Variability of stuttering frequency in adults across five consecutive days

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Dissertation submitted in part fulfillment

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CERTIFICATE

This is to certify that this dissertation entitled "**Variability of stuttering frequency in adults across five consecutive days**" bonafide work submitted in part fulfillment for the degree of Master of science (Speech Language Pathology) of the student (Registration No: 14SLP024). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award or any other diploma or degree.

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DECLARATION

I hereby declare that this dissertation entitled "**Variability of stuttering frequency in adults across five consecutive days**" is the result of my own study under the guidance of Dr. M. Santosh, Reader in Speech Science, Department of Speech -Language Sciences, All India Institute of Speech and Hearing, Manasagangothri, Mysore, and has not been submitted earlier to any other university for the award or any other Diploma or Degree.

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CHAPTER 1: Introduction

Variability in the frequency of stuttering is one of the most commonly reported clinical observations from both clinicians and clients (Bloodstein & Ratner, 2008; Van Riper, 1971). Multiple studies have reported that stuttering frequency varies due to the effect of several factors. These factors include: when speakers are speaking alone when compared to speaking to their conversational partners (Martin & Haroldson, 1988), with respect to different linguistic factors (Brown, 1937, 1938a, 1938b, 1938c, 1945), changes in the attitude of the speakers (Ulliana & Ingham, 1984), communicative intent (Davis, 1940; Stocker, 1980; Weiss, 1995), under different fluency inducing conditions such as when individuals speak while hearing delayed auditory feedback (DAF), frequency-altered auditory feedback (FAF), masking noise, or the simultaneous presentation of a second speaker's voice (unison or choral speech) (Ingham & Packman, 1979; Kiefte & Armson, 2008; Macleod, Kalinowski, Stuart, & Armson, 1995; Martin & Haroldson, 1979; Martin, Johnson, Siegel, & Haroldson, 1985; Max, Caruso, & Vandevenne, 1997; Soderberg, 1969; Stuart, Kalinowski, Armson, Stenstrom, & Jones, 1996; Stuart, Frazier, Kalinowski, & Vos, 2008). One related issue with respect to variability is how stuttering frequency varies over time.

Although it is known that there is high degree of variability in the frequency of stuttering over time, limited studies have been conducted to support these claims. Yairi and Ambrose (1992), studied early stuttering variation in 27 children who stutter (CWS) up to 12years of age. Within 5 follow-up sessions, although there was no significant decline in the frequency of "*other disfluencies*

(ODs)", "*frequency of total disfluencies (TDs)*" and "*stuttering like disfluencies* (SLDs)" showed marked downward trend overtime. In another study, Throneburg, Yairi, and Ambrose (1993) recorded variability in stuttering frequency across several months in 16 preschoolers who reported to have stuttering like disfluencies. They found significant differences in the disfluency rates over time. Onslow, Andrews, and Costa (1990) collected daily speech samples from four preschool-aged children with around 10 minute audio recording of the everyday conversation. Based on compiled agreement report of parent and clinician severity rating, the results revealed all participants showed variation around their mean stuttering frequency within and between six consecutive days. Karimi, O'Brian, Onslow, Jones, Menzies, and Packman, (2013) studied stuttering variation across different speaking situations for 12-hours in a single day. They plotted their results of individual participants as statistical charts. They found significant variation in stuttering frequency across situations and there was no consistent pattern across individuals. In a recent study, Constantino, Leslie, Quesal, Yaruss, and Scott, (2016) explained day to day variability in stuttering analyzed for different tasks. They did three day-to-day comparisons (Days 1, 2, and 3), as well as three week-to-week comparisons (Days 1, 7, and 14). The authors reported that day-to-day variability for same individual showed greater range in percentage of syllables stuttered and also there was wide range of variability across tasks. Overall, there is limited literature with respect to documentation of variability in different aspects of stuttering over time.

In addition to frequency and types of disfluencies; *duration and loci* of disfluencies are other aspects of stuttering. The overall duration of disfluencies like repetition, prolongation, and blocks has been considered a diagnostic indicator for severity of stuttering in young children (Conture & Caruso, 1987; Cooper, 1987; Curlee, 1980; Johnson, Darley, & Spriestersbach, 1963; Riley, 1981; Van Riper, 1982; Wall & Myers, 1984; Zwitman, 1978). Studies have suggested that average duration of sound/ syllable repetition and prolongation was not less than one seconds in children with stuttering (Riley, 1981; Van Riper, 1982; Zwitman, 1978), whereas the study by Zebrowski, (1991) reported no significant difference in the duration of stuttering- like disfluencies in stuttered and non stuttered peers. But research is lacking in path of studying duration of disfluencies so as the loci of disfluencies in adult persons who stutter.

Need for the study

As there is limited literature with respect to variability in the different aspects of stuttering, there is need to document variation shown by the disorder over time in terms of multiple parameters such as frequency, type, duration, and loci of stuttering.

Aim of the study

The aim of the present study was to document day-to-day variation in stuttering for four main aspects of stuttering: (a) frequency of stuttering; (b) type of disfluencies; (c) duration of disfluencies; and (d) loci of disfluencies. We hypothesize that there is indeed no marked variation in stuttering in Hindi

Speaking adults who stutter across five consecutive days, and obtaining single recording may provide a clear picture about the severity of stuttering during both assessment and treatment of these individuals.

Objective of the study

1. To investigate the variability in different aspects of stuttering (overall frequency, frequency of different types of disfluencies, duration of disfluencies, and loci of disfluencies) across five consecutive days in Hindi speaking adults who stutter.
2. To investigate the relationship between severity of stuttering and variability in different aspects of stuttering.

CHAPTER 2: Review of Literature

The primary aim of current study was to document variability in different aspects of stuttering (percentage of syllables stuttered, types of disfluencies, duration, and loci of disfluencies) across five consecutive days in Hindi speaking adults who stutter. The secondary aim was to investigate the relationship between the day-to-day variability in the different aspects of stuttering and severity of the disorder. For the purpose, the review has been provided under the following headings:

I. Views on variability of stuttering

II. Variability of stuttering in children

III. Variability of stuttering in adults

IV. Locus and duration of stuttering

Views on variability of stuttering

Fluency of speech varies greatly depending on communicative situations (Manning, 2010). Even for proficient speakers, particularly under linguistically loaded or emotionally stressed conditions, disruption in the forward flow of speech is often noted that leads to variation in speech fluency (Bogels, Alden, Beidel, Clark, Pine, Stein, & Vonken, 2010). This disruption is more pronounced in persons who stutter (PWS) owing to their past experiences of fluency failure (Blood, Wertz, Blood, Bennett, & Simpson, 1997). Many early researchers sought to explain this disruption leading to variability by looking for a pattern or

relationship between past and future stuttered events. It has been reported that from the past experiences of disfluent instances, PWS can somewhat predict the occurrence of stuttering in future (Johnson & Innes, 1939; Johnson & Knott, 1937). Conversely, these discoveries have not yet allowed the researchers to completely predict, about occurrence of stuttering instance. Hence, there is limited research available describing the degree or trend in this variability in frequency or types of disfluencies. (Bloodstein & Bernstein Ratner, 2008; Conture & Curlee, 2007; Guitar, 2013; Manning, 2010, Pittenger, 1940; Taylor & Taylor, 1967). Also, the need to understand variability in stuttering arises from the clinical requirement of understanding the disorder in its fullest sense for designing appropriate assessment procedures and treatment techniques. This variability has been providing greater impact on the clinician as they seems to be uncertain about the speech sample they have obtained during first assessment single session is or not actually representing the speaker's overall experiences of stuttering (Ingham, 1975; Ingham & Lewis, 1978; Johnson et al 2009). Henceforth it is, established that a single assessment tool or single sitting assessment will only provide a glimpse of the depth and breadth of the problem.

