INTERACTION OF SPEECH MOTOR AND LANGUAGE PROCESSES IN STUTTERING CHILDREN

M.PUSHPAVATHI
All India Institute of Speech and Hearing
Naimisham Campus, Mysore-570 006

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Dedicated to

My Parents

&

All my teachers

Certificate

This is to certify that the thesis entitled "Interaction of Speech Motor and Language Processes in Stuttering Children" submitted by Ms. M Pushpavathi for the Degree of Doctor of Philosophy (Speech and Hearing) to the University of Mysore, Mysore was carried out at the All India Institute Speech and Hearing, Mysore.

Mysore

Date:9.3.2004

Dr. M. Jayaram.
Director
All India Institute of Speech & Hearing
Mysore-570 006

Certificate

This is to certtify that this thesis entitled "Intertaction of Speech Motor and Language Processes in Stuttering Children submitted by Ms. M Pushoavathi for the Degree of Doctor of Philosophy Speech and Hearing) to the University of Mysore, Mysore is the result of work done by her at the All Inddia Institute of Speech and Hearing, Mysore, under my guidance.

Savithri S.R

Mysore

Dare:20.2.04

Dr. S.R. Savithri
GUIDE
Reader & Head .
Dept. of Speech Language Sciences
All India Institute of Speech & Hearing
Mysore-570 006

Declaration

I declare that this thesis entitled "Interaction of Speech Motor and Language Processes in Stuttering Children" submitted for the award of the Degree of Doctor of Philosophy (Speech and Hearing) to the University of Mysore, Mysore is the result of work carried out by me at the All India Institute of Speech and Hearing, Mysore. I further declare that the results of this work have not been previously submitted for any other Degree.

Mysore

Date:23.2.04

M. Pushpavathi
Lecturer, Dept. of Speech Pathology
All India Institute of Speech and Hearing
Naimisham Campus
Mysore-570 006

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

"Stuttering has been called a riddle. It is a complicated, multidimensional jig jaw puzzle with many pieces still missing. It is also a personal, social and scientific problem with many unknown causes" (Van Riper 1982).

Stuttering is a disorder known for its variability, both for inter and intra individual variations as well as within and across situational variations. The variability can be in the frequency, type, severity and duration of stuttering as well as in releted speech and non-speech behavior or attributes. Stuttering is thus considered as a syndrome where three basic aspects called the 'ABC of stuttering' are impaired (Curlee 1993). These include affective (feelings), behavioral (moments of stuttering) and cognitive (thoughts and attitudes) domains.

Wingate (1964) proposed three-part standard definition of stuttering. The first part denotes the core features of stuttering that have universal applicability the second and third parts identify the accessory and associated features, respectively.

According to Wingate(1964) the term 'Stuttering' means:

(1) (a) Disruption in the fluency of verbal expression, which is (b) characterized by involuntary audible (or) silent repetition (or) prolongations in the utterance of short speech elements, namely: sound syllables and words of one syllable. These disruptions (c) usually occur frequently (or) are marked in character and (d) are not readily controllable.

(2) Sometimes the disruptions are (e) accompanied by accessory activities involving the speech apparatus, related (or) unrelated body structures, (or) stereo typed speech utterances. These activities give the appearance of being speech-related struggle.

(3) Also, these are not infrequently (f) indications (or) report of the presence of an emotional state, ranging from a general condition of excitement (or) 'tension' to more specific emotions of a negative nature such as fear, embarrassment, irritation, (or) the like, (g) The immediate source of stuttering is some incoordination expressed in the peripheral speech mechanism; the ultimate cause is presently unknown and may be complex (or) compound.

Wingate's (1964) statement that the "ultimate cause of stuttering is presently unknown" still holds good. The state of the field is perhaps best reflected in Van Riper's personal experience as follows: " When I was a youth of sixteen, I swore an oath to a birch sapling that I would devote my life to finding the cause and the cure fr stuttering. Decade after decade I returned to the tree and confessed I had found neither. That birch tree died a long time ago. But if it were still living I would have to say the same thing today. Have I anything more to say? Yes, that I still hope that sooner or later others will fulfill the vow, I made to the birch tree" (Van Riper, 1990). Extensive research has been conducted to investigate the etiology of stuttering. In 1960s and 1970's, the etiology was focused on emotional issues, (Sheehan, 1958), (earning theory (Brutten & Shoemaker. 1967), and parental reactions (Bloodstein, 1970). Later in 1970's the focus was changed to various communication process such as language (Bloodstein, 1974) and articulation (Zimmerman, 1980).

Speech language pathology with special reference to the exploration of the disorder of stuttering has had a surge of vocal onset studies followed by a surge of vocal reaction time studies in 1970's. But towards the end of 1980's the literature of stuttering focused on laryngeal dynamics, which gave birth to a broader interest in the

role of speech motor behavior on fluency (Cross & Luper, 1983). Approaches to stuttering, whether for theory construction or therapy, have, in the last few years focused either on motoric or on linguistic factors. A review of stuttering and motor skill indicates that stutterers unequivocally demonstrate slower speech reaction times (Adams. 1974), which seem to result from a slower preparation or programming of speech utterances as well as slower initiation of the speech movements themselves (Peters. Hulstjin & Starkweather, 1989). The research on aerodynamic functions by Peters & Boves (1988) suggests a diminished capacity of stutterers to co-ordinate respiratory movements with laryngeal adjustments during the onset of phonation and unusual patterns of air pressure building. Abnormal laryngeal behavior during perceptually fluent speech of stutterers has been reported by Freeman & Ushijima (1978), Shapiro (1980), Van Lieshout, Peters, Hulstjin & Starkweather (1988). The results of the studies by Zimmerman (1980) and Caruso, Gracco & Abbs (1987) reveal abnormal articulatory behaviour in the perceptually fluent behaviour of clients with stuttering. Also, greater variability in the physiologic processes just before the onset of speech has been reported by several authors (Janssen, Wieneke & Vaane, 1983; Watson & Alfonso, 1987).

Due to the ample evidence of involvement of motoric aspects in stuttering, various models were proposed by several authors to explain the act of speech planning and execution (Mackay & Soderberg, 1970; Marsden, 1984; Evarts, Shinoda & Wise, 1984; Levitt, 1989).

The findings with regard to stuttering and linguistic skills are multifold. The results of the research in this area indicate that (1) children with stuttering are slightly

but significantly slower in the development of language skills than closely matched non-stuttering children (Kline & Starkweather, 1979), (2) children whose language development is delayed often begin to stutter as language emerges during treatment (Merits-Patterson & Reed, 1981), (3) stuttering occurs more often at points of more accoustic demands (Wall, Starkweather & Cairns, 1981; Jayaram, 1984), and (4) normal nonfluencies in young children occur more often on syntactically complex than on syntactically simple sentences when syntactic formulation precedes their production (Gordon, Luper & Peterson, 1986).

Peters & Starkweather (1990) hypothesized that there are subgroups of stutterers such that one group develop the disorder primarily out of a motor deficit, while another group develops it primarily out of a linguistic deficit. According to them, combinations of such deficits are also possible, and it could be that an imbalance between linguistic and motoric development could be related to stuttering. Peters et al. (1990) suggest three hypotheses that seem to account for these findings - viz-

1. **Sub-group Hypothesis**: There are sub-groups of clients with stuttering such that one develops primarily out of motoric deficit while another develops it primarily out of a linguistic deficit.

2. **Interference Hypothesis**: Language and speech motor act processes may interfere with one another during the act of talking, at least in children who are beginning to stutter. This interference hypothesis is based on research in non-stutterers, which suggests that the simultaneous performance of

language formulation and motor programming may result in deterioration of performance in one or both areas (Kinsboume & Hicks, 1978). Such a hypothesis is suggestive for a number of reasons, one of which is the explanation it offers for the location of stuttering between sentences. The location that has the most power in eliciting stuttering are those that are complex both linguistically and motoricatly. For example, the beginning of a sentence or clause, where movement is fast and where formulation activity is most likely to occur, is the most probable location of stuttering. Also, longer sentences are more likely to be stuttered than a shorter one (Bloodstein & Gantwerk, 1967; Jayaram, 1984) and longer sentences might be expected to be motorically more complex and therefore require more formulation effort as well as effort of motor programming.

3. Competence and Performance Hypothesis: Competence and performance have different effects on fluency. Higher levels of language competence (knowledge) could hinder fluency by creating a large lexicon and a greater available pool of syntactic forms from which to choose words and formulate sentences. Higher-level performance skills such as word finding and sentence construction can only improve fluency by increasing the rate at which language performance is executed. In this way, the child whose language is delayed although he or she Is not hindered by a large vocabulary or syntactic variation, might find it difficult to find words even from a small lexicon or to construct even simple sentences and perform motor activities.

Peters & Starkweather (1990) have suggested several lines of research to test the above hypotheses. Administering various tests for language skills, oral motor behaviour, and tests of general motor behavior and motor coordination can test the first hypothesis. If there are subtypes with purely motoric/purely linguistic, clients with stuttering should produce low scores on either ofthe two variables. An investigation of the speech motor language interference hypothesis requires two comparisons: - (1) comprasion of the interference effect of a language task on a simultaneous speech motor task with interference effect of a non-language cognitive task on simultaneous speech motor performance and (2) comparison of the interference effect of a non-speech motor task on simultaneous language performance. Investigating relationship between stuttering and cluttering in more detail can test the third hypothesis. .

Deepa (1994)and Nandakumar (1994) made an attempt to evaluate the interference hypothesis and tested 15 children with stuttering, each in the age group of 6-9years,and 9-12 years, respectively. They tested the children on three tasks as follows:Interfernce between (1) language and speech motor tasks, (2) language and non0-speech motor tasks and (3) non-speech motor and cognitive tasks. The authors reported a significant interference of language and speech motor tasks in clients with stuttering, which was not found in normal children. They also reported that language and speech motor interference decreased with age and that children with stuttering performed poorly on speech motor task compared to language task, which suggests the possibility of occurrence of the subgroups of stuttering, with greater percentage of occurrence of the subgroup with motoric deficits. Though the results of these studies support the interference hypothesis, large group of children with stuttering should be

In view of the above, the present study attempted verification of subgroup and interference hypothese. Specifically 100 children with stuttering were investigated on speech motor and linguistic skills by which it may be possible to classify these children under three subgroups as (a) predominantly motor (b) predominantly linguistic and (C) a combination of motor and linguistic. The same 100 children were tested for verifying interference hypothesis. For this, three tasks - (a) language and non-speech motor task (b) lanuage and speech motor task (c) cognitive and non-speech motor task- were used.

CHAPTER II

REVIEW OF LITERATURE

"Inconsistent and conflicting findings in the literature on stuttering appears to. be a rule rather than exception" (Bloodstein,1987).

The study attempted verification of sub grouping and language and speech motor interference in stutterers. Therefore, the review will be dealt under sub grouping of children with stuttering, speech motor aspects in stuttering, linguistic aspects in stuttering and interference of speech and motor acts in children with stuttering.

I Sub grouping ofchildren with stuttering:

Stuttering research has been particularly notorious in finding conflicting, ambiguous results or data, which cannot be generalized. Speech and non-speech differences among people with stuttering, particularly children with stuttering, may be as important as speech and non-speech differences between them. Such speculation appears related to the fact that various differences in speech and non-speech associated behaviors exists among children with stuttering (Douglass & Quarrington: 1952, Prins & Lohr; 1972: Schwartz & Coniure, 1988). If stuttering is not a unitary disorder, then a need exists to identify components that affect a child's threshold for fluency. If these components are regular and independent a sub typology may be possible. Examination of differences among stutterers have led investigators to suggest that identifying and describing subgroups of stuttering may account for these differences (Prins& Lohr 1972; Riley&Riley, 1979; Preus 1981).

The idea that stutterers can be classified has been expressed by numerous writers (Daly 1981; Preus; 1981, Rentschler; 1984) during the past several years. Most research in the area of stuttering compares subjects with stuttering and non-stuttering on various skills, behaviors and performances. There are several possible

iexplanations, which are offered to address the issue of possibilities of sub grouping stuttering. A common assumption in stuttering research has been that subjects manifesting a common symptom represent a homogeneous population. It is reasonable to support that people with stuttering differ from one another in any number of respects. In fact, most studies (Adams & Hayden, 1976: Cross & Luper 1979, 1983) report higher variability in their experimental group (stuttering) than control group (non stuttering). Two points arise from this observation. First, grouping and the use of group mean scores serve to obscure information relative to the characteristics of individuals with stuttering. Many researchers (Prins & Lohr, 1972; St.Onge, 1963) acknowledge that the " Average stutterer" is non-existent and that there are no traits that are common to all stutterers. Thus the average performance or characteristics of group of children with stuttering should not be considered to be representative of stutterers in general. This only serves to dilute the power of research findings. Second, higher variability suggests less group homogeneity. It is, thus, reasonable to suggest that stutterers might be delineated into subgroups based upon certain commonalities.

Identifying and describing subgroups in children with stuttering has three important clinical and research implications. First, identifying and describing the behaviors that characterize the subgroups may help to explain description of published findings. If the investigator knew the criteria for subgroup membership, he can investigate the differences among the subgroups as well as their normally fluent peers. This could make it possible to determine the potential sources of within as well as between group variability. Second, knowing the specific behaviors that characterize the subgroup could assist in the diagnosis of children with stuttering

based upon the behaviors and problems specific to the sub group, rather than the entire population of stuttering. Third, knowing the specific subgroup with which a child falls could provide diagnostic information relative to the therapeutic intervention. With this, it is possible for the clinician to implement specific therapeutic strategies specially designed for a subgroup unique problem behaviors. That should enhance both the efficacy as well as the economy of the child 's rehabilitation (Preus, 1981).

Preus (1981) points out in his study that "the subgroup hypothesis has neither been proved nor disproved, but has found partial support in some studies. The need for new and better empirical investigations of this hypothesis is strong". Thus, while many studies suggest the presence of subgroups, the conclusions drawn from these studies are limited, because of lack of empirical data and clearly specified methodology. Typically, investigations of subgroups of stuttering have either focused on the characteristics of children with stuttering (language problems, intelligence, articulation problem etc.) or the characteristics of their stuttering (the type of speech dysfluency, associated speech and non speech behaviors). Although children with stuttering appear to differ among themselves when their characteristics are examined (Daly, 1981, Preus, 1981) many of these examinations have involved the use of unclearly or qualitatively defined variables. Examination of variables that characterize the stutterers dysfluency (speech dysfluency type, associated speech and non speech behavior) would appear to provide a more quantifiable and objective means of studying the sub groups.

Several researchers have been attracted to the idea that subtypes of stuttering may be found which will help to organize the descriptions of children who stutter. These researchers have generated data that challenge the traditional concept of stuttering as a unitary disorder. As early as 1940, Barr suggested that non-speech behavior should be considered when evaluating a stutterer's speech, as non-speech behaviors helps in identifying the subgroups of stuttering. The possibility of subgroups of stuttering was presented by Johnson (1957) and highlighted again by Brown, Sheehan, West & Wischner (1959). Johnson (1957) opines that it is the speech behavior itself that appears to differentiate stutterers from their normally fluent peers, rather than intelligence, birth order etc.

There are few widely scattered research findings to identify etiological subtypes of people with stuttering. Sub grouping has been done based on features of stuttering, age of onset, performance of the subjects on various tasks, and etiology. Several attempts have been made to differentiate among persons who stutter using the adaptation phenomenon (Laynon, 1963; Newman, 1963; Prins, 1968) type of stuttering moment (Douglass & Quarrington, 1952; Emerick, 1966) and evidences of CNS dysfunction (Graham & Brumlik, 1965; Sayles, 1971). However, these results had minimal success in differentiating subgroups. But these findings suggest that further description and evaluation of behavioral variations during stuttering may help to investigate the subgroups in stuttering.

Researchers have described a variety of auditory anomalies which may form the basis for subgroups. The skills that have been reported as significantly different among stutterers include (1) the inability to resequence backward speech (Perozzi,

1970; Wingate, 1971), (2) below average performance in dichotic listening test (Curry & Gregory 1969; Sommers, Brady & Moore 1975), (3) reduced auditory threshold (Mac Culloch, Eaton & Long (1970), and (4) impaired auditory memory (Williams & Marks, 1972).

Berlin (1955) tried to classify children with stuttering into three groups - familial, neurogenic and psychogenic. St. Onge (1963) suggested three types - organic, psychogenic, and speech phobic stutterers. Andrews & Harris (1964) tried to classify based on the subject's case histories. Systematic research on types of child stutterers began with Andrews & Harris (1964) study of school age children. Multiple regression analysis was employed to identify the differences on variables such as age, intellectual level, and age of onset of stuttering.

Etiology has been a frequent basis of classification. Luschinger & Arnold (1965) proposed six-type scheme, which includes organic (inherited), symptomatic (of organic lesions), developmental, traumatic, physiological and hysterical stutterers. Another possible subgroup that emerges from a review of the research includes children with stuttering who have difficulty with syntax, grammar and other skills requisite to language formulation. Soderberg (1967) described this difficulty as grammatical and lexicon uncertainty. Bloodstein & Gantwerk (1967) concluded that children with stuttering might have difficulty in getting started on the execution of an identifiable segment of language.

Sayles (1971) subgrouped children on the basis of abnormal EGG. He tested 23 children with stuttering along with control group. Abnormal EEG was observed in 49% of the children with stuttering compared to 12% of controls.

