful.
3. All children rated themselves as faster.

Summary
-Parents and children were not in agreement on their perceptual ratings of each other.
-In addition, graduate student clinicians agreed with parents' and children's ratings of perceived rate of speech, but disagreed with their perceptions of tension, comfortability, and effort.
CHAPTER IV

DISCUSSION

When various production and perception comparisons were analyzed, many trends were established which were unique to each parent-child situation. The following discussion considers the theoretical and clinical implications of the measured variables of rhythmicity, rate, and perceived effort level.

Production Considerations

Rate of tapping and of speech was measured in terms of mean interval duration for comfortable, fast, and slow conditions. Similarly, variability of rate and range of mean interval change from slow to fast tapping and from slow to fast speech were determined. Mean intervals of tapping and speech were unique to each individual, as were ranges and variability of rate. In light of these observations, it seems appropriate to hypothesize that each individual operates at a rate which is emergent from his/her unique organismic characteristics, and which may be independent of optimal rates for other individuals. Given this observation, previous group findings that stutterers use inappropriate rate and inferences that
abnormal speech rate is a causal element in stuttering may be erroneous. Optimum rate, as with other other organismic and environmental factors, may be most appropriately considered as a motoric variable which, while subject to obvious mechanical constraints, is intimately integrated with other linguistic, psychological, emotional, and environmental inputs. If optimum rate is a subject-specific characteristic, it seems reasonable to assume that different thresholds of discoordination may characterize and affect individual systems in unique ways. Thus, what may be an appropriate rate for one individual may be inappropriate for another individual, thereby differentially promoting fluency or speech motor breakdown. Similarly, as suggested by Kelso, Tuller, and Harris, (1983) and others, rate and rhythmicity may be closely related as conditions which lawfully represent optimal or aberrant neurophysiological control mechanisms.

Rhythmicity was compared across modalities by comparison of tapping to speech mean interval duration within individuals under comfortable, fast, and slow conditions. All subjects appeared to establish "sub- or superharmonic ratios" (of tapping and speech intervals). These findings support earlier contentions (Kelso,
Tuller, and Harris, 1983) that rhythmicity may be systematically controlled across apparently unrelated systems within each organism. The contentions of von Holst (1927) and Kelso, Tuller, and Harris, (1983), that a substrate of the human movement system may be somewhat analogous to a system of coupled oscillators, is also supported by the observation of obvious ratio relationships of rhythmicities in this experiment. The eventual verification of the existence of such oscillators, however, must be established through careful, physiological descriptive study of individuals whether animal or human. Group comparisons would almost certainly obscure patterns which seem to be so unique in nature. In light of these contentions, it seems appropriate to consider speech rhythmicity as it relates to rate and stuttering from a descriptive, individual viewpoint.

Although effort level was not directly manipulated or measured as a production variable for the current study, recent literature (Kelso, Tuller, and Harris, 1983; Zimmermann, 1980) has implicated effort level as one kind of epiphenomenon which may reflect an extreme input of neural energies. If these energies exceed a certain threshold level, the stability of the motor
system may be affected. While the origin and loci of these inputs have not been established, it seems reasonable that they may reflect a number of alterations which may be physiological, psychological, emotional, or linguistic in nature. Thus, for example, if the organism reacts to a stressful speaking situation, or perceives a situation as stressful, there may be a "bombardment" of neuronal firing within the organism, possibly at a brainstem level. Again, considered as an individual characteristic, it seems reasonable to assume that effort, or its emergent muscle tension, may be due to overenergizing different neural and/or muscle systems. Each organism may operate at an optimal movement control energy threshold. When effort, as expressed by muscular tension, neuronal firing, etc., becomes too great, a point of overload may be reached, causing the system to malfunction or break down. While the physiological or environmental events underpinning extreme, maladaptive effort levels are undetermined, we must recognize that they may be influenced by other speakers in the communicative "niche." At early developmental stages, these "effortful" modes may reflect, in part, an imitation of the "effort" models which exist in the child's environment. Thus, the child's perception of
effort becomes a potentially significant process which may be related to the development of appropriate or inappropriate neurophysiological patterns.