There might be changes in the degree or types of stuttering instance but its occurrence is uncertain that it's due to improvement from the intervention or it's the individual's variation in the stuttering (Bloodstein & Bernstein Ratner, 2008). Owing to this variation, the effectiveness of the treatment approach is questionable or an illogical approach may appear to provide good improvement from its baseline (Constantino et al 2016). Further, it is postulated from various

studies that this uncertainty can be overcome by carrying multiple times baseline measures for each PWS before and following treatment (Costello & Ingham, 1984). One another way of understanding the nature of the disorder is by documenting variability in the stuttering frequency. In the past limited attempt has been made to document the variability in stuttering in children and adults who stutter. Below is the comprehensive review of studies conducted in this area are done.

Variability in children:

Evidence has proved that stuttering in children tends to vary over time, whereas in adults it is more likely to vary in severity and even in its actual appearance, from one communicative context to another. However, the development of stuttering within any child can be unpredictable, diverse, and nonlinear, as evidenced by the extensive variety of outcomes and rate of progression. It is these characteristics that make stuttering so unique in nature. Onslow, Andrew and Costa (1990) collected daily speech samples from four preschool-aged children. They recorded 10-minute audio recording conversation for six consecutive days. The mothers were instructed to record their child's conversation samples with different persons every day. The six listening tapes were given to the clinician for counting the disfluent episodes using the button press counting device. Along with the clinicians, the listening taps were given to mothers for parent severity rating. The task of the parents and clinician was to rate the severity of each 5-minute sample using a 10-point scale where, '10' stands for 'most severe' and '1' stand for 'least severe'. Based on compiled agreement

report of parent and clinician severity rating, the results revealed that all participants showed variation around their mean stuttering frequency within and between six consecutive days. The interjudge agreement between mother and clinician rating had score difference of 0 or 1. The intrajudge reliability with clinician achieved the score difference of 2 or less for more than 90 percent of the samples and for mothers varied with individual child (1-3 score difference). Spearman correlation was computed for statistical analysis. It was concluded that there was striking variability in the number of stuttering within and between days. Such information was of prime importance in clinical management.

Yairi and Ambrose (1992), studied early stuttering variation in 27 children up to 12 years of age. This was a longitudinal report which provided a general longitudinal group trends as well as individual longitudinal data of speech disfluency for preschool-age children who stutter. Twenty-seven children (19 males and 8 females) participated in the study and were rated on 7- point rating scale. The included CWS had a minimum score of 2 on the scale. Verbal interactions of the child during play, conversation with parent and clinician were audio-tape recorded for approximately 15 minutes in the first visit and followed by 3 follow ups within a 2-year period. For the fourth follow-up 21 subjects responded with a varying gap interval of 3-12 years. Using the Yairi (1981) and Yairi and Lewis (1984) classification, disfluency analysis was done. They reported the mean and standard deviation of Stuttering-like-Disfluencies (SLD), Other Disfluencies (OD), and Total Disfluencies (TD) across the testing period for both treated and untreated population. Two -way analysis of variance was

employed, and it suggested that the two groups were not significantly different. Post-hoc comparisons between the pairs (untreated and treated groups) reported several significant differences. For untreated group only first and fifth visit had significant difference in the disfluencies. Within four follow-up sessions, although there was no significant decline in the frequency of other disfluencies, frequency of total disfluencies and *stuttering like disfluencies* (SLDs) showed marked downward trend overtime. Wide range of individual diversity was also noted in the developmental course of SLD. Based on individual data authors concluded that much of the improvement occurred in early visits and the progression of stuttering is by no means uniform. Overall the authors suggested that along with the positive prognosis for improvement across the follow-ups, much of the amelioration can be expected within approximately 12 to 14 months after the problem first manifests.

A similar study by Throneburg, Yairi, and Ambrose (1993) recorded variability in stuttering frequency for six months study in 16 preschoolers who reported to have stuttering like disfluencies. The 16 subjects presented in the report included 10 Males and 6 females. All the subjects exhibited at least 4.50 SLDs per 100 Syllables. Conversational speech sample of 30- 45 minutes, two recordings per visits was audio and videotape recorded in a sound treated room during the initial evaluation (first visit), at 3 month follow- up and at 6-month follow- up visit. Seven disfluency types were considered (1) Part-Word Repetition, (2) Single-Syllable Word Repetition, (3) Disrhythmic Phonation, (4) Polysyllable Word Repetition, (5) Phrase Repetition, (6)Interjection, (7)

Revision-Incomplete Phrase, among them first three were stuttering-like disfluencies and last four were other- disfluencies. Group mean and standard deviation were computed for different measures like frequency of stuttering, severity rating by parents and clinicians and number of facial and head movements. Correlation among the measures was also computed. They found significant differences in the disfluency rates overtime and a positive correlation among the various measures. This study suggested the rapidly changing symptom in early stuttering to be the main reason for early intervention.

In another study, Johnson et al (2009), investigated variations in disfluencies of young children who stutter (CWS) and children who do not stutter (CWNS). They postulated that one of the factors for variations in disfluencies might be due to changes in their talker group and hence it may alter the diagnosis from stutterer to nonstutterer. 17 CWS and 9 CWNS were included in the study, where each child participated in a series of speaking tasks including conversation between parent and clinician and also at different location such as home and clinic and the authors' also elicited one narrative sample. Firstly, the findings of the study revealed that even though there was significant difference in statistical analysis on types of disfluencies, these variations did not markedly have effect on the diagnosis of CWS and CWNS. Secondly, in CWNS the changes in the "%SLD, % non SLD and the SLD/TD", in conversation and narration was not due to changes in context, location and conversational partner as they did not show significant difference in to any of these compared to CWS. Thirdly, descriptive analyses indicated that talker group did have some influence of conversation

context on disfluencies. Statistical analysis reported significant differences in frequency of stuttering-like disfluencies between CWS and CWNS, as well as a significant difference in the ratio of SLD/TD between CWS and CWNS. However, no significant difference in nonstuttering-like disfluencies between CWS and CWNS was reported in the study. A study on situational variability in children revealed that children exhibit a higher overall frequency of superfluous behaviors and therefore greater degree of variability. They reported there was no significant correlation for more typical types of disfluency (Yarus, 1997). The results also reported that for both 'more-typical and less-typical disfluency types', variability across situations was significantly greater than the variability within situations. From the above mentioned studies it is evident that stuttering frequency in children shows decline in early days, and shows huge variations which is difficult to set a pattern for such disfluencies.

Variability in adults:

Van riper (1982) and Bloodstein (1960a, 1960b, and 1961a) suggested that a simple sequence of stages could never capture every PWS's disfluency pattern. Children with stuttering follow different paths of development of stuttering (Guitar, 2013), therefore leading to multiple variation and exceptions. Whereas variability in stuttering across adults are not well documented. A study by Karimi et al (2013), documented within a day variations in stuttering disfluency. In the study ten PWS (nine men and one woman) within the age range 29–78 years participated in the study. Their performance was plotted on statistical process control charts to investigate variability of stuttering frequency across twenty

different speaking situations (such as individual speaking or group situation) for 12-hours in a single day. The first three authors and 11 speech-language pathology students coordinated and participated in the day in collecting the speech samples. Participants were all fitted with a digital voice recorder (Olympus WS-760M) and a microphone (Olympus ME-15) attached to their collars for high-quality recording. The percent of syllables stuttered (%SS) indicates the frequency of syllables containing unambiguous stuttering in a speech sample. An investigator counted the total number of syllables spoken and the total number of stuttered syllables for each minute of the entire 12-hr day from the digital recordings using a button press event counter. Results for the day showed that stuttering frequencies range from 3.1 %SS to 16.1 %SS, with a mean of 7.8 %SS along with self-reported severity rating scores and communication satisfaction scores of participants. They found significant variation in stuttering frequency across situations but there was no consistent pattern across individuals.