Prins & Lohr (1972) attempted to classify subjects with stuttering based on visible and audible features. They analyzed the speech and reading behavior of 19 subjects with stuttering in the age range of 14 to 23 years. They identified six factors - severity of stuttering, type of audible disfluency, adaptation, tension, and stuttering differences in reading and speaking. They reported that by identifying audible and visible features associated with instances of stuttering, they were able to identify behavioral similarities supporting the presence of " subtypes of stuttering " in adult stutterers. They used factor analysis to correlate 46 visible and audible phenomena of stuttered speech. In each instance little difficulty was found in isolating clusters of characteristics that seemed to belong together. Thus, by objectively assessing stuttering and it's associated behaviors as suggested by Prins & Lohr, it may be possible to differentiate quantitatively and more precisely between youngsters who stutter. They concluded that the 10 resulting factors might be useful in describing disorder syndromes among people with stuttering. These investigators suggested that the quantification of behaviors associated with stuttering might have imptication cfbr the manner in which we consider etiologies and therapies for stuttering.

Riley & Riley (1980) analyzed the performance of children with stuttering on tests of motor coordination, psycholinguistic abilities and severity of stuttering. The analysis yielded factors that could be presumed to be related to the development of

stuttering, notably oral motor ability, language skills and auditory perceptual ability. However, subgroups of stuttering were not identified.

Preus (1981) made a comprehensive search for subgroups among 100 children with stuttering using 70 variables related to symptamatology of stuttering. The variables that included were language development, frequency of stuttering under various conditions, signs of brain damage and general anxiety, and emotional adjustments. But he was not able to find the subgroups in stuttering .He concluded that stuttering is characterized by heterogeneity with respect to etiology and underlying mechanisms or with respect to responsiveness to treatment. Preus (1981) also proposed an etiological classification where he attempted to group young stutterers by using a large number of psychosocial variables, for example birth order and intelligence. He concluded that stuttering is a multidimensional disorder and that stutterers are characterized by heterogeneity with respect to etiology and underlying mechanism or with respect to responsiveness to treatment.

Janssen, Kraaimaat & Brutten (1983) noted some possible differences in type of stuttering between subject with and without family background of stuttering. They examined the symptomatology, reading ability and anxiety levels, responsiveness to therapy and speech motor behavior of elementary and high school children with stuttering and children with family history of stuttering and with a negative family history of stuttering. The subjects with a positive family history of stuttering differed significantly from those with a negative family history with respect to speech and non-speech motor behavior. Their findings suggest that neuromotor functioning is related to genetic susceptibility to stuttering.

Rentschler (1984) supported sub grouping of stuttering. He examined the effects of sub grouping on a sample population selected from a pool of stuttering children. The group was compared on scores of Raven's Progressive Matrices Test, errors on Benton Visual Retention Test, right - and left hand scores on the Purdue Peaboard Test and the Wechsler Digit Span score. They found that the groups were contrasted across five variables. The results indicated that the performance difference between the groups increased as the selection criterion became more stringent. They advocated examining more closely the individual differences of stutterers, which may enable researchers and clinicians to broaden their knowledge on the problems of stuttering.

Schwartz & Conture (1988) suggested that by quantifying most frequently occurring disfluency types - sound syllable repetition and sound prolongation and examining the number and variety of behaviors associated within stuttering, young stutterers could be divided into various subgroups. They studied 43 young stutterer's speech and non speech behavior in the age range of 3.10 months to 9.4 years. Fourteen associated speech and non speech behavior and speech disfluency types were identified and quantified. These behaviors were identified based on which five subgroups of stuttering were framed. The authors suggest that on the basis of number and variety of speech and non-speech behavior subgroups may be formed. They found a number of clusters and partial support for discriminating between a predominantly "clonic" and predominantly " tonic " type of stuttering.

Poulous & Webster (1991) used family history of stuttering as a basis for sub grouping 169 stutterers. They found that those without such a history were considered more likely to have suffered from birth injuries or other related conditions suggesting the possibilities for brain injuries. On the basis of this retrospective research of family history they concluded that patients with stuttering can be subgrouped on the basis of etiology and underlying mechanism despite apparent similarities with respect to time of onset of stuttering and emotional concomitants.

The above review highlights interests in sub grouping children with stuttering. Table 1 summarizes the subgroups of persons with stuttering.

Authors	Year	Subgroups
Douglass & Quarrington	1952	Interiorized, Exteriorized
Berlin	1954	Familial, Neurogenic, Psychogenic
St. Onge	1963	Organic, Psychogenic, Speech Phobic
Luschinger & Arnold	1965	Organic, Symptomatic, Developmental, Traumatic, Physiological, Hysterical
Schwartz & Conture	1988	Clonic, Tonic

Table 1: Subgroups of persons with stuttering.

It is evident that few of the investigators have attempted or been able to quantify the variables of behaviors necessary to establish criterion for subgroup, particularly, in children with stuttering. Sub grouping children with stuttering provide more quantifiable and more sensitive means of differentiating among children with stuttering than would be an examination of general characteristics such as socio economic status, birth order, etc. However, the subgroup hypothesis has neither been proved nor disproved. It has received partial support from these studies. Also, it has

not been possible to use the results of these studies either in diagnosis or in therapy for young stutterers. If one were to find a subgroup it should be clinically easy to diffrentiate stutterers belonging to a subgroup and provide remediation to them. Peters et al. (1990) suggest sub-groups of clients with stuttering such that one develops primarily out of motoric deficit while another develops it primarily out of a linguistic deficit. The present study attempted verification of these subgroups in children with stuttering.

II Speech motor aspects in stuttering:

Stuttering is a complex clinical problem that presents a number of faces to the clinician. First, there is the motor disturbance that is evident in the abnormal type and amount of speech dysfluencies. Then there is a complex set of relations between the motor disturbances, the emotional accompaniment of the disorder and further alterations in the speech behavior. Speech is more than the specification of characteristic motor pattern adjusted for context. During speech, different vocal tract actions are sequenced to produce a group of linguistically relevant speech sounds. Several attempts have been made to determine the specific organization of speech motor actions. The lack of invariant individual articulatory action and relatively consistent articulator action suggest that the nervous system does not explicitly control the action of a single muscle or articulator.

Speech motor actions are organized at a level that reflects the interaction of various systems and muscles. Stuttering can be considered as a disorder of speech motor control. Speech motor control refers to the systems and strategies

that regulate the production of speech including the planning and preparation of movements (sometimes called motor programming) and the execution of movement plan to result in muscle contractions and structural displacements. This conception is more of a perspective than one single viewpoint. It encompasses a family of theories or models and it leads to unique type of investigations. The motoric approach in stuttering has grown substantially in the past twenty years. The theory that stuttering is based on an organic predisposition of a neuromuscular nature has stimulated a large amount of research on the motor abilities of stutterers.

A large number of muscles and anatomical structures are involved during the production of speech. Speech production involves two terminal stages or levels of control. First there is a planning or pre motor stage at which speech segments, that is phonemes, are selected and placed in proper order. Second, at the execution of motor control stage, the speech segments are translated into motor programs which in turn lead to the muscle innervations underlying speech movements. The errors may occur not only at the programming level but also when motor execution is required. The following section highlights various theories on the motoric aspects of stuttering.

II.1 Stuttering as a defect in phonetic and syllabic contextual programming (MacKay,1970)

Mac Kay (1970) proposed a speech production model at the phonetic level, which can account for stuttering also. According to him, the model contains four levels as in figure I.

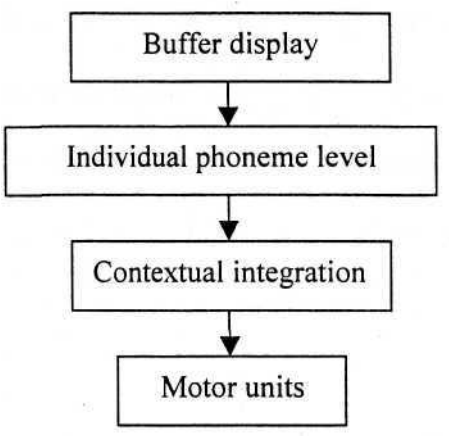


Figure 1: Schematic diagram of speech production model (MacKay, 1970).

The buffer stores the word to be produced in abstract form and generates a set of programmes to modify the phonemes (required in the production of target word) according to the context. The buffer feeds into the individual phoneme level when the phoneme in the target word gets partially primed. But the activation is not in a serial order. The buffer system also modifies the phonemes according to the contextual constraints after which the information from these levels are fed in to the motor units where the contextually variant phonemes are coded. This model also involves a scanner that scans the motor variants in the motor unit in a unidirectional manner and at a voluntarily determined rate. When the scanner passes a partially activated motor variant, it gets an additional boost of excitation, thus reaching the threshold at which the series of motor commands are sent to the musculature. The authors state that it is in the scanning level that the disruption occurs.

MacKay (1970) and MacKay & Soderberg (1970) suggest that the contextual model can also account for pathological stuttering. Model (1) postulates that the motor unit threshold may be lowered in people with stuttering. Model (2) hypothesizes greater level of hyper excitability than normal subjects leading to stuttering. Model (3) postulates greater preprinting for stuttered units.

II. 2 Stuttering as a defect in coarticulatory timings

Van Riper (1971) defined stuttering behavior as a word improperly patterned in time. He hypothesized that there is a break down in the timing of coarticulatory events in the production of syllables. This break down may occur due to the following reasons.

* Stutterers inability to monitor speech inappropriately through tactile-kinesthetic and proprioceptive feedback,
* deficient ability to integrate long motor sequences, and
* organic deficiencies in speech related functions.

He also takes in to account the physiological difficulties such as defective breathing, voicing, and articulation that could lead to the speech deficiencies. Thus stuttering is a result of deficiency in motor stability for syllables and ability to integrate large number of discrete events in correct temporal order or disruption in related respiration, phonation, and articulation. Due to this, stuttering behaviors such as syllabic repetition, sound prolongation, silent articulatory postures and phonatory arrest may result.

II.3 Speech motor research within the framework of a speech production model:

In the last two decades, there has been a growing body of research into speech motor behavior in stuttering. This research was strongly motivated by some striking results of Freeman & Ushijima's (1978) investigation that used EMG measurements to record laryngeal and articulatory muscle activity during fluent and nonfluent speech of people who stutter. They reported a disruption of the normal reciprocity of abductor muscles in dysfluent speech utterances. These results lead to the hypothesis that stuttering might be linked to a discoordination of activity between and within the speech motor subsystems involved in speech production (Peters, Hulstijn & Van Lieshout, 2000).

Research findings on speech motor control can be interpreted from two different perspective: in terms of faults or failures in one or more process in the speech production itself or in terms of the use of the system as a result of motor learning processes. Motor performance could be the result of either the capacities of the system itself and or the motor skills, which are learned over a longer period. Learning motor skills proceed through stages from a cognitive stage to automatic performance. Individuals may differ largely in the amount of speech motor skill they have achieved or can ever achieve. Speech motor skill can be viewed as a continuum. Speech motor research into stuttering will be discussed in relation to the various stages and processes of the Van Lieshout (1995) model. These stages can be further divided into a number of sub stages as in figure 2.

Lieshout (1995) model. These stages can be further divided into a number of sub stages as in figure 2.

The model consists of three main stages:

1. The motor plan assembly stage, in which an abstract motor plan is assembled,
2. the muscle command preparation stage, in which muscle commands are turned to the context of the verbal motor task, and
3. the muscle command execution stage, in which muscle commands are initiated and executed.

Motor Plan Assembly Stage: One of the arguments for attributing stuttering to a perturbation of speech planning is the well-established influence of linguistic factors on stuttering. Specifically, stuttering events frequently occur at the beginning of a word or utterance and moreover there is a greater tendency of stuttering to occur on longer rather than shorter words (Soderberg, 1966), and sentences (Tomick & Bloodstein. 1976, Jayaram, 1984). Peter & Hulstijn's (1984) view that speech utterances are supposed to be programmed before their initiation and that a programming or planning process may be involved in or is responsible for the origin of stuttering.

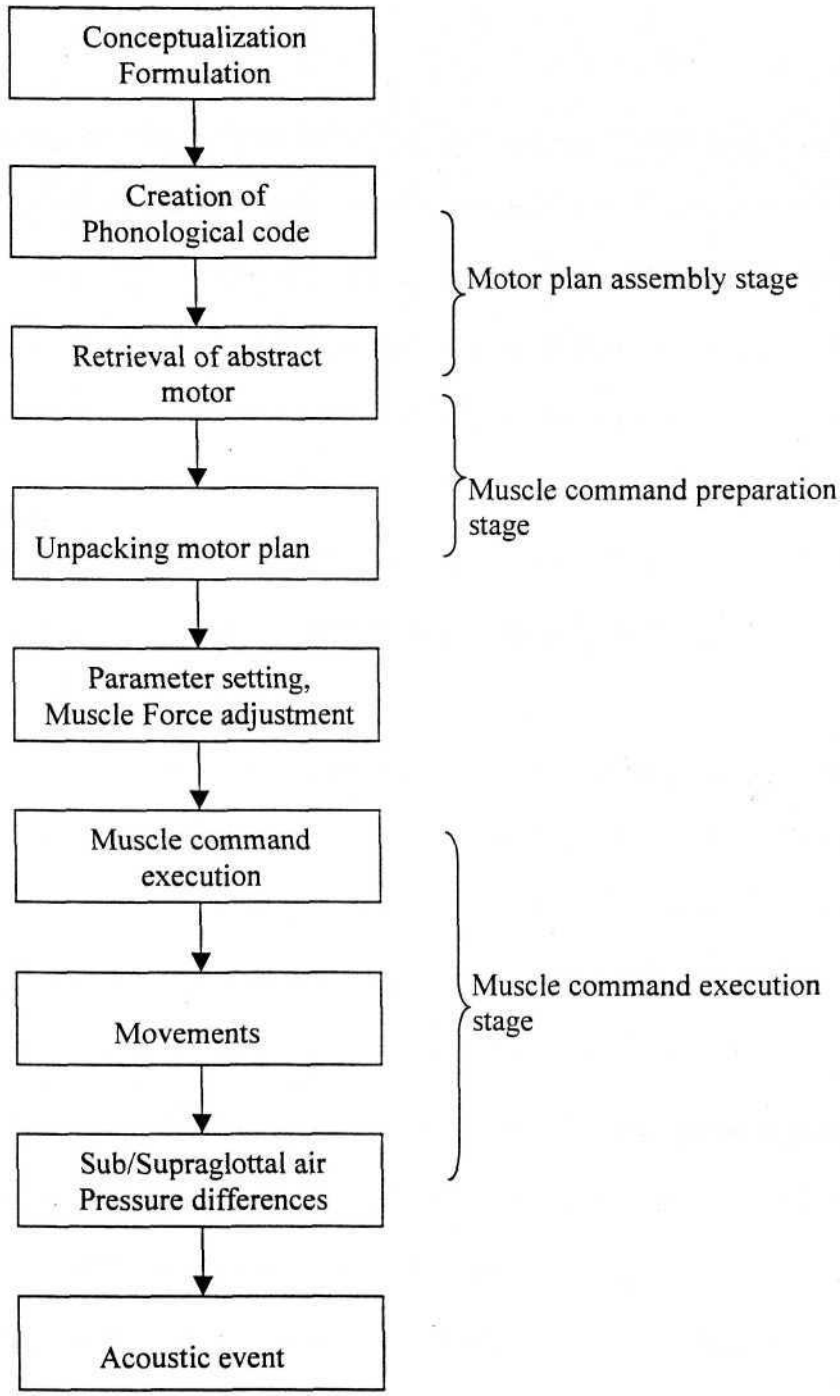


Figure 2: Stages and processes in speech motor production as described by Van Lieshout (1995).

Introducing simultaneous recordings of various speech physiological processes and employing systematic manipulations of speech tasks within the reaction time paradigm, Peters, Hulstijn & Starkweather (1989) tested whether stutterers have more problems in the planning processes than nonstutterers. They reported larger reaction time differences between stutterers and matched controls for longer verbal sequences, more specifically in comparing monosyllabic and polysyllabic words. These results are interpreted as suggesting that the stutterers may have difficulty in the motor programming of speech behaviour.

Another argument for locating the cause of stuttering in the speech planning is strengthened by the results of the experiment by Postma, Kolk, & Povel (1990). A silent speech technique was used in order to determine the relative importance of speech planning and execution in stuttering. Their results showed that stutterers are slower than nonstutterers in silent speech and to an increased degree in lipped and overt speech. The difference in silent speech suggests that speech planning is impaired in stutterers. With respect to the lipped and overt condition, the data indicated that either speech execution stage is independently impaired or that the planning defect has stronger consequences with actual speech motor movements.

In a similar study, Bosshardt (1990) found that stutterers subvocalize more slowly than nonstutterers. The stutterers silent presentation times were significantly slower than those of nonstutterers. In a subsequent study, Bosshardt (1993) found that stutterers displayed a serial short-term reproduction performance inferior to that of nonstutterers. This was accounted for by assuming (a) that stutterers have slower phonological encoding and rehearsal times and (b) that they use nonphonological forms of coding to a lesser extent.

