

Words Stress: Pre and post therapy analysis in persons with stuttering

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ALL INDIA INSTITUTE OF SPEECH AND HEARING
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May, 2002

Dedicated To
My Guide
Savithri Maam

With Love

CERTIFICATE

This is to certify that this dissertation entitled "**Words Stress: Pre and post therapy analysis in persons with stuttering**" is the bonafide work in part fulfilment for the degree of Master of Science (Speech and Hearing) of the student with Register Number M2K02.

Mysore
May, 2002



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CERTIFICATE

This is to certify that this dissertation entitled "**Words Stress: Pre and post therapy analysis in persons with stuttering**" has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other university for the award of any diploma or degree.

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DECLARATION

I hereby declare that this dissertation entitled "Words Stress: Pre and post therapy analysis in persons **with stuttering**" is the result of my own study under the guidance of **Dr. S.R. Savithri**, Reader and Head in-charge, Department of Speech - Language Science, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other diploma or degree.

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CHAPTER -1

INTRODUCTION

The environment calls a stutterer a stutterer because of certain specific speech characteristics. When speech includes stutterings, it will be judged less normal, less natural than the speech of non stutterers (Franken, 1988). It is not sure, however, that the disfluencies are the only cause of the lack of naturalness.

Stutterers cannot speak free of stuttering all the time, however, and therefore many stutterers go into therapy, hoping that they will reach the stage where they are not recognized as 'special' in a group of non stutterers. The ultimate aim of therapy should be to restore or increase the stutterer's ability to speak normally in any situation (Speech Foundation of America, 1960).

The post-therapy speech, however, may contain new characteristics that are not immediately associated with stuttering, but are considered as non-normal. Evidence mounts to show that stutterers treated by current therapy procedures may produce stutter-free speech but often at the cost of normal sounding speech quality (Ingham & Packman, 1978; Runyan & Adams, 1978, 1979).

Perceptual studies have been conducted as one means of investigating whether the speech of treated stutterers is different from that of normally fluent talkers.

Ingham & Packman (1978) found that 1-minute speech samples produced by treated stutterers received significantly fewer normal talker judgements than the samples of nonstutterers. Runyan & Adams (1978) found that cases of "severe" pretreatment stuttering were the easiest for listeners to distinguish from nonstutterers, "moderate" clients the next easiest to distinguish from nonstutterers, and "mild" clients the most difficult for listeners to distinguish. Runyan & Adams, (1979); Prosek & Runyan, (1982) reported that speech samples of treated stuterers were perceptibly different from those of non stutterers. Martin, Haroldson, & Triden, (1984); Ingham, Gow & Costello, (1985) applying a 9-point speech naturalness rating scale, found that speech samples of stutterers were judged as sounding more unnatural than those produced by non stutterers. Runyan, Bell & Prosek (1990) compared the speech naturalness ratings of perceptually fluent speech samples produced by non stutterers and stutterers who had been treated in six different therapy programs. Results indicated significant difference between the naturalness ratings of the nonstutterers and the treated stutterers. Such results were also replicated by Onslow, Hayes, Hutchins & Newman (1992), Martin & Haroldson (1992). In each of these studies it was found that the post-therapy stutterer's speech was significantly more unnatural than the non-stutterer's speech.

Subramanian (1997) conducted a study to find out the parameters which according to the unsophisticated listeners, contributed to speech naturalness and to investigate speech naturalness in the pre and post therapy samples rated by unsophisticated listeners across these parameters. The results indicated that the

unsophisticated listeners were able to differentiate between the pre-therapy and post-therapy samples. It was found that the unsophisticated listeners used some parameters similar to the sophisticated listeners, such as continuity and speed.

Several variables effect changes in stress, the most prominent of which are pitch, intensity and duration. A few studies have aimed at investigating the influence of stuttering therapy on the prosodic features of speech.

Franken, Boves, Peters & Webster (1991) reported narrower Fo range, smoother amplitude envelope and lengthened duration of the utterances in the post therapy speech of stutterers. The speech sounded monotonous due to lack of prosodic variation.

In the 1920s, Scripture (1925) in Germany and Travis (1927) in the United States noted that the speech of stutterers sounds monotonous even in passages free of stuttering. Fernau-Horn (1973) and Von Essen (1939) viewed stuttering symptomatology as characterized by monotony of speech melody.