A recent study by Constantino et al (2016) investigated the variability of frequency and duration across days and on five different speaking tasks for both stuttered and nonstuttered disfluencies. They conducted three week-to-week comparisons (Days 1, 7, and 14) and three day-to-day comparisons (Days 1, 2, and 3). Six monolingual English speaking PWS (mean age range of 24-51 years) volunteered for the study. Among the participants four were males and two were females and none were undergoing treatment at the time of study. Prior to initiation of the study the subjects were assessed using 'Stuttering Severity Instrument-Fourth Edition (*SSI-4*; Riley, 2009) and the Overall Assessment of the

Speaker's Experience of Stuttering for Adults' (*OASES-A*; Yaruss & Quesal, 2010). Data collection was carried out in five speaking situations: three spontaneous language formulation tasks i.e a conversation, a monologue, and a picture description task; and two reading tasks- one involving a single passage that participants were asked to read every day, and the other containing set of passages that changed on every data collection session. The mean, standard deviation (SD), and coefficient of variation (COV) were calculated across days and for tasks intended for each participant, for % SS and %NS (non-stuttered) of each 300 word sample. Statistical descriptors were also provided for explaining the variability between speaker, within speaker on same task, and on same sessions across time. Variability in different aspects of stuttering like frequency, severity, and experience with stuttering were also analyzed. Correlation in SSI-4 and OASES-A scores across the five data-collection sessions were also measured. The results of the study revealed evident difference in %SS during the spontaneous speaking tasks and the two reading tasks. Along with this they also suggested that the most and least disfluent episodes for the three participants ranged from 20-6 %. High degree of variability existed in %SS and SSI-4 (Riley, 2009) scores whereas the scores on OASES-A (Yaruss & Quesal, 2010) were highly consistent across days. Further analyzing of the results, revealed that OASES-A scores correlated with variability (CV) in %SS, that is, greater impact on quality of life.

Locus and duration of stuttering

It has been reported from previous studies that stuttering shows variations in loci and duration of each instance of disfluencies, Evidences have shown that in children, there is greater frequency of stuttering in terminal sentence positions which might be due to greater occurrence of vital words in the same position (Kaasin & Bjerkan, 1982). Along with loci parameter, even duration of the disfluencies plays important role in diagnosing the severity of stuttering. Along with the type, frequency and loci of stuttering; duration of disfluencies may also thought to be contributing factor to the identification and severity of stuttering in children. But studies on same footnotes are lacking in adults. To summarize these studies suggest that frequency of stuttering varied greatly from year to year, week to week, day to day and in fact within a single day. Also the variation might be because of multiple factors or task specific. Hence, this variability should be documented further for clinical assessment and intervention.

CHAPTER 3: Method

The aim of the present study was to document the day-to-day variability in stuttering across five consecutive days in Hindi speaking adults who stutter.

3.1 Participants

Fifteen native Hindi speaking adult males who stutter (*Mean* = 27.66 years, SD $\pm$ 8.47) were recruited. All the participants were from Ajmer, Rajasthan, India. Participants were identified through clinical records at Jawaharlal Nehru hospital, Ajmer, and through snowball sampling. Using a self-reported questionnaire their demographic details were obtained. All the participants had their development of stuttering during their childhood. All the participants were right-handed individuals. Apart from stuttering, none reported any other associated problems such as neurologic, psychological, or communication problems. The participants' severity of stuttering was documented using Stuttering Severity Instrument for Children and Adults (SSI-III, Riley, 1994). Based on SSI measurement, two had very mild stuttering; four had mild stuttering; five had moderate stuttering; one had severe stuttering, and three had very severe stuttering at the time of the study (table 1). Further, in an attempt to minimize possible treatment effects, it was ensured that none were enrolled for treatment at the time of study. Informed consent was obtained from all the participants prior to their participation in the study.

Table1

Demographic details of participants

Subject	Age	Gender	SSI score	SSI severity	TT
S1	22	Male	15	Very mild	No
S2	23	Male	15	Very mild	No
S3	28	Male	19	Mild	No
S4	17	Male	24	Mild	No
S5	42	Male	23	Mild	No
S6	22	Male	18	Mild	No
S7	45	Male	27	Moderate	No
S8	17	Male	27	Moderate	No
S9	35	Male	26	Moderate	No
S10	25	Male	25	Moderate	No
S11	29	Male	26	Moderate	No
S12	18	Male	31	Severe	No
S13	36	Male	44	Very severe	No
S14	24	Male	42	Very severe	No
S15	32	Male	39	Very severe	No

Note. Treatment taken -TT

3.2 Procedure

Each participant's spontaneous speech samples were audio-video recorded across ***five*** consecutive days. All the data were collected at one point of time which differed for each person, during the five consecutive days. Before recording, participants were told the purpose of the study. Further, they were asked to speak in their comfortable speech rate. The duration of the sample was approximately for 10 minutes and from it middle 350 syllables were taken. The topics for the spontaneous speech were day-to-day activities, hobbies, work, family, general topic like village-city, festivals in India, bollywood, etc. All the recordings were done in participant's home with an Android phone having high

quality video camera, kept at 30cm from the speaker's face. Each individual's everyday speech samples stored separately.

3.3 Analysis

3.3.1. Frequency and type of disfluencies

The recorded samples were first orthographically transcribed by a native Hindi speaking SLP. Further, the SLP identified stuttering moments which included three categories and seven descriptors, based on stuttering behaviors described in the Lidcombe Behavioral Data Language (LDBL; Teesson, Packman, & Onslow, 2003). LBDL is a taxonomy of stuttering, which categorizes stuttering behaviors, just as other taxonomies. The following are the three categories and seven descriptors as in the table: 2 (a) repeated movements (syllable repetition, incomplete syllable repetition, multi-syllable unit repetition), (b) fixed postures (with audible airflow and without audible airflow), and superfluous behaviors (verbal and non-verbal).

Table 2

Lidcombe classifications of disfluencies

Disfluency type	Examples
1. Repeated movements(RM)	
Syllable repetition (SR)	"ʤ-ʤ-ʤʤa:t̪ɛhæ̃"
Incomplete syllable repetition (ISR)	"p-p-p-pɛhlɛ"
Multisyllabic unit repetition (MSR)	"ʤʌb-ʤʌbmæ̃ samʤʰa-samʤʰa"
2. Fixed postures(FP)	
Inaudible Fixed posture (IFP)	"gulɑl l-(pause) gɑt̪ɛ hæ̃"
Audible Fixed posture (AFP)	"Mmmmuʤʰɛ"
3. Superfluous behaviors(SB)	
Verbal	um, eh, hmm, throat clearing
nonverbal	"muscle tension"

The calculation was done for all five core stuttering categories, including syllable repetition, incomplete syllable repetition, multiunit syllable repetition, audible fixed postures and inaudible fixed postures. After all the individual stuttering moments were identified for each participant across days, the overall percentage of stuttering for spontaneous speech was calculated. The total percentage of stuttering was calculated for each day by adding the two different categories of stuttering moments for a total over the number of syllables spoken (overall % = [total number of disfluencies/ total number of syllables] x 100).

3.3.2. Duration of disfluencies

The duration of the disfluencies was calculated using Praat software (http://www.fon.hum.uva.nl/praat/). The samples were opened in waveform and wide-band spectrogram windows. From the spectrum the duration of each disfluency was calculated by noting the onset of first iteration or initiation of audible prolongation till the end of disfluent event for repeated moments and prolongations (Kelly, 1989; Kelly & Conture, 1988; Zebrowski & Conture, 1989). For fixed postures duration was measured along with keeping in consideration, the tension of the vocal tracts and neck muscles as well as facial grimaces, which evidences commencement of such disfluency. Further, averaging of all the disfluencies category wise was carried out. The duration of the disfluent episode was marked based on both visual & auditory perception and contextual factors as observed by the clinician. The clinician noted the duration of 5 types of disfluencies, then averaging of each type was done according to sub- categories of disfluencies (RM, FP). The mean duration of two core categories of disfluencies for an individual was separately grouped.