The first process in the motor plan assembly stage is that of phonological encoding, in which the correct phonemes for a particular word or sentence are selected in such a way that segmental and metrical word form information from the mental lexicon is integrated. According to Kolk (1991), stuttering is the result of a phonological encoding problem. In phonological encoding, segments (phonemes) are selected for syllable frames. Segments are considered to be nodes in an activation spreading network. Several segments may compete for a particular syllable slot. The segment that is most activated is selected. Kolk proposed that in stutterers, activation spreading is slower than in nonstutterers. As a consequence, several elements that compete for the same slot are at the same level for activation for a longer period of time. The speaker's wish to produce speech at a "normal" speaking rate increases the chance of segment misselection. The speech monitor detects and corrects the resulting error before it is uttered. These covertly repaired errors interfere with speech delivery and show up as disfluencies. Thus, according to this explanation, repetitions, prolongations and blocking of speech sounds are a byproduct of covertly repairing errors in the speech plan. This explanation, which relates disfluencies (including stuttered

disfluencies) to repair processes during speech production, is called the covert repair hypothesis (Postma&Kolk, 1993).

Wijnen & Boers (1994) attempted to test the hypothesis that stuttering involves a perturbation of the process of phonological encoding. They combined Wingate's (1988) proposal and the ideas of Kolk (1991), which relates stuttering to a specific problem in the computation of prosodic parameters of articulatory plan, which led to the hypothesis that stutterers have difficulty in the phonological encoding of, in particular, the rhyme (i.e., the syllable constituent that is involved in stress and accent). They compared stutterers and nonstutterer s responses in an experimental paradigm - phonological priming - that has been argued to probe this level of processing. The results suggested that phonological encoding processes in stutterers differ from those in fluent speakers.

Throneburg, Yairi & Paden (1994) investigated the relation between the phonologic difficulty of words and the point at which stuttering like disfluencies occurred in the speech of preschool children identified as having a stuttering problem. The results did not show a systematic predictable relation between phonologic difficulty and the occurrence of stuttering like disfluencies at the early stage of stuttering. Such a relation may be formed as the problem progresses and - - becomes chronic. Hence, the assertion that speech difficulty of children who stutter may result from problems with central premotor planning of the speech act (Postma et al., 1990) is not supported by this study. And if at all, this is not aggravated by words that are phonologically more difficult.

Burger & Wijnen (1999) replicated the phonological priming experiment with a large group of subjects and a new set of stimulus words. The results showed that nonstutterers responded faster than stutterers, as they did in Wijnen & Boer's experiment. Also, homogeneous condition yielded faster reaction times than heterogeneous condition. Moreover, response words with identical initial CV's primed better than response words with identical initial C's. However, the expected interaction of group, prime type and condition did not show up. The reaction times as a function of the interaction between prime type and condition showed the same pattern in stutterers and nonstutterers. These findings do not support the hypothesis that stuttering is the result of a phonological encoding deficit. They also examined the influence of stress upon phonological encoding in nonstutterers and stutterers. The mean reaction time for words stressed on the second syllable was significantly longer than for words stressed on the first syllable, but no significant interaction between subject group and stress position was found. These results do not support the hypothesis that stuttering is specifically related to difficulty in the phonological encoding of the stress bearing part of the syllable.

Muscle command preparation stage: This stage involves two sub stages. First, there is the retrieval of the motor plan: well learned motor plans are retrieved from short-term memory. During the last few years, the notion that stuttering has its origin in motor learning failures resulting in inefficient plans (Peters et al., 2000) gaining popularity.

Second stage, involves the parameter setting. Individual movement characteristics such as stress, loudness, rate (all variables related to the speech

situation) are added to the motor plan. The selection of the proper values requires the processing of sensory information or sensory afference. At this level, stutterers experience some problems. Pindzola (1987) and Neilson & Neilson (1991) hypothesize that people who stutter may have difficulty in interpreting sensory information for the control of movement. Further more, the deficiency is related to movement, speed and stuttering severity. Severe stutterers find it difficult to use kinesthetic information quickly during the performance of small articulatory movements. They further hypothesized that deficiency in the processing of oral kinetic feedback during speech may be related to patterns of articulatory discoordination. Recent literature also supports this notion of limited abilities in people who stutter to process sensory information or acquiring and using sensory information for ongoing movement coordination (Archibald & DE Nil, 1999).

There is also some evidence that stutterers exhibit a reduced ability in the precise regulation of speech related forces. A study conducted by Grosjean, Van Galen, Jong, Van Lieshout & Hulstijin (1997) showed that they exhibit less strength and are more inaccurate or variable than non stutter when pressing their lips on a pressure transducer. From this study, it may be hypothesized that force control is less accurate in stutterers.

Muscle command execution stage: After setting the parameter values, the new concrete programs must be initiated and executed, which is done in the third and final stage. The motor units of muscles in the speech motor effector system are activated which gives rise to muscle contractions and thus to the movements in the

respiratory, phonatory and articulatory subsystems involved in the speech production. During the last two decades, a large number of authors have pointed out defective or inefficient speech movement initiation processes in stuttering.

Speech reaction time studies (SRT) studies using isolated vowels have often found significant differences between stutterers and nonstutterers (Adams & Hayden, 1976; Cross, Hayden & Luper, 1979; Cross & Luper, 1979, 1983), but there also been some studies using isolated vowels in which no significant differences were found (Murphy & Baumgartner 1981; Venkatagiri, 1981: Watson & Alfonso, 1982). On the other hand, in reaction time studies in which words or phrases were used, the picture is clear. Without exception, these studies have found that stutterers are slower in speech initiation than non-stutterers. Borden (1983) compared the initiation and execution intervals in the fluent utterances of stutterers with the same intervals in the utterances of non stutterers. They also examined the finger movements in a non speech non serially ordered task in order to determine whether differences between stutterers and controls extend beyond the speech mechanism. Stutterers were found to be significantly slower than control subjects in performing a speech counting task as well as counting on their fingers silently. For both counting tasks, time taken to execute the numerical series accounted for more of the differences between severe stutterers and control than the time taken to prepare and initiation the task. (Adams 1987; Peters et al, 1989). Study by Habrison, Robert & Porter (1989) also showed that stutterers difficulties appear to lie after response initiation suggesting they have problems in coordinating of gestures during execution of fluent responses. Their results indicated that stuttereres were, on average, 34 msecs slower on acoustic responses

than non stutterers in a shadowing response in which speakers exactly repeated vowel stimulus.

Recently Van Lieshout, Hulstjin & Peters (1996) found that people who stutter had longer vowel duration than control speakers, in particular for longer words. They speculated that this effect might reflect the differences in type of motor control strategy used by the two groups.

The review suggests that stutterers have problems in motor programming or execution. However, the equivocal results indicate that not all stutterers may have motor problem which is suggestive ofsub grouping among them.

III Linguistic aspects in stuttering:

Stuttering presents many paradoxes, among which the relation between motoric disturbances and linguistic functioning is of interest. There is ample evidence that adult stutterers are disrupted in the motoric expression of speech. They are disrupted in the motoric expression of various speech related and non-speech related behaviour. The evidence for a similar disruption in children is somewhat weaker. The available literature makes it clear that there is a relation between language and stuttering in young children. But the more precise nature of -- this relation is obscure. Children may develop stuttering as a result of advanced language skills or knowledge combined with poorly developed language execution or motor skills thus creating an expectation of performance in both child and parent that cannot be easily realized.

The possible relationship between stuttering and linguistic variables remains unclear. With regard to childhood stuttering, it has been speculated that pathologic disfluencies emanate from the normal-non-fluencies in the spontaneous speech of young children. Bloodstein (1970) argues in favor of such relationship and has proposed the "Continuity Hypothesis" in which normal non-fluencies of early childhood change over time (perhaps because of the child's concern about speech and language production) and evolve into tense utterance and fragmentations of words that are perceived by the listener as disfluencies of stuttering.

The relation of childhood stuttering to language has three faces. The first face is the well known set of facts concerning the tendency for stuttering behavior and the disfluencies of nonstutterers to be distributed in ways that can be described in linguistic terms at clause boundaries (Wall, Starkweather & Cairns, 1981), on longer words and more complex sentences (Bloodstein & Gantwerk, 1967, Gordon, Luper & Peterson, 1986), on words that are longer, less frequently encountered in the language, and that bear higher load of information (Soderberg, 1966). Stuttering behaviors and the disfluencies of normal speakers are likely to occur at locations where the requirements for motor programming, or for language formulation or for both together are usually high. The possibility then exists for a complex relation between motor and language functions and stuttering.

The second face of the relation of stuttering to language has to do with linguistic abilities of children who stutter. A number of investigations have noted a small but clear tendency for the language performance of stuttering children to

lag behind that of non-stuttering children (Andrews. 1984). This tendency has been seen in the area of expressive language performance and it has also seen in receptive language performance. But a question remains whether this set of findings should be interpreted as suggesting a delay in the acquisition of linguistic knowledge among nonstuttering children on the one hand or more conservatively an artifact of language performance based as a tendency of stuttering children to choose shorter, less complicated sentences so as to avoid stuttering.

The third face of the relation between language and stuttering has to do also with pressure to perform linguistically. It is a well-known tendency of stuttering to develop in children being treated with language stimulation techniques for delayed language development (Merits-Peterson & Reed, 1981). While those on the waiting list for the same treatment are not so likely to develop stuttering. The second version of this was reported by Amster (1989). He described a series of cases in which stuttering had developed due to over stimulating the children linguistically. He referred "Over stimulation" as great deal of time spent talking to the child or using a high level of language to the child. These high levels of stimulation are coupled with a pressure to perform linguistically.

Language development involves a gradual increase in the grammatical complexity of the utterances used by children. If there is a relationship between expressive language development and disfluencies, then experimental manipulation of grammatical complexity should influence the occurrence of disfluencies. It has been noted that the age interval in which the onset of

stuttering is most commonly observed from approximately 3-5 years, is also the period in which children are mastering the major linguistic aspects of their language (Muma, 1971; Haynes & Hood, 1978; Bloodstein, 1981). While extensive research has failed to consistently support any broad differences in the language abilities of stuttering and non-stuttering children (Johnson 1959; Perozzi & Kunze, 1969; Murray & Reed, 1977; Riley & Riley, 1979), the potential relatedness of language development and disfluencies in children has been repeatedly suggested in several ways. In their theoretical accounts of the possible causes of stuttering, Van Riper (1973) and Bloodstein (1983) included difficulties in developing language skills as a possible contributing factor.

The apparent lateness of many stutterers in acquiring language has led to a series of comparison of stutterers and non-stutterers on broad measures of language ability. Children with stuttering have been reported to have language deficits by many investigators. How the language deficits are related to their fluency disorder, however, has been controversial. Various methodologies have been devised to discover the nature of the relationship between language and stuttering in young children. All these studies have not been able to give a consensus. Systematic research into linguistic aspects of stuttering began at the university of IOWA in the 1930s. Much of the work has been done on children of school age, which is highlighted in the following section.

Berry (1938) reported that children who stuttered were more likely to have been delayed in speaking their first words when compared with non-stuttering and were also more likely to be delayed in producing speech that was intelligible to

persons outside their families. Silverman & Williams (1967) carried out a linguistic ability test on stuttering Kindergarten and first grade children and normal children. They found a slight tendency for the stutterers to be poorer in measures like mean length of response, and structural complexity of their utterance.

Peters (1968) employed the same measures as that of Silverman & Williams (1967) on elementary school children, but did not find any significant difference between stuttering children and normal children. Perozzi & Kunze (1969) found no differences between second grade and third grade stutterers and controls on the Van Alstyne Picture Vocabulary Test and measures of verbal output and structural complexity. Williams, Silverman & Kools (1969 a) analyzed the verbal imitations of oral reading performance of elementary school aged children. Long words were associated with stuttering than short words. Williams, Silverman & Kools (1969 b) examined stuttering in the repeated speech and oral reading of children aged 5-13 years and found that the children exhibited the same location of stuttering as the older stutterers.

Muma (1971) provided an explanation for the possible relationship between language skill and disfluencies. He posited that as disfluent children attempt to use complicated grammatical structures, they exhibit disfluencies. Thus disfluent children may frequently use simple or immature grammatical constructions in their speech to avoid dysfluencies, because their expressive language level proficiency does not enable them to use complex constructions with ease. He also reported that highly fluent nonstuttering preschool children

used more double based transformations in their spontaneous speech than their more disfluent group.

Bloodstein (1974) noted that there appeared to be a relationship between the loci of stuttering and the constituent structure of a sentence in child stutterers. In an informal analysis of tape-recorded samples of spontaneous speech, he observed that children tended to stutter at the onset of clauses or phrases. Children who were classified as disfluent on the basis of number of word repetitions, ungrammatical pauses and incomplete phrases, obtained lower scores on Developmental Sentence Scoring Analysis of their spontaneous speech than their more fluent peers.

Berryman & Kools (1975) analyzed the spontaneous language of first grade non-stuttering children and found no relationship between language development and the frequency of total disfluencies. Haynes & Hood (1977) analyzed spontaneous language samples of non-stuttering children 4, 6 and 8 years of age using the Developmental Sentence Scoring Analysis (DSS). No significant correlations were found between eight disfluency types and DSS scores or between total number of disfluencies and DSS scores. In a study by Murray & Reed (1977) preschool stutterers scored lower than their controls on the Peabody Picture Vocabulary Test, the Northwestern Syntax Screening Test, and the Verbal Abilities Scale of the Zimmerman Preschool Language Skills.

Stocker& Parker (1977) examined the relationship between auditory recall and stuttering in children aged 4-11 years. They found no difference in digit

recall between the stutterers and the matched control subjects; the stutterers exhibited significantly lower scores in the recall of meaningful verbal material than nonstutterers. The discrepancy in the scores of the two groups decreased considerably after the stutterers had given two months of language based fluency enhancing programs of therapy. Falck, Phelps-Teraski & Sartin-Lawler (1979) found that language training resulted in an improvement in fluency in a stuttering child.

Haynes & Hood (1978) reported that significantly more disfluency occurred on complex as opposed to simple, constructions when he elicited repeated language samples in 5-year-old children through sentence modeling response. Kline & Starkweather (1979) found that stutterers aged 3-6 years had a lower M L U than normal and lower scores on the Carrow Test for Auditory Comprehension of Language. The lower performance on M L U of the stutterers was found to be due to high number of responses used by the stuttering child.

In a study by Westby (1979), children with stuttering scored lower than normal children in frequency of grammatical errors, and receptive vocabulary on the Peabody Picture Vocabulary Test (PPVT) and incorrect responses on semantic tasks selected from the Torrance Test of Creative Thinking. They also reported that the stuttering or highly dysfluent child is a child whose linguistic ability does not adequately match his perceptual and cognitive understanding of his environment. Such a child would have difficulty linguistically coding his understanding of his environment.

Pearl & Bernthat (1980) investigated the effect of grammatical complexity on the disfluency behaviour of nonstuttering 3 and 4-year-old children. Thirty normal children repeated 30 sentences that represented six different grammatical constructions after the examiner. The total number of disfluencies that occurred in each sentence type was compared. The occurrence of specific disfluency categories in each sentence type was also examined. Subjects produced significantly more disfluencies on passive sentences than on any other sentence type. The results suggested that when grammatical complexity is controlled, the relationship between disfluencies and grammatical complexity is complicated. When grammatical constructions were relatively difficult for children, complexity affected the occurrence of disfluencies.

Wall (1980) carried out a constituent syntactic analysis of the speech of four stutterers and four normal children aged 5-6 years and found that the stutterers tend to use simpler and less mature language. There was a higher use of one-word responses and limited use of complex sentences in children with stuttering.

Wall (1980) and Wall, Starkweather & Caims (1981) and Bernstein (1981) analyzed the conversation samples of nine stuttering and non-stuttering children "and they found reduced language proficiency and also loci of stuttering to be at the beginning of utterances. They also found that significantly more stuttering occurred at clause boundary positions than at other points in the utterance. Approximately 20% of the clause boundaries were stuttered in contrast to 4% of words in internal positions, such as phrase boundaries or randomly positioned

words. The hierarchical structure within the clause did not affect the rate of stuttering. The strength of the clause as a unit of encoding as reported by Boomer (1965), Fodor (1975) and Garrett (1976) was supported by the findings of Wall et al. (1981). It is clear that the occurrence of stuttering in young children follows a predictable pattern in which the clause plays an important role.

The results of the longitudinal study by Colbum & Mysak (1982) demonstrated that individual children show different patterns in the proportion of dysfluency types at different MLU. They also reported a weak trend for an intervention disfluency types with semantic-syntactic structures. This trend was interpreted to support a hypothesis that developmental disfluency is more strongly attached to syntax than to lesion. In a study by Pitluk (1982), four stutterers aged 9-11 years performed adequately well as their controls on the Reporter's Test, devised by Derenzie & Ferrari to detect minimal expressive language impairments in aphasia.

Wall & Myers (1984) stated that there are very few diagnosis of stuttering in language disordered children and that those few children who did stutter during the course of language treatment 'out grew' the fluency problem concurrent with their language improvement. Ratner & Sih (1987) examined the effects of both syntactic complexity and sentence length on fluency and accuracy of sentence imitation responses of stuttering and non-stuttering children. They reported that complexity of the utterance was significantly correlated with the occurrence of 'dysfluency' in the speech of both stuttering and non-stuttering subjects. Length of the utterance was, however, not significantly correlated with fluency

breakdown. St. Louis & Hinzman (1988) reported a lower average of M L U in stuttering group in grades 1 to 12.