Perception Considerations

Each child in the current study showed unique perceptions of effort level characteristic of his/her speech behavior, and of effort levels characteristic of different parents and for other children. Similarly, individual parents' and children's perceptions of effort level, when compared within and between subjects, were different from one another. Graduate clinicians' perceptual ratings were also discrepant with individual parents' and children's perceptions of effort level. Because perceptions of effort level were individual, it seems reasonable to hypothesize that perhaps the parent and child subjects possess perceptual mechanism(s) which may be inherently or developmentally different, and these perceptual characteristics may vary with the alteration of environmental, linguistic, or emotional conditions. Moreover, perception may be inherently or developmentally different in relation to a large number of communicative variables such as linguistic/phonemic variation, emotional affect, extraneous visual or auditory input,
etc. For example, although perceptions of effort level were discrepant, perceptions of subject speech rate among children, parents, and graduate students were consistent in almost every case. While relative rate may have been easier to judge than effort in the current study, it also seems possible that individual children may be more or less developmentally equipped to perceive and/or analyze rate, effort level, emotionality, affect of speakers, etc. If this were the case, then the variables which are "perceptually relevant" for communicative behavior would need to be determined from careful description of the individual and his/her communicative setting.

If modeling-imitation strategies are relevant for the development of communicative phenomena, then events related to speech rhythmicity, rate, and effort level may be perceived by children as relevant models. These models may lead to the development of behaviors or reactions which facilitate or limit the development or reestablishment of normal "modes" of production. To imitate or evaluate models, children must be able to differentially perceive those variables which are modeled. If a mismatch occurs between what the child perceives and what is being produced or modeled, or if the child is unable to perceive certain aspects of the model, the child may receive inappropriate environmental
cues as stimuli related to attempts to modify his/her speech behavior. Speech motor breakdown or increased probability of speech motor breakdown may increase. The child's speech model (i.e., clinician or parent) may fail to take into consideration such specific events and may attempt to modify other speaking behaviors of the child which are irrelevant. Again, an awareness of the child's perceptions may enhance the development of efficient management strategies. The awareness of the child's perceptions may be obtained using procedures such as those in the present experiment. Using similar methods, estimations of optimum rate may be gathered. Then the clinician may use modeling-imitation strategies to present the child with optimal rate examples.

A parent or clinician may perceive the parent's speech behavior (e.g., rhythmicity, rate, effort level) as extreme, and may choose to modify that behavior to develop a more "suitable" model. However, if the speech behavior is not perceptually relevant for the child, modifications of that speech behavior may be ineffective for that child. The relevance of such variation must be determined empirically. Similarly, the likelihood that a particular model will be of therapeutic benefit depends upon the degree to which the speech behavior is relevant for a child. If the appropriate model is provided, and
if the child chooses to imitate or is capable of imitating that model, then therapeutic benefit may be achieved.

If the child's fluency and/or speech breakdown is studied individually, described carefully, and viewed from each of the foregoing perspectives (physiological, psychological, language, psychosocial) as they relate to that child, the speech/language pathologist may be better able to target those components of disfluency which are perceptually relevant for the child.

Clinical Implications

As previously discussed, a priori determinations of relevant factors as important in stuttering may be erroneous at this point. Given the hypotheses of current researchers (e.g., Zimmermann, Smith, and Hanley, 1981; Kelso, Tuller, and Harris, 1983) and the hypotheses of the present study, the speech/language pathologist may be wise to employ descriptive measures in his/her assessment and management methods.

With regard to assessment, consideration of every relevant facet of the child's speech may be unattainable in one session, and may never be fully achieved. Unless the speech/language pathologist can ascertain those critical associated conditions of fluency or disfluency
for a particular child, therapy procedures which follow may be misdirected or inefficient. In light of the detailed description which may be necessary in each case, the speech/language pathologist needs to realize that assessment may not be accomplished in one isolated session, but may need to occur throughout the course of therapy, and in a number of different environmental settings.

During any assessment, speech motor breakdown may need to be viewed from each of the traditional perspectives, in varying degrees, as they relate to the speech motor breakdown of the individual child being assessed. Further, consideration of any variable as a discrete causal factor in a particular child's problem may be inappropriate, since the "ingredients" of breakdown for each child may involve a variety of emotional, linguistic, and environmental stimuli.

The hypothesis that a variety of organismic/environmental variables and a number of production-perception interactions are the underpinning of speech motor breakdown implies the need for descriptive methods in approaching a problem from a clinical management standpoint. The speech/language pathologist may need to understand that he/she cannot use one therapy approach for all clients with disfluencies,
since each client's speech motor breakdown may be generated or promoted by a variety of elements. Therefore, the speech/language pathologist must tailor each management system to the needs of each client.

