INVESTIGATION OF SPEECH RHYTHM IN INDIVIDUALS WITH STUTTERING: UNDERSTANDING ITS NATURE, EFFECT OF FLUENCY INDUCING CONDITIONS AND THE EFFECT OF TREATMENT

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PROJECT REPORT

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CHAPTER 1

INTRODUCTION

Stuttering is a multidimensional disorder which is characterized by certain core behaviors (like repetitions, prolongations, blocks etc.), surface behaviors (like movements of extremities, facial grimacing etc) and attitudinal changes. Although a number of elucidations have been given for stuttering but the most comprehensive and widely accepted definition is the one given by Wingate (1964). According to Wingate (1964), Stuttering is a “Disruption in the fluency of verbal expression, which is characterized by involuntary, audible or silent, repetitions or prolongations in the utterance of short speech elements, namely: sound, syllables and words of one syllable. These disruptions usually occur frequently or are marked in character and are not readily controllable. Sometimes the disruptions are accompanied by accessory activities involving the speech apparatus, related or unrelated body structures, or stereotyped speech utterances. These activities give an appearance of being a speech related struggle. Also, there are not infrequently 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 dislike. 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”.

It is estimated that around 1% of the world’s population stutters. Stuttering usually starts between 2 and 4 years of age and in 50% of the children, condition persists. Although stuttering is one of the extensively researched topics in the field of speech language pathology, till today, its cause remains unknown. Previously, several attempts have been made to understand the underlying mechanisms behind stuttering.

Rhythm can be a pattern of any sequence, but mostly time and accentuation are involved (Randel 1986). In speech production, rhythm has been defined as an effect involving the isochronous recurrence of some type of speech unit, (Pike, 1946; Abercrombie, 1965, 1967). Based on perception studies in the speech rhythm languages were classified into different rhythmic classes. Isochrony principle suggests that all spoken languages exhibit isochronous units of speech, and that languages are either stress-timed or syllable-timed (Abercrombie, 1965, 1967; Pike, 1946). In stress-timed languages, intervals between stresses or rhythmic feet are said to be near-equal, whereas in syllable-timed languages, successive syllables are said to be of near-equal length. A third type of rhythm, mora timed was also proposed by Ladefoged (1975). In mora-timing languages, successive sub-units of syllables consisting of one short vowel and any preceding onset consonants are said to be near-equal in duration (Bloch, 1942; Han, 1962; Ladefoged, 1975).. Thus, mora-timed languages are more similar to syllable-timed languages than to stress-timed languages.

Need for the study

Stuttering is disorder in the rhythm of speech. Most of these studies have investigated the temporal patterning or rhythm at the segmental level. To date, surprisingly no study has been attempted quantifying speech rhythm in sentence level in stuttering individuals. One reason for this could be difficulty with the quantification of speech rhythm. As the durational measures can be used to quantify variability in successive acoustic phonetic intervals, it will be interesting to see if stutterers differ from their fluent peers on these different measures of durational variability. Such evidence will fill remaining gaps in the field's knowledge and help us understanding the mechanisms underlying stuttering.

Aims and objectives

The Aims and objectives of the study are to investigate (1) Whether individuals with stuttering differ from individuals without stuttering on the measures of speech rhythm; (2) Whether different fluency conditions (adaptation effect and DAF) have any effect on speech rhythm in individuals with stuttering; and (3) Whether prolongation therapy brings changes in speech rhythm of stutters.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Speech and non-speech timing in persons who stutter

Among the many different proposed factors for the development of stuttering, large amount of attention has been paid to investigate the hypothesis that stuttering is a disorder of speech timing or temporal pattering. Most of this work has been done during their fluent speech production, and available empirical data suggests that individuals with stuttering are slower when compared to individuals without stuttering. At the segmental level, perceptually fluent speech of individuals with stuttering showed aberrant timing patterns in the production of C-V-C clusters (Starkweather & Myers, 1979; Zimmerman, 1980); individuals with stuttering have longer voice onset times (VOT), longer voice initiation times (VIT), longer voice termination times (VTT), and longer vowel durations (Agnello, 1975; Agnello, Wingate, & Wendell, 1974, among others) than individuals without stuttering. However, few other studies (Cullinan & Springer, 1980; McFarlane & Shipley, 1981; Venkatagiri, 1982) did not find any timing abnormalities when compared to individuals without stuttering. The differences in the results may be due to different response modes employed (phonatory gestures, phonation of speech-like sounds, phonation of words, etc.) and differences in the severity of stuttering. Further, studies reporting the finding that individuals who stutter are slower than individuals without stuttering are not sufficient evidence for the problem of timing in these individuals.

Many other studies have investigated the regularities in the timing of speech and non-speech events. Cooper and Allen (1977) reported increased variability in persons who stutter in their self-paced finger tapping task. This supports the motor timing deficit theory (Max, Caruso, & Gracco, 2003; Olander, Smith, Zelanik, 2010; Zelanik et. al., 1997) according to which individuals who stutter have underlying motor timing deficit which is expressed as differences in their timing, coordination and synchronization abilities. Few other studies have also found individuals with stuttering to be more variable than fluent peers (Boutsen, Brutten, & Watts, 2000; Olander, Smith, & Zelaznik, 2010), however others have found no differences between groups (Max & Yudman, 2003; Zelaznik, Smith, & Franz, 1994). Persons with stuttering were slower and less variable than controls on rhythmic tasks involving speech, jaw movements and finger tapping (Brown, Zimmerman, Linville, & Hegmann, 1990). Individuals with stuttering differ from normals in terms of the variability, speed and relative timing of their articulatory movement when producing perceptually fluent speech (Kleinow & Smith 2000; Max & Gracco, 2005; McClean & Runyan, 2000; McClean, Tasko & Runyan, 2004; Zimmerman, 1980). Based on their results, Zelaznik et al. (1994) suggest that stuttering is a disorder of speech specific rhythmic timing. However, most of these studies have investigated the temporal patterning or rhythm at the individual segmental level.

Apart from research in individuals with stuttering, rhythmic timing tasks in individuals with Parkinson's disease (who have basal ganglia dysfunction) and patients with cerebellar dysfunction suggests increased variability in their synchronization, and continuation of isochronous lip, finger and wrist movements. (Freeman, Cody, & Schady, 1993; Nakamura, Nagasaki, & Narabayashi, 1978, Ivry & Kkeele, 1989). Further, fMRI evidence suggests basal ganglia (Rao et al., 1997) and cerebellar involvement (Jancke, Loose, Lutz, Specht, & Shah, 2000) in the continuation phase of finger tapping tasks. It is clear from the results of these studies that both basal ganglia and cerebellum contribute to the generation of rhythmic temporal patterns (Max & Yudman, 2003). Studies on neural basis of stuttering suggest that various cerebral areas different subcortical regions also have been implicated for the development of stuttering. Alm (2004) suggests that individuals who stutter have defective basal ganglia-cortical route. Likewise, two other studies have also reported increased cerebellar activation in individuals who stutter (Brown, Ingham, Ingham, Laird, & Fox, 2005; De Nil, Knoll, Houle, 2001). Hence, it is possible that abnormal motor circuits of basal ganglia and cerebellum of these individuals might be resulting in increased rhythmic variability in these individuals. Although stuttering is a disorder in the rhythm of speech, to date, surprisingly, no published study has been done to quantify speech rhythm in sentence level. One reason for this could be difficulty with the quantification of speech rhythm.

2.2 Speech Rhythm and measurement of rhythm metrics

Speech rhythm refers to temporal patterning of speech events at the level of phonetic segments. Over the years, speech rhythm has been empirically investigated using the notion of isochrony, i.e., classifying the languages either as stress timed or syllable timed (Abercrombie, 1964). Later, another class of mora-timed languages was added to this classification (Hoequist, 1983). As reported by Grabe and Low, (2002) rhythmic diversity is the outcome of language specific phonological, phonetic, lexical and syntactic characteristics. Traditionally, languages were classified into different rhythmic classes based on perception. However, with the development of quantification measures like various rhythm metrics, more work is done at the production level. Broadly, rhythm metrics can be divided into interval measures (Ramus, Nespor & Mehler, 1999) and Pairwise variability index (PVI) measures (Grabe & Low, 2002; Low, Grabe & Noolan, 2000). Both these measures are acoustic in nature and incorporate simple segmentation of speech string into vocalic and consonantal intervals. However, features like syllable complexity, vowel reduction and stress based lengthening have a marked effect on these measures. Interval measures include four rhythm metrics: Delta V (Standard deviation of vocalic intervals), Delta C (standard deviation of the

Consonantal intervals), % V (proportion of the total utterance duration which comprises of vocalic intervals), Varco-V (variable coefficient of the vocalic intervals) and Varco – C (variable coefficients of the consonantal intervals). Pairwise variability index (PVI) calculates the pattering of successive vocalic and intervocalic (or consonantal) intervals showing how one linguistic unit differs from its neighbor. Two measures are derived using PVI; normalized pairwise variability index (nPVI) and raw pairwise variability index (rPVI). Both these measures help in computing the variability of successive measurements and have been successfully used to classify different languages as stressed-timed, syllable timed or mora-timed languages. PVI measures are also found to be robust in capturing the syntagmatic nature of rhythm (Liss et al., 2009). Grabe and Low (2002) calculated PVIs in 18 languages traditionally classified as stress timed, syllable time, mora timed and unclassified languages. Based on PVIs they could classify English, Dutch and German as stress timed languages, French and Spanish as syllable timed languages, Japanese as mora timed language. The remaining was unclassified. Among Indian languages Hindi is classified as syllable timed language and the Kannada language wherein there is negligible variability within its successive vocalic and inters vocalic segments is classified as mora-timed language (Savithri,Goswami, Kedarnath, 2007).

2.3 Effect of fluency inducing conditions (Adaptation effect and DAF) on stuttering

In individuals who stutter, several studies have shown that repeated readings of same passage decreases stuttering to a significant amount (adaptation effect) (Johnson, Brown, Curtis, Edney, & Keaster, 1967; Balasubramanian, Max, Van Borsel, Rayca, & Richardson, 2003; Caruso & Max, 1997; Max, 2004; Max, Caruso, & Vandevenne, 1997; Max & Caruso, 1998). Although several attempts have done to explain underlying mechanism(s) for this (see Max & Baldwin, 2010 for review), the exact reason for inducement of fluency during adaptation effect in not known. Max and Baldwin (2010) hypothesized that adaptation effect could be mainly because of motor learning. It highlights more directly the learning processes involved in motor skill improvements. However specific aspects of motor learning are not documented. Although this explanation is partially correct, the term motor learning is too broad to explain the underlying mechanism(s). Studies have not clearly explained the specific changes in the different aspects of speech motor production during this act of "motor learning". If adaptation effect is mainly because of motor learning, from the speech rhythm perspective, it could also hypothesized that during the adaptation effect there are also changes in rhythm characteristics of individuals who stutter.