Byrd & Cooper (1989) analyzed the expressive and receptive language skills of 76 3-9 year ofd stutterers. Their findings suggested that young stutterers were not delayed in their receptive skills but were delayed in their expressive skills. This supports the conclusion that language deficits observed in stuttering children results from their attempts to simplify verbal responses as a means of coping with their stuttering.

Brundage & Ratner (1989) studied the relationship between the different indices of utterance length M L U in morphemes, syllables and words and the frequency of stuttering in children's speech. Spontaneous speech samples from eight stuttering children were analyzed and correlation between length of utterance measures and stuttering frequency were computed. Increase in utterance length was significantly associated with stuttering.

Gordon & Luper (1989) investigated the number of disfluencies of 3, 5 and 7 year old nonstuttering children. They varied the syntactic complexity in three different syntactic constructions: (1) simple affirmative declarative with copulating (2) future and (3) passive within a sentence imitation and sentence-modelling task. The subjects repeated 30 sentences from the modeling task stimuli. The 3 year old exhibited significantly more disfluency than 5 year old and the 5 year old exhibited significantly more disfluencies than 7 year old. All three age groups produced significantly more disfluency on the modeling task

than on the imitation task. The results revealed that disfluencies of non-stuttering children are significantly affected by syntactic complexity in addition to language elicitation task.

McLaughlin & Cullinan (1989) analyzed the spontaneous speech samples of 10 male and 10 female children in the age range of 60-71 months. Children participated in modeling procedures employed to evoke four sets of utterances representing two levels of utterance length and two levels of linguistic complexity. Analysis suggested significantly greater rates of disfluency in the modeling task that evoked linguistically more complex utterances.

Meyers, Ghatak & Woodfbrd (1989) described the nonfluent speech characteristic of a stuttering child, a language impaired child, and a non-stuttering child. Initial assessment revealed that the stutterer produced more stuttering, the language-impaired child emitted more disfluencies, and the non-stutterers had only few disfluencies. Six months after therapy, the stutterer had decreased stuttering behavior but increased in normal disfluency. Six months after initial evaluation and without fluency intervention, the language impaired child showed an overall decrease in nonfluent behaviours, especially in part-word, whole-word and phrase repetition. Minimal nonfluency was observed in the non-stutterers during the initial and post observation periods. All children produced more disfluencies on conjunctions and pronouns (age 3.8 years - 3.9 years -3 children).

Nippold, Schwartz & Jeschemiak (1991) reported that 6 to 11 years aged stutterers are equal to non-stutterers in narrative ability and performance on the

clinical evaluation of language fundamentals. Postma & Kolk (1992) found that stutterers did not differ from non-stutterers in identifying phonemic errors as they recited a string of non-sense syllables, but detected fewer errors than control subjects in a tape recording of other speakers reciting the syllables. Ryan (1992) found small but significant differences between 2-5 years old stuttering children on the Peabody Picture Vocabulary Test (PPVT) and Test of Language Development (TOLD).

In an investigation involving 60 preschool aged children with developmental language disorders, Hall, Yamashita & Aram (1993) found an association between discrepancies in the development of certain aspects of language, specifically better-developed lexical abilities than morphosyntactic skills, and an increase in disfluency in 10 of these children. The investigators interpreted their findings according to the neuro-psycholinguistic model of disfluencies (Perkins, Kent & Curlee, 1991), which hypothesizes that dysynchrony among aspects of the underlying processes of speech and language can lead to breakdown in fluency. Thus, it appears that a subgroup of children with developmental language disorders manifest increased disfluencies as a result of poor integration of lexical and morphosyntactic processes. The authors suggested that their findings lend support to the Demand and Capacity Model of Disfluencies (Adams, 1990; Startweather & Gottwald, 1990), which infers that breakdown in fluency is the result of speaking demands exceeding speech production capacities. For the subjects in the Hall et al's (1993) study, the linguistic demands of well-developed lexical abilities exceeded the morphosyntactic capabilities, leading to fluency disorder. These findings have

clear implications for intervention in child language disorders in achieving better co-ordination among lexical, morphosyntactic and speech production processes. At the same time, it is equally important to gain an understanding of the manifestations of change in linguistic skills as related to fluency in children with language disorder for designing intervention, but potentially as a means of marking change. If disfluency may be considered a marker for dysynchronies among linguistic skills in children with language disorders, it may also be a signifier of change in these skills. Therefore, studying change in fluency and language in children with language disorders over time may provide insight into the improvement of language abilities.

Weiss & Zebrowski (1994) evaluated the narrative ability of 16 normal and stuttering children in the age range of 5-11 years. Analysis of the length and complexity of the stories and their constitution episode in stutterers revealed some non-significant differences between the narratives produced by the normal subjects. Most of the stories produced by stutterers were shorter and fewer complete episodes than those produced by their age and gender matched peers. Additionally looking at the relationship between language and fluency in child language disorders over time may aid in our understanding of this relationship in those with fluency disorders thus providing valuable information for identifying speech and language disorder and planning for intervention, as well as for developing and modifying theories.

Hall (1996) conducted a follow-up study on fluency and language data on nine of the children who were investigated in 1993 by the same author.

Comparisons from the previous study indicated improvement in fluency correlated with more synchronous language development. Individual subjects differed in fluency characteristics and language profiles and speculations are offered regarding the role fluency may play in identifying dysynchonies in language development and differentiating language impairments.

Yairi, Ambrose, Paden & Throneburg (1996) found that children with stuttering scored significantly lower on both receptive and expressive components of the Preschool Language Scale Revised. Watkins & Yairi (1997) found that children whose stuttering persisted showed greater variability in their language production than their spontaneously recovered counterparts. They concluded that language deficits do not appear to be widespread in children with stuttering.

Watkins, Yairi & Ambrose (1999) analyzed the expressive language abilities of preschool aged children with stuttering (2-5 years). They analyzed the language on lexical, morphological and syntactic measures on Developmental Sentence Scoring for syntactic analysis. They found that their subjects showed no significant differences on DSS.

Prachi (2001) studied the syntactic abilities of children with stuttering in comparison with their normal peers. The subjects were seven children with stuttering aged 2.3 to 4.1 years and age matched normal children. The Screening Test for Acquisition of Syntax in Kannada (Basavaraj, 1981) was administered. The results indicated that children with stuttering were significantly lower than age controls on total comprehension, total expression and total scores. Significant

differences between the two groups were obtained on adjectives, embedded sentences and narration among the expression items. But the difference between comprehension and expression scores of children with stuttering was not significantly greater than that for age controls.

The review on linguistic abilities of children with stuttering is equivocal. Some studies indicate poorer linguistic abilities in stutterers compared to their normal peers while some do not,suggesting subgroups among stutterers.

IV Interaction of language and speech motor aspects:

Peters & Starkweather (1990) have formulated hypothesis and suggested lines of research to explore the relationship between motoric and linguistic function in stutterers. They suggest three hypotheses that seem to account for these findings:

1. Sub-group Hypothesis: There are sub-groups of clients with stuttering such that one develops primarily out ofmotoric deficit while another develops it primarily out ofa linguistic deficit.

2. Interference Hypothesis: Language and speech motor act processes may interfere with one another during the act of talking, at least in children who are beginning to stutter. This interference hypothesis is based on research in non-stutterers, which suggests that the simultaneous performance of language formulation and motor programming may result in deterioration of performance in one or both areas (Kinsboume & Hicks, 1978). Such a

hypothesis is suggestive for a number of reasons one of which is the explanation it offers for the location of stuttering between sentences. The location that has the most power in eliciting stuttering are those that are complex both linguistically and motorically. For example, the beginning of a sentence or clause, where movement is fast and where formulation activity is most likely to occur, is the most probable location for stuttering. Also, longer sentences are more likely to be stuttered than a shorter one (Bloodstein & Gantwerk, 1967; Jayaram, 1984) and longer sentences might be expected to be motorically more complex and therefore require more formulation effort as well as effort of motor programming

3. Competence and Performance Hypothesis: Competence and performance have different effects on fluency. Higher levels of language competence (knowledge) could hinder fluency by creating a large lexicon and a greater available pool of syntactic forms from which to choose words and formulate sentences. Higher-level performance skills such as word finding and sentence construction can only improve fluency by increasing the rate at which language performance is executed. In this way, the child whose language is delayed, although he or she is not hindered by a large vocabulary or syntactic variation, might find it difficult to find words even from a small lexicon or to construct even simple sentences and perform motor activities.

Peters & Starkweather (1990) have suggested several lines of research to test the above hypotheses. Administering various tests for language skills, oral

motor behavior, and tests of general motor behavior and motor coordination can test the first hypothesis. If there are subtypes with purely motoric/purely linguistic, the clients with stuttering should produce low scores on either of the two variables. An investigation of the speech motor/language interference hypothesis requires two comparisons: (1) comparison of the interference effect of a language task on a simultaneous speech motor task with interference effect of a non-language cognitive task on simultaneous speech motor performance and (2) comparison of the interference effect of a non-speech motor task on simultaneous language performance. Investigating relationship between stuttering and cluttering in more detail can test the third hypothesis.

Deepa (1994) and Nandakumar (1994) attempted verification of the second hypothesis. Each of them evaluated 15 children with stuttering in the age range of 6-9 years and 9-12 years, respectively and compared their performance with age matched normal children. They tested the children on interference between (I) language and speech motor tasks, (2) language and non-speech motor tasks, and (3) cognition and non-speech motor tasks. The results of their studies indicated that children with stuttering had interference between language and speech motor act, which was not found in normal children. However, the subject number was small for the authors to conclude on sub grouping or interference. In this context, the present study aimed at verifying the **Sub grouping and Language and speech motor interfernce hypotheses** in children with stuttering.

CHAPTER Ⅲ

METHOD

The principle question about stuttering 25-30 years age was what is it?What causes it ? How should we treat it? Those were the big question then, and of course, they are still unanswered now. A very large amount of information about stuttering has accumulated but the basic question remains....What relationship, if any, does early stuttering have to normal childhood disfluency...(Bloodstein, 1987).

Subjects: Subjects for this study were from two groups. Group I consisted of 100 Kannada speaking children with stuttering and Group II consisted of 100 normal children matched for age and gender. In group I, only those children (a) diagnosed to have stuttering by a speech pathologist (b) with no visual or any other speech and hearing problems, (c) having normal orofacial structure and function, and (d) normal intelligence as assessed by a psychologist were considered. Table 2 depicts subject details:

Age Range (in years)	Group I			Group II		
	Boys	Girls	Total	Boys	Girls	Total
3-4	4	6	10	4	6	10
4-5	8	2	10	8	2	10
5-6	7	3	10	7	3	10
6-7	6	4	10	6	4	10
7-8	7	3	10	7	3	10
8-9	9	1	10	9	1	10
9-10	8	2	10	8	2	10
10-11	8	2	10	8	2	10
11-12	6	4	10	6	4	10
12-13	9	1	10	9	1	10
Total	72	28	100	72	28	100

Table 2 : Subject details.

Material:

Task 1 - Testing subgroup hypothesis: In this, speech motor and linguistic abilities were examined.

A) Speech motor abilities: Examination of speech mechanism and oral motor examination

Material: This consisted of two sub tests- (a) examination of speech mechanism,

and(b) oral motor coordination. Oral motor coordination activites were based on motor activities developed by Kavitha (1989). The test contained 30 items of which 20 items were non-speech related items and 10 were speech related items. Speech related items consisted of utterance of single syllable sequence and triple syllable sequence. Table 3 shows test items for oral motor coordination.

I Nonspeech related items	**II Speech related items**
A. Lip	**A. Single verbal sequence**
1. Rounding	1. p..t…k
2. Retraction	2. k...t....k
3. Closing lip from open position	3. t…t….p
4. Opening lips with teeth clenched	4. p…p…t
5. Side to side movement of lips	5. k…k…t
6. Upper teeth on lower lip	
7. Lower teeth on upper lip	**B. Triple sequence**
B. Tongue	l.p..t..k p..t..k p..t..k
8. Tongue tip behind lower teeth	2. k..t..p k..t..p k..t..p
9. Tongue tip behind upper teeth	3. t..t..p t.t.p t.t.p
10. Protrusion of the tongue	4. p..p..t p..p..t p..p..t
11. Tongue on lower lip	5. k..k..t k..k..t k..k..t
12. Tongue on upper lip	
13. Side to side movement of the tongue	
14. Elongation outside the mouth	
15. Bite tongue	
16. Alternate retraction and protrusion of the tongue	
17. Raising and lowering of the tongue against upper lip and lower lip	
18. Touch chin with tongue tip	
C. **Jaw**	
19. Chewing	
20. Opening mouth as in yawning	

Table 3: Test items for oral motor coordination.

Procedure: Subjects were tested individually. They were seated comfortably in a quiet place and were examined for oral structure and function. For oral motor

coordination activities subjects were provided with models of each item and were instructed to make the movements. Practice trial was given to subjects before the actual task. Speech related items were evaluated by instructing the client to utter single and triple sequences of /p.t.k/ as fast as possible.

Scoring: A score of T was given for each correct performance on oral motor coordination activity and a score of '0' was given if the subject was unable to perform the activity or showed significant difficulty on an item. Also distorted or fragmented activities were scored '0'.

B) Linguistic Analysis:

Material: Appropriate language test (Appendix -I) was administered depending on the age of the subject. Screening Test of Acquisition of Syntax in Kannada (STASK - Basavaraj, 1981) was administered to children in the age range of 3-5 years, Language Test in Kannada (KLT - RRTC & AYJNIHH, 1990) was administered to children in the age range of 5-7 years and Linguistic Profile Test (LPT - Suchitra & Karanth , 1990) was administered to children above 7 years of age.

Procedure: Subjects were tested individually and they were instructed appropriately depending on the test.

Scoring: A score of '1' for each appropriate response and a score of '0' for each inappropriate response was given.

Task 2 - Testing Interference Hypothesis: This consisted of three sub tests - viz. -

a) Interference between language and speech motor skill,

b) Interference between language and non-speech motor skill, and

c) Interference between cognitive and non-speech motor skill.

Material: For test (a) and (b), material was selected based on the age of the subject. For children in the age group of 3-5 years, eight picturable meaningful Kannada words were selected which were categorized under nouns and verbs. Two of these words were considered as key words. Table 4 shows the word list and figure 3 shows the pictures.

Nouns	**Verbs**
Flower	Eating
Bus*	Sleeping
Biscuit	Brushing
Cat	Drinking*

Table 4: Word list for children in the age group of 3-5 years. (* Key words).

For children in the age group of 5-13 years, 16 picturable meaningful Kannada words categorized under nouns, adjectives, transitive and intransitive verbs were selected. Four of these words were considered as key words. Table 5 shows the word list and figure 4 shows the pictures. :

Noun	Adjective	Transitive verb	Intransitive Verb
Mustache*	White	Writing	Dancing
Knife	Yellow*	Brushing	Running
Vessel	Red	Reading*	Coughing
Leg	Brown	Washing	Crying*

Table 5: Word list for children in the age group of 5-13 years (* Key words).

Four sets of pictures were made for testing each group of children. Each set consisted of two stalks (3-5 year children) or four stalks (5-13 year children) of pictures in which pictures representing key words were arranged in a random order. The key words as uttered four times by an adult normal female was audio-recorded on a cassette with an inter-word interval of 5 seconds, which formed the audio-material. For test (c), puzzles appropriate for the age group were selected as in figures 5 and 6.

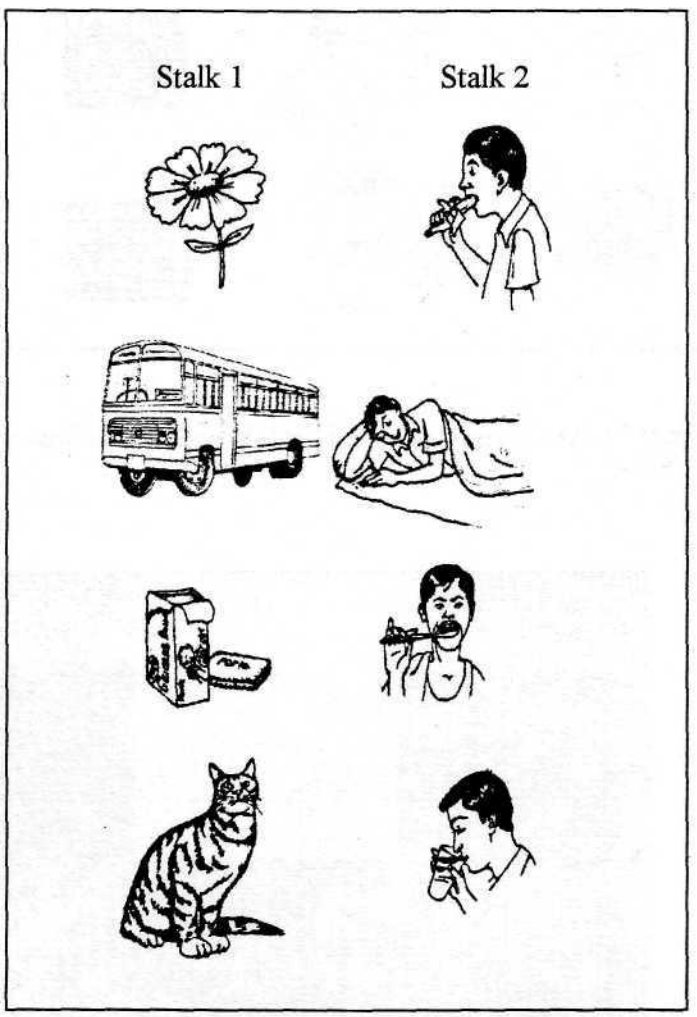


Figure 3: Picture cards used for children in the age range of 3-5 years.