Moreover, the speech/language pathologist may not be able to assume that the child perceives and/or is able to imitate those speech behaviors which the clinician attempts to modify. In order for the child to benefit from therapy techniques, the clinician may need to make modification procedures as relevant for the child as possible, and allow the child to provide input as to what is relevant for him/her.

As previously discussed, the outcomes of this experiment were generated from descriptive measures of a small number of subjects. No attempt was made to generalize any conclusions to stutterers or nonstutterers as members of groups. As the literature well reflects, the masses of data on stuttering are usually based upon group means. These data are almost always extremely variable, and they suggest a heterogeneity which is obscured by analysis of group data. The intent of this research was to generate hypotheses regarding variables which may or may not be pertinent to the description of speech motor breakdown for some individuals. The test of the validity of such observations may be best
accomplished by evaluating the clinical efficiency which results from the manipulation of variables such as those measured in this study.
CHAPTER V

SUMMARY AND CONCLUSIONS

Purpose

This study was designed to determine whether four to eight year old children differed a) among themselves with regard to interval durations as estimates of rhythmicity during production of tapping and speech samples at slow, comfortable, and fast rates; b) from their parents on these measures; c) from their parents and graduate clinicians with regard to perceptual ratings of speech rate, and speech effort level in each subject. Means of tapping and speech interval duration, and duration ranges were determined. Perceptual ratings of speech were compared within and between children, parents, and graduate clinicians.

Experimental Design

Speakers

Seven children, aged four years, three months to eight years, two months (mean age five years, five months), were selected for participation in this study of production and perception. Four of the children were
diagnosed as stutterers, and three of the children were judged to be normal speakers. The mother of each child also participated. Nine graduate students served as judges during the perception portion of the experiment.

**Dependent Variables**

The dependent variables chosen for this study were mean interval duration for tapping and speech and perceptual ratings of speech rate and effort level. These variables were chosen in light of recent research supporting a correlation of alterations in background neural activity and movement coordination with measures of tapping patterns as estimates of rhythmicity, speech rate, and perceived effort level (for example, Kelso, Tuller, and Harris, 1983).

**Procedures**

Three experimental procedures were implemented for the experiment: a finger tapping procedure; a speech repetition task; and a parent-child speech interaction session. The finger tapping and speech repetition measurements were used for the production estimates of rhythmicity and rate, and for the comparison of these measures within and between subjects. The speech interaction sessions were videotaped, and later used by
the children, parents, and graduate students to obtain perceptual ratings of rate, comfortability, tension, and effort.

Findings and Conclusions

Findings

The findings of this study provided answers to the experimental questions:

a) children's measures of rhythmicity and rate were individual with regard to mean interval duration, variability, and ranges across conditions of slow, comfortable, and fast;

b) children differed from their parents on these measures; and

c) children, parents, and graduate clinicians were discrepant in their perceptual ratings of rate and perceived effort level.

Conclusions

Results of this study indicated that reasonable hypotheses could be made with regard to fluency and speech motor breakdown. The individual nature of the children's and parents' tapping and speech mean interval durations, variabilities, and ranges suggests that the
individual may operate at a rate concordant with his/her own system. Similarly, rhythmicity measures and rate measures suggested that present modeling or imitation procedures used by clinicians and parents may be inappropriate if the child cannot perceive the behavior being manipulated, or cannot control that variable voluntarily.

Clinically, assessment and management techniques may be more efficient if the clinician considers each case individually, using a descriptive method, and without attempting to determine the nature of the problem a priori. The clinician may need to be flexible in his/her techniques, since each problem may have a variety of components in varying degrees.

This study was intended only to generate hypotheses about what factors may be perceptually relevant for the child who is beginning to stutter. Further manipulation of the variables of rhythmicity, rate, and perceived effort level, as well as manipulation of many other variables is needed before any conclusion with regard to their relevance can be determined.
APPENDICES
Appendix A

Instructions for Speakers

Parents

You are about to participate in a study of speech patterns of children and their parents during verbal interaction.

You will be asked to engage in a brief conversation with the investigator about your child's hobbies, past times, friends, or some similar topic.

You will then be asked to tap on a circuit board at a "comfortable" rate, then at a "fast" rate, then at a "slow" rate. The investigator will tell you when you should start and stop tapping. Afterwards, you will be asked to say simple words (e.g. pat, pat) at a comfortable, fast, and slow rate.

Your child will be asked to perform the above activities in a similar way.