Like adaptation effect, altered auditory feedback (AAF) also has been found to induce fluency in many individuals who stutter (Armson & Stuart, 1998; Hargrave, Kalinowski, Stuart, Armson & Jones 1994; Howell, El-Yaniv, & Powell, 1987; Kalinowski, Armson, Roland-Mieszkowki, Stuart, & Gracco, 1993; Macleod, Kalinowski, Stuart, & Armson, 1995; among others). The fact that fluency improves in the presence of altered auditory feedback conditions also evidently suggests relationship between auditory processing and stuttering. Goldiamond (1965) was the first researcher who reported the improvement in fluency when persons with stuttering are placed under delayed auditory feedback (DAF). Following this Curlee and Perkins (1969) and Perkins (1973) formulated a management technique in which the fluency was induced in persons with stuttering by participants speak under DAF with a delay of 250 milliseconds. Gradually the delay was reduced in 50 milliseconds until the fluent speech was generalized. Frequency altered feedback and delayed auditory feedback was utilized by Macleod, Kalinosky, Stuart and Armson(1995) to assess the processing abilities in adult with stuttering. 10 individuals with stuttering and non individuals with stuttering read passage in presence and absence of altered feedback and combination of each (FAF & DAF).

Specifically, three forms of feedback manipulation have been shown to exert such an ameliorative effect on stuttering: masked auditory feedback (MAF), delayed auditory feedback (DAF), and frequency-shifted auditory feedback (FAF) (Adams & Hutchinson, 1974; Andrews, Howie, Dozsa, & Guitar, 1982; Bloodstein, 1950; Bloodstein & Bernstein Ratner, 2008; Chase, Sutton, & Rapin, 1961; Cherry & Sayers, 1956; Cherry, Sayers, & Marland, 1956; Conture & Brayton, 1975; Goldiamond, 1965; Johnson & Rosen, 1937; MacLeod, Kalinowski, Stuart, & Armson, 1995; Lotzmann, 1961; Maraist & Hutton, 1957; Murray, 1969; Neelly, 1961; Soderberg, 1969; Stuart, Kalinowski, Armson, Stenstrom, & Jones, 1996; Stuart, Frazier, Kalinowski, & Vos, 2008; Zimmerman, Kalinowski, Stuart, & Rastatter, 1997). To date, surprisingly little is known about the causative factors underlying the fluency enhancing effect of AAF. Very few studies have focused on identifying which specific aspects of speech are changed under the manipulated auditory input. In typical laboratory studies of DAF/FAF, the dependent variables are in terms of percentage of syllables stuttered, speech rate, and speech naturalness rating. It is worth noting if DAF has any change in the speech rhythm of individuals with stuttering.

2.4 Effect of fluency shaping therapy on stuttering

As a last point of interest in this brief review, it should be noted that there is no data available regarding the effect of speech therapy on the speech rhythm of individuals with stuttering. One of the most commonly used therapy technique with individuals with stuttering is prolonged speech therapy. Interestingly, during prolonged speech therapy, stuttering participants are asked to lengthen their vowels and syllables to bring in changes in fluency. Packman, Onslow & Menzies (2000) proposed ***variable syllabic stress*** model for stuttering. According to this model, in English speech requires the production of syllables with a range of stress. Syllabic stress varies along a continuum and this variability is motorically achieved by changing the amount of effort from syllable to syllable. Hence, the speaker is constantly making finely tuned adjustments to the subsystems of speech from syllable to syllable for which a normal speech neuromotor system is required. The PWS may have underlying deficit in speech production (unstable speech motor system) which can be the source of perturbation in production of syllabic stress. This model was used to explain why the prolonged speech is so effective in reducing stuttering. Packman et al. (2000) suggested that prolonged speech therapy reduces the variability in contrastive syllabic stress. This is suppose to simplify speech production considerably and hence reduces the motoric task demands on an unstable speech production system. Hence, AWS achieve fluent speech post-therapeutically. Reduction in the variability of syllabic stress is also a feature of syllable timed or rhythmic speech, which is an even more powerful stuttering suppressant or fluency enhancing condition. (Packman et al, 2000). So it will be interesting to see if prolonged speech therapy in individuals with stuttering has brought any change in speech rhythm of individuals with stuttering.

CHAPTER 3

METHOD

The present study was conducted in order to gain an insight about the rhythmic characteristics of speech of persons who stutter by means of calculating assorted rhythm metrics. The study was divided into three experiments.

Experiment 1

The main objective of the first experiment was to understand the nature and characteristics of the rhythm in the speech of persons who stutter.

Participants

In experiment 1, the participants were divided into two groups – Group A and Group B. Fifteen adult male Persons with Stuttering (PWS) were enrolled in group A. Fifteen age and gender matched fluently speaking individuals, with no history of any speech, language and communication problems, formed group B. The age of the participants in group A ranged from 17 to 30 years with the mean of 21.27 years and in group B ranged from 17 to 29 years with the mean of 20.9 years. All the participants in both groups were native speakers of Kannada language and were also proficient in reading and writing Kannada. The participants in Group A were diagnosed with developmental stuttering ranging in severity from very mild to very severe. The severity of stuttering was calculated using the Stuttering Severity Instrument – 3, SSI – 3 (Riley, 1994). Also, with a detailed case history, any other kind of speech, language, communication, neurological and psychological problems were ruled out. Table 2.1 shows the demographic details of individuals with stuttering. Table 2.2 shows the demographic details of control participants.

Table 2.1

Demographic details of individuals with stuttering for experiment 1

Subject No.	***Age (in years)***	***Severity of stuttering***
S1	22	Moderate
S2	25	Severe
S3	21	Very Mild
S4	21	Moderate
S5	23	Mild
S6	20	Mild
S7	21	Mild
S8	17	Mild
S9	19	Mild
S10	30	Mild
S11	22	Very severe
S12	17	Very mild
S13	22	Mild
S14	21	Mild
S15	18	Mild

Table 2.2

Demographic details of control participants for experiment 1

Subject No.	***Age (in years)***
C1	20
C2	25
C3	19
C4	21
C5	24
C6	20
C7	20
C8	18
C9	17
C10	29
C11	23
C12	18
C13	22
C14	20
C15	18

Materials

To calculate severity of stuttering, spontaneous speech task and 300-word standardized reading passage in Kannada language (Savithri, 2007) was used. Appendix 1 gives the 300-word reading passage used in the present study. For rhythm metrics calculation, five short and natural sentences were formulated for the measurement of rhythm (Set 1, Appendix 2). These five sentences were simple sentences. The sentences which were formulated were given to five native speakers of Kannada for rating its familiarity. All the raters rated the sentences to be simple and familiar.

Recording procedures

The participants were made to sit comfortably in a silent room and the recordings were done using a headphone microphone, directly onto the laptop. A comprehensive case history was taken before the recordings. For participants in Group A, the first set of recordings included a detailed conversation for a minimum duration of 10 minutes and reading of the 300 word standardized Kannada reading passage. These two recordings were done to calculate the severity of stuttering using the SSI – 3 (Riley, 1994).

After this, the participants were given the set of sentences prepared for calculating the rhythm metrics and were instructed to silently read and rehearse (White & Mattys, 2007). Once they were well versed with the material, recording of these sentences was done. They were instructed to read the sentences in their normal loudness and comfortable rate. Repetition was asked in case of any mistake while reading the sentences (White & Mattys, 2007). The control participants (Group B) were also asked to read the same set of sentences, in the manner described above.

Analysis & Measurements

The first step was to calculate the percentage of syllables stuttered and severity of stuttering for each participant in Group A. After this, the recorded files for rhythm analysis were separated and saved as smaller files containing one sentence each. Each of these sound files was opened in Praat software (http://www.fon.hum.uva.nl/praat/download_win.html) and was edited by removing the silences between the words (Grabe & Low, 2002) and also omitting all kinds of disfluencies. These edited files were then segmented into vocalic and consonantal intervals from left to right direction using both auditory and visual cues from the wideband spectrogram. The duration between the onset and the offset of the vowel or cluster of vowels was considered as the vocalic duration (figure1). Similarly, the duration between the onset and the offset of the consonant or a cluster of consonants was taken as the consonantal duration (figure1).

The rules that governed the segmentation of the sounds were based on former studies on acoustic analysis (e.g. Peterson & Lehiste, 1962). The boundary between the vocalic and the consonantal intervals was indicted by a significant drop in the amplitude and a break in the second formant structure. The identification of consonant boundaries was made easy by the cues obtained from the spectrogram which was associated to the manner of production of that sound. Apart from this standard criterion, a few other factors were taken into consideration in order to obtain the consistency in the measurements. As it is difficult to determine the boundaries of approximants reliably, they were taken as a part of vocalic interval (White & Mattys, 2007). Pre-vocalic glides were included in the consonantal duration and the post vocalic glides were included in the vocalic duration (Ramus et al., 1999). Aspiration following the stop release was taken in the consonant duration (White & Mattys, 2007). Even though there is significant lengthening noticed in the phrase final position, it was not excluded from the analysis (White & Mattys, 2007). As glottal sound /h/ marking was difficult, it was also taken as a part of vocalic interval for uniform analysis.

Subsequent to measuring the vocalic and the consonantal durations, the various measures under the two kinds of rhythm metrics, that is, the interval measures and pairwise variability indices were derived. For calculations of these metrics, the first pair of vocalic and consonantal interval was eliminated in order to control variations in the speech characteristics related to the abrupt or sudden start of the utterances. The variables calculated under interval measures were percentage of vocalic intervals (%V), standard deviation of the vocalic intervals (delV), standard deviation of the consonantal intervals (delC), variable coefficients of vocalic intervals (VarcoV) and variable coefficients of the consonantal intervals (VarcoC). In pairwise variability indices, raw pairwise variability for the consonantal intervals (rPVI-C) and normalized pairwise variability index for the vocalic intervals (nPVI-V) were calculated. (See Appendix 3 for the formulae for all the listed metrics under study). The average of each of the rhythm metrics for each experiment was calculated for all the participants and these values were subjected to further statistical analysis.

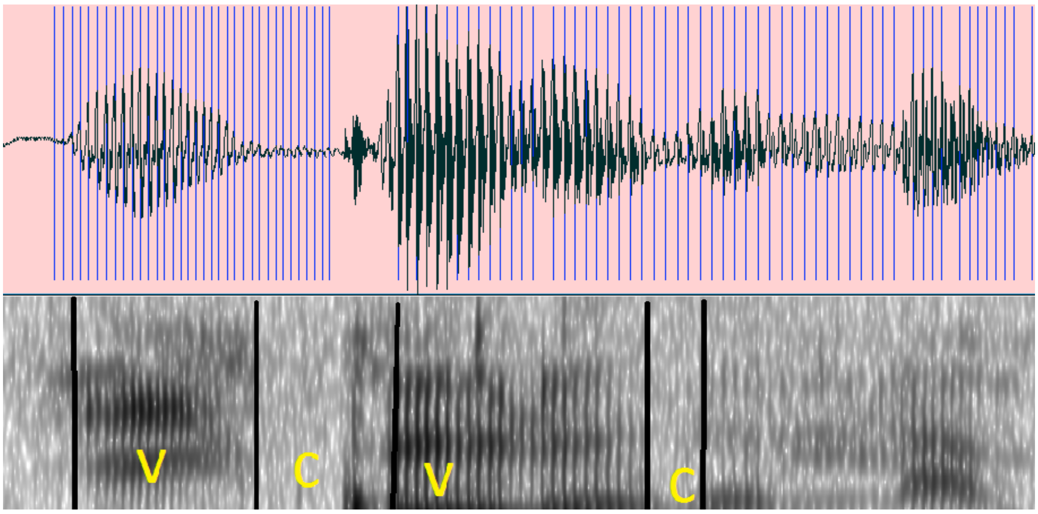

Figure1: Spectrogram showing the marking of vocalic and consonantal intervals.