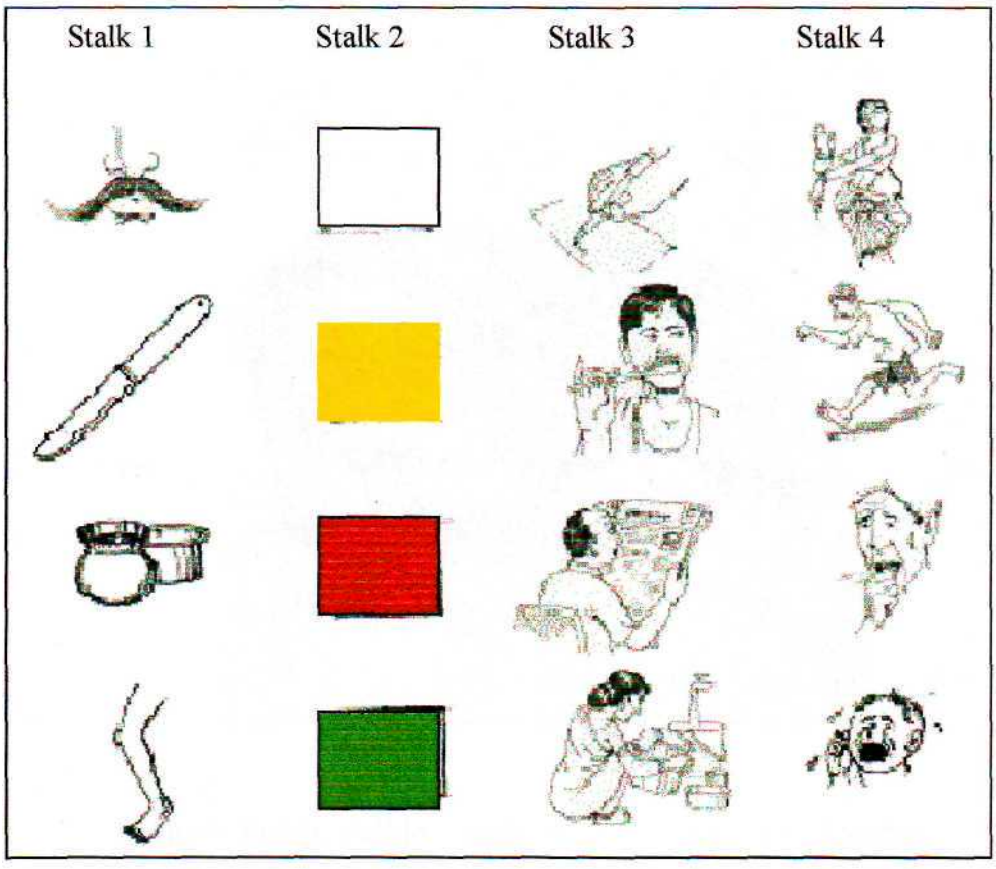


Figure 4: Picture cards used for children in the age range of 5-13 years.

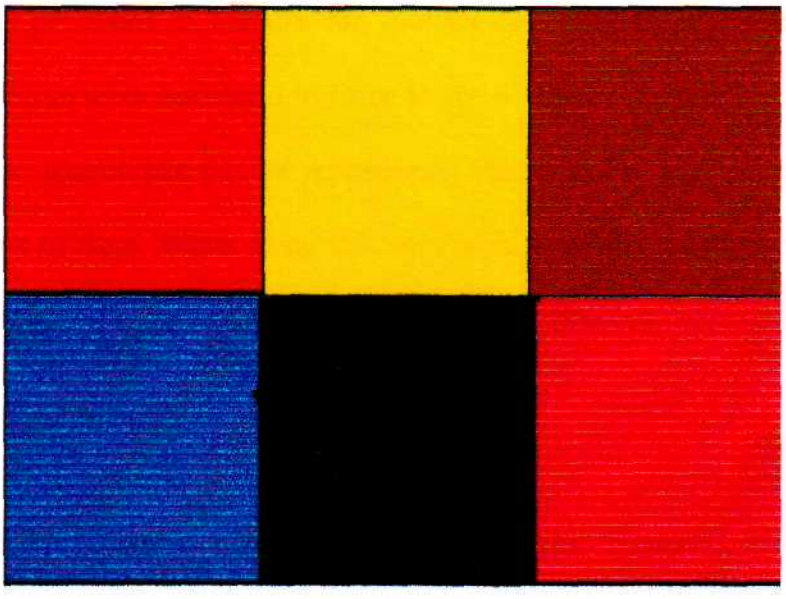


Figure 5: Puzzle used for children the age range of 3-5 years.

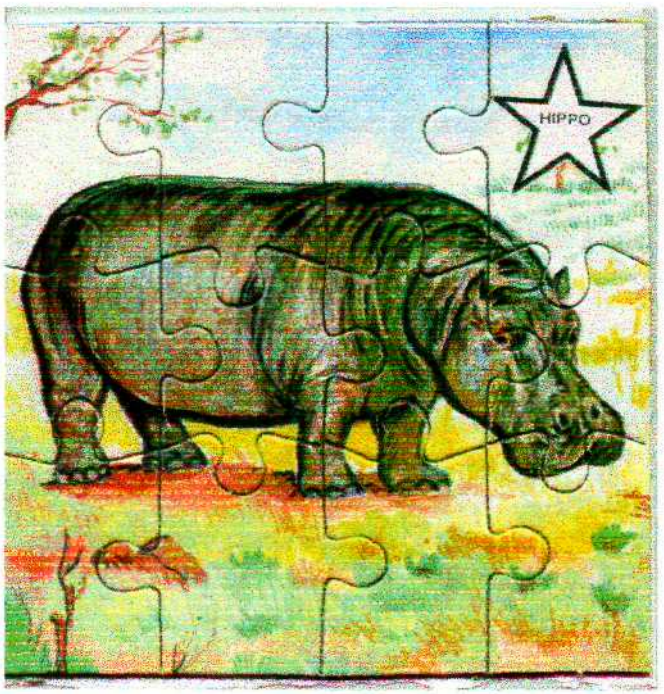


Figure 6: Puzzle used for children the age range of 5-13 years.

Procedure: Subjects were tested individually. They were seated comfortably in a quiet place and the audio-material was presented through headphones. Picture sets were visually presented in 2 stalks for younger children and in 4 stalks for older children. Children were instructed to listen to the words through the headphones and 10 point to the appropriate picture representing the word in the set of 8/16 pictures placed in front of them. While doing this, they were instructed to simultaneously and continuously say "papapa" fbr test (a) (Interference between language and speech motor task).

The same experiment was conducted for test (b). However, in this, subjects were instructed to simultaneously and continuously tap his/her foot (Interference between language and non-speech motor task). In test (c), subjects were provided

with a puzzle and he/she was instructed to complete the puzzle by referring to the model. While performing this task, the subject was asked to tap his /her foot simultaneously and continuously (Interference between cognitive and non-speech motor task).

Scoring: A score of T was given for a correct performance on each test and a score of '0' was given for an incorrect performance (Unable to point to appropriate picture/unable to tap foot correctly/unable to repeat 'papa.../ continuously/unable to complete the puzzle/interrupting the task by either stopping, repeating initial syllable or prolonging it).

Statistical analysis: The total score on each task was computed for each subject and the raw scores were converted to percentage scores. Canonical Discriminant Function Analysis was performed for sub grouping and Two-way Analysis of Variance was carried out across the three tests to find the significant difference between the tasks across various ages and groups. This was followed by Duncan Post Hoc test to identify the locus of significant difference.

CHAPTER IV

RESULTS AND DISCUSSION

"Stuttering speaks are so greatly disfluent...in that their abilities to generate error free speech programs are disordered"(Postma & Kolk,1993)

The results are presented in two major sections. The first section presents the data on sub grouping children with stuttering and the second section presents data on language and speech motor interference.

Task 1-Testing Subgrouping Hypothesis

Children were tested for structure and function of speech mechanism. Tests for oral motor coordination and language were administered to all children with stuttering and normal children. The results indicated that all children had normal oral structure and function. Children with stuttering obtained lower scores compared to normal children on all tests. Also, in children with stuttering, range of scores was wider compared to normal children. Some children with stuttering performed better compared to normal children on tests of oral motor coordination and language. Also, scores of children in both groups on all tests increased with increase in age. Table 6 shows the average and range of scores on nonspeech related items, speech related items, total of nonspeech and speech related

Age in Years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
3-4	10.2	2.4	12.6	57.8	13.9	4.2	18.1	71.6
4-5	11.6	4.3	15.9	68.6	15.7	5.9	21.6	79.0
5-6	15.1	4.7	19.8	71.9	17.0	6.1	23.1	81.1
6-7	17.2	51.	22.3	83.4	19.9	6.1	26.0	92.6
7-8	16.2	5.4	21.6	200.4	19.8	7.2	27.0	212.0
8-9	17.4	6.1	23.5	201.4	19.8	8.8	28.6	252.4
9-10	16.4	6.8	23.2	237.2	19.9	9.3	29.2	271.1
10-11	18.6	**7.9**	26.5	240.7	19.8	9.6	29.4	280.4
11-12	18.6	8.4	27.0	240.5	19.9	9.6	29.5	280.0
12-13	18.5	6.1	24.6	265.1	20.0	9.9	29.9	265.1
Average	15.98	5.72	21.7	135.15	18.57	7.67	26.24	188.53
Range	10.2-18.6	2.4-8.4	12.6-27.0	57.8-24.95	13.9-20.0	4.2-9.9	18.1-29.9	71.6-280.4

Table 6: Scores on non speech related items (NS), speech related items (S), total of NS and S (T), and language test (L).

A Canonical Discriminant Function Analysis indicated no subgrouping of children with stuttering. Figure 7 shows the Canonical Discriminant Function Analysis.

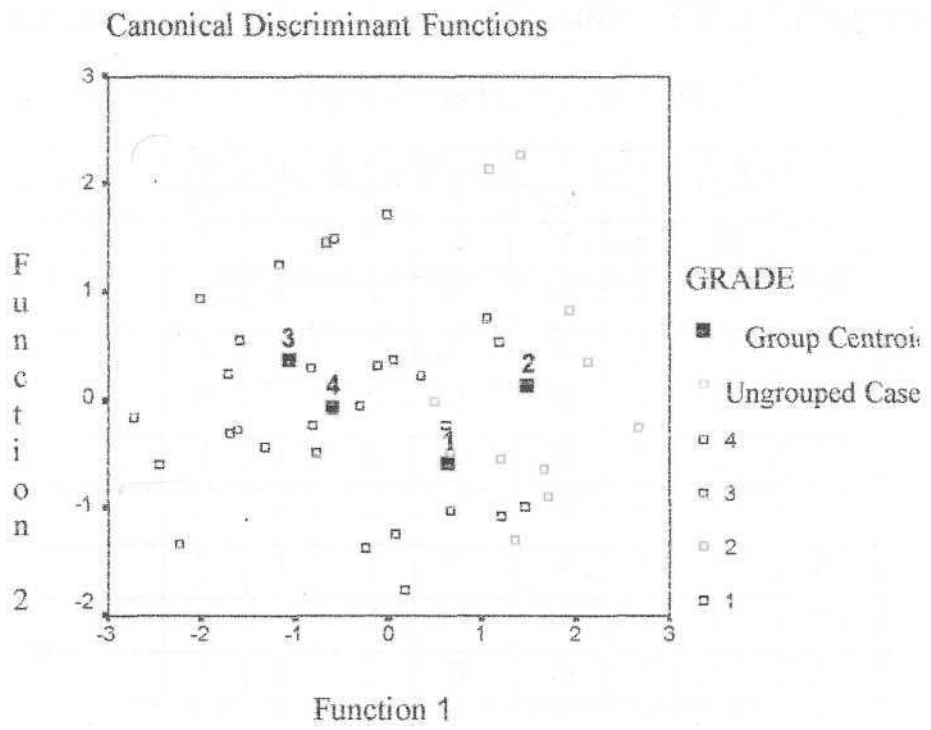


Figure 7: Canonical discriminant function analysis for subgrouping children with stuttering.

As canonical discriminant function analysis did not reveal any subgrouping, descriptive statistics was used for subgrouping. Scores obtained by children with stuttering on tests of oral motor coordination and language were compared with those obtained by normal children. Mean scores of normal children on tests of oral motor coordination and language in each age group were considered as standard. Those children with stuttering who scored higher than standard scores (either on test of oral motor coordination or language or both) were considered as better performers. Children who scored less compared to standard scores on test of oral motor coordination were grouped under '**predominantly motor**', children who scored less compared to standard scores on language test were grouped under '**predominantly linguistic**' and children who scored less compared to standard scores on both oral motor coordination test and

language test were grouped under '**motoric and linguistic**'. Tables 7-16 show details of scores in age group and table 17 shows the results of subgrouping.

Age in Years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
3-4	9	2	11	43	13	6	18	60
	12	3	15	43	12	5	17	62
	13	2	15	41	12	5	17	59
	12	3	15	52	17	4	21	63
	9	3	12	55	18	4	22	74
	10	2	12	60	12	5	17	73
	9	3	12	62	12	4	16	83
	9	3	12	64	14	3	17	78
	9	2	11	76	13	4	17	83
	10	1	11	82	16	2	18	81
Average	10.2	2.4	12.6	57.8	13.9	4.2	18	71.6
Range	9-13	1-3	11-15	41-82	12-18	2-6	16-22	59-83

Table 7: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 3-4 years children.

Age in Years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
4-5	18	5	23	53	17	5	22	66
	9	4	13	55	17	6	23	73
	12	7	19	61	16	4	20	72
	11	7	18	66	16	6	22	74
	11	6	17	67	16	7	23	76
	12	4	16	73	16	5	21	80
	11	4	15	74	17	5	22	81
	12	2	14	75	14	7	21	80
	11	1	12	79	13	6	19	93
	9	3	12	83	15	8	23	95
Average	11.6	4-3	15.9	68.6	15.7	5.9	21.6	79.0
Range	9-18	1-7	12-23	53-83	13-17	4-8	19-22	66-95

Table 8: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 4-7 years children.

Age in years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
5-6	20	5	25	56	20	5	25	66
	14	4	18	58	19	6	25	71
	18	4	22	60	18	6	24	69
	14	5	19	64	17	6	23	83
	16	6	22	71	17	6	23	64
	15	6	21	71	15	6	21	93
	16	4	20	76	16	6	22	95
	13	4	17	75	16	**6**	22	83
	11	3	14	93	15	8	23	91
	14	6	20	95	**17**	**6**	**23**	%
Average	15.1	4.7	19.8	71.9	17	6.1	23.1	81.1
Range	11-20	3-6	14-25	56-95	15-20	5-8	21-25	64-96

Table 9: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 5-6 years children.

Age in years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
6-7	19	5	24	72	20	7	27	93
	19	7	26	73	20	6	26	89
	17	6	23	75	20	6	26	97
	18	5	23	79	20	6	26	101
	15	6	21	80	19	5	24	95
	20	5	25	85	20	5	25	93
	19	5	24	85	20	6	26	86
	14	4	18	93	20	7	27	84
	15	4	19	95	20	5	25	93
	16	4	20	97	20	8	28	95
Average	17.2	5.1	223	83.4	194	6.1	26.0	926
Range	14-20	4-7	18-26	72-97	19-20	5-8	24-28	84401

Table 10: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 6-7 years children.

Age in years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
7-8	20	7	27	177	19	7	26	210
	20	5	25	181	20	6	26	209
	17	5	22	191	19	6	25	205
	18	7	25	202	20	6	26	217
	20	7	27	202	20	8	28	219
	15	4	19	204	20	9	29	217
	12	5	17	207	20	8	28	200
	13	6	19	211	20	7	27	220
	13	4	17	214	20	6	26	210
	14	4	18	215	20	9	29	213
Average	162	5.4	21.6	200.4	19.8	7.2	27	212
Range	16.2	4-7	17-27	177-215	19-20	6-9	25-29	200-219

Table 11: Scores on non speech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 7-8 years children.

Age in years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
8-9	19	6	25	219	20	9	29	225
	17	7	24	217	20	10	30	240
	19	5	24	216	20	8	28	253
	20	10	30	214	20	7	27	260
	19	5	24	213	19	10	29	239
	17	8	25	211	19	7	26	251
	16	5	21	183	20	9	29	268
	17	6	23	183	20	9	29	266
	15	5	20	180	20	10	30	259
	15	4	19	178	20	9	29	263
Average	17.4	6.1	23.5	201.4	19.8	8.8	28.6	252.4
Range	15-20	4-10	19-30	178-219	19-20	7-10	26-30	225-268

Table 12: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 8-9 years children.