You will then be asked to talk with your child for a period which will not exceed 1/2 hour. During this time, you will be provided with ten pictures to show your child. You should give your child instructions for each picture, such as, "Tell a story about what's happening in this picture". If your child is hesitant or reluctant to talk about a picture, you should encourage him/her to "tell me some more about this picture." Some of the pictures will be easy to describe and some will be difficult. When you and your child complete the picture activity, the investigator would like you to talk with your child about one of several topics that your child is familiar with (e.g. going to the circus, going to the movies, watching a favorite cartoon, or any topic which will help your child to do most of the talking).

Later, you will be shown some videotape recordings of mothers and children. The investigator will ask you questions about the speech of the mothers and children.

Children

You are going to be part of a study of talking between mothers and children.

* Please continue reading on the next page.
Appendix A (continued)

First, you will talk to me about your favorite hobby, friend, or something else.

Then you will tap on a board at first a "normal" speed, then at a "fast" speed, then at a "slow" speed. You will then say some easy words (like pat, pat) at a normal, fast, and slow speed.

Your mom will do the same things when it's her turn.

After this, you will talk to your mom about some pictures. Some will be easy to talk about and some will be hard. You should talk about what's happening in the pictures the best way you can. Then your mom will talk with you about something you like doing.

Later, you will see some moms and some children talking on the T.V. screen. I will ask you some questions about them.

Judges

You are about to participate in a study of the speech patterns of mothers and children during verbal interaction.

You will be presented with randomized segments of videotaped verbal interactions between mothers and their children. The investigator will ask you questions regarding the speech patterns of the mothers and children during interaction.

* * * * * * * *

Please feel free to ask any questions before, during, or after the experiment.

Do you have any questions or concerns?

I have read these instructions (and have had them read to my child) and I have had all questions answered to my satisfaction.

Name:__________________________

Date____________________________
Appendix B

Informed Consent Release Form

I _________________________ freely and voluntarily consent to participate (and have my child participate) in the experiment described on the attached page.

I also understand that I may withdraw (have my child withdraw, or that my child may choose to withdraw) from this experiment at any time, and that my (and my child's) participation or withdrawal will in no way affect my standing (or my child's standing) with this university or my role as a consumer of its clinical offerings.

I understand that I (and my child) will not be exposed to any experimental procedure which would in any way be detrimental to my (or my child's) physical or psychological well being.

I understand that other individuals will be participating in the experiment with me (and my child). However, I also understand that none of my (or my child's) responses will in any way be associated with me (or my child) or with my name (or my child's name).

I engage in this study freely, without monetary payment and with no other contingencies being placed on my (or my child's) participation. I also understand that I (or my child) will not directly benefit personally from the results of this study.

I understand that I have had and will have the opportunity to ask questions about the nature and purpose of the study, and I understand that upon completion of this study at my request, I can obtain additional explanation about this study and its implications.*

Date__________________________ signed

__________________________ witness

__________________________ witness

* For additional information contact John M. Hanley, Ph.D. (383-0963) or Lorraine DeStefano Proctor (349-9067).
Appendix C

Sample Response Sheet - Perceptions

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<th>subject/judge viewing</th>
<th>slower than</th>
<th>faster than</th>
<th>more relaxed than</th>
<th>more tense than</th>
<th>more comfortable than</th>
<th>more uncomfortable than</th>
<th>more effortless than</th>
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Appendix D

Summary of Comparisons

PRODUCTION COMPARISONS

Individual
- Comparison of means (X) and standard deviations (SD) of interval durations across conditions for each subject.
- Comparison of within subject variability across conditions for tapping and speech.
- Comparison of means (X) and standard deviations (SD) of interval durations across conditions for tapping and speech in parents and children.

Group
- Consistency of variability across conditions of tapping and speech for stuttering and nonstuttering children and parents.
- Comparison of the tapping and speech interval durations across conditions for stuttering and nonstuttering children and parents.
- Direction of change of mean interval duration from tapping to speech in each subject in order to compare performance of stuttering and nonstuttering children and parents to one another.
Appendix D (continued)

PERCEPTION COMPARISONS

Individual
- Parent perceptual ratings of self
- Parent perceptual ratings of child
- Child perceptual ratings of self
- Child perceptual ratings of parent
- Comparison of agreement between parent and child ratings of each other.

Group
- Comparisons between how subjects (stutterer/nonstutterer) rate themselves and how other subjects rate them.
- Comparisons between how subjects (stutterer/nonstutterer) rate themselves and how graduate clinicians rate them.
BIBLIOGRAPHY


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