Schilling (1962) found no differences between stutterers and nonstutterers with respect to mean and range of fundamental frequency (Fo). However, his results were based on moderate stuttering by persons with no known neuropathological symptoms. When he tested stutterers with abnormal EEG patterns he confirmed the hypothesis of monotony. Schmitt & Cooper (1978) studied the fundamental frequencies of the voices during oral reading of 12 stuttering and 12 nonstuttering 7 to 12 year old males matched according to age, height, weight, and race. No statistically significant

differences were found between the stutterers and non stutterers with respect to the mean fundamental frequency, the lowest fundamental frequency, the highest fundamental frequency, and the difference between the lowest and highest fundamental frequency values.

Lechner, (1979), Schaferskupper, (1982), Schmitt & Cooper, (1978) demonstrated that stutterers generally do not differ significantly from other speakers in the mean and range of F_0 . In contrast, Healey (1982) found stutterers to have a smaller range of F_0 even though there was no difference in mean F_0 .

Bergmann (1986), conducted two experiments where various aspects of prosody in adult male stutterers and non stutterers were studied. The results showed that:

- (a) Stutterers did not speak with a generally reduced pitch pattern,
- (b) They were able to place sentence accent correctly but had difficulty executing this prosodic feature,
- (c) Stuttering episodes were located mainly on stressed syllables, and
- (d) A fixed timing pattern of speech enhanced fluency.

The intervals between stressed syllables were more variable in the speech of stutterers, even in symptom-free passages, than in the speech of nonstutterers. Results support the conclusion that stuttering, seen on the symptomatic level of disfluencies produced, is a prosodic disturbance.

If the speech has to sound more natural, we must improve our therapies, because it appears to be extremely difficult if not virtually impossible, to reach the stage where the post-therapy speech sounds completely normal. It is very important to investigate the acoustic speech signal to trace the several aspects that affect the overall perception of normalcy.

It seems that the therapy affects some features that are important for the impression of natural speech like intonation, stress, rhythm and speech rate. If we want to shape the speech of the stutterer towards more natural sounding speech, we must begin by improving our own understanding of these features determining naturalness. In this context, the present study aimed at understanding the word stress patterns in stutterer's speech before and after prolongation therapy. Specifically acoustic parameters contributing to word-stress in the speech samples of ten individuals with stuttering were analyzed before and after therapy. It is expected that the results of such an investigation will enable us to come up with detailed and specific instructions of how the speech should be changed in the model that the therapist provides and how the stutterer's response should be shaped by the clinician towards normal speech.

CHAPTER-II

REVIEW OF LITERATURE

Prolongation technique involves increasing the production duration of speech sounds, with appropriate adjustments in the rate of speech, in articulator movements and contacts, in the timing of syllable and pause durations, and in the characteristics of prosody. Phonation across voicing boundaries, within or between words, also may occur.

-Ham (1986)

Literature related to the treatment of stuttering abounds with many descriptions of successful fluency enhancement (Andrews, Craig, Feyer, Hoddinott, Howie & Neilson, 1983). Many of the successful treatment approaches reported in the literature incorporate prolonged speech and gentle voice onset while emphasizing fluency enhancement training (Perkins, 1973; Shames & Florance, 1980). These treatments aim to replace stuttered speech with a novel speech pattern that is incompatible with stuttering. The benefits derived from these specific techniques appear to be greater than other treatment approaches (Andrews, Guitar & Howie, 1980; Hand & Luper, 1980).

To date, however, a recurring criticism of stuttering therapies that use speech-pattern techniques, such as prolonged speech is that the stutterer may achieve fluency at the cost of speaking in an abnormal manner (Boehmler, 1970; Van Riper, 1971, 1973; Sheehan, 1975). In the past years some therapy programs employing prolonged

speech endeavoured to solve this problem by incorporating procedures to shape these speech patterns into "normal" speech (Goldiamond, 1965; Ingham, Andrews, & Winkler, 1972; Perkins, 1973; Ingham & Andrews, 1973). These procedures have, for the most part, provided the stutterer a combination of sustained fluency and speech-rate control.