Age in years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	**T**	L
9-10	20	10	30	190	20	9	29	260
	20	8	28	210	19	9	28	265
	16	7	23	212	20	7	28	245
	19	7	26	212	20	10	30	273
	19	6	25	231	20	9	29	276
	12	7	19	252	20	10	30	280
	12	6	18	265	20	10	30	256
	17	5	22	266	20	10	30	279
	17	5	22	266	20	10	30	286
	12	7	19	268	20	9	29	291
Average	16.4	6.8	23.2	237.2	19.9	9.3	29.3	271.1
Range	12-20	5-10	18-30	190-268	19-20	7-10	28-30	245-291

Table 13: Scores on non-speech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 9-10 years children.

Age in years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
10-11	20	10	30	218	20	10	30	275
	20	10	30	228	20	10	30	290
	16	8	24	230	19	7	26	263
	14	4	18	234	19	10	29	286
	20	10	30	234	20	9	29	269
	19	6	25	240	20	10	30	289
	19	5	24	240	20	10	30	270
	20	10	30	250	20	10	30	283
	18	6	24	261	20	10	30	292
	20	10	30	272	20	10	30	287
Average	18.6	7.9	26.5	240.7	19.8	9.6	29.4	280.4
Range	14-20	4-10	18-30	218-272	19-20	7-10	26-30	263-292

Table 14: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 10-11 years children.

Age in years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
11-12	20	10	30	230	20	10	30	268
	20	10	30	232	19	8	30	270
	20	9	29	236	20	10	30	281
	20	10	30	248	20	10	30	277
	19	8	27	251	20	8	30	283
	19	5	24	252	20	10	30	284
	20	10	30	255	20	10	30	286
	19	7	26	257	20	10	30	279
	14	7	21	266	20	10	30	291
	15	8	23	268	20	10	30	289
Average	186	8.4	27	249.5	19.9	9.6	30	280.8
Range	14-20	5-10	21-30	230-268	19-20	8-10	30	268-291

Table 15: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 11-12 years children.

Age in Years	Children with Stuttering				Normal Children			
	NS	S	T	L	NS	S	T	L
12-13	20	10	30	245	20	10	30	245
	20	5	25	250	20	10	30	250
	20	10	30	252	20	10	30	252
	20	9	29	256	20	10	30	256
	20	4	24	260	20	10	30	260
	17	4	21	273	20	10	30	273
	20	6	26	276	20	10	30	276
	17	5	22	279	20	10	29	279
	16	4	20	280	20	9	30	280
	15	4	19	280	20	10	30	280
Average	18.5	6.1	24.6	265.1	20	10	29.9	265.1
Range	15-20	4-10	19-30	245-280	20	9-10	29-30	245-280

Table 16: Scores on nonspeech related items (NS), speech related items (S), total of NS and S (T), and language test (L) of 12-13 years children.

Age range	N	Purely Motoric	Purely Linguistic	Motoric and Linguistic
3-4	10	2	-	8
4-5	10	2	1	7
5-6	10	2	1	7
6-7	10	3	1	6
7-8	10	2	2	6
8-9	10	-	1	9
9-10	10	-	1	9
10-11	10	-	5	5
11-12	10	-	4	6
12-13	10	5	2	3
Total	100	16	18	66

Table 17: Subgrouping children with stuttering.

The results of descriptive statistics indicated that 16% of children with stuttering had purely motoric problem, 18% had purely linguistic problem and 66% had both motoric and linguistic problems. The results also indicated that motoric or linguistic difficulties were not unique to any age group studied. However, among the children studied, no child in the age range of 8-12 years could be grouped under 'purely motoric'.

Task 2-Testing Interference Hypothesis

This consisted of three sub tests viz.

(a) Interference between language and speech motor skill,

(b) Interference between language and non-speech motor skill, and

(c) Interference between cognitive and non-speech motor skill

1) **Comparison of children with stuttering on three tests of language and speech motor interference:**

. Generally, the performance of children with stuttering was better on test (c) followed by test (b) and test (a). On test (a) and (b), the scores increased with increase in age. On test (c), scores increased from 3 years to 10 years. Table 18 shows the mean score and standard deviation on all the three tests. Figure 8 shows the scores of children with stuttering in all the tests. Significant difference (at 0.01 level) between the scores of three tests was observed.

No. of subjects	Age in years	Test (a)	Test (b)	Test (c)
10	3-4	7.5 (12.07)	25.0 (11.7)	20.0 (42.16)
10	4-5	7.5 (12.07)	22.5 (18.44)	30.0 (48.30)
10	5-6	15.0 (12.90)	27.5 (18.44)	40.0 (51.63)
10	6-7	15.0 (17.48)	35.0 (12.90)	60.0 (51.63)
10	7-8	17.5 (20.58	42.5 (26.48)	70.0 (48.30)
10	8-9	32.5 (12.07)	40.0 (21.08)	80. (42.16)
10	9-10	32.5 (20.58)	75.0 (23.57)	100 (.00)
10	10-11	32.5 (26.48)	92.5 (16.87)	100 (.00)
10	11-12	55.0 (36.89)	77.5 (27.52)	100 (.00)
10	12-13	55.0 (22.97)	92.5 (16.87)	100 (.00)
Average		27.0	53.0	70.00

:

Table 18: Mean score and standard deviation (in parenthesis) on all three tests in children with stuttering.`

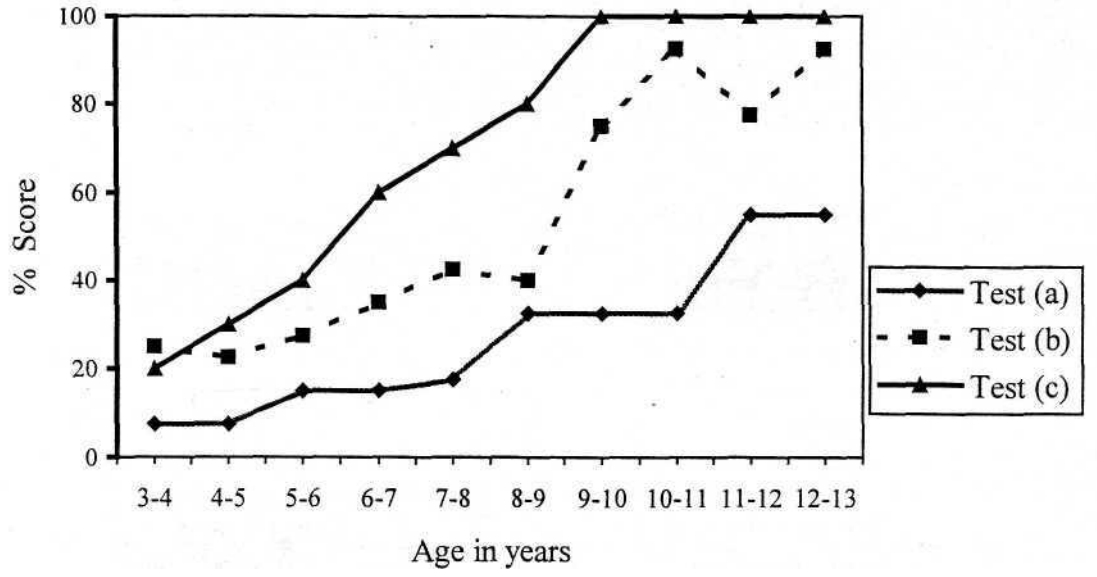
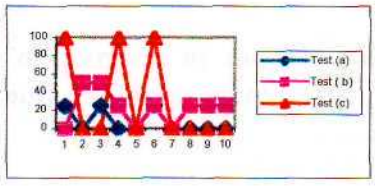
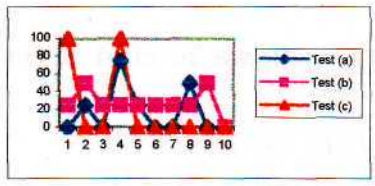


Figure 8: Scores of children with stuttering on all three tests.

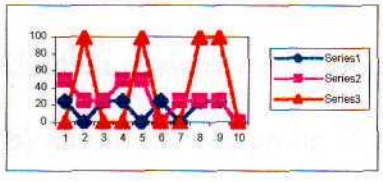
Individual Performance: Children with stuttering performed better on test (c) compared to test (b) and test (a). In the age group of 3-4 years, 60% of children obtained 0 score on test (a) and 10% of children obtained 0 score on test (b). Among 4-5 year old children, 70% obtained 0 score on test (a) and 30% obtained 0 score on test (b). In the age group of 5-6 years, 40% and 20% obtained 0 score on test (a) and (b), respectively. Among children in 6-7 years, 50% and 10% obtained 0 score on test (a) and (b), respectively. 10% and 20% of children in 8-9 years scored 0 on test (a) and (b), respectively. 10% (9-10 years), 30% (10-11 years) and 20% (11-12 years) scored 0 on test (A). Also, 10% of children in the age group of 11-12 years scored 0 on test (b). None of the children in the age group of 12-13 years scored 0 on any test. Figure 9 shows percent scores obtained by children with stuttering on all the three tests. The results indicated that children's score increased with increase in age though not linearly.



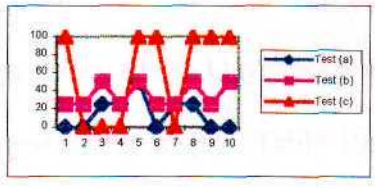
3-4 years



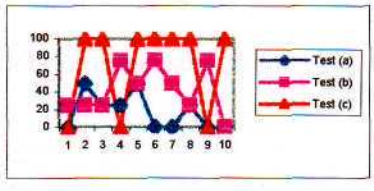
4-5 years



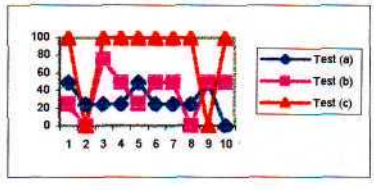
5-6 years



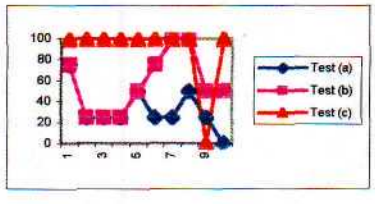
6-7 years



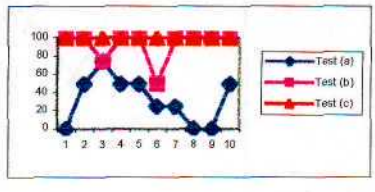
7-8 years



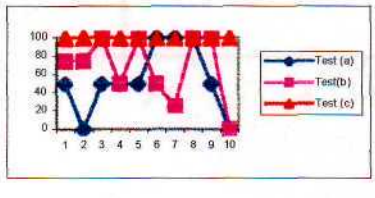
8-9 years



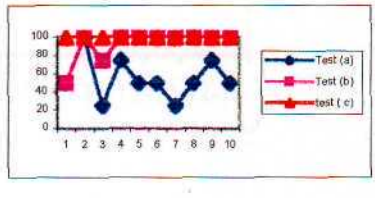
9-10 years



10-11 years



11-12 years



12-13 years

Figure 9: Performance of children with stuttering (x axis shows subject number and Y axis shows % score).

Comparison of normal children on all three tests of language and speech motor interference:

In general, performance of normal children was better on test (b), followed by test (c) and test (a). Scores increased from 3-13 years, though not linearly. Children attained maximum score in the age group of 10-11 years on test (a) and (b) and in the age group of 8-9 and 11-12 years on test (c). Table 19 shows the mean score and SD on all the tests. Figure 10 shows percent scores of normal children on all the tests. Two-way ANOVA showed significant difference between the scores of three tests at 0.01 level.

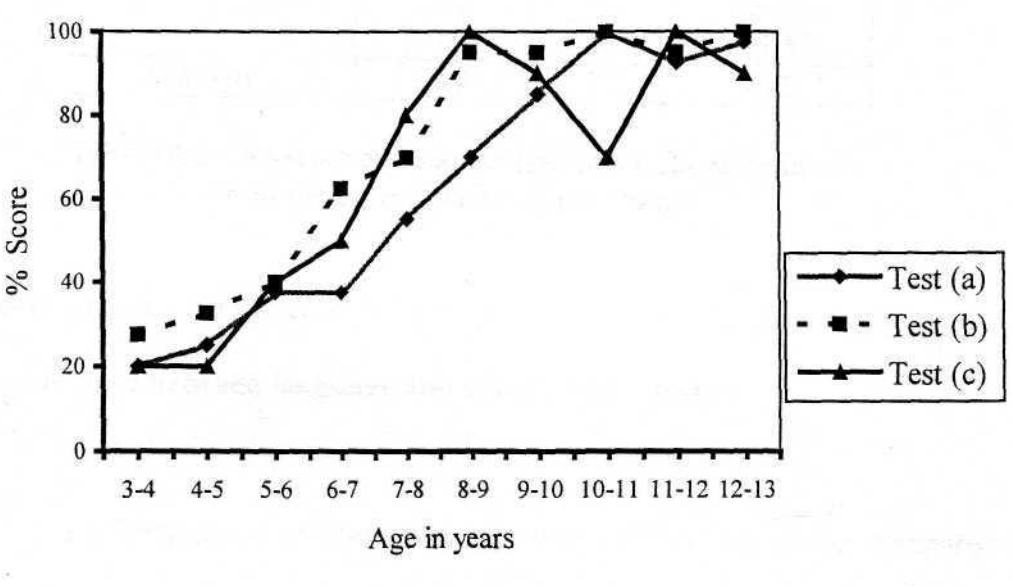


Figure 10: Percent score in normal children on all the tests.

No. of subjects	Age in years	Test (a)	Test (b)	Test (c)
10	3-4	20.0 (15.81)	27.5 (7.90)	20.0 (42.16)
10	4-5	25.0 (16.66)	32.5 (12.07)	20.0 (42.16)
10	5-6	37.5 (17.67)	40.0 (26.87)	40.0 (51.63)
10	6-7	37.5 (17.67)	62.5 (29.46)	50.0 (52.70)
10	7-8	55.0 (10.54)	70.0 (22.97)	80.0 (42.16)
10	8-9	70.0 (10.54)	95.0 (10.54)	100 (.00)
10	9-10	85.0 (21.08)	95.0 (15.81)	90 (31.62)
10	10-11	100.0 (.00)	100. (.00)	70 (48.30)
10	11-12	92.5 (16.87)	95.0 (15.81)	100 (.00)
10	12-13	97.5 (7.90)	100 (.00)	90. .00 (311.62)
Average		62.0	72	66.0

Table 19: Mean score and standard deviation (in parenthesis) on all the three tests in normal children.

3) **Performance of children with stuttering and normal children on test (a) - Interference between language and speech motor tasks:**

Performance of children with stuttering (27%) was poorer compared to normal children (62%) on test (a). Children with stuttering (in all the age groups) performed poorly compared to normal children. Also, children with stuttering showed high individual variability. Figure 11 shows the performance of children with stuttering and normal children on test (a). Maximum difference between children with stuttering and normal children was noticed in the age of 10-11 years and least difference was noticed in the age of 3-4 years. Table 20 shows the mean

score and standard deviation in children with stuttering and normal children on test (a). Two-way ANOVA showed significant differences between groups (F = 118.06 at 0.00 level), age (F = 34.55 at 0.00 level), and interaction between group and age (F = 4.37 at 0.00 level).

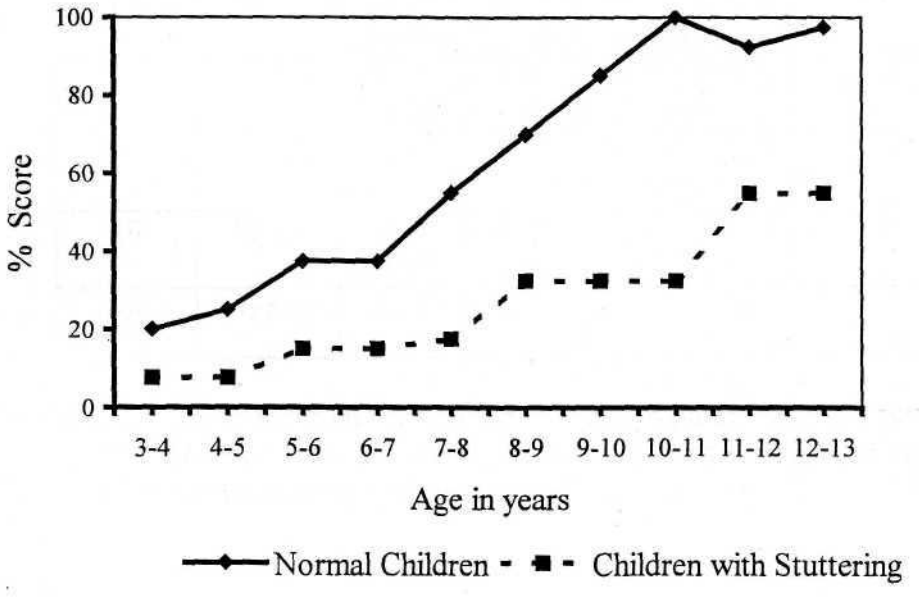


Figure 11: Percent scores in children with stuttering and normal children on test (a).

