CHAPTER VI

SUMMARY AND CONCLUSIONS
The concept of a neuropsychological basis for stuttering was first proposed by Orton (1927) and Travis (1931) more than 50 years ago. They suggested that stutterers lack cerebral dominance for speech resulting in aberrant interhemispheric relations. With the advent of sophisticated techniques for assessing hemispheric lateralization, this theory has been repeatedly tested. A number of studies have demonstrated hemispheric processing differences between stutterers and nonstutterers.

Dichotic studies which have used meaningful linguistic stimuli have revealed a significant number of right-handed stutterers to have either less of a right-ear advantage, a lack of ear preference or a left-ear advantage when compared to right-handed normals who commonly reveal a right-ear advantage (Curry and Gregory, 1969; Quinn, 1972; Sommers, Brady and Moore, 1975; Davenport, 1979).

Bilateral tachistoscopic presentation of meaningful linguistic stimuli have found that stutterers showed a left visual field preference unlike normals who commonly demonstrate a right visual field preference (Moore, 1976; Johannsen and Victor, 1986; Rastatter and Dell, 1987a; 1988).

EEG studies have found greater alpha suppression over the right hemisphere in stutterers during the processing of verbal tasks (Moore and Lorendo, 1980; Moore, 1984). This is
unlike the results obtained in normals who demonstrate alpha suppression over the left hemisphere during verbal processing.

Another technique that has been widely used to study hemispheric specialization and processing is the dual task paradigm. Here, the subject is required to process two tasks simultaneously, for example, a motor task and a verbal task or a motor task and a visuospatial task. Under such a condition, it has been found that performance on one or both the tasks deteriorate. The rationale behind the dual task paradigm is that interference occurs when the two concurrently performed activities compete for contiguous functional space within the same hemisphere. Thus, speaking and simultaneous right-hand tapping (activities processed in the left hemisphere) can be expected to produce more interference than speaking and tapping with the left hand (activities processed in opposite hemispheres). In fact, many studies have found this to be true in normal right-handed males indicating that they have left hemisphere dominance for speech.

Dual task studies have been used with stutterers in order to study hemispheric language representation. They have yielded conflicting results. Other investigators using different dual task procedures have suggested that the
problem in stutterers may be one of interhemispheric interference.

Thus, the theoretical issues pertaining to the neural mechanisms underlying stuttering cannot be resolved without adequate experimental evidence to support or refute them. With this aim in mind, the present study was taken up in order to study the nature of verbal and visuospatial hemispheric processing in stutterers and to examine the hypothesis that stuttering is due to aberrant interhemispheric relations. This was done by comparing the performance of stutterers with a matched group of nonstutterers on various dual task procedures. In addition, the present study attempted to find out whether stutterers could be divided into subgroups according to family history, age of onset and severity levels based upon their performance in the tasks.

The following were the main hypotheses for the present study:

Dual task study:

1) Stutterers and controls will not differ in their performance under baseline conditions of right tapping, left tapping and visuospatial tasks.

2) In the dual task condition of tapping task and verbal task, controls will show decrements in right tapping
only, while stutterers will show decrements in left tapping or tapping decrements in both hands. In both groups, left tapping as well as right tapping will not interfere with the verbal task. Stutterers will have significantly poorer overall scores than controls.

3) In the dual task condition tapping task and visuospatial task, stutterers and controls will demonstrate decrements in only the left hand. The degree to which the visuospatial task interferes with tapping will not differ between the two groups. Both left tapping and right tapping will not interfere with the performance of the visuospatial task in stutterers and controls.

Bimanual handwriting task:

4) With regard to the quality of letter formation (QLF) and mirror reversals (MRs) it is expected that stutterers will have poorer QLF and more MRs than controls in positions 1, 2 and 3. QLF will become poorer and the number of MRs will increase progressively from positions 1 to 3 in both groups. The degree to which performance deteriorates will not differ between the two groups.
Right-hand performance will be superior to left-hand performance in both groups with regard to QLF as well as MRs.

5) Stutterers and controls will not differ in overall response time for positions 1, 2 and 3.

Comparison of subgroups

6) There will be no difference in the performance of various subgroups of stutterers (Family history + vs Family history - ; Early onset vs Late onset; Mild vs Moderate vs Severe) on all the different tasks.

The experimental group consisted of 30 stutterers while the control group consisted of 30 nonstutterers matched for age and education. All subjects were male, right-handed and ranged in age from 15-35 years.

A pilot study was undertaken to finalize the design of the study as well as the tools and test procedures to be used.

In the main study, each subject was interviewed independently and socio-demographic data were collected. The following tests were then administered in the order given below:

1) The Edinburgh Handedness Inventory was used to assess handedness.
2) The Stuttering Severity Instrument was used to assess the level of stuttering severity. Three judges made independent assessments of stuttering severity.

3) The dual task paradigm was used to study the nature of hemispheric processing of verbal and visuospatial tasks. The motor task used was index finger tapping (L tapping and R tapping). The verbal task consisted of a word recognition task while the visuospatial task consisted of a face recognition task. The tasks were first performed under the baseline conditions following which they were performed under dual task conditions.

4) The bimanual handwriting task was used to find out whether interhemispheric communication in stutterers is poorly regulated when compared to nonstutterers. Subjects were required to repeat four words that were called out and then to write with both hands simultaneously the first letter of each word on a vertical board. They were instructed to keep their eyes closed while writing. The writing surfaces of the vertical board were placed in three different angles during trials. The quality of letter formation, number of mirror reversals and response time were compared in the two groups.