Research designed to assess whether normal fluency has been achieved in these programs has been carried out. Perceptual evaluations have been used as one means of investigating whether the speech of treated stutterers is different from that of normally fluent talkers. Reports (Ingham & Packman, 1978; Runyan & Adams, 1978, 1979; Prosek & Runyan, 1982; Runyan et al, 1982; Martin et al, 1984; Ingham et al, 1985; Runyan et al, 1990; Onslow et al, 1992; Martin & Haroldson, 1992) conclude that the speech samples of treated stutterers were perceptibly different from those of non stutterers.

Given that the speech of some treated stutterers is perceptually, distinguishable from that of normally fluent talkers, it would be beneficial to determine the aspects of the treated speech which may influence the listener judgements.

Metz, Onufrak & Ogburn (1979) examined specific acoustic characteristics in the fluent speech of nine adult stutterers sampled before treatment and at the end of treatment. Following treatment they found that stuttering frequency had decreased significantly after treatment when compared to pre treatment levels but the vowel durations and the frequency of inappropriate voicing both increased significantly.

Reading rate was found to be slower at the termination of therapy than it was prior to treatment, even though a large number of overt stuttering behaviours had been eliminated from the speech samples. Examining the same group at 6 months post treatment, Onufrak (1980) observed small increases in vowel duration of fluent word productions and overall speech disfluency. None of the measures returned to their pretreatment values. Furthermore, he reported a significant increase in the percentage of occurrences of voicing through initial-stop consonants. In retrospect, it appears that temporal characteristics of stutters' fluent speech were altered through treatment.

Healey (1980) investigated certain acoustic characteristics of stutters' and nonstutters' fluent speech. When compared to nonstutters, he found that stutters had consistent difficulty regulating the speed of change in fundamental frequency during word onset. He hypothesized that the untreated stutters did not produce greater muscular tension in their vocal folds during fluent word productions than the nonstutters, but did have more difficulty controlling the rate of frequency change during the initiation of vocal-fold vibration. He suggested that stutters may be less able than nonstutters to make rapid and efficient shifts in laryngeal tension during fluent speech.

Prosek & Runyan (1982) obtained measurements of speaking rate, number of pauses, average pause duration, and average vowel duration for treated stutters and matched nonstutters. Difference scores were obtained on each measurement for each pair of talkers by subtracting the nonstutterer's value from that of the treated stutterer.

These scores were used as predictors in multiple linear regression analysis, with percent correct identifications of the treated stutterers used as the criterion variable. The results showed that a combination of rate and either pause measure accounted for approximately 70% of the variance in the listener responses. They concluded that rate and pauses could underlie listener identifications of treated stutterers.

These findings suggest that rate is an important variable used by listeners to distinguish the speech of treated stutterers from that of non stutterers.

If listeners use rate as their primary criterion for identifying treated stutterers, it should be possible to demonstrate this experimentally and to alter their judgements by manipulating rate. Prosek & Runyan (1983) examined the hypothesis that reading rate affects the identification of treated stutterers. The duration and pauses of the treated stutterer's segments (32 pairs) were adjusted to match those of the nonstutterer as closely as possible by means of a computer based wave form editor. Listeners were required to indicate which member of each pair was the treated stutterer. Results indicated that the listener's ability to distinguish between talkers was significantly reduced for the edited stimulus pairs. Results indicate that the rate achieved by the stutterer during and at the termination of therapy should be evaluated critically.

Metz, Samar, & Sacco (1983) examined selected acoustic characteristics in the fluent speech of 14 stutterers analyzed pre and post therapy. The subjects were enrolled in a 5-week program utilizing a Van Riper's (1973) approach to improving speech

fluency. The end results of therapy showed a marked decrease in speech disfluency. The observed decreases in speech disfluency were significant and positively correlated with the amount of silence the speakers demonstrated among intervocalic intervals. The authors theorized that the decrease in intervocalic silence as a result of therapy success assists the stutterers in normalizing articulatory timing gestures of the speech mechanism for producing fluent utterances.

Selection of a specific treatment approach emphasizing slowed speech rate and development of voicing across word junctures, as in the stutter free speech program (Shames & Florance, 1980) would be expected to change temporal and acoustic aspects of the fluent speech production of stutterers.