No. of Subjects	Age in years	S	N	Total	N-S	Duncan post hoc analysis
10	3-4	7.5 (12.07)	20.0 (15.81)	13.75 (15.12)	12.5	a
10	4-5	7.5 (12.07)	25.0 (16.66)	16.25 (16.77)	17.5	ab
10	5-6	15.0 (12.90)	37.5 (17.67)	26.25 (18.97)	22.5	be
10	6-7	15.0 (17.48)	37.5 (17.67)	26.25 (18.97)	22.5	be
10	7-8	17.5 (20.58)	55.0 (10.54)	36.25 (24.96)	37.5	cb
10	8-9	32.5 (12.07)	70.0 (10.54)	51.25 (22.17)	37.5	d*
10	9-10	32.5 (20.58)	85.0 (21.08)	58.75 (33.17)	52.5	d*
10	10-11	32.5 (26.48)	100 (0.00).	66.25 (39.13)	67.5	de
10	11-12	55.0 (36.89)	92.5 (16.87)	73.75 (33.90)	37.5	ef
10	12-13	55.0 (22.97)	97.5 (7.90)	76.25 (27.47)	42.5	ef
100	Average	27.0	62.0		35.0	

Table 20: Mean score and standard deviation (in parenthesis) on test (a) in children with stuttering (S) and normal children (N)(* same letters are not significantly different from each other).

4) **Comparison of children with stuttering and normal children on test (b) - Interference between language and non-speech motor skills:**

Mean score and standard deviation scores on test (b) across age groups for children with stuttering and normal children and significant difference between age groups (Duncan Post Hoc Analysis) are shown in table 21. In general, children with stuttering performed poorly compared to normal children. Performance of children varied across age groups. Normal children obtained maximum score at the age of 12-13 years while children with stuttering did not

obtain 100% scores even at 12-13 years of age. The difference in performance between groups was most evident at 8-9 years of age and least evident at 3-4 years of age. In both groups mean scores increased from 3-13 years of age, though not linearly. Significant difference between groups (F = 50.57 at 0.00 level), age (F = 44.54 at 0.00 level) and group and age interaction (F = 3.36 at 0.00 level) was noticed. Compared to test (a), the difference in the mean score of the two groups in test (b) was reduced. Figure 12 shows percent score obtained by both groups on test (b).

No. of Subjects	Age in years	S	N	Total	N-S	Duncan post hoc analysis
10	3-4	25.00 (11.78)	27.50 (7.90)	26.25 (9.85)	2.50	a*
10	4-5	22.50 (18.44)	32.50 (12.07)	27.50 (16.01)	10.00	a*
10	5-6	27.50 (18.44)	40.00 (26.87)	33.75 (23.33)	12.50	a*
10	6-7	35.00 (12.90)	62.50 (29.46)	48.75 (26.25)	27.50	b
10	7-8	42.50 (26.48)	70.00 (22.97)	56.25 (27.95)	27.50	bc
10	8-9	40.00 (21.08)	95.00 (10.54)	67.50 (32.54)	45.00	bc
10	9-10	75.00 (23.57)	95.00 (15.81)	85.00 (22.06)	25.00	d*
10	10-11	92.50 (16.87)	100 (.00)	96.25 (12.23)	8.50	d*
10	11-12	77.50 (27.51)	95.00 (15.81)	86.25 (23.61)	17.50	d*
10	12-13	92.50 (16.87)	100.00 (.00)	96.25 (12.23)	7.50	d*
100	Average	53.00	72.00		19.00	

Table 21: Mean score and standard deviation (in parenthesis) on test (b) in children with stuttering (S) and normal children (N) (* same letters are not significantly different from each other).

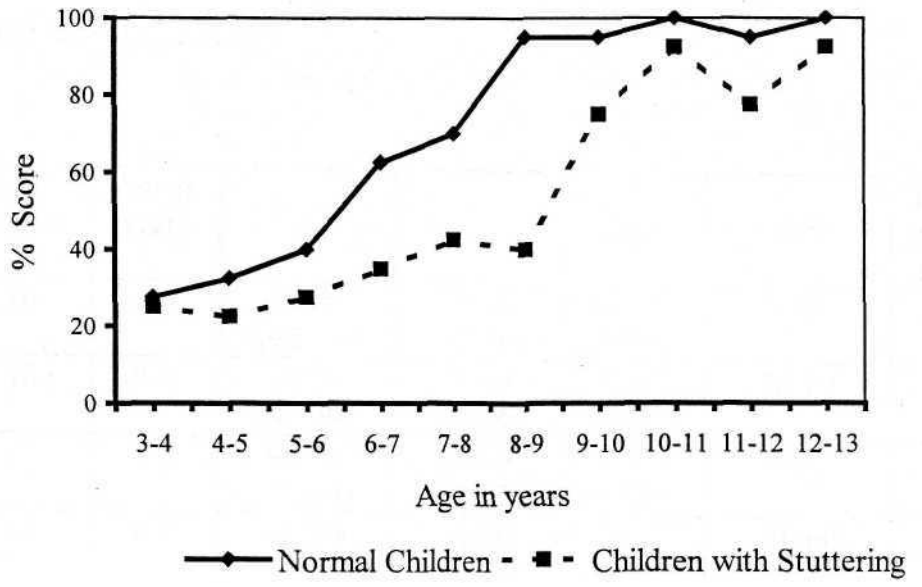


Figure 12: Percent scores in normal children and children with stuttering on test (b).

5) **Comparison of children with stuttering and normal children on test (c) - Interference between cognition and non-speech motor skill:**

Table 22 shows the mean scores on test (c) in both groups. It was interesting to observe that the performance of children with stuttering was better compared to normal children, except in the age group of 3-4, 5-6. 7-8, 8-9 and 11-12 years. The difference between scores of two groups was most evident in the age range of 10-11 years, with better scores in children with stuttering and was least evident in the age group of 3-4, 5-6 and 11-12 years, where both groups of children performed equally. In children with stuttering, scores increased from 3-13 years of age. However, it was not so in normal children. Two-way ANOVA indicated significant group and age effects. (F = 13.04 at 0.00 level). However, no significant differences were observed between groups and group Vs age interaction. Percent scores on test (c) are shown in figure 13. Children with stuttering obtained 70% on test (c) while normal children obtained 66%. Difference

between scores of children with stuttering and normal children was least in test (c) compared to test (a) and (b).

No. of subjects	Age in years	S	N	Total	N-S	Duncan post hoc analysis
10	3-4	20.00 (42.16)	20.00 (42.16)	20.00 (41.03)	0.00	a*
10	4-5	30.00 (48.30)	20.00 (42.16)	25.00 (44.42)	10.00	a*
• **10**	5-6	40.00 (51.63)	40.00 (51.63)	40.00 (50.26)	0.00	ab
10	6-7	60.00 (51.63)	50.00 (52.70)	55.00 (51.04)	-10.00	bc
10	7-8	70.00 (48.30)	80.00 (42.16)	75.00 (44.42)	10.00	cd
10	8-9	80.00 (42.16)	100.00 (0.00)	90.00 (30.77)	20.00	d*
10	9-10	100.00 (0.00)	90.00 (31.62)	95.00 (22.36)	-10.00	d*
10	10-11	100.00 (0.00)	70.00 (48.30)	85.00 (36.63)	-30.00	d*
10	11-12	100.00 (0.00)	100.00 (0.00)	100.00 (0.00)	0.00	d*
10	12-13	100.00 (0.00)	90.00 (31.62)	95.00 (22.36)	-10.00	d*
100		70.00	66.00		-4.00	

Table 22: Mean score and standard deviation (in parenthesis) on test (c) in children with stuttering (S) and normal children (N) (* same letters are not significantly different from each other).

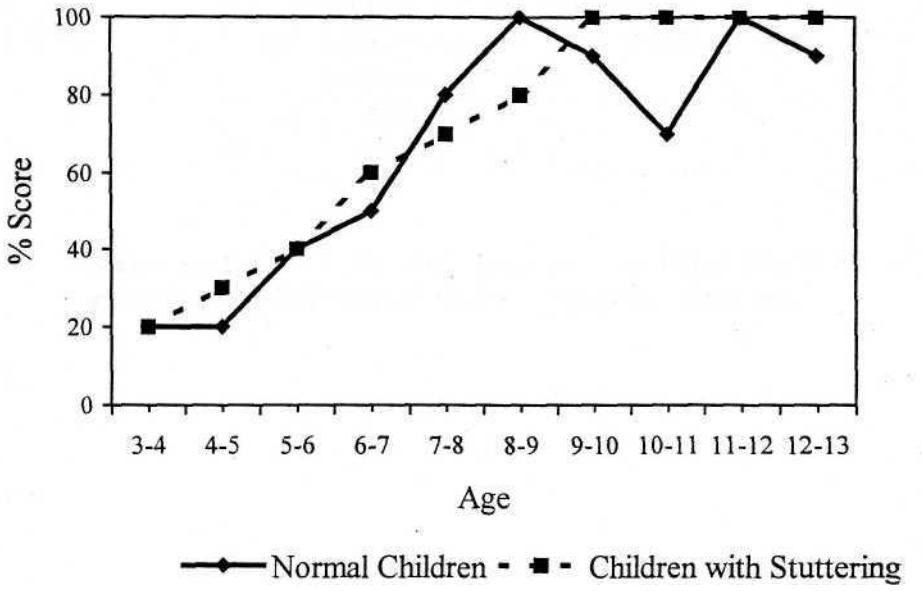


Figure 13: Percent scores in children with stuttering and normal children on test (c).

i) **Inter-test comparison between children with stuttering and normal children:**

Table 23 shows percent scores of children with stuttering and normal children across tests (a), (b) and (c). Children with stuttering performed poorly on test (a) and (b), and better on test (c) compared to normal children. Two-way ANOVA showed significant differences between tests ($F = 42.89$ at 0.00 level), -groups ($F = 58.75$ at 0.00 level), tests and group interaction ($F = 27.33$ at 0.00 level) and group Vs age interaction ($F = 1.96$ at 0.05 level). No significant differences were observed in the test-group interaction and test-group-age

Test	S	N	N - S
(a)	27.00 (11.78)	62.00 (32.65)	35.00
(b)	52.00 (33.00)	71.75 (32.50)	19.75
(c)	70.00 (46.05)	66.00 (47.60)	-4

Table 23: Mean scores and standard deviation (in parenthesis) of children with stuttering (S) and normal children (N) on all three tests.

Discussion:

The result indicated several points of interest.First of all, children with stuttering could be subgrouped as '**purely motoric**', '**purely linguistic**', and'**motoricand linguistic**'.The results supported the subgroup hypothesis. Those under the subgroup of 'purely motoric' might have difficulties in the motor plan assembly stage, or motor command preparation or execution stage. The subgroup '**purely motoric**' supports the notion that stuttering is a defect of coarticulatory timing (Van Riper, 1971) and the notion that stuttering is a speech motor defect (Peters, Hulstijin and Van Leishout, 2000). Therapy for this group may be aimed at improving oral motor coordination. Therapy for oral motor coordination should provide a vivid model that may involve the slowing of speech production and an increasing of the duration of speech segments, especially those involved in initiation with smoother blending. In modifying a motor pattern, regardless of etiology, it is usually necessary to decrease the speed of the activity. In stuttering therapy, as learning occurs and fluency improves, rate should be increased to what appears to be within the normal speech production capacity of the individual. Peters and Starkweather (1990) state, "perhaps it is time to consider the usefulness of trying to

develop the speech coordination of children who stutter. The repeated use of coordinateve structures increases the case with which movements are made by facilitating the inhibition of unrelated muscle groups". Assuming that the fluency of speech, particularly when children are experiencing linguistic and/or environmental stress, is related to these basic skills, it could be important, along with other procedures, to improve these abilities.

Those under the subgroup '**purely linguistic**' might have difficulty in language formulation or pressure to perform linguistically. The sub group '**purely linguistic**' supports the notion that stuttering is a linguistic deficit (Bernstein, 1981; Wall 1980; Wall, Starkweather & Cairns, 1981; Westby, 1979). This highlights the importance of assessing language functions in children with stuttering. A comprehensive assessment of phonologic, syntactic, semantic and pragmatic aspects is essential in children with stuttering. A systematic description of parent's language behavior is also useful in the assessment of a child's stuttering. Speech rate and language complexity are important parameters. As mentioned by Meyers & Freeman (1985a) and Starkweather (1987), pragmatic aspects such as questioning, interruptions and topic changes should be investigated systematically as related to child's speech behavior. Peters & Starkweather (1990) opined that an attempt to improve language skills of children need to be implemented in a way that minimizes pressure to perform and the motoric sequelae to the emotional changes that this pressure can induce. Even without pressure to perform, increased language performance is almost inevitably accompanied by increased motoric demands, since longer sentences and words require a more elaborate motor plan and are executed at faster rates than shorter ones. Yet another sub group who have both language and motor problems might encounter problem starting from the stage of formulation of

language to the speech execution stage. These results have implications for therapy. If a client is under the sub group 'motoric and linguistic ; he can be helped with motoric and linguistic aspects.

Secondly, language and speech motor interference was observed in children with stuttering. Children with stuttering obtained a score of 27, while normal children obtained a score of 62 on test (a). The results supported the interference hypothesis of Peters & Starkweather (1990). Third, children with stuttering exhibited interference in language and non-speech motor tasks. They obtained a score of 52 while normal children obtained a score of 72 on test (b). This is partly in consonance with the results of studies by Deepa (1994) and Nandakumar (1994) in that the results of their study indicated poor performance of children with stuttering on test (a). However, Deepa (1994) and Nandakumar (1994) tested children in the age range of 6-9 and 9-12 years respectively. The scores in children of these age groups as obtained in the present study are 22% and 40 % respectively, which are lower compared to the results obtained by Deepa and Nandakumar. Table 24 compares the percent scores obtained by children with stuttering on three tests by different authors. Also, in the present study significant differences between tests were noticed in children with stuttering, while Deepa (1994) and Nandakumar (1994) did not notice any significant difference between test (b) and test (c).

Author (year)	Task (a)	Task (b)	Task (c)
Deepa(1994)	53	100	100
Nandakumar (1994)	56	100	100
Current Study - Total	27	52	70
6-9 years	22		
9-12 years	40		

Table 24: Percent scores on tasks (a), (b) and (c) as obtained by different authors.

Speech is the externalized expression of language and speech sensory motor control can be defined as "the motor afferent mechanisms that direct and regulate speech movements"(Netsell 1982). As a motor skill speech is "goal directed" and "afferent guided" and it meets the general requirements of a fine motor skill. It is performed with accuracy and speed and uses knowledge of results and improves with practice. It demonstrates motor flexibility in achieving goals and regulates all of this to automatic control, where consciousness is freed from the details of action plans. (Netsell, 1982). During the production of speech, the intended message has to be changed from an abstract idea to meaningful language symbols and then to a code amenable to a motor system. The overall motor control process involves planning, programming and execution. The interference between speech and language in children with stuttering indicates that the problem/breakdown can be at the level of planning or programming or execution.

Fourth, performance on all the tests improved with age in both the groups. However, performance of children with stuttering was poor compared to normal children. During preschool period normal children make strong gains in the motoric control and coordination of speech compared to children with stuttering. Specifically speech motor control becomes more consistently timed, better organized with regard to timing and more implied during this period. These changes lead to a more automated system of motor control (Sharkey & Folkins 1985; Watkin & Fromm, 1984). But children with stuttering do not follow this same path of steadily improving confidence, skill and growing sophistication. Instead their speech motor skills are less well developed, do not match the expectations of their parents and do not lead to the confident anticipation of success. In general, their movements are performed at a slower rate and contain more

frequent errors and irregularities (Blackburn, 1931; Chowarowski, 1952; Hunsley, 1937; Rickenberg 1956). Also unlike normally speaking children, stutterers respond to requests for rapid movements in a speech motor-task with slower movements (Starkweather, 1986). Around the age of 7-10 years, normal children make great gains in speech motor control developing at adult level of coordination. At about age 7, the patterns of motor organization that make possible the extremely rapid and precise movements become much flexible. As a consequence, they perform better as the age increases. But, at the age of 9-11 years, the influence of parents decline while that of peers increases. Children develop a sense of their own strengths and weaknesses and inevitably begin to compare themselves with one another. But in some cases, the sense of overwhelming and a low self-esteem develops, which may persist for many years. In contrast to this, the motor skills in children with stuttering are not so fast enough to achieve stable patterns. Due to this, their motoric pattern develops slowly compared to normal children. Motor flexibility and plasticity changes with age, but in some tasks, subjects become more flexible and in others less flexible. In children with stuttering flexibility and plasticity varies with in the group. The importance of the developmental course of motor behaviors in stuttering group is stressed by Conture (1990) who opines that "children who stutter are not small adults who stutter; their speech production behaviors undoubtedly change in number and nature as they develop and mature, and as such, their data cannot be readily extrapolated to those of adults who stutter and vice versa".

Fifth, the significant difference between children with stuttering and normal children on non-speech motor activities suggests that children with stuttering have difficulty in non-speech motor activities also. However, their performance is better on non-speech motor activities compared to speech motor activities. This supports the

findings of Kiehn (1935), Bilto (1941), William, Bishop & Cooper (1992), who opined that subjects with stuttering perform poorly on tasks involving body coordination. However, the findings of the present study do not support that of Deepa (1994) and Nandakumar (1994). They investigated children with stuttering on similar methodology and found that children with stuttering and normal children do not differ in tasks related to non-speech motor activity and cognition. However, the age group they tested was different.