Statistical analysis for experiment 1

As the goal of this experiment was to obtain the differences in rhythm metrics between persons who stutter and fluent speaking individuals, MANOVA was done in order to compare the two groups (A & B).

Experiment 2

In the second experiment, we investigated the effect of two kinds of fluency inducing conditions, adaptation effect and delayed auditory feedback, on the speech rhythm of persons who stutter.

A. Comparison of rhythm metrics during adaptation task in AWS

Participants

Twenty adult males with developmental stuttering in the age range of 17 to 30 years (ten adults with a mean age as 22.3 years for adaptation task, and ten adults 21.9 years for delayed auditory feedback (DAF) task) participated in this experiment. Separate group of ten adults participated in each adaptation and DAF tasks as we wanted to include those individuals who exhibited adaptation and DAF effects. Other than stuttering, all the participants had no history of speech, language, hearing, psychological and neurological problems. The diagnosis of developmental stuttering was made by a qualified Speech Language Pathologist. The severity of stuttering varied from very mild to very severe (SSI – 3) stuttering. All the participants were native speakers of Kannada language and were proficient in reading and writing Kannada. Table 2.3 shows demographic details of AWS for adaptation task. Table 2.4 shows demographic details of AWS for DAF task.

Table 2.3

Participant details for experiment 2 (Adaptation task)

Subject No.	***Age (in years)***	***Severity of stuttering***
S1	25	Severe
S2	21	Moderate
S3	20	Mild
S4	30	Mild
S5	27	Mild
S6	22	Very severe
S7	17	Very mild
S8	22	Mild
S9	21	Mild
S10	18	Mild

Table 2.4

Participant details for experiment 2 (Delayed auditory feedback)

Subject No.	***Age (in years)***	***Severity of stuttering***
S1	22	Moderate
S2	21	Mild
S3	19	Mild
S4	30	Mild
S5	27	Mild
S6	22	Very severe
S7	17	Very mild
S8	22	Mild
S9	21	Mild
S10	18	Mild

Materials and instrumentation

For the purpose of calculating the adaptation effect, and changes in percentages of syllables stuttered under delayed auditory feedback, two short separate passages were composed one for each task (Appendix 4 and appendix 5 respectively). For calculating rhythm metrics, another two sets of five sentences were created separately for adaptation effect and delayed auditory feedback (Set 2 and set 3, Appendix 6 and appendix 7). Both the passages and sentence sets were given to five native speakers of Kannada language for familiarity rating. All of them rated the materials as familiar. The instrument used for inducing delayed auditory feedback was DAF 1000, by *voicetech.*

Recording procedures

The participants were seated in a quiet room and recordings were made using a headphone microphone directly on to the laptop. First, participants were given passage (appendix 4), and were instructed to read the material aloud for five times with a gap of 20 seconds in between the readings. Following this, set of five sentences (specifically developed for this task) were given and they were asked again to read aloud each sentence for five times with a gap of 20 seconds between each readings.

For, DAF task, participants were asked to read the another passage (appendix 5), under four different delay conditions (0ms, 50ms, 100ms and 200ms) induced with delayed auditory feedback device. Subsequently, another set of five sentences were given and participants were asked to read each sentence aloud under the above mentioned four delay conditions. Sentence readings were repeated in case of errors. To minimize order effect, counter-balancing was done across four delay conditions for the recording of passage readings and sentences from AWS.

Analysis and measurements

First, the percentage of adaptation effect was calculated. For this, the percentages of syllables stuttered was calculated for the first and the fifth reading of the passage and then the percentage of adaptation was calculated using the following formula-

(Percentage of syllables stuttered in the fifth reading/percentage of syllables stuttered in the first reading)*100

Similarly, from the next reading passage, the percentage of syllables stuttered was calculated under the four different delayed auditory feedback conditions (0ms, 50ms, 100ms and 200ms). The findings were graphically plotted using bar diagrams to get a clear picture of the effect of delayed auditory feedback on the reading of passage.

Next, for the two sets of sentences recorded under adaptation effect and under delayed auditory feedback tasks, all the seven rhythm metrics were calculated using the similar procedure as described in experiment 1. The obtained values for all the sentences under each fluency inducing condition was then averaged and were subjected to statistical analysis. Statistical analysis for both the conditions was done separately, using repeated measures ANOVA.

Experiment 3

The purpose of third experiment is to probe into a) the changes in rhythm metrics prior to and soon after the non-programmed prolonged speech (PS) therapy in AWS, b) to compare different rhythm metrics between treatment recovered AWS and control participants.

a. Comparison of rhythm metrics in Pre- and post-therapy conditions

Participants

Five male adults with developmental stuttering in the age range of 21 to 30 years (Mean age of 24 years) took part in the third experiment. All of them were diagnosed with developmental stuttering with no other history of speech, language and communication and psychological and neurological problems. Participants were native speakers of Kannada language and were competent in reading and writing in Kannada. The severity of their stuttering varied from mild to severe according to SSI – 3. All these clients had attended a minimum of five and a maximum of fifteen prolonged speech therapy sessions for fluency shaping.

Table 2.5

Participant details for experiment 3a

S. No.	***Age (years)***	***Severity of stuttering***	***No. of therapy sessions***
S1	22	Moderate	10
S2	25	Severe	10
S3	30	Mild	15
S4	22	Mild	5
S5	21	Mild	5

Materials

Another fresh set of five sentences (Set 4, Appendix 8) was created to measure the rhythm metrics for this experiment. The sentences were subjected to familiarity rating and were rated as simple and familiar.

Recording procedures

The recording was done two times using the same material. First, conversation and reading samples (reading 300-word standard reading passage) were recorded from all five AWS. These samples were used to document the severity of stuttering both before and after prolonged speech therapy. Second, participants read five sentences developed for specifically for this experiment before the beginning of the therapy program and after the prolongation therapy program. For the recording, the participants were comfortably seated in a quiet room and recordings were done via the headphone microphone onto the laptop. The steps in the non-programmed prolonged speech therapy program incorporated in this experiment are as follows-

Treatment Program

Steps in prolongation therapy are as follows:

Step 1: Prolongation of all the syllables in subjects with severe stuttering. Prolongation of initial syllable of the word in subjects with mild and moderate stuttering.

Step 2: Prolongation of the initial syllable of the word when stuttered or when anticipated to have stuttering - Experimenter monitoring.

Step 3: Prolongation of initial syllable of the word when stuttered or anticipated to have stuttering – Self - monitoring.

Step 4: Generalization with experimenter’s support.

Step 5: Generalization without experimenter’s support.

Step 6: Follow up after six months.

Analysis and measurements

Percentage of syllables stuttered was calculated for spontaneous speech and reading passage samples recorded before and after prolonged speech therapy. Further, from the recording of sentences. rhythm metrics were calculated using the similar procedure as described in experiment 1.The rhythm metrics calculated were then averaged across the five sentences for each participant for both pre and post therapy recordings. These averaged values were then subjected for statistical analysis. As the goal was to ascertain the changes in the rhythm metrics prior to and soon after the prolongation therapy program, Wilcoxon signed ranks test was done.

b. Comparison of rhythm metrics between AWS who recovered from treatment and normal control participants

Participants

Seven male AWS in the age range of 21 to 32 years (Mean of 23 years) took part in this experiment. All of them were diagnosed with developmental stuttering with no history of other speech, language, communication, psychological, and neurological problems. All the participants were native speakers of Kannada and were competent in reading and writing Kannada. All the seven AWS were old clients who had attended prolonged speech therapy and had recovered from stuttering by taking prolonged speech therapy (fluency shaping). Before prolonged speech therapy, their severity of stuttering varied from mild to moderate according to SSI – 3. Clients had attended a minimum of 6 sessions and a maximum of 32 prolonged speech therapy sessions for fluency shaping. For the comparison purposes, these seven AWS were compared with age, gender matched seven individuals without stuttering.

Table 2.6

Demographic details of AWS for experiment 3b

Subject No.	***Age*** (years)	**Earlier Diagnosis of stuttering**	**Present diagnosis**	**No. of sessions attended**
S1	24	Mild	Clinically fluent speech	15
S2	20	Moderate	Mild	6
S3	20	Moderate	Very mild	6
S4	23	Moderate	Mild	20
S5	25	Mild	Clinically fluent speech	30
S6	19	Mild	Clinically fluent speech	19
S7	32	Moderate	Very mild	32

Procedure

First, conversation and reading samples were recorded from all seven AWS. These samples were used to document the severity of stuttering at the time of recording. Other than this these clients also read five separate set of sentences (set 5). Similar to other experiments, from these five recorded sentences, the seven rhythm metrics were calculated and then averaged across the five sentences for each participant. These averaged values were then subjected for statistical analysis.

Statistical analysis

As the goal was to compare the rhythm metrics between recovered AWS and control participants, independent sampled t-test was done.

CHAPTER 4

RESULTS AND DISCUSSION

The results of the study are reported separately for each experiment. The objective of first experiment was to compare different rhythm metrics between individuals with stuttering and individuals without stuttering. The objective of second experiment was to compare different rhythm metrics of individuals with stuttering during two fluency inducing conditions, namely, Adaptation task and speaking under delayed auditory feedback task (DAF). The objectives of third experiment were a) to compare different rhythm metrics before and after prolonged speech therapy in individuals with stuttering, b) to compare rhythm metrics between post-treatment recovered individuals with stuttering and normal control participants.

3.1 Results for Experiment 1

This experiment compared the rhythm metrics between individuals with stuttering and individuals without stuttering. Overall the mean values of different rhythm metrics were higher for AWS than control speakers except for rPVI and DeltaC. However, compared to control subjects, in AWS the median values were higher for all metrics except for Delta V. MANOVA was done to statistically compare the two groups including all the rhythm metrics expect rPVI and Delta C. Results of MANOVA showed statistically significant difference ($p < 0.05$) between the two groups for nPVI and for all the interval measures except VarcoV. Table 3.1 shows comparison of Mean, Median, and S.D, values for different rhythm metrics between AWS and control groups. Table 3.2 shows ‘F’ values, ‘df’ values and ‘p’ values for different rhythm metrics in AWS and control groups.

For rPVI and DeltaC measures, Mann Whitney test was done as for these measures the standard deviation values were higher than mean values. The Mann Whitney results showed statistically significant difference ($p < 0.05$) between the groups only for rPVI. Table 3.3 shows 'Z' values, 'df' values and 'p' values for rPVI and DeltaC measures.

Table 3.1

Mean, Median, S.D. values for different rhythm metrics in AWS and control groups.

Rhythm metrics	Groups	Mean	Median	S.D.
nPVI_V	**control**	81.21	81.72	3.30
	AWS	84.03	82.66	3.93
rPVI_C	**control**	.0510	.0334	.0654
	AWS	.0391	.0400	.0057
PercV	**control**	69.36	69.36	1.89
	AWS	72.52	72.38	2.51
DeltaC	**control**	.0815	.0333	.1025
	AWS	.0356	.0354	.0051
DeltaV	**control**	.1410	.1380	.02367
	AWS	.1726	.1679	.03154
VarcoC	**control**	43.57	42.42	2.53
	AWS	48.60	48.11	4.92
VarcoV	**control**	85.25	84.98	2.95
	AWS	85.99	84.35	7.71

Table 3.2

'F' values, df values and 'p' values for different rhythm metrics in AWS and control groups.