Healey (1982) found that stutterers effected a significantly smaller range of speaking fundamental frequencies than did nonstutterers during utterances of phrase length reading material. On the other hand, a comparison of stutterers' and nonstutterers' range of F_0 change during the production of CV syllables within a carrier phrase revealed no between group differences.

Healey & Gutkin (1984) examined stutterers' and nonstutterers' fluent voice onset time (VOT) and fundamental frequency (F_0) contour measures from target syllable located at the beginning of a carrier phrase. Oscillographic and spectrographic analysis of subjects VOT and F_0 at vowel onset, average vowel F_0 and speed and range of F_0 change were obtained from fluent productions of 18 stop consonant-vowel

syllables. Results showed that VOT's for voiced stops and the range of F_0 change for voiceless stops were associated with significant between group differences. All other dependent measures were not significantly different between the two groups.

Robb, Lybolt, & Price (1985) examined selected acoustic variables, namely average fundamental frequency (F_0), F_0 onset, voice onset time (VOT), and percent vocalized time, in the fluent speech production of a group of stutterers. The purpose of the investigation was to compare stuttering frequency with the acoustic variables as sampled before, during, and 2-month post treatment, and to examine the concomitant changes in acoustic behaviour that might result in therapy success. Subjects' (12 school-age stuttering males) speech was recorded pre-and post therapy and at 2-month follow-up. Mean F_0 and voice onset time values remained stable from pretherapy to 2-month follow-up, and an increase of 12% vocalized time was maintained across all post therapy samples. It was suggested that increases in speech fluency may not be accompanied by changes in fundamental timing gestures. Increased speech fluency may be accomplished through increases in vocalized time permitting adjustments in motor sequencing which accompany stuttering.

Mallard & Westbrook (1985) conducted a study to determine the extent to which stutterers manipulate vowel duration to achieve fluency after participating in precision fluency shaping program. Nine stutterers who read an all-voiced sentence fluently before and after therapy were selected for study. Wide - band spectrograms were made of the initial phrase of the sentences, and vowel durations were computed.

Results indicated that extended vowel durations were characteristic of the fluency of stutterers post therapy. The subject who had the highest rate of disfluency after therapy had the shortest vowel durations.

Franken et al (1991) investigated the post therapy speech of four stutterers who underwent Dutch adaptation of the precision fluency shaping program. They analysed the speech which showed less prosodic variation, acoustically, which seemed associated with more monotony, perceptually. The Fo-contour and the amplitude envelope showed that the post therapy utterances of the stutterers were characterized by a much narrower Fo - range and a smoother amplitude envelope. The overall duration of the utterances was lengthened, and the voice onsets were particularly prolonged. This also showed up in the amplitude envelope where slopes were much less steep. Moreover the range of the amplitude envelope seemed to be narrower and part of the intensity variation occurred at unexpected places.

Latha (1997) investigated the prosodic aspects (specifically intonation) in the speech of stutterers before and after therapy. The subjects consisted of one normal fluent female Kannada speaker and ten stutterers in the age range of 15-30 years. Material consisted of ten sentences of different intonation patterns depicting various emotions such as anger, sarcasm, surprise, command, question and statement. The utterances of the model and the imitations of the intonation patterns by stutterers were recorded both before and after therapy. Acoustic and perceptual analysis were done on

the recorded data. Parameters related to Fo, intensity and voicing were analysed. The results indicated the following:

- (a) The pre-and post-therapy speech of the ten stutterers who underwent prolongation therapy differed from that of the normals.
- (b) A reduced prosodic variation (reduced FO range) was seen in the stutterer's speech.
- (c) The stutterer's speech also revealed longer sentence duration due to reduced temporal coordination when compared to normals.
- (d) There was no significant change in the prosodic aspect of the post-therapy speech as expected.
- (e) The intonation patterns of pre-therapy and post-therapy speech were not perceived as significantly different from that of the model.

Savithri (1998) conducted a study to investigate whether the prolongation and the air flow therapies influence the prosodic aspects in stutterers. A total of 50 stuttterers in the age range of 12 to 40 years participated in the study. Ten meaningful Kannada phrases consisting of an adjective and noun (uttered with stress on the first word) formed the material. The subjects were instructed to listen to the phrase and repeat with the stress on the first word. The subjects were tested individually before and after therapy. Using a display programme, the duration of the stressed word were measured. The results indicated that the stressed word durations were 489 msec and 466 msec before and after therapy respectively (difference was not significant).