There is a growing body of data suggesting that stuttering may involve a generalized neuro motor deficit that involves temporal control of both speech and non-speech movements. Kent (1985) hypothesized that timing and sequencing is the "central disturbance" in the disorder of stuttering. It appears that the disorder of stuttering primarily impairs the temporal rather than spatial aspects of coordination and this

The timing/sequencing relations among arn'culators have been hypothesized to be critical in the neuro motor control of normal speech (Gracco & Abbs, 1987). Therefore stuttering appears to be primarily a disorder of timing/sequencing multiple movements of a single structure and/or timing/sequencing multiple structures to achieve a common movement goal. However, it is important to continue to investigate if there are any timing/sequencing difficulties in stutterers in non-speech mechanisms, and if the nature of those difficulties is similar to movements during speech. Such data would strongly argue for an underlying neuro motor disruption, which is associated with contributing or perhaps even causal to the disorder of stuttering. The results of test (a) and (b) provide information on timing/sequencing breakdowns in both speech and non-speech system

within the same group of stutterers, which support speculations that the supplementary motor area, plays a critical role in the disorder of stuttering.

Finally, no significant difference between the performances of two groups was observed on test (c). Children with stuttering performed better compared to normal children on test (c). These results are not in consonance with the notion of Conture & Caruso (1987) that stutterers have impairment in cognitive aspects. The results do not support a cognitive impairment in children with stuttering.

To summarize, the results of the present study supported subgrouping and speech motor interference hypothesis. Children subgrouped under predominantly motoric, predominantly linguistic and motoric and linguistic can be specifically helped with motoric and linguistic aspects. However, while it is possible to develop therapy methods that emphasize motor or linguistics aspects one should understand that the entire speech and language production system is involved when the speaker exhibits speech and language behavior. The results also indicate the need to develop procedure through which speech language interference can be reduced thus enabling fluency in children with

CHAPTER V

SUMMARY AND CONCLUSIONS

There are of course,observable aspects of this disorder, but do we want to say that efficacious therapies are those that deal only with the observable aspects?If anything, should be the other way around.The unobservable events seem more important than the observable ones (Starkweather,1999).

Stuttering is a fluency disorder known for its variability, both for inter and intra individual variations as well as within and across situational variations. The variability can be in the frequency, type, severity and duration of stuttering as well as in related speech and non-speech behavior or attributes. Stuttering is thus considered as a syndrome where three basic aspects called the 'ABC of stuttering' are impaired (Curlee, 1993). These include affective (feelings), behavioral (moments of stuttering) and cognitive (thoughts and attitudes) domains.

Approaches to stuttering, whether for theory construction or therapy have, in the last few years focused either on motoric or on linguistic factors. Peters 6 Starkweather (1990) summarize the literature on motoric and linguistic skills of stutterers and put-forth three hypotheses that are explanatory of these findings.

1. **Sub-group Hypothesis:** There are sub-groups of clients with stuttering such that one develops primarily out of motoric deficit while another develops it primarily out of a linguistic deficit.

2. **Interference Hypothesis**: Language and speech motor act processes may interfere with one another during the act of talking, at least in children who are beginning to stutter. This interference hypothesis is based on research in non-stutterers, which suggests that the simultaneous performance of language formulation and motor programming may result in deterioration of performance in one or both areas (Kinsboune & Hicks, 1978). Such a hypothesis is suggestive for a number of reasons, one of which is the explanation it offers for the location of stuttering between sentences. The location that has the most power in eliciting stuttering

are those that are complex both linguistically and motorically. For example, the beginning of a sentence or clause, where movement is fast and where formulation activity is most likely to occur, is the most probable location of stuttering. Also, longer sentences are more likely to be stuttered than a shorter one (Bloodstein & Gantwerk, 1967; Jayaram, 1984) and longer sentences might be expected to be motorically more complex and therefore require more formulation effort as well as effort of motor programming.

3. **Competence and Performance Hypothesis**: Competence and performance have different effects on fluency. Higher levels of language competence (knowledge) could hinder fluency by creating a large lexicon and a greater available pool of syntactic forms from which to choose words and formulate sentences. Higher-level performance skills such as word finding and sentence construction can only improve fluency by increasing the rate at which language performance is executed. In this way, the child whose language is delayed although he or she is not hindered by a large vocabulary or syntactic variation, might find it difficult to find words even from a small lexicon or to construct even simple sentences and perform motor activities.

Peters & Starkweather (1990) have suggested several lines of research to test the above hypotheses. Administering various tests for language skills, oral motor behavior, and tests of general motor behavior and motor coordination can test the first hypothesis. If there are subtypes with purely motoric/purely linguistic, clients with stuttering should produce low scores on either of the two variables. An investigation of the speech motor/language interference hypothesis requires two comparisons: - (1) comparison of the interference effect

of a language task on a simultaneous speech motor task with interference effect of a non-language cognitive task on simultaneous speech motor performance and (2) comparison of the interference effect of a non-speech motor task on simultaneous language performance. Investigating relationship between stuttering and cluttering in more detail can test the third hypothesis.

However, these hypotheses have not been tested sufficiently. In this context, the present study attempted verification of subgroup and interference hypotheses. To investigate these hypotheses two groups of children were selected. Group I consisted of 100 children with stuttering in the age range of 3-13 years (10 children each in 1-year interval). Group II consisted of 100 age-and gender matched normal children.

To test subgroup hypothesis, speech motor and linguistic abilities were examined. Speech motor testing consisted of speech mechanism examination and test for oral motor coordination. Oral motor coordination activities were based on motor activities developed by Kavitha (1989). The test contained 30 items of which 20 items were non-speech related items and 10 were speech related items. Speech related items consisted of utterance of single syllable sequence and triple syllable sequence. Subjects were tested individually. They were seated comfortably in a quiet place and were examined for structure and function of oral mechanism. For oral motor coordination activities subjects were provided with models of each activity and were instructed to make the movements. Practice trial was given to subjects before the actual task. A score of T was given for each correct performance on oral motor coordination activity and a score of '0' was given if the subject was unable to perform the activity or showed significant difficulty on an item. Also distorted or fragmented activities were scored '0'.

For linguistic analysis, Screening Test of Acquisition of Syntax in Kannada (STASK) was administered to children in the age range of 3-5 years, Language Test in Kannada (KIT) was administered to children in the age range of 5-7 years and Linguistic Profile Test (LPT) was administered to children above 7 years of age. A score of T for each appropriate response and a score of '0' for each inappropriate response was given.

To test speech motor interference hypothesis, three sub tests were used- viz. -

(a) Interference between language and speech motor skill,

(b) Interference between language and non-speech motor skill, and

(c) Interference between cognitive and non-speech motor skill.

For tests (a) and (b), material was selected based on the age of the subject. For children in the age group of 3-5 years, eight picturable meaningful Kannada words were selected which were categorized under nouns and verbs. For children in the age group of 5-13 years, 16 picturable meaningful Kannada words categorized under nouns, adjectives, transitive and intransitive verbs were selected. Of these, one word in each category was considered as key word. Four sets of pictures were made for testing each group of children. Each set consisted of two stalks (3-5 year children) or four stalks (5-13 year children) of pictures in which pictures representing key words were arranged in a random order. The key words as uttered four times by an adult normal female was audio-recorded on a cassette with an inter-word interval of 5 seconds, which formed the audio-material. For test (c), puzzles appropriate for the age group were selected.

Subjects were tested individually. They were seated comfortably in a quiet place and the audio-material was presented through headphones. Picture sets were visually presented in 2 stalks for younger children and in 4 stalks for older children. Children were instructed to listen to the words through the headphones and to point to the appropriate picture representing the word in the set of 8/16 pictures placed in front of them. While doing this, they were instructed to simultaneously and continuously say "papapa" for test (a) (Interference between language and speech motor task).

The same experiment was conducted for test (b). However, in this, subjects were instructed to simultaneously and continuously tap his/her foot (Interference between language and non-speech motor task). In test (c), subjects were provided with a puzzle and he/she was instructed to complete the puzzle by referring to the model. While performing this task, the subject was asked to tap his /her foot simultaneously and continuously (Interference between cognitive and non-speech motor task). A score of T was given for a correct performance on each test and a score of '0' was given for an incorrect performance (Unable to point to appropriate picture/unable to tap foot correctly/unable to repeat 'papa.../ continuously/unable to complete the puzzle/interrupting the task by either stopping, repeating initial syllable or prolonging it).

The total score on each task was computed for each subject and raw scores were converted to percentage scores. Canonical Discriminant Function Analysis was performed for sub grouping and Two-way Analysis of Variance was carried out across the three tests to find the significant difference between the tasks across various ages and groups. This was followed by Duncan Post Hoc Test to identify the locus of significant difference.

The results indicated that children with stuttering could be subgrouped as '**purely motoric**' (16%), '**purely linguistic**'(18%), and **motoric and linguistic** (66%). The results upported subgroup hypothesis of Peter & Starkweather (1990). This was based on tescriptive statistics as Canonical Discriminant Function Analysis did not reveal any ubgrouping, Table 25 shows the results of sub grouping.

Age range	N	Purely Motoric	Purely Linguistic	Motoric and Linguistic
3-4	10	2	-	8
4-5	10	2	1	7
5-6	10	2	1	7
6-7	10	3	1	6
7-8	10	2	2	6
8-9	10	-	1	9
9-10	10	-	1	9
10-11	10	-	5	5
11-12	10	-	4	6
12-13	10	5	2	3
Total	100	16	18	66

Table 25: Sub grouping children with stuttering.

Those under the subgroup of '**purely motoric**' might have difficulties in the motor plan assembly stage, or motor command preparation or execution stage. The subgroup '**purely motoric**' supports the notion that stuttering is a defect of coarticulatory timing (Van Riper, 1971) and the notion that stuttering is a speech motor defect (Peters, Hulstijin & Van Leishout, 2000). Therapy for this group may be aimed at improving oral motor coordination. Those under the subgroup '**purely linguistic**' might have difficulty in language formulation or pressure to perform linguistically. The sub group '**purely linguistic**' supports the notion that stuttering is a linguistic deficit (Westby, 1979; Wall 1980; Bernstein, 1981; Wall,

Starkweather & Caims, 1981). This highlights the importance of assessing language functions in children with stuttering. A comprehensive assessment of phonologic, syntactic, semantic and pragmatic aspects is essential in children with stuttering. If a client is under the sub group '**motoric and lingusitic**', he can be helped with motoric and linguistic aspects.

Secondly, language and speech motor interference was observed in children with stuttering. Children with stuttering obtained a score of 27, while normal children obtained a score of 62 on test (a). These results supported the interference hypothesis of Peters & Starkweather (1990). Also, children with stuttering exhibited interference in language and non-speech motor tasks. They obtained a score of 52 while normal children obtained a score of 72 on test (b). Also, in the present study significant differences between tests were noticed in children with stuttering, while Deepa (1994) and Nandakumar (1994) did not notice any significant difference between test (b) and test (c). The interference between speech and language in children with shuttering indicates that the problem/breakdown can be at the level of planning or programming or execution. Table 26 shows scores obtained by both groups on all tests.

Test	S	N	N-S
(a)	27.00 (11.78)	62.00 (32.65)	35.00
(b)	52.00 (33.00)	71.75 (32.50)	19.75
(c)	70.00 (46.05)	66.00 (47.60)	-4

Table 26: Mean scores and standard deviation (in parenthesis) of children with stuttering (S) and normal children (N) on all three tests.

Third, performance on all the tests improved with age in both the groups. However, performance of children with stuttering was poor compared to normal children. During preschool period normal children make strong gains in the motoric control and coordination of speech compared to children with stuttering. Specifically speech motor control becomes more consistently timed, better organized and more implied during this period. These changes lead to a more automated system of motor control (Watkin and Fromm, 1984; Sharkey and Folkins 1985). But children with stuttering do not follow this same path of steadily improving confidence, skill and growing sophistication. Instead their speech motor skills are less well developed, do not match the expectations of their parents and do not lead to the confident anticipation of success.

Fourth, a significant difference between children with stuttering and normal children on test (b) suggested that children with stuttering have difficulty in non-speech motor activities also. However, their performance was better on non-speech motor activities compared to speech motor activities. This supports the findings of Kiehn (1935), Bilto (1941), Yaughn & Webster (1989), and William, Bishop & Cooper (1992), who opined that subjects with stuttering perform poorly on tasks involving body coordination.

Finally, no significant difference between the performances of two groups was observed on test (c). Children with stuttering performed better compared to normal children on test (c). These results were not in consonance with the notion of Conture & Caruso (1987) that stutterers have impairment in cognitive aspects. The results did not support a cognitive impairment in children with stuttering.

To summarize, the results of the present study supported **subgrouping and imterference hypothesis**. Children sub grouped under **predominantly motoric, predominantly linuistic and motoric and linguisti** can be specifically helped with motoric and linguistic aspects. However, while it is possible to develop therapy methods that emphasize motor or linguistics aspects one should understand that the entire speech and language production system is involved when the speaker exhibits speech and language behavior. The results also indicated the need to develop procedure through which speech language interference can be reduced thus enabling fluency in children with stuttering.

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APPENDIX I

Language Tests

Screening Test For the Acquisition of Syntax in Kannada

The screening test for acquisition of syntax in Kannada was developed by Basavaraj (1981). The test assesses syntax in Kannada speaking children aged 1-5 years. The test has a total of 50 items that tap the sub components of syntax - verbal comprehension and expression of seven grammatical categories and several sentence types. The test makes use of toys and photographs. Separate score for comprehension and expression of different aspects of syntax of the child's verbal language is possible. Shown below are the items and maximum score possible on STASK.

Item	Maximum scores on	
	Comprehension	Expression
Grammatical categories		
Person	4	4
Case marker	2	2
Adjectives	4	4
Post position	4	4
Definitive determiner	2	2
Tense marker	2	2
Number marker	4	4
Sentence types		
Simple sentences	4	4
Wh - questions	2	2
Yes/No questions	2 .	2
Negatives	4	4
Embedded sentences	4	4
Co-ordinate sentences	6	6
Narration	6	6
Total score	50	50

Kannada Language Test (KLT)

KLT (1990) was developed by Regional Rehabilitation, Training Centre (Chennai) and Ali Yavar Jung National Institute for the Hearing Handicapped (Mumbai) as a part of the UNICEF project titled "Development and standardization oflanguage and articulation tests in seven Indian languages". The tesi assesses both comprehension and expression and uses verbal and picture stimuli. KLT has semantic and syntax subsection and tests the following: .

Section	Possible Total Score	Patient's Score		Total Scores
		Receptive	Expressive	
Semantic Section	R E !			
Naming	3 , 3			
Semantic discrimination A-Colours B - Bodv Parts	 3 - 3 –			
Lexical category	- 3			
Semantic similarity	3 | 3			
Semantic anomaly	3 3			
Semantic contiguity	3 3			
Paradigmatic relations	3 3			
Syntagmatic relations	3 3			
Polar questions	3			
Antonym	3 . 3			
Synonym	3 3			
Homonym -	3 3			
Total score	36 30			

Section	Possible Total Score		Patient's Score		Total Scores
			Receptive	Expressive	
Syntax Section	R	E			
Morphophonemic structures	3	3			
Plural forms	3	3			
Tenses	3	3			
Person, Number. Gender	3	3			
Case markers		3			
Conditional clauses		3			
Transitives, intransitives and causatives					
Sentence types	3	3			-
Conjunctives and quotatives		3			
Comparatives	3	3			
Participle construction	3	3			
Total score	33	33			

Each sub division has 6 items, 3 items testing receptive abilities and 3 items testing expressive skills. But semantic discrimination section has only receptive items and lexical categi y has only expressive abilities. All sub divisions except naming have one or two model items. Out of 12 semantic sections, section 1, 2, 3 and 9 are pictorial and others are in sentential form. In the 11 syntactic sections, each section has 10 items, 5 items testing receptive abilities and 5 items testing expressive ability of the subjects. Comprehension is tested by asking the subjects to point to the correct picture out of a set of three to four related pictures in response to an auditorily presented sentence describing the target picture. The items evaluating expression requires the subject to describe the pictures which specifically test the usage of specific syntactic structures.

Linguistic Profile Test

This test was developed by Suchitra & Karanth (1990) and evaluates phonology syntax, and semantic aspects of the language within receptive and expressive modalities. It also has a section on discourse included in it. It provides both qualitative and quantitative assessment at various linguistic levels. A pattern of acquisition within the linguistic framework can be formulated. Following are the test items of LPT.

Section	Possible Total Score	Subject's score					Total scores on sections
		Stimulus			Response		
		Verbal	Graphic ; Verbal		Graphic	Gestural	
Section I (Phonology)							
Phonemic discrimination	43						
Phonetic Expression	52						
Section II (Syntax)							
Morphophonemic structures	10						
Plural Forms	5						
Tenses	5						
PNG Markers	10						
Case Markers	10						
Transitives, Intransitives and Causatives	10						
Sentence Types	10						
Predicates	10						
Conjunctives, Comparatives and Quotatives	10						
Conditional clauses	10						
Participle construction	10						

Section	Possible	Subject's score					Total scores on sections
	Total	Stimulus		Response			
	Score	Verbal	Graphic	Verbal	**Graphic**	**Gestural**	
Section ED (Semantics)							
Semantic Discrimination							
a) Colours							
b) Furniture							
c) Body parts	5						
Semantic Expression							
Naming	20						
Lexical Category	15						
Synonym	5						
Antonym	5						
Homonym	5						
Polar Questions	10						
Semantic Anomaly	5						
Paradigmatic Relations	5						
Syntagmatic Relations	5						
Semantic Contiguity	5	!					
Semantic Similarity							
Grand Total							

* Verbal -Blue Graphic- Green Gestural -Red