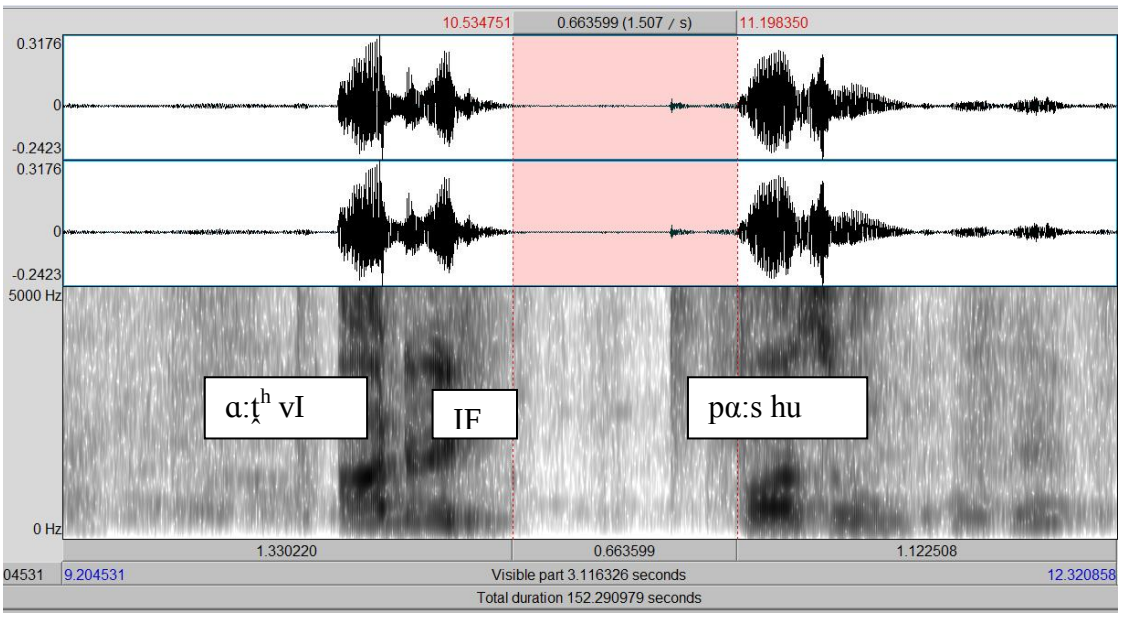


Figure 1: Spectrogram showing duration of the fixed posture.

3.3.3. Loci of disfluencies

The position of the disfluencies in a stuttered word or phrase was also assessed for variation across days. For example, in /b/ /bɒ/ /bɒndɒr/ the repetition occurred in the 'initial position' and in /pɛd/ if the sound /ɛ/ is abnormally prolonged then it was considered as a disfluency (prolongation) occurring in the 'medial position'. If the disfluency occurred at end of the word or sentence, then the disfluency was said to occur in the final position. For instance, if disfluency occurs before or after the grammatical marker. Therefore, all the variation in locus of stuttering was calculated in percentage for each individual.

3.4 Inter - and intra-judge reliability

Both intra-judge and inter judge reliability was obtained for 10 percent of the recorded samples. For intra-judge reliability, the samples were reanalyzed after a month. For inter- judge reliability, another Hindi speaking SLP was asked to calculate %SS using the same procedure as described above. For both inter- and intrajudge reliability, Cronbach's alpha value was calculated. The Cronbach's alpha value for intra-judge reliability for % SS was .955, and inter-judge reliability was .946. The Cronbach's alpha value for intra-judge reliability for duration was .534, and inter-judge reliability for duration was .702. Greater internal consistency reliability is shown when the Cronbach's alpha coefficient is closer to 1.0.

3.5 Statistical analysis

The data analyzed was entered in to SPSS (17.0 version) software. The range, minimum, maximum, mean, standard deviation and coefficient variation were calculated for each individual. One way Analysis of Variance was used to compare the mean coefficient of variation (COV) values across three severity groups. In addition, repeated measures ANOVA were employed to find the main effect of severity, types of disfluencies, and interaction between severity and types of disfluencies. Line graphs were drawn to plot the individual subject's disfluency variations across the five consecutive days. Individuals were grouped based on severity of disfluencies and graphs were plotted for the same.

CHAPTER 4: Results

The primary aim of current study was to document variability in different aspects of stuttering (percentage of syllables stuttered, types of disfluencies, duration, and loci of disfluencies) across five consecutive days in Hindi speaking adults who stutter. The secondary aim was to investigate the relationship between the day-to-day variability in the different aspects of stuttering and severity of the disorder. Cumulative scores (number of disfluencies) of the participants on each of the categories of disfluencies were converted into percentages. Descriptive and inferential statistics were used in order to represent the variability in frequency, types, duration, and loci of stuttering.

4.1 Variability in percentage syllable stuttered

4.1.1. Frequency of overall disfluencies

Table 3 shows the individual data for variability in the overall percentage of syllables stuttered across five days. Table 3 also shows the range, minimum (min), maximum (max), mean, and variability (measured as standard deviation and Coefficient of Variation, CV) for each participant. The percentage of syllable stuttered was calculated for only two core categories i.e. repeated movements and fixed postures.

It is evident from the table 3 that there is high variability (high SD and CV values) in the %SS across five days. Across five days, the difference between most and least disfluent day was less than 5% in five participants, between 5-

10% in seven participants, between 10-20% in two participants, and greater than 20% in one participant.

As the numbers of participants in few sub-categories of severity were less, the participants with the very-mild and mild stuttering were combined to single category as very mild-mild, and very-severe and severe are combined to form severe-very severe category. Henceforth, based on the severity there were three categories of participants: very mild-mild, moderate and severe-very severe. Among the participants, across days, in the very mild-mild category percentage of overall disfluencies ranged from 3.45 to 7.12, in the moderate category disfluencies ranged from 2.63 to 11.4, and in severe-very severe category 9.28 to 24.5. Wider ranges of overall disfluency were observed in the severe-very severe category of stuttering participants.

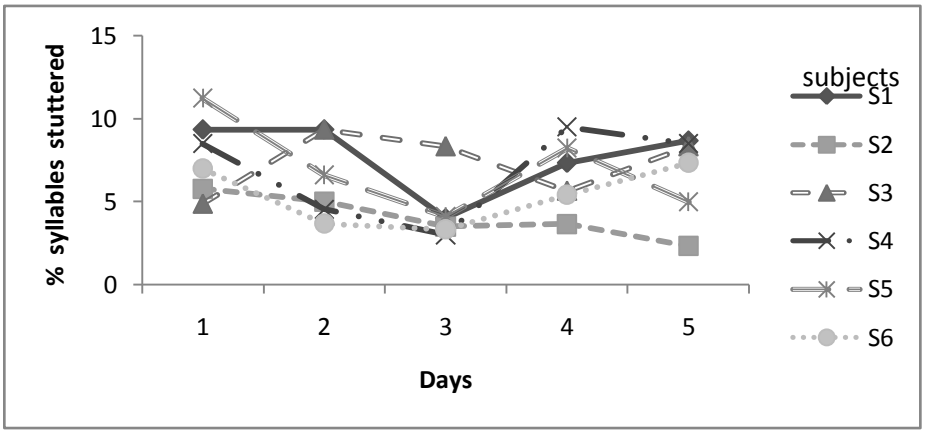
The COV provides information about the distribution of data points in a data series; it shows the amount of variability in data. In the very mild- mild category COV ranged from 0.29 to 0.42 (mean of 0.34), in the moderate category ranged from 0.10 to 0.38 (mean of 0.272) and in severe-very severe category ranged from 0.16 to 0.33 (mean of 0.22). Higher the value of variability indices indicates greater variation over time. From the values it can be interpreted that across days more variability was observed in very mild-mild category (Figure 2). However, results of one way Analysis of Variance (ANOVA) revealed no significant differences ($F(2, 12) = 2.43$; $p < 0.05$) in the mean COV values across three severity groups.

Table 3

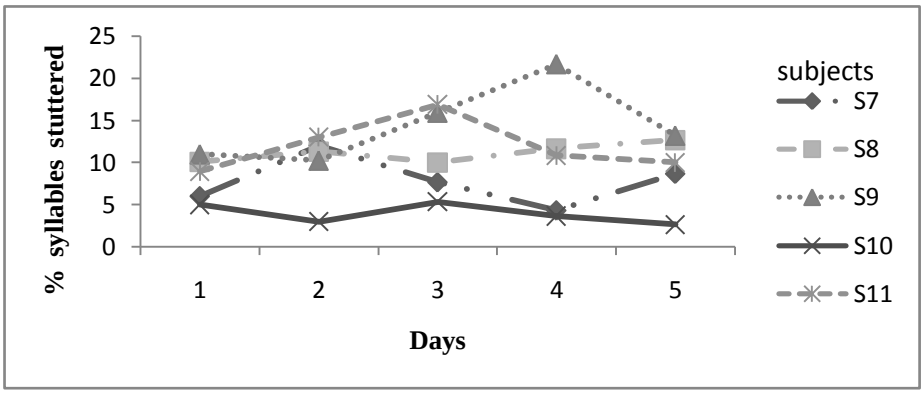
Individual data for variability in percentage of syllables stuttered (%SS) across five days.