However, 53% and 33% of the patients practicing prolongation and airflow therapy showed significantly longer durations in the post therapy samples.

The studies cited above indicate that overall, the speech of treated stutterers differ acoustically from non-stutterers. These studies analysed the parameters manipulated by stutterers to achieve fluency.

The effect of stuttering therapy is reduced prosodic variation which interferes with the linguistic and emotional function of the speech. The present study was aimed at analysing the acoustic parameters of word-stress in persons with stuttering.

CHAPTER-III

METHOD

Material:

10 phrases (adjective + noun) in Kannada with stress on adjective was used.

The phrases were written down on a card with the stressed word underlined.

1. <u>chikka</u>	angi	- Small	shirt
2. <u>Ni : li</u>	bassu	-Blue	bus
3. <u>Hasiru</u>	betta	- Green	hill
4. <u>Bili :</u>	butti	- White	basket
5. <u>putta</u>	gombe	- Small	toy
6. <u>Dappa</u>	manushya	-Fat	man
7. <u>kempu</u>	gula:bi	-Red	rose
8. <u>Dodda</u>	mara	-Big	tree
9. <u>Kempu</u>	pennu	-Red	pen
10. <u>kappu</u>	shoe	- Black	shoe

Table 1 Material for the study

Subjects:

Ten Kannada speaking individuals with stuttering in the age range of 12-30 years attending prolongation therapy and age, sex matched normal speakers served as subjects.

The prolongation therapy consisted of the following steps:

1. Prolongation of initial syllable of each word in speech.
2. Prolongation of initial syllable of each word in reading.
3. Speaking at a normal rate; prolongation of the stuttered syllable, monitoring by the therapist.
4. Speaking at a normal rate; prolongation of the initial syllable stuttered or anticipated to have stuttering, self monitoring.
5. Generalization within the clinic with the therapist's support.
6. Generalization outside the clinic with therapist's support.
7. Generalization without therapist's support.

The client moved from one step to another on 95% fluency. Table 2 shows the details of the subjects.

No.	Age/Sex	Onset	Rate of speech in words per minute	% Dys fluency Pre/Post	No. of Hours of practice
1	18/M	Childhood	79	17/0	70
2	22/M	Childhood	63	28/5	125
3	20/M	Childhood	73	5/0	60
4	25/M	Childhood	75	10/0	65
5	16/M	Childhood	80	41/17	60
6	14/M	Childhood	70	35/13	70
7	12/F	Childhood	47	30/13	70
8	21/M	Childhood	80	30/7	75
9	16/F	Childhood	95	25/5	100
10	22/M	Childhood	60	35/10	110

Table 2 : Details of the subjects

Procedure:

Each subject was given detailed instruction regarding the utterance of the phrases. Model of the utterances was provided for familiarization. Two test phrases were used to ensure that the subject had understood the task.

The subjects were then instructed to read the phrases and the speech sample was audio recorded. In case of stutterers the first sample was recorded just before therapy and the second sample was recorded immediately after therapy.

Analysis:

The analysis was done in two stages: Perceptual and Instrumental.

Perceptual analysis:

The experimenter listened to the recorded sample to identify stress. Only those phrases in which words were stressed were considered for further instrumental analysis.

Instrumental analysis:

Using the waveform and Fo display of SSL the following acoustic parameters were extracted:

- (1) Duration of the stressed word: This was measured as the time difference between the onset and offset of the word.
- (2) Peak F_0
- (3) Lowest F_0
- (4) F_0 Range : This was measured as the frequency difference between the lowest and the highest F_0 .