	F values	df	p
nPVI_V	4.517	1,28	.043*
PercV	15.120	1,28	.001*
DeltaV	9.619	1,28	.004*
VarcoC	12.372	1,28	.002*
VarcoV	.121	1,28	.731

Table 3.3

'Z' values and 'p' values for rPVI and DeltaC metrics.

Rhythm metrics	Z values	Asymp. Sig. (2-tailed)
rPVI_C	-2.053	.040*
DeltaC	-.809	.419

Note: AWS- adults with stuttering, nPVI- normalized pairwise variability index, rPVI- raw pariwise variability index, PercV- percentage of vocalic intervals, DeltaC – standard deviation of consonant intervals, DeltaV- standard deviation of vocalic intervals, Varco V – variable coefficients of vocalic intervals, Varco C- variable coefficients of consonant intervals. * indicates significance at 0.05 level.

Results revealed significantly higher mean values in AWS than controls for nPVI, %V, delta V and Varco C. For rPVI, the median values were significantly higher in AWS than individuals without stuttering. Pairwise variability index (PVI) calculates the pattering of successive vocalic and intervocalic (or consonantal) intervals showing how one linguistic unit differs from its neighbor (Low, 1998). High values of PVI measures are suggestive of the fact that there is high variability between the successive vocalic and intervocalic segments of speech. It indicates that speech rhythm of AWS is more variable in terms of temporal patterning of successive vocalic and intervocalic intervals. Further, the combined results from other rhythm metrics also highlight that isochronous rhythmic speech timing of individuals with stuttering is highly dissimilar to that of individuals without stuttering and individuals with stuttering have deficits with their ability to generate regular rhythmic speech gestures. As per our knowledge, there are no other published studies on speech rhythm of individuals with stuttering. Although differing in their methodologies few past studies also reported increased timing variability in the form of more variable temporal patterns across trials for speech and non-speech tasks (Cooper & Allen, 1977; Kleinow & Smith, 2000; Wieneke, Janssen, & Brutten, 1995; Howell, A-Yeung, & Rustin, 1997; Olnder, Smith, Zelaznik, 2010). The results of present study support the “motor timing deficit” theory (Max, Caruso, & Gracco, 2003; Olander Smith, Zelanik, 2010; Zelaznik et. al., 1997). According this theory individuals who stutter have underlying motor timing deficit which is expressed as differences in their timing, coordination and synchronization abilities.

The results also indicate that selected rhythm metrics can be objectively used to document the rhythm abnormalities in people who stutter. The results can also be discussed with respect to native-language like speech rhythm. The native language of the all the AWS was Kannada. Kannada language is classified under mora-timed language (Savithri, Goswami, & Kedarnath, 2007), wherein there is negligible variability within its successive vocalic and inters vocalic segments. Higher PVI values (for both nPVI and rPVI) are typically noticed in stress timed languages compared to syllable timed languages (Grabe & Low, 2002). Typical example of stress timed language is English. In English, unstressed syllables are followed by stressed syllables. Unstressed syllables will have shorter vowel and consonantal durations compared to stressed syllables. Because of this, there will be large difference between the successive vocalic and intervocalic values. In addition, the syllabic structure of English language is more complex than syllable–timed languages (more instances of CCV, CCCV), which in turn will increase the durational variability of intervocalic intervals. Higher mean values of PVI measures in our Kannada speaking individuals who stutter suggest that their rhythm is more like stress-timed than mora-timed, where the latter is typically noticed in normal Kannada speaking individuals (Savithri, Gowswami, & Kedarnath, 2007). These durational differences could be the reason for the perceived differences in speech naturalness of individuals who stutter.

The results can also be discussed taking into account neural resources recruited for the isochronous rhythmic timing in general. Available evidence from rhythmic timing tasks in individuals with Parkinson's disease (who have basal ganglia dysfunction) suggests increased variability in their synchronization, and continuation of isochronous lip, finger and wrist movements. (Freeman, Cody, & Schady, 1993; Nakamura, Nagasaki, & Narabayashi, 1978). Likewise increased variability in isochronous movement timing was found in patients with cerebellar dysfunction (Ivry & Kkeele, 1989). Further, fMRI evidence suggests basal ganglia (Rao et al., 1997) and cerebellar involvement (Jancke, Loose, Lutz, Specht, & Shah, 2000) in the continuation phase of finger tapping tasks. Two other areas which have been found to play important role in rhythmic movement timing are supplementary motor area (SMA) and premotor cortex (PMC) (Halsband, Ito, Tanji, & Freund, 1993). It is clear from the results of these studies that both basal ganglia and cerebellum contribute to the generation of rhythmic temporal patterns (Max & Yudman, 2003).

Several recent studies have used anatomical and/or functional neuroimaging techniques to investigate the neural basis of stuttering. Scans have been taken during a variety of different speech tasks (including rest, listening to linguistic stimuli, speaking naturally, speaking in fluency-enhancing conditions) and in pre- and post-treatment comparisons. Along with various cerebral areas different subcortical regions also have been implicated for the development of stuttering. Alm (2004) discusses several possible reasons for basal gangia involvement in individuals who stutter and suggests that individuals who stutter have defective basal ganglia-cortical route. Further, Giraud et al. (2007), found significant correlation between the activity of the caudate nucleus and severity of stuttering. Likewise, two other studies have also reported increased cerebellar activation in individuals who stutter (Brown, Ingham, Ingham, Laird, & Fox, 2005; De Nil, Knoll, Houle, 2001). Given that stuttering individuals in the present study also had increased variability of different rhythmic metrics, and previous research suggests basal ganglia and cerebellar circuits' role for rhythmic speech timing, it is possible that abnormal motor circuits of basal ganglia and cerebellum of these individuals might be responsible for increased rhythmic variability in these individuals.

3.2 Results for Experiment 2

This experiment compared effect of two kinds of fluency inducing conditions, adaptation effect and delayed auditory feedback on the rhythm metrics of the individuals with stuttering.

a. ***Adaption Condition***: First, the percentage of adaptation effect was calculated for each AWS. Results revealed that all the subjects demonstrated the adaptation effect. The percentage of adaptation effect for each AWS is shown in table 3.4 and figure 2. The percentage adaptation effect ranged from 26% to 84% (mean 41.8, S.D., 18.8). Second, the different rhythm metrics were measured from sentences read successively for five trails. This was done to investigate the effect of adaptation effect on the rhythm metrics. Table 3.5 shows the mean and the standard deviation values for all rhythm metrics. The mean values of different rhythm metrics were lower for the fifth reading compared to the first reading.

   Repeated measure of ANOVA was done to compare different rhythm metrics across five different readings. Results of repeated measures of ANOVA showed statistically significant difference ($p < 0.05$) between the five readings for parameters nPVI [$F, (4,36) = 18.879, p < 0.05$], rPVI [$F, (4,36) = 2.944, p < 0.05$], PercentV [$F, (4,36) = 8.083, p < 0.05$], DeltaV [$F, (4,36) = 15.979, p < 0.05$], VarcoV [$F (4,36) = 19.664, p < 0.05$]. There was no significant difference between five readings for Delta C [$F(4,36) = 0.722, p>0.05$], Varco C [$F(4,36) = 1.165, p >0.05$]. Results of Bonferroni pairwise comparison showed a significant difference ($p<0.05$) between readings, 1-4, 2-4, 4-5 for nPVI; 1-5, 4-5 for rPVI;

1-2, 1-3, 2-3, 2-4 for PercentV; 1-2, 1-3, 1-4, 1-5 for DeltaV; 1-3, 1-4, 3-5, 4-5 for VarcoV.

Table 3.4

Percentage of adaptation effect for individual individuals with stuttering

S. No.	***PSS %***					***% Adaptation Effect***
	Trial1	***Trial 2***	***Trial 3***	***Trial 4***	***Trial 5***	
1.	23.68	22.72	21.29	19.85	19.85	83.82
2.	15.07	8.37	4.78	5.26	3.11	20.63
3.	1.6	1.6	0.7	0.7	0.7	43.75
4.	2.4	2.4	2.15	1.67	0.7	29.16
5.	2.4	1.91	1.43	1.43	0.7	29.16
6.	13.4	12.68	9.57	8.13	3.5	26.11
7.	9.57	8.13	6.22	5.98	5.74	59.98
8.	9.09	5.02	3.83	3.58	3.11	34.2
9.	5.02	4.78	4.06	3.35	2.4	47.8
10.	4.3	3.11	2.15	1.9	1.9	44.18

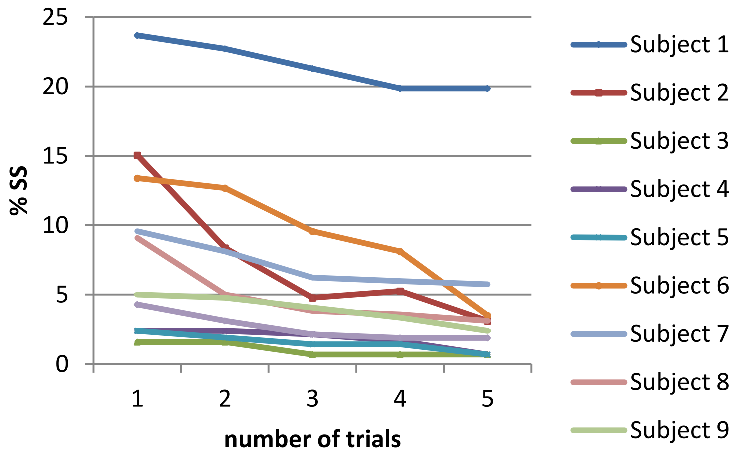

Figure2: Graphical representation *of adaptation effect for individuals with stuttering*

Table 3.5

Mean & S.D. (in parenthesis) for different rhythm metrics in AWS across five readings

Rhythm metrics	**Trial1**	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**
nPVI	78.55 (5.24)	78.55 (5.24)	70.09 (5.88)	62.41 (4.18)	71.64 (7.52)
rPVI	.0457 (.016)	.0454 (.007)	.0473 (.006)	.0428 (.015)	.0352 (.011)
PerV	66.77 (2.58)	60.41 (3.40)	64.45 (3.30)	65.81 (3.33)	63.98 (4.52)
DeltaC	.0426 (.024)	.0403 (.005)	.0436 (.007)	.0413 (.017)	.0358 (.014)
DeltaV	.1631 (.042)	.0989 (.031)	.1091 (.030)	.0974 (.018)	.1132 (.028)
VarcoC	50.87 (25.12)	47.54 (4.25)	54.08 (5.22)	53.78 (15.81)	46.56 (12.01)
VarcoV	98.34 (12.34)	80.58 (9.95)	71.29 (9.42)	67.75 (11.53)	82.52 (10.88)

The goal here was to examine differences in the rhythm metrics under two fluency inducing conditions like adaptation and delayed auditory feedback. First, the percentage of adaptation effect was calculated. For this, the percentages of syllables stuttered was calculated for the first and the fifth reading of the passage and then the percentage of adaptation was calculated. Percentage of adaptation effect for all the subjects demonstrated significant adaptation effect across the trials.