	Days					Statistical descriptors				
P	1	2	3	4	5	Range	Min	Max	Mean	SD	COV
S1	9.33	9.33	4.00	7.33	8.66	5.33	4.00	9.33	7.73	2.23	0.29
S2	5.78	5.00	3.50	3.66	2.33	3.45	2.33	5.78	4.05	1.35	0.33
S3	4.88	9.33	8.33	5.66	8.33	4.45	4.88	9.33	7.30	1.92	0.26
S4	8.50	4.54	3.00	9.50	8.50	6.50	3.00	9.50	6.80	2.85	0.42
S5	11.23	6.61	4.11	8.23	5.00	7.12	4.11	11.23	7.03	2.82	0.40
S6	7.00	3.66	3.33	5.41	7.33	4.00	3.33	7.33	5.34	1.84	0.34
S7	6.00	12.0	7.66	4.33	8.66	7.67	4.33	12.00	7.73	2.90	0.38
S8	10.12	11.33	10.03	11.65	12.66	2.63	10.03	12.66	11.15	1.10	0.10
S9	10.99	10.25	15.92	21.65	13.20	11.4	10.25	21.65	14.40	4.61	0.32
S10	5.00	3.00	5.33	3.66	2.66	2.67	2.66	5.33	3.93	1.18	0.30
S11	8.94	13.00	16.87	10.83	10.00	7.93	8.94	16.87	11.92	3.13	0.26
S12	23.43	19.92	12.66	18.00	16.60	10.77	12.66	23.43	18.12	3.98	0.22
S13	21.73	23.57	27.61	38.00	46.23	24.50	21.73	46.23	31.42	10.40	0.33
S14	20.00	21.00	22.14	22.94	29.28	9.28	20.00	29.28	23.07	3.64	0.16
S15	34.74	23.50	23.65	22.22	25.26	12.52	22.22	34.74	25.87	5.07	0.20

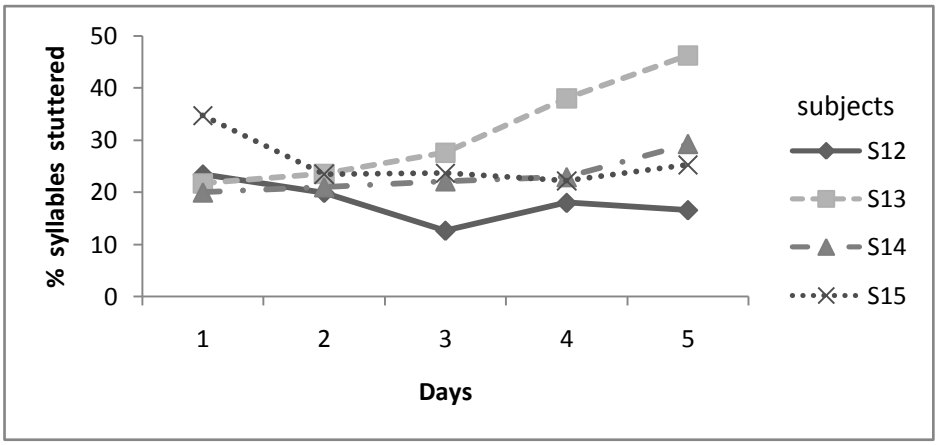
Note P- participants, COV-coefficient of variation, SD-standard deviation



a) % SS in the very mild-mild category



b) % SS in the moderate category



c) % SS in the severe-very severe category.

Figure 2: Pattern of variation in % SS across five days for different severity groups (a, b, c)

4.1.2. Analysis on Types of disfluencies

Table 4 shows individual data for the variability in the percentage of repeated movements (RM) across five days. Table 4 also shows the range, minimum (min), maximum (max), mean, and variability (measured as standard deviation (SD) and Coefficient of Variation (COV)) for each participant for percentage of RM. It is evident from the table 4 that there is high variability (high SD and COV values) in the percentage of RM across five days. Across days, the difference between minimum and maximum percentage of RM across days was between 10-20 % in two participants, between 20-30 % in six participants, 30-40 % in four participants, 40-50% in two participants and greater than 50% disfluencies in one participant.

Table 5 shows the individual data for the percentage of fixed postures (FP) across five days. Table 5 also shows the range, minimum (min), maximum (max), mean, and variability (measured as standard deviation (SD) and Coefficient of Variation (COV)) each participant for percentage of FP. It is evident from the table that there is high variability (high SD and CV values) in the percentage of FP across five days. The difference between minimum and maximum FP across days was between 0-10 % for one participant, 10-20 % in two participants, 20-30 % in five participants, 30-40 % in four participants, 50-60% in one participant and greater than 60% in two participants.

Table 6 shows individual data for the percentage of superfluous behaviors (SB) across five days. Table 6 also shows the range, minimum (min), maximum

(max), mean, and variability ((measured as standard deviation (SD) and Coefficient of Variation (COV)) for each participant for percentage of SB. While, the participant S15 did not show any superfluous behaviors. It is evident from the table that there is high variability (high SD and COV values) in the percentage of SB across five days. The difference between minimum and maximum percentage of SB across five days was between 0-10 % in four participants, 10-20 % in six participants, 20-30 % in one participant, and 30-40 % in three participants.

Across the three types of disfluencies, the mean COV for repeated movements was .612 (SD=.41), for fixed postures was .30 (SD= .33) and for SB was .89 (SD= .51). The results of descriptive data for variability in frequency of different types of disfluencies across days suggest that across days, there was greater variation in the frequency of SB when compared to other two types. One-way ANOVA was done to compare the COV across three types of disfluencies.. The results of ANOVA suggested significant difference across three types ($F(2, 43) = 6.906$, $p = .003$). The results of post-hoc test suggested significant difference only between variability in the frequency of fixed postures and superfluous behaviors.

COV values of different types of disfluencies [Repeated Movements (RM), Fixed Postures (FP) and Superfluous Behavior (SB)] were compared across three severity groups. The results of repeated measures ANOVA revealed significant main effect of type of disfluency ($F(1.795, 5.849) = 3.683$, $p = 0.040$). However, there no main effect of severity ($F(2,12) = 0.065$, $p = 0.937$), or interaction between severity and types of disfluency ($F(0.526, 5.849) = 0.540$, p

= 0.708). Further, on Pair-wise comparison among the sub-categories of disfluencies, RM-FP; RM-SB: showed no significant ($p > 0.05$) differences, whereas FP-SB showed significant difference ($p < 0.05$) on variability indices. Across days greater the values of SD and CV in the RM, FP and SB category suggestive of higher degree of variability.

Table 4

Individual data for variability in percentage of repeated movements across five days.

	Days (%)					Statistical descriptors				
P	1	2	3	4	5	Range	Min	Max	Mean	SD	COV
S1	50.00	42.85	16.66	27.27	50.00	33.34	16.66	50.00	37.35	14.83	0.40
S2	27.27	53.33	14.28	18.18	28.57	39.05	14.28	53.33	28.32	15.22	0.54
S3	15.38	28.57	28.00	17.64	36.00	20.62	15.38	36.00	25.11	8.50	0.34
S4	0.00	0.00	16.60	26.30	11.76	26.30	0.00	26.30	10.93	11.26	1.03
S5	30.00	18.75	0.00	7.14	0.00	30.00	0.00	30.00	11.17	13.01	1.16
S6	52.38	45.45	30.00	30.76	31.81	22.38	30.00	52.38	38.08	10.21	0.27
S7	5.55	28.57	0.00	76.92	11.53	76.92	0.00	76.92	24.51	31.19	1.27
S8	12.00	50.00	39.28	15.78	23.68	38.00	12.00	50.00	28.14	16.08	0.57
S9	12.90	20.00	24.00	38.23	11.42	26.81	11.42	38.23	21.31	10.76	0.51
S10	46.60	66.60	81.25	90.90	50.00	44.30	46.60	90.90	67.07	19.23	0.29
S11	17.64	17.94	7.40	0.00	47.61	47.61	0.00	47.61	18.11	18.11	1.00
S12	93.33	90.90	97.72	100.00	96.00	9.10	90.90	100.00	95.59	3.57	0.04
S13	72.00	100.00	98.27	75.00	72.09	28.00	72.00	100.00	83.47	14.36	0.17
S14	52.27	19.04	51.61	33.33	46.34	33.23	19.04	52.27	40.51	14.21	0.35
S15	2.43	21.27	0.00	0.00	20.83	21.27	0.00	21.27	8.90	11.13	1.25

Note. P- participants, COV-coefficient of variation, SD-standard deviation

Table 5

Individual data for variability in percentage of Fixed Postures across five days.