Figure 1 depicts the F₀ trace and waveform of the phrase / Chikka angi / before and after therapy

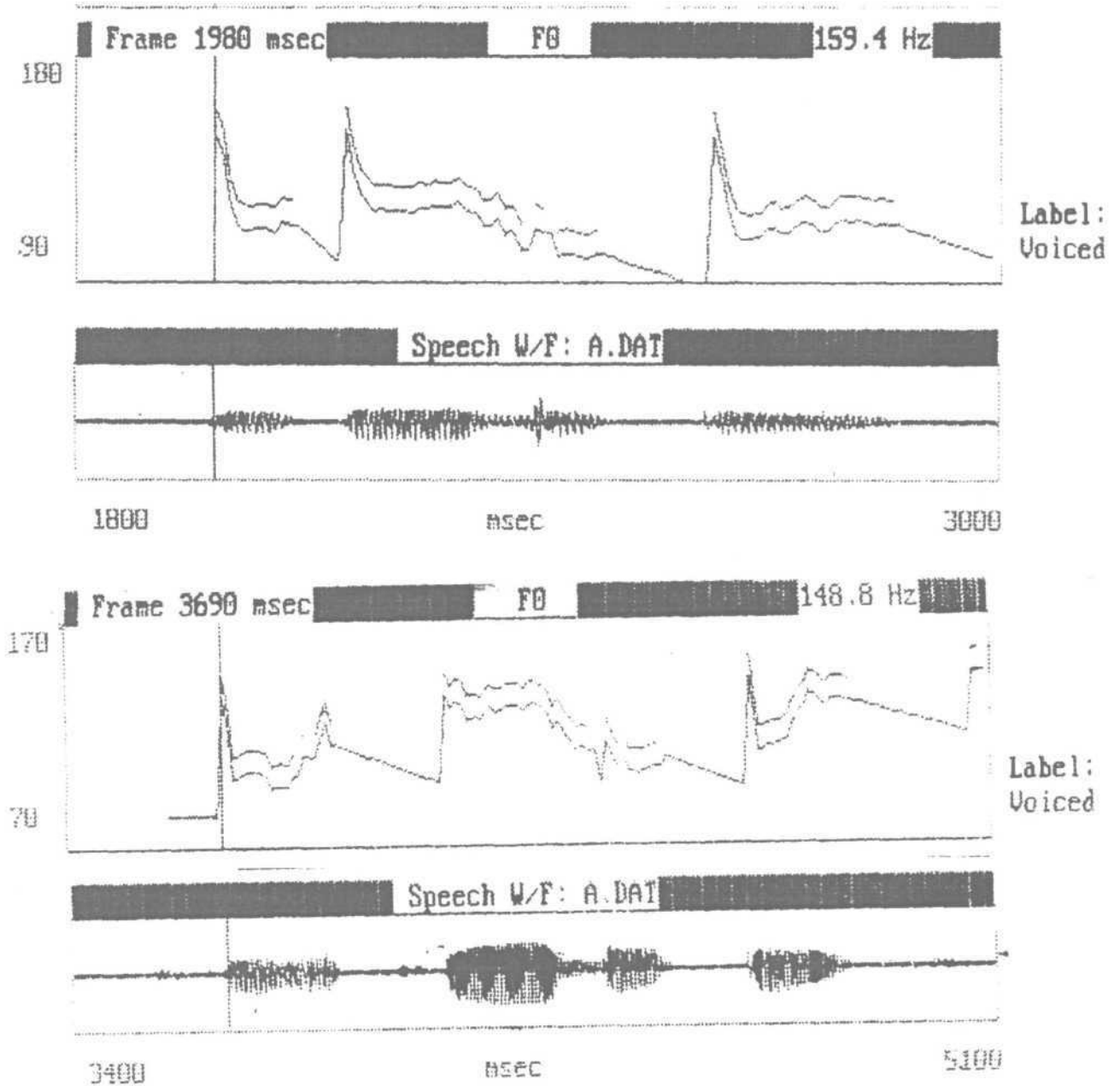


Figure 1: Shows the F₀ traces and waveform of a phrase, before and after therapy.

These parameters were compared before and after therapy, which in turn was compared with normals. Within the subject the peak Fo and duration were compared. Across subjects the Fo range and duration were compared.

Further, data was subjected to statistical analysis using SPSS software to obtain non-parametric descriptive statistical information. X test was performed to compare across means.

CHAPTER IV

RESULTS AND DISCUSSION

The following were compared:

1. Pre-therapy Vs post-therapy duration of the stressed word
2. Post-therapy Vs normals' duration of the stressed word
3. Pre-therapy Vs post-therapy peak Fo in the stressed word
4. Post-therapy Vs normals' relative Fo in the stressed word.