Second, for the repeated readings of the same sentences, mean values of rhythm metrics were significantly lower in the fifth reading compared to first reading for all measures. This suggests that there is a less variability in fifth reading due to adaptation. The results of first experiment also showed that there is a higher variability in AWS compared to control group and the speech of AWS is deviant from that of its native language with respect to speech rhythm. With adaptation task, AWS showed a lower variability indicating that the rhythmic timing of AWS has changed from first to fifth reading. It has been suggested that the inducement of fluency during adaptation effect may be a result of motor learning (Balasubramanian, Max, Van Borsel, Rayca, & Richardson, 2003; Caruso & Max, 1997; Max, 2004; Max, Caruso, & Vandevenne, 1997; Max & Caruso, 1998). Motor learning Hypothesis proposed by Max et al. (1997) highlights more directly the learning processes involved in motor skill improvements. However specific aspects of motor learning are not documented. The results of the present study indicate that there is decreased variability in the durations of successive vocalic and intervocalic intervals. This decrease in the variability suggests that individuals with stuttering are able to generate more regular rhythmic behaviors during adaptation task. This 'regular speech timing' could be one of the aspects of the motor learning process which induces fluency during adaptation effect.

b. ***Delayed auditory feedback condition***: For each AWS, percentage of syllables stuttered (%SS) was calculated for passage reading under the four different delayed auditory feedback (DAF) conditions (0ms, 50ms, 100ms and 200ms). The results revealed that all the participants showed significantly lower percentage of syllables stuttered under the 200ms delay when compared to 0ms delay. The mean %SS was 4.74(S.D., 3.66) for 0 ms delay; 3.05 (S.D., 2.17) for 50 ms delay; 1.76 (S.D., 1.8) for 10 ms delay; 1.20 (S.D., 0.89) for 200 ms delay. To investigate the effect of DAF on the rhythm metrics, the different rhythm metrics were calculated from sentence readings read across four DAF conditions. Table 3.6 and figure 3 give the mean and the standard deviation scores for all rhythm metrics. The mean values of different rhythm metrics were higher for 200ms delay than 0ms except for nPVI.

Repeated measure of ANOVA was done to compare different rhythm metrics across four DAF conditions. Results of repeated measures of ANOVA showed statistically significant difference ($p < 0.05$) between the four DAF conditions for metrics rPVI [F, (3,27) = 14.197, $p < 0.05$], DeltaC [F, (3,27) = 12.785, $p < 0.05$], DeltaV [F, (3,27) = 10.663, $p < 0.05$], VarcoC [F, (3,27) = 7.510, $p < 0.05$]. There was no significant difference between four delay conditions for nPVI [F (3, 27) = 0.448, $p > 0.05$], percV [F (3, 27) = 1.675, $p >0.05$], varcoV [F (3, 27) = 1.748, $p > 0.05$]. Results of Bonferroni pairwise comparisons showed significant difference between readings 0ms-200ms, 50ms-100ms, 50ms-200ms for rPVI; 0ms-200ms, 50ms-200ms for DeltaC; 100ms-200ms for DeltaV; 0ms-200ms for VarcoC.

Table 3.6

Percentage of syllables stuttered (%SS) in individual AWS under different delayed auditory feedback conditions.

S. No.	***PSS (%)***			
	0ms	***50ms***	***100ms***	***200ms***
1.	7.2	3.5	3.08	2.8
2.	3.3	2.2	2	1.4
3.	1.8	1.03	0.8	0.8
4.	3.7	2.5	1.03	1.03
5.	2	1.6	1.03	0.4
6.	13.6	8.02	4.1	2.8
7.	2.5	1.2	0.6	0.4
8.	4.5	3.7	2.8	0.8
9.	6.8	5.14	1.2	1.03
10.	2	1.6	1.03	0.6

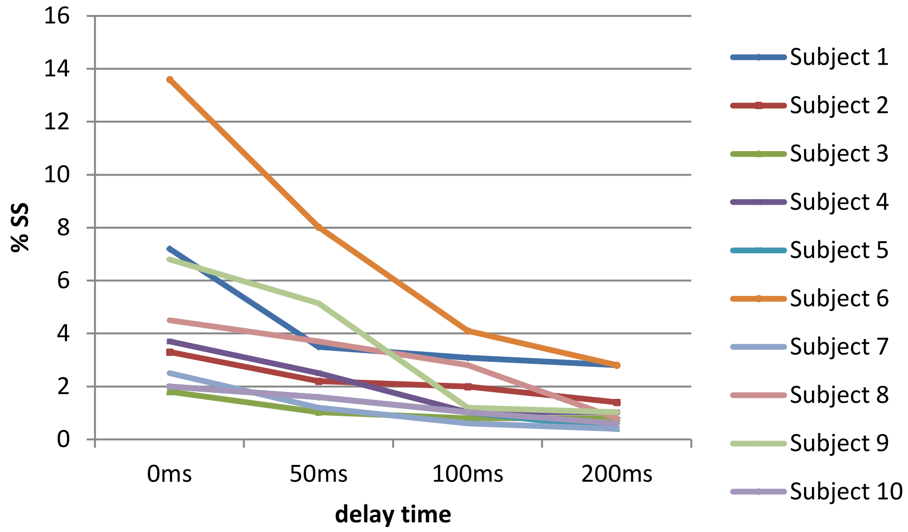

Figure 3: Graphical representation of change in percentage of syllables stuttered (%SS) in individual AWS under different delayed auditory feedback conditions

Table 3.7

Mean & S.D (in parenthesis) for different rhythm metrics in AWS across 4 DAF conditions

Rhythm metrics	***DAF conditions***			
	0ms	***50ms***	***100ms***	***200ms***
nPVI	71.63 (4.88)	70.47 (4.43)	71.14 (2.83)	70.84 (3.35)
rPVI	0.037 (0.006)	0.037 (0.007)	0.042 (0.006)	0.046 (0.007)
PerV	68.49 (3.40)	68.85 (2.66)	69.10 (3.00)	69. 96 (2.81)
DeltaC	0. 035 (0.007)	0. 036 (0.007)	0.044 (0.008)	0. 045 (0.006)
DeltaV	0. 115 (0.022)	0. 113 (0.021)	0.119 (0.020)	0. 138 (0.022)
VarcoC	48.67 (3.69)	49.41 (6.15)	52.32 (5.11)	55.86 (6.11)
VarcoV	70. 31 (5.77)	68. 64 (7. 02)	68.76 (3.45)	72.10 (5. 93)

For DAF, individuals with stuttering first read passage under four delay conditions (0 ms delay, 50 ms delay, 100 ms delay, and 200 ms delay). After this they read set of five sentences under the same delay conditions. The recorded passages were used to compare the percentage of syllables stuttered across four delay conditions. The results suggested significant decrease in the percentage of syllables stuttered from 0 ms delay to 200 ms in all the participants. Further, statistically significant difference was observed for rPVI, delta C, delta V and Varco C measures across 4 different delay conditions. The mean values these rhythm metrics had significant increased in 200 ms delay condition compared to 0ms delay. In other words there is increased variability of selected aspects of rhythmic speech timing (in terms of increased variability of successive intervocalic intervals) when individuals with stuttering speak under altered auditory feedback conditions. Several hypotheses have been proposed for the reduction in stuttering under DAF. Previously, reduced rate was considered as the reason for decrease in stuttering (Costello-Ingham, 1983; Goldiamond, 1960). However, Kalinowsky, Stuart, Sark, & Armson (1996) found that persons who stutter were fluent under both normal and fast speaking rates with DAF. They concluded that reduction in stuttering is not due to motoric changes in terms of prolonged speech, but due to auditory second speech signal itself. The results of the present study suggest that, under DAF, there is altering of rhythmic timing of consonant and vocalic intervals.

3.2 Results for Experiment 3

The objective this experiment was to compare a) rhythm metrics prior to and soon after prolonged speech therapy in individuals with stuttering, b) rhythm metrics between recovered AWS (post-treatment) and normal control participants.

a. Comparison of rhythm metrics in Pre- and post-therapy conditions

In general, mean percentage of syllables stuttered decreased significantly from pre-therapy to post-therapy condition. The results of paired t-test showed statistically significant difference between conditions only for spontaneous speech [t (4) = 3.481, p <0.05] task. There was no statistically significant difference between two conditions for reading task [t (4) = 2.354, p > 0.05].

Comparison of rhythm metrics between pre-therapy and post-therapy conditions showed a higher mean values in pre therapy condition for VarcoC and VarcoV measures. For other rhythm metrics mean values were higher in the post-therapy condition. Wilcoxon signed ranks test was done to compare rhythm metrics values between pre-therapy and post-therapy conditions. The results Wilcoxon test showed statistically no significant difference (p>0.05) between two conditions. Table 3.8 and figure 4 show comparison of percentage of syllables stuttered between pre-therapy and post-therapy conditions. Table 3.9 shows comparison of Mean, S.D, 'Z' values, and significance values for different rhythm metrics between pre-therapy and post-therapy conditions.

Table 3.8

Comparison of percentage of syllables stuttered between pre-therapy and post-therapy conditions.

Participants	*Pre-therapy*		*Post-therapy*	
	Conversation	*Reading*	*Conversation*	*Reading*
S1	11.67	14.67	5.2	1.9
S2	20.8	17.1	5.5	1.8
S3	11.1	3.1	5.5	1.5
S4	11.15	1.3	2.5	1.08
S5	6.5	6.9	4.4	1.5
Mean(S.D)	12.24 (5.22)	8.61(6.99)	4.62(1.26)	1.55(0.32)

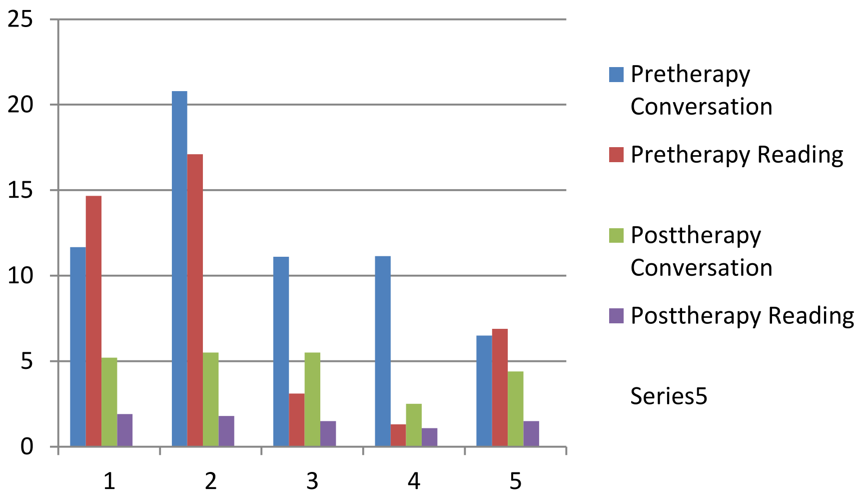

Figure 4: Comparison of percentage of syllables stuttered between pre-therapy and post-therapy conditions.

