Chapter V

Summary and Conclusions

The present study investigated the efficacy of non-programmed prolonged speech technique in persons with stuttering and effect of age at the time of treatment on the efficacy of such technique. A total of 30 Kannada speaking persons with stuttering in the age range of 15-38 years participated in the study. Subjects were stratified into two groups based on their age at the time of treatment. Group I consisted of 20 subjects in the age range of 15-24 years and group II consisted of 10 subjects in the age range of 25-38 years. All subjects attended 3-week non-programmed prolonged speech therapy that had 6 steps. Prolongation of word-initial syllable was taught in step 1. Subjects were instructed to speak/ read in a natural manner and were instructed to use prolongation during moments of stuttering as indicated by the therapist (step 2). Self-monitoring was taught in step 3. The next two steps involved generalization with and without therapists’ support. The criterion to move from one step to another was 95% fluency. Subjects were followed up monthly for 6 months. In addition each subject practiced for 2 hours per day.

A 300-word Kannada passage was developed by the experimenter that served as reading material. Also, 16 bisyllabic Kannada words that had stop consonants in word-initial and word-medial positions were selected. Subjects’ reading, spontaneous speech / conversation were recorded prior to, after and 6 months after non-programmed prolonged speech therapy.
Reading and speech samples were transcribed verbatim for perceptual analyses. They were digitized and stored on to the memory of the computer for acoustic analyses. Perceptual measures included calculation of percent dysfluencies, types of dysfluencies, rate of reading (syllables per minute) and speech naturalness. Acoustic measures included voice onset time, vowel duration, closure duration, total duration, $F_2$ transition duration, burst duration, voicing duration (temporal measures), extent of $F_2$ transition, speed of $F_2$ transition, terminal frequency, formant frequencies $F_1$ and $F_2$, and type of transition. All acoustic measurements were done using CSL 4500 (Kay Elemetrics, New Jersey). Voice onset time, vowel duration, closure duration and total duration were measured using the 16 words and the remaining 9 measures were performed on dysfluent words taken from spontaneous speech / conversation and reading in the pre-therapy recording and the same words in the post-therapy and 6-month post-therapy samples. Different types of aerodynamic, laryngeal, and articulatory errors were identified and classified as visualized on wide-band spectrograms.

The results revealed several points of interest. First of all, mean percent dysfluency decreased significantly from pre- to post-therapy condition and increased from post- to 6-month post-therapy condition in both tasks and groups. This suggests no effect of task and group on percent dysfluencies. The reason for increase in percent dysfluencies in 6-month post-therapy condition can be attributed to lack of maintenance phase in the present study. Second, the number, but not the type, of dysfluencies significantly reduced in post-therapy condition compared to pre-therapy condition. Third, Syllables per minute (SPM) reduced
and Mean naturalness score (MNS) increased significantly from pre- to post-therapy condition in both groups. Perceptual data indicate no effect of age on treatment measures except MNS which was maintained better in group II compared to group I in 6-month post-therapy condition. Table 80 shows mean values of perceptual parameters.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>% dys R</th>
<th>% dys S</th>
<th>SPM</th>
<th>MNS R</th>
<th>MNS S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-therapy</td>
<td>25.40</td>
<td>26.75</td>
<td>306</td>
<td>41.00</td>
<td>50.33</td>
</tr>
<tr>
<td>Post-therapy</td>
<td>1.65</td>
<td>1.83</td>
<td>290</td>
<td>77.00</td>
<td>89.33</td>
</tr>
<tr>
<td>6-month post-therapy</td>
<td>7.03</td>
<td>6.14</td>
<td>316</td>
<td>69.33</td>
<td>80.66</td>
</tr>
</tbody>
</table>

Table 80: Mean values of % dysfluency (% dys), rate of reading (SPM), and mean naturalness score (MNS) in reading (R) and speech (S).

Among acoustic measures, significant difference between conditions was observed on voice onset time (group II), vowel duration (both groups), total duration and voicing duration of stop consonants. Group II had longer VOT compared to group I in post-therapy condition. Vowel duration and total durations were longer in post-therapy condition compared to pre-therapy condition. Voicing duration as longer in post-therapy condition compared to other conditions. Longer durations in post-therapy conditions indicated a slower initiation of voicing or articulatory movement rather than difficulties with the coordination of articulation and phonation. Importantly this observation does not necessarily imply a laryngeal deficit because phonatory processes are also influenced by changes in air pressure caused by articulatory movements and alternatively subjects in group II may prefer longer VOT as a strategy to compensate for difficulties of motor control. Table 81 summarizes data on 4 temporal measures.
Table 81: Mean values of voice onset time (VOT), vowel duration (VD), total duration (TD) and voicing duration (VgD) in four conditions (all in ms).