	Days (%)					Statistical descriptors					
P	1	2	3	4	5	Range	Min	Max	Mean	S D	COV
S1	50.00	57.14	83.33	72.72	50.00	33.33	50.00	83.33	62.63	14.82	0.24
S2	72.72	46.66	85.71	81.81	71.42	39.05	46.66	85.71	71.66	15.22	0.21
S3	84.61	17.42	72.00	82.35	64.00	67.19	17.42	84.61	64.07	27.36	0.43
S4	100.00	100.00	83.30	73.68	88.20	26.32	73.68	100.00	89.03	11.28	0.13
S5	70.00	81.25	100.00	92.80	100.00	30.00	70.00	100.00	88.81	13.01	0.15
S6	47.61	54.54	70.00	69.23	68.18	22.39	47.61	70.00	61.91	10.21	0.16
S7	94.44	97.22	100.00	92.30	88.46	11.54	88.46	100.00	94.48	4.44	0.05
S8	88.00	50.00	60.71	84.21	76.31	38.00	50.00	88.00	71.84	16.08	0.22
S9	87.09	80.00	76.00	61.76	88.57	26.81	61.76	88.57	78.68	10.76	0.14
S10	53.30	33.30	18.75	9.09	50.00	44.21	9.09	53.30	32.88	19.20	0.58
S11	82.35	82.05	92.59	100.00	95.23	17.95	82.05	100.00	90.44	7.98	0.09
S12	66.60	9.09	22.72	0.00	4.00	66.60	0.00	66.60	20.48	27.16	1.33
S13	28.00	0.00	17.24	25.00	27.90	28.00	0.00	28.00	19.62	11.81	0.60
S14	47.72	80.95	48.38	66.66	48.78	33.23	47.72	80.95	58.49	14.86	0.25
S15	97.56	97.87	100.00	100.00	97.91	2.44	97.56	100.00	98.66	1.22	0.01

Note. P- participants, COV-coefficient of variation, SD-standard deviation

Table 6

Individual data for variability in percentage of superfluous behaviors across five days.

	Days (%)					Statistical descriptors					
P	1	2	3	4	5	Range	Min	Max	Mean	SD	COV
S1	3.44	12.50	29.41	24.13	13.33	25.97	3.44	29.41	16.56	10.26	0.62
S2	8.33	28.57	22.22	35.29	46.15	37.82	8.33	46.15	28.11	14.16	0.50
S3	13.33	6.66	10.71	0.00	0.00	13.33	0.00	13.33	6.14	6.08	0.99
S4	0.00	9.09	14.28	13.63	0.00	14.28	0.00	14.28	7.40	7.04	0.95
S5	16.66	0.00	0.00	12.50	0.00	16.66	0.00	16.66	5.83	8.12	1.39
S6	19.23	35.29	41.17	7.14	12.00	34.03	7.14	41.17	22.96	14.73	0.64
S7	10.00	7.69	8.00	23.52	3.70	19.82	3.70	23.52	10.58	7.58	0.72
S8	10.71	8.11	17.64	5.00	2.56	15.08	2.56	17.64	8.80	5.82	0.66
S9	0.00	4.76	0.00	0.00	0.00	4.76	0.00	4.76	0.95	2.12	2.24
S10	46.42	78.04	61.90	65.62	46.66	31.62	46.42	78.04	59.72	13.44	0.23
S11	5.55	4.87	0.00	3.70	4.54	5.55	0.00	5.55	3.73	2.18	0.59
S12	0.00	0.00	4.34	1.61	3.84	4.34	0.00	4.34	1.95	2.06	1.05
S13	0.00	0.00	0.00	2.43	2.27	2.43	0.00	2.43	.94	1.28	1.37
S14	12.00	16.00	6.06	7.14	4.87	11.13	4.87	16.00	9.21	4.66	0.51

Note. P- participant, COV-coefficient of variation, SD-standard deviation

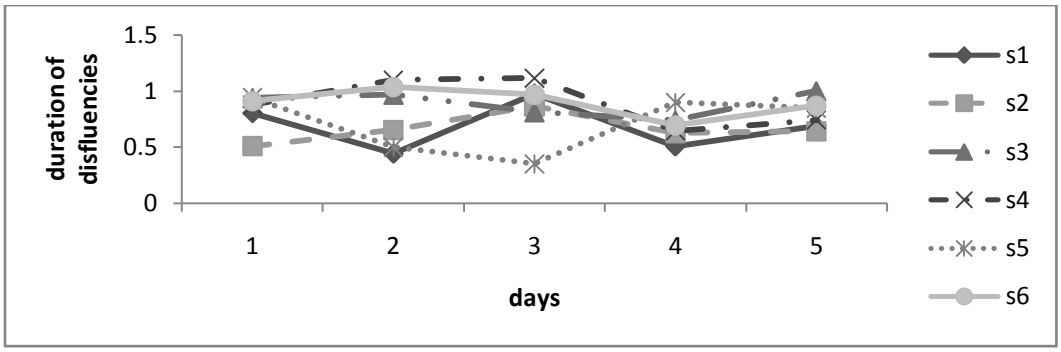
4.2 Duration analysis

4.2.1 Overall disfluencies duration

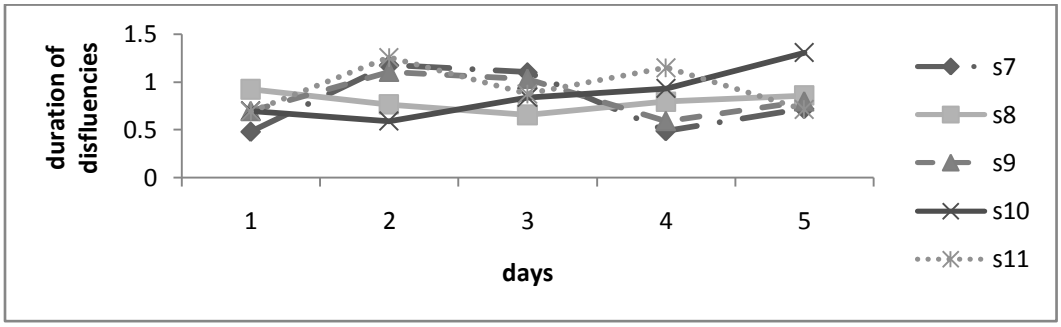
Table 7 shows individual data for duration of disfluencies across five days. It also shows Range (range), minimum (min), maximum (max), mean, standard deviation (SD) and Coefficient of Variation (CV) of duration for overall disfluencies. It is evident from the table 7, across five days, that there is high variability (high SD and COV values) in the overall duration of disfluencies. Across days, the difference between minimum and maximum duration across days was between 0.10-0.50 seconds in six participants, between 0.50- 1.00 seconds in eight participants, and in one participant it was >1.00 second across days.