Table 3.9

Mean, S.D, 'Z' values, significance values for different rhythm metrics pre and post therapy condition

Rhythm measures	***Mean***		***Standard Deviation***		**Z values**	**'p' values**
	Pre therapy	***Post therapy***	***Pre therapy***	***Post therapy***		
nPVI	76.57	82.14	8.97	2.83	-1.095[a]	.273
rPVI	.0413	.0442	.009	.0100	.000[a]	1.000
PerV	64.44	64.36	.9853	6.635	-.365[a]	.715
DeltaC	.0429	.0406	.0165	.0073	.000[a]	1.000
DeltaV	.1295	.1492	.0290	.0188	-1.095[a]	.273
VarcoC	52.51	47.19	13.31	3.79	-.365[a]	.715
VarcoV	86.93	79.00	8.71	2.92	-1.461[a]	.144

a. The sum of negative ranks equals the sum of positive ranks.

b. Comparison of rhythm metrics between recovered AWS (post-treatment) and normal control participants

The different rhythm metrics were compared between recovered AWS and control participants. It was found that the recovered AWS showed a high mean value compared to the control subjects. However,‘t’ test showed statistically significant difference ($p < 0.05$) between the groups only for PercV. For other rhythm metrics there was no significant difference between two groups. Table 3.10 shows comparison of Mean, S.D, ‘t’ values, df values and ‘p’ values for different rhythm metrics between recovered AWS and control participants.

Table 3.10

Mean, S.D, ‘t’ values, df values and ‘p’ values for different rhythm metrics in recovered AWS and control groups.

Rhythm metrics	Groups	Mean	S. D	‘t’ values	df	P values
nPVI	control	79.68	2.99	-1.174	12	.775
	AWS	81.34	2.25			
rPVI	control	.035	.004	-1.371	12	.629
	AWS	.039	.005			
PercV	control	69.24	.916	-1.749	12	.017
	AWS	70.72	2.04			
DeltaC	control	.031	.002	-2.382	12	.064
	AWS	.036	.005			
DeltaV	control	.146	.022	-1.486	12	.482
	AWS	.171	.037			
VarcoC	control	42.80	2.15	-1.250	12	.547
	AWS	44.58	3.09			
VarcoV	control	82.89	4.98	-1.449	12	.938
	AWS	86.45	4.17			

This experiment aimed at comparing the a) rhythm metrics prior to and soon after prolonged speech therapy in individuals with stuttering, b) rhythm metrics between recovered AWS (post-treatment) and normal control participants. Both the comparisons showed a significant reduction in the frequency of stuttering however there was no significant difference in rhythm metrics. Packman, Onslow & Menzies (2000) proposed ***variable syllabic stress*** model for stuttering. According to this model, in English speech requires the production of syllables with a range of stress. Syllabic stress varies along a continuum and this variability is motorically achieved by changing the amount of effort from syllable to syllable. Hence, the speaker is constantly making finely tuned adjustments to the subsystems of speech from syllable to syllable for which a normal speech neuromotor system is required. The individuals with stuttering may have underlying deficit in speech production (unstable speech motor system) which can be the source of perturbation in production of syllabic stress. This model was used to explain why the prolonged speech is so effective in reducing stuttering. Packman et al. (2000) suggested that prolonged speech therapy reduces the variability in contrastive syllabic stress. This is suppose to simplify speech production considerably and hence reduces the motoric task demands on an unstable speech production system. Hence, AWS achieve fluent speech post-therapeutically. Reduction in the variability of syllabic stress is also a feature of syllable timed or rhythmic speech, which is an even more powerful stuttering suppressant or fluency enhancing condition. (Packman et al, 2000).

In present study, even though there was significant decrease in stuttering frequency post-therapeutically, there was no significant difference in mean values of rhythmic metrics before and after prolonged speech therapy. Going by Packman et al’s explanation, there should be significant decrease in variability of syllabic stress (indirectly documented in terms of reduction in the mean values of PVI measures) in the post-therapy condition. However, such a phenomenon was not observed. This could be mainly because of differences in the rhythmic structure of two languages. The AWS in this study were native speaker of Kannada and Kannada language is classified as mora-timed language (Savithri, Goswami, Kedarnath, 2007), wherein there is negligible variability within its successive vocalic and inters vocalic segments. As Kannada does not have syllabic stress like English language such an explanation of reduction in syllabic stress may not hold good here. This leads to an impression that there is innately some other mechanism acting in prolonged speech which reduces stuttering.

CHAPTER 4

SUMMARY AND CONCLUSIONS

The present study was conducted to investigate the rhythmic characteristics of speech of persons who stutter by measuring the rhythm metrics. Three separate but related experiments were done for this purpose. The first experiment aimed to understand the nature and characteristics of the rhythm in the speech of persons who stutter. Fifteen individuals with stuttering were compared with age and gender matched individuals without stuttering. The mean values of different rhythm metrics were higher for AWS than control speakers for most of the rhythm metrics signifying a high variability between the successive vocalic and inter-vocalic segments of speech. It indicates that AWS are less regular in timing of speech events compared to individuals without stuttering.

In the second experiment, the effect of two kinds of fluency inducing conditions, adaptation effect and delayed auditory feedback, on the rhythm metrics of the speech of persons who stutter was investigated. The results of adaptation effect suggested that there is a less variability in most of the rhythm metrics in fifth reading compared to first reading due to adaptation. The results of delayed auditory feedback suggested that there is an increased variability in most of the rhythm metrics in 200msec delay condition compared to 0 mms delay. The purpose of third experiment was to probe into the changes in rhythm metrics prior to and after the prolongation therapy in persons with stuttering. The results of this experiment showed that there was no significant difference between pre therapy and post therapy rhythmic metric values. Also the comparison between the recovered subjects and controls subjects did not show any significant change. Hence, it suggests that prolongation therapy resulted in reduced stuttering frequency but did not have a significant effect on rhythm characterisitcs. Results highlight that selected rhythm metrics can be objectively used to document the rhythm abnormalities in people who stutter. However it's not possible to use it as an effective measure to document the changes after the therapy.

To conclude, the study provides scientific evidence for speech rhythm deficits in persons with stuttering. However, in the present study speech rhythm was documented during reading task. Further studies need to be done with spontaneous speech task to corroborate present findings. Further, studies with children are indeed essential for understanding the role that any factors of interest may play in the *etiology* of stuttering. If a reported difference between individual with and without stuttering cannot be replicated with children who are closer to the onset of the disorder, then it would seem unlikely that any limitations observed in the stuttering adults were already present during early childhood and may have contributed to the development of stuttering. The information derived in this research can be utilized in understanding nature of prosody in persons with stuttering.

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Appendix I

300 Word Reading Passage

MAzÀÄ HgÀ°è M§â ¨Áæ°ÀätzÀÝ. CªÀ£ÀÄ wAzÀÄ-vÉÃV vÀÄA¨Á zÀqsÀÆw DVzÀÝ. J®ègÀÆ EªÀ£À£ÀÄß oÉÆt¥À – UÀt¥À JAzÉÃ PÀgÉAiÀÄÄwÛzÀÝgÀÄ. ¥ÀÅµÀÌ¼ÀªÁzÀ Hl CAzÀgÉ CªÀ¤UÉ vÀÄA¨Á EµÀÖ. AiÀiÁgÉÃ HlPÉÌ PÀgÉAiÀÄ°, AiÀiÁªÀÅzÉÃ ¸ÀªÀiÁgÀA¨sÀªÁUÀ° ºÁdgÁUÀÄwzÀÝ. C¯ÉÆèAzÀÄ £ÀUÀgÀ. zsÀ£À¥ÀwAiÉÄA§ ªÁå¥Áj EzÀÝ. oÉÆt¥À ¨Áæ°ÀätUÀÆ EªÀ¤UÀÆ ¨Á®å¢AzÀ®Æ ¸ÉßÃºÀ.

MAzÀÄ ¨Áj ªÁå¥ÁjAiÀÄ ªÀÄUÀ¤UÉ ºÀÄlÄÖºÀ§âzÀ ¸ÀªÀiÁgÀA¨sÀ dgÀÄVvÀÄ. ¸ÁPÀµÀÄÖ ªÀÄA¢ UÀtåjUÉ PÀgÉ PÀ¼ÀÄ»¹zÀ. ¨Áæ°ÀätUÀÆ PÀgÉAiÉÆÃ¯É §AvÀÄ. ¦æÃwÃAiÀÄ ¨Á®å ¸ÉßÃ»vÀ£À ªÀÄ£É, eÉÆvÉUÉ ¸ÁºÀÄPÁgÀ ¸ÉßÃ»vÀ£À ªÀÄ£ÉAiÀÄ ¸ÀªÀiÁgÀA¨sÀ ¸Àäj¸ÀÄwzÀÝAvÉÃ ¨Á¬Ä vÀÄA¨Á ¤ÃgÀÆjvÀÄ. DzÀgÉ CªÀ£À ªÀÄ£É EzÀÝzÀÄÝ ¨Áæ°ÀätjzÀÝ Hj¤AzÀ DgÀÄ ªÉÄÊ°UÀ¼À zÀÆgÀzÀ°è. zÀqsÀÆw EzÀÄÝzÀÝjAzÀ §¸ÀÄìUÀ¼À°è ºÉÆÃUÀ®Ä ¸ÀºÀ vÀÄA¨Á ªÀÄÄdÄUÀgÀ. "£ÀqÉzÀÄPÉÆAqÉÃ ºÉÆÃzÀgÁ¬ÄvÀÄ. DgÉÆÃUÀåªÀÇ, eÉÆvÉUÉ ºÀ¹zÀ ºÉÆmÉÖUÉ HlªÀÇ vÀÄA¨Á gÀÄa¸ÀÄvÀÛzÉ" CAzÀÄPÉÆAqÀ.

¸ÀªÀiÁgÀA¨sÀzÀ ¢£À §AvÀÄ. ¨ÉÃUÀ ¸Áß£Á¢UÀ¼À£ÀÄß ªÀÄÄV¹zÀ. ºÀuÉUÉ «¨sÀÆw zsÀj¹zÀ. £Á®ÄÌ ¨ÉgÀ¼ÀÄAa£À zsÉÆÃvÀæ GlÖ. dgÀvÁj ±Á®Ä ºÉÆzÀÄÝPÉÆAqÀ. ªÀÄ£É¬ÄAzÀ ºÉÆgÀUÉ PÁ°qÀÄwÛzÀÝAvÉ M§â PÀÄµÀÖgÉÆÃV PÁtÂ¹zÀ. "¢QÌ®è vÀAzÉÃ, AiÀiÁgÁzÀÄæ zÁ£À ªÀiÁr C¥Áà" JAzÀÄ gÁUÁ¯Á¥À£É ªÀiÁqÀÄvÁÛ §AzÀ. "xÀÆ C¥À±ÀPÀÄ£À" CAzÀÄPÉÆqÀÄ ªÀÄ£ÉAiÉÆ¼ÀUÉ »A¢gÀÄVzÀ.

LzÀÄ ¤«ÄµÀzÀ £ÀAvÀgÀ ªÀÄvÉÛ ªÀÄ£É¬ÄAzÀ ºÉÆgÀUÉ §AzÀ. CvÀå®à zÀÆgÀ ºÉÆUÀÄwÛzÀAvÉ MAzÀÄ PÀjAiÀÄ ¨ÉPÀÄÌ EªÀ£À ¥ÁzÀUÀ¼À ªÉÄÃ°AzÀ ºÀjzÀÄ ºÉÆÃ¬ÄvÀÄ. CªÀ£À eÉÆvÉUÁgÀ ¨ÁæºÀätgÀÄ "K¤æÃ UÀt¥ÀAiÀÄå£ÀªÀgÉÃ, §gÉÆÃ¢¯ÉéÃ?" JAzÀÄ «ZÁj¸ÀÄvÁÛ ªÀÄÄAzÉ ªÀÄÄAzÉ ºÉÆÃzÀgÀÆ ¸ÀºÀ EªÀ£ÀÄ C¥À±ÀPÀÄ£À D¬ÄvÉAzÀÄ ªÀÄvÉÛ ªÀÄ£ÉUÉ »A¢gÀÄVzÀ. ªÀÄvÉÛ LzÁgÀÄ ¤«ÄµÀUÀ¼À PÁ® ¨ÉPÀÄÌ ºÁUÀÆ gÉÆÃVAiÀÄ£ÀÄß ±À¦¸ÀÄvÁÛ ªÀÄ£ÉAiÀÄ¯ÉèÃ EzÀÄÝ, ªÀÄÆgÀ£ÉAiÀÄ ¨Áj ªÀÄ£É¬ÄAzÀ ºÉÆgÀl.