Once the data was collected, it was subjected to statistical analysis. The inferential statistics that were
applied to the data consisted mainly of the t test, the one way ANOVA, the paired t test and the repeat measures ANOVA.

CONCLUSIONS

The following conclusions are drawn based on the findings of the present study:

Dual Task Study

I Baseline Conditions:

Stutterers were found to have significantly poorer right tapping baseline scores than controls. The two groups did not differ significantly with respect to the other baseline conditions.

In both the groups, right tapping rates were significantly higher than left tapping rates.

Stutterers did not differ from controls in the degree of difference between right and left baseline tapping rates.

II Dual task condition of tapping task and verbal task:

The verbal task significantly interfered with both right tapping as well as left tapping in stutterers. Neither right, nor left tapping produced interference in the verbal task in stutterers.

Controls did not show the expected pattern of verbal task interference in right tapping alone. The verbal task did not interfere with either right tapping or left tapping
in controls. However, both right and left tapping were found to interfere with the verbal task in controls.

Stutterers were found to have poorer tapping scores overall than controls.

There was no significant difference in overall verbal scores between stutterers and controls.

III Dual task condition of tapping task and visuospatial task:

The visuospatial task significantly interfered with both right and left tapping scores in stutterers. The visuospatial task did not interfere significantly with right tapping and left tapping in the case of controls. In both groups, the left hand was less affected than the right.

Tapping did not interfere with visuospatial scores in both stutterers and controls.

Stutterers were found to have poorer overall tapping scores than controls.

Both stutterers and controls were found to have comparable visuospatial scores.

Bimanual handwriting task

I Quality of letter formation (QLF):

No differences were observed between stutterers and
controls with regard to QLF. In both groups, performance in the right hand was found to be significantly better than in the left hand. In both groups, QLF deteriorated from positions 1 to 3. The degree to which QLF in the right hand, was superior to QLF in the left hand, did not differ between the two groups.

II Mirror reversals (MRs):

Stutterers made significantly more MRs than controls. In both groups, the left hand made more MRs than the right hand. In both the groups, the number of MRs increased progressively from positions 1 to 3. Finally, the degree to which the right hand performance was superior to that of the left hand performance did not differ between the two groups.

III Response time:

The overall response time did not differ significantly between the two groups.

Comparison of subgroups

Both family history (+) and family history (-) stuttering groups were found to have significantly lower right tapping baseline scores than controls. In addition, left tapping exerted greater interference on verbal scores in the family history (+) group than in the family history (-) group.
Severe stutterers were found to have significantly poorer right tapping baseline scores than controls. Also, the verbal task exerted significantly greater interference on right tapping in moderate and severe stutterers than in the control group.

QLF in the early onset stuttering group was found to be significantly poorer than in the late onset stuttering group as well as in the control group.

In brief, the dual task study revealed bilateral decrements in both stutterers and controls in the tapping-verbal condition. In the tapping - visuospatial condition, bilateral decrements were observed only in the stuttering group. In the bimanual handwriting task, stutterers and controls made mirror reversals in both the dominant as well as the nondominant hand. In all conditions, the performance of stutterers was found to be poorer than that of controls. The results were interpreted according to a model of limited capacity and it was suggested that the neuromotor capacity of stutterers is weaker than that of nonstutterers.

LIMITATIONS OF THE PRESENT STUDY

1) The sample size was limited. This was especially true in the case of the subgroups. Perhaps, some patterns may have emerged if the sample size had been larger.
2) Subjects of the present study were not monolinguals. The possibility of language influencing results cannot be ruled out. However, this factor could not be controlled as it was difficult to get monolingual subjects.

3) The instrument used for the motor task was originally designed to record index finger tapping as well as sequential finger tapping. The latter task was excluded when it was found that the instrument was unable to record the entire range of errors. Inclusion of a sequencing finger tapping task as an additional motor task might have made the study more meaningful.

4) Verbal as well as visuospatial tasks of varying difficulty could have been included but this had to be eliminated due to time constraints.

5) As handedness and sex has been found to affect cerebral processing, inclusion of female subjects and left-handers would have been desirable. This could not be done due to difficulty in obtaining left-handed stutterers and female stutterers.

SUGGESTIONS FOR FURTHER RESEARCH

1) Assessment of stuttering severity can be made more accurate if the subjects are videotaped. In addition, it
is suggested that the assessment of each subject be repeated after a period of two to three weeks in order to ensure reliability of the assessment.

2) Studies using left-handed subjects, females and monolinguals need to be undertaken. Normative data needs to be established for these subjects to permit comparisons with stutterers. This is especially so in the Indian setting, where a majority of the literate population are bilinguals or multilinguals and left-handed subjects are difficult to obtain.

3) Studies using even larger samples would permit statistical comparisons between subgroups classified according to the stuttering severity, family history, age of onset, handedness, sex and linguistic status.

4) In order to determine the effects of task difficulty on performance, tasks of varying difficulty (demand levels) can be included in dual task studies.

5) A second task to study hemispheric processing differences, such as a dichotic listening task can be utilized along with a dual task study to confirm the findings. Since the utility of the dual task paradigm as a tool to investigate hemispheric processing is being questioned currently, the addition of such a test may throw some light on this issue.
6) The findings from behavioral techniques can be correlated with the findings from electrophysiological research when comparing stutterers and nonstutterers. Such investigations will add much to the development of a neuropsychological model of stuttering.