Transition duration of F<sub>2</sub> was significantly longer in dysfluent pre-therapy condition compared to that in post-therapy and 6-month post-therapy conditions. Longer transition duration in dysfluent pre-therapy condition indicates a longer time to move articulators from one position to another. This observation may indicate problem in smooth transition in dysfluent utterances of persons with stuttering. Table 82 shows mean transition duration of F<sub>2</sub> in four conditions.

Table 82: Mean transition duration of F<sub>2</sub> (ms) in four conditions.

Significantly higher speed of F2 transition in dysfluent pre-therapy and 6-month post-therapy condition (compared to post-therapy condition) was noticed in both groups. Speed of transition indicates the speed of movement of articulators from one place to another. Higher speed indicates faster movement of articulation in dysfluent pre-therapy conditions. It is possible that dysfluencies occurred because of higher speed of transition (for example, a fricative will sound like a plosive when transition is fast). Transitions higher than intended
may also produce faster speech along with unacceptable articulatory outputs. Further research in this area is warranted.

The data indicated significant association between type of transition and conditions. Non-discrepant transitions increased and discrepant transitions decreased from pre-therapy to post-therapy condition in group I. Non-discrepant transitions refer to abnormal or opposite transitions and hence indirectly provide information on articulatory movement from one phoneme to another. One can expect reduction in discrepant transitions and increase in non-discrepant transitions in fluent utterances compared to dysfluent utterances. The data precisely indicated this. However, future research in this direction may throw more light.

No significant difference across conditions or groups was detected on acoustic measures syllable repetition duration, extent of F2 transitions, F2 terminal frequency and formant frequencies. All these measures, except syllable repetition duration, are related to articulatory movements and vocal tract size and shape. In dysfluent utterances their may be articulatory undershoot. Therefore, differences in these measures were expected. However, data did not support this explanation at least in some subjects.

Examination of spectrograms revealed aerodynamic, laryngeal, articulatory and multiple errors in all conditions and groups. These errors can be explained on the basis of air way dilation reflex or stuttering as a timing or speech motor disorder.
In summary, results of the present study indicated that percent and type of
dysfluency, rate of reading, and speech naturalness can be used as efficacy
measures of prolonged speech technique. Along with this, vowel duration, $F_2$
transition duration, and type of transition will provide additional information.
Further, errors visualized on spectrograms provide information on the various
miscoordinations in persons with stuttering. The results indicated that these
ersors might persist even when speech sounds perceptually normal. These results
warrant some suggestions for future research as follows:

First of all, speech of persons with stuttering can be acoustically analyzed
for type of errors and miscoordinations. Client oriented therapy techniques can
be designed based on type of miscoordinations. For example, if the client
demonstrates laryngeal miscoordination, coordination of laryngeal system can be
worked on. The client can be taught the difference between voiced, unvoiced and
partially voiced and their relative laryngeal gestures. Therapy can further be
focused on implementing appropriate laryngeal gestures in speech and reading.

Second, the present study has not investigated the time at which fluency
or coordinated movement is achieved. This should be possible by analyses of
subjects’ speech in each session of therapy. Such analyses will also provide
information on the dysfluencies and miscoordinations that are corrected earliest.
If some dysfluencies or miscoordinations are corrected earlier than others a
graded therapy approach (gradation of dysfluencies or miscoordinations from
easiest to difficult) may be beneficial.
Third, in the present study speech and reading samples of persons with stuttering were recorded before, after and after 6-months post-therapy. The client came for monthly follow-up. However, no audio recordings were made during this follow-up. Such audio-recordings would throw light on the time point at which a client reverts to dysfluencies and miscordinations.

Lastly, the present study has confirmed the results of the earlier studies on perceptual measures of treatment efficacy and has contributed additional information in the area of acoustic measures and miscoordinations of various subsystems of speech in persons with stuttering. It is a tedious process to investigate these miscoordinations in persons with stuttering and design specific therapy technique for each miscoordination. However, it is worth making an effort in this regard and future research on this subject is warranted.