ºÉÆ¹®Ä §½ §gÀÄwÛzÀÝAvÉ ªÀÄ£ÉAiÀÄ ºÉÆ¸À°£À §½ JqÀ¥ÁzÀ vÁQ JqÀ«zÀ. AiÀiÁPÉÆ UÀæºÀZÁgÀ ¸Àj¬Ä®è CAzÀÄPÉÆAqÀÄ E£ÀÆß PÉ®ªÀÅ ¤«ÄµÀUÀ¼À PÁ® ªÀÄ£ÉAiÉÆ¼ÀUÉÃ EzÀÄÝ ªÀÄvÉÛ ¨ÉÃUÀ ¨ÉÃUÀ ¸ÉßÃ»vÀ£À ªÀÄ£É PÀqÉ £ÀqÉzÀ. ªÉÆzÀ¯ÉÃ ¨ÉÆdÄÓ ºÉÆmÉÖ ¨ÉÃUÀ ¨ÉÃUÀ ºÉeÉÓ ºÁPÀÄwÛzÀÝAvÉ, ¨ÁæºÀät¤UÉ ªÉÄÃ®Ä¹gÀÄ ºÉZÁÑ¬ÄvÀÄ. ºÁUÀÆ »ÃUÀÆ PÀµÀÖ¢AzÀ ¸ÉßÃ»vÀ£À ªÀÄ£É vÀ®Ä¦zÀ. ºÉÆÃVzÀÝªÀgÉ®ègÀÆ, Hl ªÀiÁr, PÉÊ vÉÆ¼ÉzÀÄPÉÆAqÀÄ ¸ÀAvÉÆÃµÀ¢AzÀ vÀÆUÀÄvÁÛ vÁA§Æ¯Á ¥ÀqÉAiÀÄÄwÛzÀÝgÀÄ.

EµÀÄÖ ºÉÆvÀÄÛ «ÄÃj §AzÀ ¨ÁæºÀät£À£ÀÄß PÀAqÀÄ zsÀ£À¥ÀwAiÀÄÄ ¥ÉÃZÁrzÀ "AiÀiÁPÀAiÀÄå EµÀÄÖ vÀqÀ ªÀiÁrzÉ? HlzÀ ªÉÃ¼ÉAiÉÄÃ ªÀÄÄVzÀÄ ºÉÆÃVzÉ! C£ÀÄßvÁÛ JgÀqÀÄ ¨Á¼ÉºÀtÄÚ, MAzÀÄ ¯ÉÆÃl ºÁ®Ä vÀj¹PÉÆlÖ.¨ÁæºÀät CµÀÖjAzÀ¯ÉÃ vÀÈ¦Û ¥ÀlÄÖ ¸ÀÄAPÀ E®è C£ÀÄßªÀAvÉ ¸ÁPÉÆÃ ¸ÁPÁV £ÀqÉzÀÄPÉÆAqÉÃ ªÀÄ£ÉUÉ §AzÀ. DUÀ®Æ CªÀ¤UÉ ªÀÄÆqsÀ£ÀA©PÉUÀ¼À ªÉÄÃ¯É EzÀÝ «±Áé¸À C½¢gÀ°®è. ºÁ¼ÀÄ ¨ÉPÀÄÌ, PÀÄµÀÖgÉÆÃV F ¢£À £À£ÀUÉ°è PÁ¢zÁÝgÉÆÃ CAzÀÄPÉÆAqÉÃ ªÀÄ®VzÀ. JqÀ«zÀÝ ¥ÁzÀzÀ £ÉÆÃªÀÅ CªÀ£À ¤zÉæUÀÆ ¨sÀAUÀ vÀA¢vÀÄ.

Appendix II

Set I Sentences

1) ಈ ಕಾಲದಲ್ಲಿ ಒಳ್ಳೆ ತಳಿಯ ಕಾಶ್ಮೀರದ ಸೇಬುಗಳು ಮಾರುಕಟ್ಟೆಯಲ್ಲಿ ಸಿಗುವುದು ಕಷ್ಟ ಮತ್ತು ದುಬಾರಿ ಕೂಡ.

2) ಊರಿನ ಹುಡುಗಿಯರು ಮನೆಯ ಬಳಿ ಇರುವ ಮರದ ಅಡಿ ಕುಳಿತುಕೊಳ್ಳುವರು.

3) ಭ್ರಷ್ಟಾಚಾರವನ್ನು ಹೋಗಲಾಡಿಸಲು ಅಣ್ಣಾಹಜಾರೆ ಅವರು ನಡೆಸಿದ ಉಪವಾಸವು ಜನರಲ್ಲಿ ಭಾರೀ ಪ್ರಮಾಣದ ಜಾಗೃತಿಯನ್ನು ಬೆಳೆಸಿತು.

4) ನನ್ನ ಸ್ನೇಹಿತೆ ಮೊದಲ ಸಂಬಳ ಪಡೆದ ಸಂತೋಷಕ್ಕಾಗಿ ಆಕೆ ತನ್ನ ತಾಯಿಗೆ ಒಂದು ಸುಂದರವಾದ ಸೀರೆಯನ್ನು ಉಡುಗೊರೆಯಾಗಿ ಕೊಟ್ಟಳು.

5) ನಾವು ಏಳು ಜನ ಆಟೋಗಳಲ್ಲಿ ರಾತ್ರಿ ಸಿನೆಮಾ ನೋಡಲು ಹೋದೆವು.

Appendix III

FORMULAES USED

1. Normalized pair – wise variability index of Vocalic interval (nPVI-V):

   $nPVI\text{-}V = 100*(\sum_{k=1}^{m-1} | (d_k - d_{k+1})/(d_k + d_{k+1})/2|)/(m-1)$

2. Raw pair – wise variability index of the Consonantal interval (rPVI-C):

   $rPVI\text{-}C = (\sum_{k=1}^{m-1} |d_k - d_{k+1}|)/(m-1)$

3. Percentage of Vocalic interval:

   $\%V = \sum V / \sum (V + C)$

4. Delta C:

   ▲C = Standard deviation of C

5. Delta V:

   ▲V = Standard deviation of V

6. Variable coefficient of consonantal Interval (VarcoC):

   VarcoC = ▲C/Average C

7. Variable coefficient of Vocalic Interval (VarcoV):

   VarcoV = ▲V/Average V

Abbreviations index:

m = total number of intervals

d = duration of "k^{th}" interval

V = duration of vocalic interval

C = duration of consonant interval

Appendix IV

Passage to test Adaptation effect

ಜನಸಂಖ್ಯಾ ಸ್ಫೋಟದಿಂದ ಆಗುವ ತೊಂದರೆಗಳು ಹಲವು. ಮೊದಲಿಗೆ ನಾವು ಬಳಸುವ ಆಹಾರದ ಮೇಲೆ ಪರಿಣಾಮ ಉಂಟಾಗುತ್ತದೆ. ಜನಸಂಖ್ಯೆ ಬೆಳೆಯುವ ವೇಗದಲ್ಲಿ ಮತ್ತು ಪ್ರಮಾಣದಲ್ಲಿ ನಾವು ಆಹಾರವನ್ನು ಉತ್ಪತ್ತಿ ಮಾಡಲಿಲ್ಲದಿದ್ದರೆ ಆಹಾರದ ಸಮಸ್ಯೆ ತಲೆದೋರುತ್ತದೆ. ಮಕ್ಕಳಿಗೆ, ಹೆಂಗಸರಿಗೆ, ಕಾರ್ಮಿಕರಿಗೆ ಮತ್ತು ದುರ್ಬಲರಿಗೆ ಪೌಷ್ಟಿಕ ಆಹಾರ ದೊರೆಯದಂತಾಗುತ್ತದೆ. ಜನಸಂಖ್ಯಾ ಸ್ಫೋಟದ ಪರಿಣಾಮವಾಗಿ ನೂರಕ್ಕೆ ಐವತ್ತಾರು ಮಕ್ಕಳು ಶಾಲೆಗೆ ಸೇರುತ್ತಾರೆ ಎಂದು ಸರ್ಕಾರದ ಒಂದು ವರದಿ ಹೇಳುತ್ತದೆ. ಅಕ್ಷರತೆಯು ಸ್ವಲ್ಪ ಪ್ರಗತಿಯನ್ನು ಸಾಧಿಸಿದ್ದರೂ, ನಿರಕ್ಷರರ ಸಂಖ್ಯೆಯೂ ಹೆಚ್ಚುತ್ತಲೇ ಇದೆ. ವಿದ್ಯಾವಂತರ ಸಂಖ್ಯೆಯು ಕಡಿಮೆಯಿದ್ದರೂ, ಅವರಿಗೆ ಉದ್ಯೋಗ ದೊರೆಯದೆ ನಿರುದ್ಯೋಗದ ಸಮಸ್ಯೆ ತಲೆದೋರುತ್ತದೆ. ಮೂರನೆಯದಾಗಿ ವಸತಿ ಸಮಸ್ಯೆ ಕೂಡ ತಲೆದೋರುತ್ತದೆ. ಎಲ್ಲರಿಗೂ ತಮಗೆ ಸಾಕಾದುವಂತಹ ಮನೆಗಳನ್ನು ಕಟ್ಟಿಕೊಳ್ಳಲು ಜಾಗ ಸಾಕಾಗುವುದಿಲ್ಲ. ಒಟ್ಟಿನಲ್ಲಿ ಸುಖಮಯ ಜೀವನವನ್ನು ನಡೆಸಲು ತೊಂದರೆ ಆಗುವುದು. ಈ ದೃಷ್ಟಿಯಿಂದ ಪ್ರತಿಯೊಂದು ಕುಟುಂಬದ ಬೆಳವಣಿಗೆಯೂ ನಿಯಂತ್ರಣಗೊಳ್ಳಬೇಕು. ಹೀಗೆ ದೇಶದ ಅನೇಕ ಕುಟುಂಬಗಳು ನಿಯಂತ್ರಿತವಾದರೆ ದೇಶದ ಜನಸಂಖ್ಯೆ ಮಿತಿ ಮೀರಿ ಬೆಳೆಯುವುದು ನಿಂತು ದೇಶದ ಸಂಪತ್ತು ಜನಾಂಗದ ಅಭಿವೃದ್ಧಿಗೆ ಸಾಕಾಗಬಲ್ಲದು. ಕೈಗೊಂಡ ಯೋಜನೆಗಳು ಗುರಿಮುಟ್ಟಬಲ್ಲವು.