In the very mild-mild category overall duration across five days ranged from 0.26 to 0.59 seconds, in the moderate category duration ranged from 0.27 to 0.71 seconds, and in severe-very severe category ranged from 0.38 to 2.04 (Figure 3). Wider ranges of overall duration were observed in the severe-very severe category of participants. Coefficient of variation for each severity, very mild-mild, moderate and severe-very severe groups were subjected to one way Analysis of Variance (ANOVA). The results revealed no significant differences between three severity groups ($F(2, 12) = .384$; $p < 0.05$). The findings suggest that the mean variability in the duration of disfluencies across the severities do not vary significantly across days. In the very mild-mild category COV ranged from 0.12 to 0. 37 (mean of 0.23, SD = 0.17), in the moderate category 0.13 to 0.41

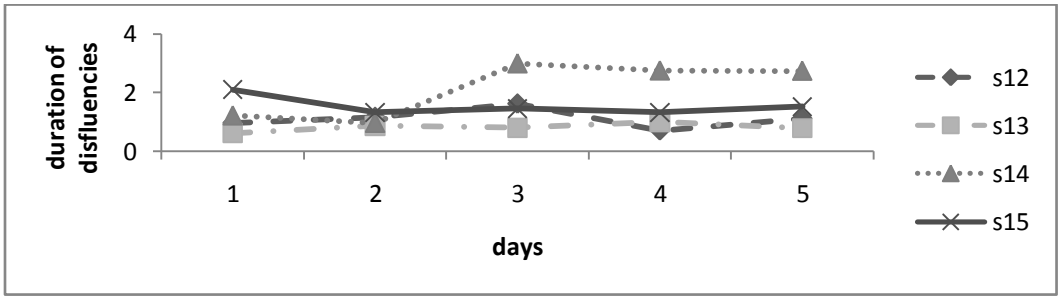
(mean of 0.27, SD = 0.23) whereas in severe-very severe category 0.17 to 0.45 (mean of 0.28, SD = 0.43). Higher the value of variability indices, greater is the variation over time. From the values it can be interpreted that more variability was observed to be seen in severe-very severe category across five days.



a) Displays duration of disfluencies in persons with mild stuttering



b) Displays duration of disfluencies in persons with moderate stuttering



c) Displays duration of disfluencies in persons with severe stuttering

Figure 3: Pattern of variations in duration of disfluencies in various severity of stuttering across five days (a, b, c).

Table 7

Individual data for variability in duration of disfluencies (seconds) across five days.

	Days (seconds)					**Statistical descriptors**					
P	1	2	3	4	5	Range	Min	Max	Mean	SD	COV
S1	0.80	0.44	0.98	0.51	0.69	0.53	0.44	0.98	0.68	0.21	0.32
S2	0.51	0.65	0.86	0.63	0.64	0.36	0.51	0.86	0.65	0.12	0.20
S3	0.94	0.97	0.81	0.74	1.00	0.26	0.74	1.00	0.89	0.11	0.12
S4	0.88	1.10	1.12	0.65	0.74	0.47	0.65	1.12	0.89	0.20	0.23
S5	0.94	0.50	0.35	0.90	0.85	0.59	0.35	0.94	0.70	0.26	0.37
S6	0.91	1.03	0.96	0.69	0.87	0.34	0.69	1.03	0.89	0.12	0.14
S7	0.48	1.18	1.10	0.49	0.72	0.69	0.48	1.18	0.79	0.32	0.41
S8	0.92	0.77	0.66	0.79	0.86	0.27	0.66	0.92	0.80	0.10	0.13
S9	0.70	1.11	1.03	0.59	0.80	0.51	0.59	1.11	0.84	0.21	0.26
S10	0.70	0.59	0.84	0.93	1.31	0.71	0.59	1.31	0.87	0.27	0.31
S11	0.69	1.26	0.88	1.15	0.71	0.56	0.69	1.26	0.93	0.25	0.27
S12	0.97	1.17	1.62	0.71	1.12	0.92	0.71	1.62	1.11	0.33	0.30
S13	0.61	0.87	0.80	0.99	0.78	0.38	0.61	0.99	0.81	0.13	0.17
S14	1.22	0.96	3.00	2.76	2.75	2.04	0.96	3.00	2.13	0.96	0.45
S15	2.10	1.33	1.46	1.33	1.52	0.77	1.33	2.10	1.54	0.32	0.21

Note. P- Participants. COV-coefficient of variation, SD-standard deviation

4.2.2 Duration of different types of disfluencies across days

Table 8 shows the individual data for the duration of repeated movements (RM) across five days. Table 8 also shows the range, minimum (min), maximum (max), mean, and variability (measured as standard deviation (SD) and Coefficient of Variation (COV)) each participant for duration of RM. As shown in the table 8, participant S15 did not have any repeated movements.

It is evident from the table 8 that there is high variability (high SD and COV values) in the duration of repeated movements across five days. Across days the difference between minimum and maximum duration of repeated movements was between 0.10-0.50 seconds in four participants, between 0.50- 1.00 seconds in eight participants, one participant had duration value between 1.00- 2.00 seconds, and greater than 3 seconds for one participant.

Table 9 shows individual data for the duration of fixed postures (RM) across five days. Table 9 also shows the range, minimum (min), maximum (max), mean, and variability (measured as standard deviation (SD) and Coefficient of Variation (COV)) each participant for duration of RM. It is evident from the table 9 that there is high variability (high SD and COV values) in the duration of fixed postures across five days. Across days the difference between minimum and maximum duration of fixed postures was between 0.10-0.50 seconds in four participants, between 0.50- 1.00 seconds in seven participants, and between 1.00-2.00 seconds two participants, and greater 3 seconds for one participant.

Paired sampled t test was done to compare the mean COV values of RM and FP. The mean COV for repeated movements was 0.406(SD= .23) and for fixed postures it was 0.397 (SD= .20). The results of paired sampled t test showed statistically no significant difference (t (13) = 0.098, p = 0.923) between two types.

The mean COV value for duration of repeated movements in very mild-mild category of participants was .40 (SD= .26), in moderate category it was .42(SD= .23) and in severe-very severe category it was .29 (SD= .28) respectively. The mean COV value for duration of fixed postures in very mild-mild category was .33 (SD=.20), in moderate category it was .43 (.15) and in severe-very severe category it was .37(SD= .22) respectively. The results of repeated measures ANOVA showed no significant effect of type of disfluency [F(14.08, .584) = 0.00, p = .987)], no significant main effect of severity [F (2,12) = .325, p = 0.729)] and no significant interaction between type of disfluency and severity of disorder [F(.016, .584)= .160, p = .854)].

Table 8:

Individual data for variability in duration of repeated movements across days

	Days (Second)					Statistical Descriptors					
P	1	2	3	4	5	Range	Min	Max	Mean	SD	COV
S1	0.45	0.29	0.39	0.51	0.65	0.22	0.47	0.69	0.56	0.10	0.30
S2	0.32	0.63	0.94	0.41	0.72	0.62	0.32	0.94	0.60	0.24	0.41
S3	0.76	1.08	0.65	0.65	0.66	0.43	0.65	1.08	0.76	0.18	0.24
S4	0.63	0.00	0.00	0.41	0.00	0.22	0.41	0.63	0.51	0.15	0.30
S5	0.00	0.46	0.31	0.00	0.95	0.95	0.00	0.95	0.43	0.39	0.92
S6	1.30	0.98	1.06	0.70	1.30	0.60	0.70	1.30	1.06	0.25	0.23
S7	0.42	0.70	0.39	0.00	0.95	0.57	0.39	0.95	0.61	0.26	0.43
S8	0.48	0.47	0.68	0.69	0.52	0.22	0.47	0.69	0.56	0.10	0.19
S9	1.39	0.00	0.74	1.90	1.24	1.16	0.74	1.90	1.31	0.47	0.36
S10	0.63	0.81	0.67	0.93	1.31	0.67	0.63	1.31	0.87	0.26	0.31
S11	0.00	1.03	0.18	0.00	0.41	0.84	0.18	1.03	0.54	0.43	0.81
S12	0.97	1.17	1.62	0.87	1.12	0.75	0.87	1.62	1.15	0.28	0.25
S13	0.73	0.90	1.29	1.41	0.99	0.69	0.73	1.41	1.06	0.28	0.26
S14	1.56	1.04	4.70	4.35	1.35	3.66	1.04	4.70	2.59	1.77	0.68
S15	0.00	0.00	0.00	0.00	0.00						