Subject No.	Pre therapy/ Post therapy	Mean	S.D	Significance
1	Pre	541.9	111.6	-
	Post	532.6	119.1	
2	Pre	637.6	217.1	+
	Post	506.8	145.5	
3	Pre	441.4	43.8	-
	Post	504.9	95.5	
4	Pre	488.5	51.5	-
	Post	513.6	72.3	
5	Pre	447.8	60.3	-
	Post	473.5	49.4	
6	Pre	393.0	23.7	+
	Post	444.2	88.3	
7	Pre	474.8	41.1	-
	Post	487.7	81.7	
8	Pre	603.6	76.4	+
	Post	696.2	49.2	
9	Pre	451.3	35.5	-
	Post	451.8	41.8	
10	Pre	539.0	70.7	+
	Post	458.6	64.4	

Table 3: Mean and S.D of duration of the stressed word pre and post therapy

S.D -> Standard Deviation

- -> Significant difference absent

+ -> Significant difference present

Pretherapy / post	Mean	S.D	Significance
Pre	502	114	-
Post	507	118	

Table 4: Mean and S.D of duration of stressed word pre and post therapy

Table 3 shows the pre-post therapy duration of the stressed word and the significant difference between them. It was observed that in 70% subjects the word duration increased after therapy. However, significant differences were observed in 40% (two out of four showed a reduction in duration) of the patients. In general, there was no significant difference between the word duration before and after therapy (Table 4).

Subject No.	Post therapy/ Normal	Mean	S.D	Significance
1	Post	532.6	119.1	+
	Normal	434.4	72.6	
2	Post	506.8	145.5	
	Normal	483.4	50.7	
3	Post	504.9	95.5	-
	Normal	457.8	34.5	
4	Post	513.6	72.3	
	Normal	547.9	46.6	
5	Post	473.5	49.4	+
	Normal	371.5	38.8	
6	Post	444.2	88.3	
	Normal	459.1	69.1	
7	Post	458.6	64.4	-
	Normal	485.6	43.2	
8	Post	696.2	49.2	+
	Normal	393	28.3	
9	Post	451.8	41.8	+
	Normal	490.5	54.0	
10	Post	487.7	81.7	-
	Normal	450.7	42.6	

Table 5: Mean and S.D of duration of stressed word post therapy and normal subjects

Pretherapy / post	Mean	S.D	Significance
Post	507	118	-
Normal	457	68	

Table 6: Mean and S.D and duration of stressed word Post therapy and normal subjects.

Table 5 shows the post-therapy and normals' duration of the stressed word and the significant difference between them. It was observed that the word duration of the post-therapy sample was longer in 70% of cases. Significant difference was found in 40% (one of the subjects showed a reduction in duration). Overall comparison showed that the post-therapy word duration was longer compared to normals. However, the difference was not statistically significant (Table 6).

Subject No.	Pre-therapy/ Post-therapy	Mean	S.D	Significance
1	Pre	192.8	20.4	
	Post	180.3	15.4	
2	Pre	184.4	26.0	+
	Post	163.0	8.3	
3	Pre	179.5	6.5	
	Post	182.9	10.8	
4	Pre	237.3	12.1	+
	Post	179.2	44.2	
5	Pre	248.3	16.1	+
	Post	154.4	6.8	
6	Pre	192.0	15.6	-
	Post	193.0	14.4	
7	Pre	274.1	14.0	
	Post	260.1	16.5	
8	Pre	160.8	10.2	
	Post	168.4	23.4	
9	Pre	292.9	11.0	+
	Post	281.4	15.4	
10	Pre	145.9	12.5	
	Post	152.6	14.5	

Table 7: Mean and S.D of pre and post therapy peak FQ in the stressed word

Pre therapy / post therapy	M	S.D	Significance
Pre	211	49	+
Post	192	46	

Table 8: Mean and S.D of pre and post therapy peak Fo in the stressed word

Table 7 and 8 show the pre and post-therapy peak Fo in the stressed word and the significant difference between them.

It was observed that the post-therapy peak F_0 was lower in 60% of the cases. However, significant difference was found in 40% of the cases. Overall comparison showed that the post-therapy peak Fo was lower compared to the pre-therapy (Table 8). The difference was found to be significant statistically at 0.01 level.