Appendix V

Passage to test DAF passage

ನಮಗೆ ಸಂಕಟ ಬಂದಾಗ ಅದನ್ನು ಯಾರಲ್ಲಾದರೂ ಹೇಳಿಕೊಳ್ಳುತ್ತೇವೆ. ನಮಗಿಂತ ದೊಡ್ಡ ಶಕ್ರಿ ಇದೆ ಎಂದು ನಂಬಿ ನಾವು ದೇವರನ್ನು ಪೂಜಿಸುತ್ತೇವೆ. ಆ ವಿಶೇಷ ಶಕ್ತಿಯಿಂದ ನಮ್ಮ ತೊಂದರೆಗಳು ಮಾಯವಾಗುತ್ತವೆ ಅನ್ದ್ ನಮ್ಬುತ್ತೇವೆ. ಯಾವುದಾದರು ನೆಪ ಒಡ್ಡಿ ಹಬ್ಬ ಆಚರಿಸುತ್ತೇವೆ. ರುಚಿಯಾದ ತಿಂಡಿ ತಿನಿಸುಗಳನ್ನು ತಿನ್ನುತ್ತೇವೆ. ಹೊಸ ಹೊಸ ಬಟ್ಟೆ ಧರಿಸಿ ನಲಿದಾಡುತ್ತೇವೆ. ದೇವರ ಹೆಸರಿನಲ್ಲಿ, ಹಬ್ಬದ ದಿನದ ನೆಪದಲ್ಲಿ ವೈಭವದ ಆಚರಣೆ ನಡೆಸುತ್ತೇವೆ. ಬಂಧು-ಬಾಂಧವರೊಡನೆ ಸೇರುತ್ತೇವೆ. ದುಃಖ ಸಂಕಟಗಳನ್ನು ಮರೆತು ಸಂತಸ ಪಡುತ್ತೇವೆ. ಈ ರೀತಿ ದೇವರ ಆಚರಣೆಗಳಲ್ಲಿ ಭೂತಗಳು ಆರಾಧನೆಯು ನಮಲ್ಲಿ ಕೆಲವು ಪಂಗಡಗಳಲ್ಲಿ ಕಂಡು ಬರುತ್ತದೆ. ದಕ್ಷಿಣ ಕನ್ನಡ ಜಿಲ್ಲೆಯಲ್ಲಿ ಜನರು ಬೇರೆ ಬೇರೆ ಹೆಸರಿನ ಭೂತಗಳನ್ನು ಆರಧಿಸುತ್ತದೆ. ಹರಕೆ ಹೇಳಿ ಕೋಳಿ ಕೊಟ್ಟು ತಮ್ಮ ಇಷ್ಟಾರ್ಥಗಳನ್ನು ನೆರವೇರಿಸೆಕೊಳುತ್ತಾರೆ. ಕೋಲದ ಸಮಯದಲ್ಲಿ ಭೂತದ ಬಣ್ಣ ಹಾಕುವ ಪಂಗಡಗಳು ಬೇರೆ ಬೇರೆ, ಧರಿಸುವ ವೇಷವೂ ಬೇರೆ ಬೇರೆ. ಸಾಧರಣವಾಗಿ ಎಲ್ಲಾ ಭೂತಗಳ ವೇಷದಲ್ಲಿಯೂ ತೆಂಗಿನ ಚಿಗುರುಗರಿ ಇದ್ದೇ ಇರುತ್ತದೆ. ಅಡಿಕೆಯ ಹೂ ಮತ್ತು ಕೇಪಳ ಹೂ ಕೂಡ ಇರುವುದು. ಕೋಲ ಕಟ್ಟಿದವರು ಕಾಲಿನ ಗೆಜ್ಜೆಯ ಸದ್ದಿನೊಡನೆ ಡೋಲಿನ ಚಂಡೆಯ ತಾಳಕ್ಕೆ ತಕ್ಕಂತೆ ಕುಣಿಯುವರು. ಈ ನರ್ತನವೂ ಒಂದು ಕಲೆಯೇ. ಇದು ಅಭ್ಯಾಸದಿಂದ ಮಾತ್ರ ಬರುವುದು. ಶಿವನು ತಾಂಡವ ನೃತ್ಯ ಮಾಡುತ್ತಾನೆ ಎನ್ನುತ್ತಾರೆ. ಆ ಶಿವನ ಗಣಗಳಾದ ಈ ಭೂತಗಳೂ ಶಿವನಂತೆ ನರ್ತಿಸಿ ಜನರನ್ನು ಉಲ್ಲಾಸಗೊಳಿಸುತ್ತದೆ ಎಂದೂ ಭೂತಾರಾಧಕರು ಹೇಳುತ್ತಾರೆ. ಬೆಂಕಿಯೊಡನೆ ಸರಸವಾಗುವುದು ಹಲವು ಭೂತಗಳ ಕೋಲದ ವೈಶಿಷ್ಟ್ಯ.

Appendix VI

Set II Sentences

6) ಮಗುವಿನ ಎರಡನೆಯ ವಯಸ್ಸಿನಲ್ಲಿ ಮನೆಯವರು ಕಿವಿ ಚುಚ್ಚಿಸಿ ಬಂಗಾರದ ಓಲೆ ಹಾಕಿದರು.
7) ಬಹಳಷ್ಟು ಜನರಿಗೆ ಸಾಮಾನ್ಯವಾಗಿ ಕೆಂಪು ಬಣ್ಣದ ಗುಲಾಬಿ ಹೂ ಇಷ್ಟವಾಗುತ್ತದೆ.
8) ಜನ ತಮಾಷೆಯ ಹೊಸ ಸಿನೆಮಾ ನೋಡಿ ಬಹಳ ಸಮಯದ ತನಕ ನಕ್ಕರು.
9) ಇತ್ತೀಚಿನ ದಿನಗಳಲ್ಲಿ ವಿದ್ಯಾರ್ಥಿಗಳು ತಮ್ಮ ಉನ್ನತ ವ್ಯಾಸಂಗಕ್ಕೆ ಹೆಚ್ಚು ಶುಲ್ಕ ಕೊಡಬೇಕಾಗಿ ಬರುತ್ತದೆ.
10) ಆರೋಗ್ಯ ಇಲಾಖೆ ಅಧಿಕಾರಿಗಳು ವಾಕ್ ಶ್ರವಣ ವಿಭಾಗಕ್ಕೆ ಇಂದು ಭೇಟಿ ನೀಡಿದರು.

Appendix VII

Set III Sentences

11) ದೀಪಾವಳಿ ಹಬ್ಬದಂದು ಎಲ್ಲರೂ ತಮ್ಮ ತಮ್ಮ ಮನೆಯನ್ನು ಅಲಂಕರಿಸುತ್ತಾರೆ ಮತ್ತು ನಾನಾ ಬಗೆಯ ತಿಂಡಿಗಳನ್ನು ಮಾಡುತ್ತಾರೆ.

12) ಸೋಮು ಶಾಲೆಯಿಂದ ಮನೆಗೆ ಸಂಜೆ ನಾಲ್ಕು ಗಂಟೆಗೆ ಬಸ್ಸಿನಲ್ಲಿ ಹಿಂದಿರುಗುತ್ತಾನೆ.

13) ಕನ್ನಡ ಅಕ್ಷರಮಾಲೆ ಬೇರೆ ಅನೇಕ ಭಾಷೆಗಳಿಗಿಂತ ಬಹಳ ಸುಂದರವಾಗಿ ಕಾಣುತ್ತದೆ.

14) ಮಾನವ ತನ್ನ ದುರಾಸೆಯಿಂದ ಕಾಡನ್ನು ಕಡಿಯುವುದರಿಂದ ವಾತಾವರಣ ಸಮತೋಲನ ಕೆಡುತ್ತದೆ.

15) ಜನರು ತಮ್ಮ ಕೆಲಸ ಮುಗಿಸಿ ರಾತ್ರಿಯ ಹೊತ್ತಿಗೆ ಮನೆಗೆ ತಲುಪಿದರು.

Appendix VIII

Set IV Sentences

16) ಹುಡುಗರು ಶಾಲೆಯಿಂದ ಕೈ ಕಾಲು ಮುಖ ತೊಳೆದು, ತಿಂಡಿ ತಿಂದು ಕ್ರಿಕೆಟ್ ಆಡಲು ಹತ್ತಿರದ ಮೈದಾನಕ್ಕೆ ಹೋದರು.

17) ಮಧ್ಯ ಸೇವಿಸಿ ವಾಹನ ಓಡಿಸುವುದರಿಂದ ಬಹಳಷ್ಟು ಅಪಘಾತಗಳು ಆಗುತ್ತವೆ ಎಂದು ಪೊಲೀಸರು ಹೇಳುತ್ತಾರೆ.

18) ಮನೆಯ ಸುತ್ತಾ ಹೂಗಿಡಗಳನ್ನು ಬೆಳೆಸುವುದರಿಂದ ಅಂಗಳ ಸುಂದರವಾಗಿ ಕಾಣುತ್ತದೆ.

19) ಕರ್ನಾಟಕದ ಮಲೆನಾಡಿನ ಪ್ರದೇಶದಲ್ಲಿ ಪ್ರತಿವರ್ಷ ಅತಿ ಹೆಚ್ಚು ಮಳೆ ಬೀಳುತ್ತದೆ.

20) ಭಾರತದ ವಾಯುಪಡೆಯು ಶತ್ರು ದೇಶದ ಆಕ್ರಮಣವನ್ನು ತಡೆಗಟ್ಟಬಹುದಾದ ಕ್ಷಿಪಣಿಗಳನ್ನು ಹೊಂದಿದೆ.

Appendix IX

Set V Sentences

21) ಪ್ರತಿ ಶನಿವಾರ ಜಾನುವಾರು ಮಾರುಕಟ್ಟೆಯಲ್ಲಿ ದನಗಳ ವ್ಯಾಪಾರ ಭಾರಿ ಸಂಭ್ರಮದಿಂದ ನಡೆಯುತ್ತದೆ.

22) ವೀರಪ್ಪನ್ ಕರ್ನಾಟಕ, ಕೇರಳ ಮತ್ತು ತಮಿಳುನಾಡು ರಾಜ್ಯಗಳ ಕಾಡುಗಳಲ್ಲಿ ನೂರಾರು ಆನೆಗಳನ್ನು ಕೊಂದು ಹಾಕಿದ್ದಾನೆ.

23) ಮೈಸೂರಿನಲ್ಲಿ ನವರಾತ್ರಿಯ ಸಮಯದಲ್ಲಿ ಪ್ರತಿದಿನವೂ ವೈವಿಧ್ಯಮಯವಾದ ಸಾಂಸ್ಕೃತಿಕ ಕಾರ್ಯಕ್ರಮಗಳು ನಡೆಯುತ್ತವೆ.

24) ಇತ್ತೀಚಿನ ದಿನಗಳಲ್ಲಿ ಯುವಜನತೆಯ ಆಹಾರ ಪದ್ಧತಿ ಹಾಳಾಗಿದೆ, ಆದ್ದರಿಂದ ಅವರ ಆರೋಗ್ಯ ಪದೇಪದೇ ಕೆಡುತ್ತಿರುತ್ತದೆ.

25) ಕರ್ನಾಟಕದ ಪಶ್ಚಿಮ ಘಟ್ಟಗಳಲ್ಲಿ ಬಹಳ ಸುಂದರ ಝರಿಗಳಿವೆ. ಇವುಗಳನ್ನು ನೋಡಲು ಜನರು ಬೇರೆ ಬೇರೆ ಊರುಗಳಿಂದ ಬರುತ್ತಾರೆ.