Note. P-participants, COV-coefficient of variation, SD-standard deviation

Table 9:

Individual data for variability in Duration of Fixed Posture

	Days					**Statistical descriptors**					
P	1	2	3	4	5	Range	Min	Max	Mean	SD	COV
S1	1.15	0.60	1.56	0.00	0.72	0.96	0.60	1.56	1.00	0.43	0.44
S2	0.70	0.67	0.79	0.85	0.57	0.28	0.57	0.85	0.71	0.10	0.15
S3	1.11	0.85	0.97	0.82	1.34	0.52	0.82	1.34	1.02	0.21	0.21
S4	0.96	1.10	1.12	0.73	0.74	0.39	0.73	1.12	0.92	0.18	0.20
S5	0.94	0.54	0.39	0.90	0.75	0.55	0.39	0.94	0.70	0.23	0.33
S6	0.84	1.00	1.94	1.33	0.00	1.94	0.00	1.94	1.02	0.71	0.70
S7	0.55	1.65	1.82	0.49	0.49	1.33	0.49	1.82	0.99	0.67	0.67
S8	0.39	0.36	0.55	0.97	0.55	0.61	0.36	0.97	0.56	0.24	0.43
S9	0.54	0.42	0.77	0.47	0.82	0.40	0.42	0.82	0.60	0.17	0.30
S10	0.76	0.37	1.01	0.00	0.00	0.63	0.37	1.01	0.71	0.32	0.45
S11	0.69	1.49	1.57	1.15	1.01	0.88	0.69	1.57	1.18	0.35	0.30
S12	0.00	0.00	0.00	0.54	0.00	0.00	0.54	0.54	0.53	0.00	0.00
S13	0.50	0.83	0.30	0.57	0.57	0.53	0.30	0.83	0.55	0.18	0.34
S14	0.88	0.89	1.30	1.16	4.15	3.27	0.88	4.15	1.67	1.39	0.83
S15	2.10	1.33	1.46	1.33	1.52	0.77	1.33	2.10	1.54	.32	0.21

Note.P- participants, COV-coefficient of variation, SD-standard deviation

4.3 Loci of disfluencies

In the mild category out of 6 participants only participant S3 had disfluencies in both initial position and medial position on day1, day 2 and day 3. All the other participants had disfluencies only on the initial position of word. In the moderate category out of 5 participants, S7 and S10 had disfluencies in both initial position and medial position on day1, and day2. Further on analyzing the severe category out of 4 participants 2 participants, S13 and S14 had disfluencies along with initial position and medial position on all five days. Hence, from the data it can be speculated that severe category had more variation in position of disfluencies than the other two severity groups

CHAPTER 6: Discussion

The primary aim of current study was to document variability in the different aspects of stuttering (percentage of syllables stuttered, types of disfluencies, duration, and loci of disfluencies) across five consecutive days in Hindi speaking adults who stutter. The secondary aim was to investigate the relationship between the day-to-day variability in the different aspects of stuttering and severity of the disorder. The results revealed several points of interest. First, percentage of overall syllables stuttered showed high degree of variability across days for all the individuals. Further, the amount of variability across the participants was different, with ranges as broad as 20% of syllables stuttered. This result is in consonance with the findings of Constantino et al. (2016) study. Constantino et al. also found high variability in the % SS across days. However, in their study, they documented variability across days with a different paradigm. Constantino et al. recorded three day-to-day comparisons (Days 1, 2, and 3) as well as three week-to-week comparisons (Days 1, 7, and 14). Further, they recorded the speech samples within the clinic. In our study we compared day-to-day variability across five consecutive days. Further, our recordings were done outside the clinic, in the client's home. In that way our results are more accurate representation of natural variability in the frequency of stuttering across days. Out of fifteen participants, the day-to-day variability was around 5-10%, in seven participants it was less than 5% in five participants, 10-20% in two participants, and greater than 20% in one participant. Current results highlight there is large individualized patterns in the variability of stuttering

frequency across time. Further, this variability in frequency of stuttering is not influenced by the severity of stuttering.

Second, across five days there was high degree of variability in all types of disfluencies. Among the three different types of disfluencies, there was greater variation (measured as coefficient of variation) in the frequency of superfluous behaviors when compared to fixed postures. However this day-to-day variability in the frequency of superfluous behaviors did not differ from frequency of repeated movements. The current results were consistent with the findings of Constantino et al. (2016) where they also reported, nonstuttered disfluencies were more variable than stuttered disfluencies (Constantino et al, 2016). It appears that variability is not unique to stuttered disfluencies but is a hallmark of all disfluencies. The participants in this study showed similar rates of nonstuttered disfluencies as that of past studies (Johnson, 1961b; Lutz & Mallard, 1986; Yairi & Clifton, 1972). Another reason for greater variability in the frequency of superfluous behaviors may be that during spontaneous speech, some people who stutter use superfluous behaviors to avoid words that they fear they will stutter on or to avoid the moment of stuttering itself (Van Riper, 1973).

Third, across five consecutive days there was high variability in overall duration of disfluencies. Current results highlight that, it is not just the frequency with which stuttering moments occur, but even in their duration of each disfluent episode, there is greater difference across days. Frequency, duration, and physical concomitant behaviors are three main parameters considered in the estimation of severity of stuttering. These data provide empirical support for the common

clinical impression that measures of stuttering frequency, duration are highly variable over time (Conture, 1990a). This finding has at least two important implications. First, results from the present study indicate that the use of multiple speech samples, obtained on separate days, is recommended when (a) evaluating/diagnosing adults with stuttering problem, or (b) assessing stuttering frequency for the purpose of monitoring treatment progress/outcome in adults enrolled in fluency therapy. Second, the present findings indicate that clinicians working with adults who stutter should be cautious when interpreting changes in stuttering frequency over longer periods of times (e.g., weeks or months) when the reported measures of stuttering frequency are based on single speech samples. Due to the high degree of day-to-day variability in stuttering frequency, such isolated speech samples are likely to be unrepresentative of the client's "typical" disfluency level at that moment in time.

Additionally, data from the present study provide empirical support for the hypothesis that at least some stuttering individual's disfluency level during a clinician-client interaction in the clinic may not be representative of the client's "typical" disfluency level outside the clinic (Dell, 1993). This finding suggests that the validity of fluency assessments in the clinic may be increased by incorporating data regarding the client's fluency level during conversational speech in the home setting. For example, because stuttering frequency counts are relatively time consuming, the use of severity rating scales has been suggested as one possible means to obtain this information (O'Brian, Packman, Onslow, 2004). Further research is needed to determine how the reliability of different methods to

obtain information regarding the client's stuttering outside the clinic can be improved.

Fourth, there was no significant interaction between the day-to-day variability in different aspects of stuttering (overall percentage, percentage of different types of disfluencies, duration) with the severity of disorder. Current results highlight that variability across time in not dependent on severity of the disorder. Fifth, current results also highlight that loci of disfluencies did not differ across time suggesting, variability noticed is only with respect of frequency and duration of disfluencies, and not with respect to the loci of the disfluencies.

It is important to continue evaluating the ***underlying cause*** of variability over time by examining factors such as linguistic load, speaking rate, cognitive load, and anxiety in AWS (Yarus, 1997). Such information would help the clinicians and researchers to understand the factors leading to such variability over time and therefore will increase the clinical value of assessing speech in multiple settings in the diagnostic evaluations of PWS.

CHAPTER 6: Summary and conclusion

In conclusion, the present findings indicate that, at least for some adults who stutter, aspects of stuttering are associated with a considerable degree of day-to-day variability. Hence, multiple speech samples, obtained across separate days, are needed when assessing stuttering frequency in adults. It is suggested that multiple speech samples should be obtained in the clinic as well as home setting to increase the likelihood of obtaining representative data. Further research is warranted to address various related issues important to fluency disorders (e.g., how many observations are needed in order to obtain a valid and representative indication of a client's "typical" stuttering frequency, amount of time between data acquisition sessions, etc.). Finally, studies designed to determine whether such variability has either diagnostic or prognostic implications would yield critical perspectives regarding the assessment and treatment of adults who stutter.

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