Subject No.	Post therapy/ Normal	Mean	S.D	Significance
1	Post	57.4	26.8	
	Normal	60.3	38.8	
2	Post	49	25.5	-
	Normal	67.1	37.7	
3	Post	34.4	11.3	-
	Normal	31.9	10.3	
4	Post	75.3	44.8	-
	Normal	69.2	13.8	
5	Post	32.7	7.3	-
	Normal	39.0	17.1	
6	Post	56.7	38.6	
	Normal	63.0	39.3	
7	Post	40.5	14.9	
	Normal	57.3	22.9	
8	Post	51.5	23.9	
	Normal	55.1	18.3	
9	Post	134.6	60.7	+
	Normal	61.6	64.9	
10	Post	52.3	22.5	
	Normal	51.4	22.4	

Table 9: Mean and S.D of post-therapy and normals' range in the stressed word.

Post-therapy / Normal	M	S.D	Significance
Post	58.4	41.4	-
Normal	55.6	30.6	

Table 10: Mean and S.D of post therapy and normals' Fo range in the stressed word

Table 9 shows the post-therapy and normals' Fo range in the stressed word. It was observed that the Fo range of the post - therapy was comparatively lower in 60% of the cases. However, significant difference was found only in 10% of the cases (One case who showed an increase in the Fo range). Overall comparison revealed no significant difference between the post therapy and normals' Fo range (Table 10).

Discussion:

First, the results indicate that the word duration of the post-therapy is longer in comparison with pre-therapy as well as normals. The results also point to the wide intra subject variation seen in stuttering population. Not all stutterers show an increase in duration after therapy. Overall the lengthening of the duration was not statistically significant. This finding is in consonance with the findings of investigation conducted by Franken et al (1991) who found that the overall duration of the utterances were lengthened after therapy.

Second, the peak Fo was lowered in the post therapy samples compared to the pre-therapy samples. Overall the difference was found to be statistically significant.

This finding is in consonance with the study by Franken et al (1991) who found narrower Fo-range in the post - therapy.

Third, the Fo range was narrower in the post-therapy compared to normals, although the difference was not statistically significant. This result is in consonance with the study conducted by Bergmann (1984) where no significant difference were found in F₀ variability of stutterers and non stutterers.

Summarising, the results of this study has shown that the pre-and post-therapy speech often stutterers who underwent prolongation therapy did not differ significantly in terms of duration of the stressed word. The post-therapy sample however differed significantly in terms of peak Fo where the post-therapy samples had lower peak Fo. Compared to normals the word duration and Fo range did not differ significantly after therapy. The results also show a wide inter subject variation i.e., all the subjects did not show the same trend.

CHAPTER-V

SUMMARY AND CONCLUSION

The present study was aimed at investigating word stress in the speech of stutterers before and after therapy. The acoustic parameters contributing to the perception of stress were investigated.

The subjects were ten Kannada speaking stutterers in the age range of 12-30 years and 10 age and sex matched normal controls. Material was ten phrases with the stressed word underlined. The subjects were given practice and were then instructed to utter the phrases. The sample was audio recorded just before and after speech therapy. The therapy consisted of prolongation in the following steps:

- a. Prolongation of initial syllable of each word.
- b. Prolongation of initial syllable of each word in reading.
- c. Speaking at a normal rate; prolongation of the stuttered syllable monitoring by the therapist.
- d. Speaking at a normal rate; prolongation of the initial syllable stuttered or anticipated to have stuttering, self - monitoring
- e. Generalization within the clinic with the therapist's support.
- f. Generalization outside the clinic with therapist's support.
- g. Generalization without therapist's support.

Acoustic analysis of the stressed word was carried out using SSL waveform and the Fo contour. The total duration of the stressed word, peak Fo, low Fo and Fo range were measured. The data was tabulated and t-test was administered to check for significant difference.

The results indicated that:

1. The post-therapy word duration was longer compared to pre-therapy, although not statistically significant.
2. The peak F₀ of the post-therapy sample was lower compared to pre-therapy which was statistically significant.
3. The post-therapy word duration and Fo range was not significantly different from that of normals.

The results of the study indicate that after therapy the duration of the word is lengthened and the Fo range is reduced. The results suggests that the naturalness of speech is affected after therapy and that efforts are required on the part of the therapist to bring about this naturalness.

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