

## A Tachistoscopic Study of Monolingual and Bilingual Children

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### Abstract

*A tachistoscopic study of 10 monolingual and 10 bilingual children, was taken up to investigate the effect of hemispheric processing in Kannada and English language using concrete nouns from both the languages. A comparison of monolingual and bilingual performance on Kannada revealed a better performance by monolingual over bilinguals. The bilinguals however, did not show a significant difference in performance on three language lists viz. Kannada-Kannada, Kannada-English and English-English. On both intergroup and intergroup performance, of monolinguals and bilinguals, a consistent left visual field superiority was found. Possible contributing factors are discussed in relation to the performance of the two groups.*

*Key words: Tachistoscopic study, Monolingual, Bilingual, Cerebral Asymmetry*

Cerebral asymmetry, with respect to language functions has been an area of interest for several decades. The early localizationist's view that language is represented solely in the left hemisphere is no longer accepted. In order to determine the functions of the two hemispheres, there arose a need for behavioral tests of laterality in normal subjects. Laterality tests have been done, using the auditory modality and visual modality. The dichotic listening tests uses the auditory mode while the tachistoscopic test uses the visual mode. "Tachistoscope" is an instrument which provides a brief viewing of stimuli. It has been extensively used to answer questions regarding hemispheric asymmetry. The lateral visual field hemisphere relationship, in which the stimulation falling upon the left hemiretinae of the eyes is propagated to the occipital areas of the right hemisphere, while stimulation falling upon the right hemisphere, provides the anatomic basis for visual laterality research. Such a procedure has been extensively used for testing the language processing in monolingual and bilinguals.

It is being increasingly argued that the right hemisphere of a bilingual may be participating in language functions to a greater extent in comparison to a monolingual (Bentin, 1981, Chernigovskaya et al. 1983). Tachistoscopic studies and other electrophysiological studies yield clues as to the neurological organization of a bilingual brain. This neural organization is dependent on several variables of a bilingual, viz. handedness, sex, type of language, script, age of acquisition which have their effect on his neurological organization for the two languages.

Only a few tachistoscopic studies on the Indian population have been reported so far. Such tachistoscopic studies, specifically regarding bilingual and monolingual children, are none. In view of this lacunae, on the Indian front, a study was conducted in order to explore the issues regarding the processing of Kannada in Kannada monolinguals and bilinguals and processing of English and Kannada by bilinguals.

Forgays (1963) studied children of 7-16 years and found that less errors were found in right visual field in case of unilateral presentation of 3-4 letter words. McKeever et al. (1973), Olsen (1973), Marcel et al. (1974) and Miller (1981) are authors who followed the similar method of unilateral presentation through a tachistoscope and studied identification of 3-4 letter familiar words and found the superiority of right visual field over the left. Hines (1975) studied the functioning of bilaterally presented tachistoscopic stimuli and found large left visual field superiority for verbal stimuli processing. He also gave the notion that unilateral presentation does not produce a significantly larger visual hemispheric field superiority. Hines (1977) also reported that high frequency abstract words showed a significantly larger right visual hemispheric field asymmetry than high frequency moderately concrete words. Walters and Zatorre (1978) studied English bilinguals and reported left hemisphere superiority for common nouns.

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Genesee et al. (1978) investigated language processing strategies of three subgroups of adult bilinguals with different histories of language acquisition. The adolescent group seemed to rely more on a right hemisphere based strategies.

Handyk et al. (1978) studied English and Chinese bilinguals. Tachistoscopically and found no cerebral lateralization effects, suggesting that active ongoing cognitive processing is independent of lateralization. Zaccolotti and Oltman (1978) studied lateralization of verbal processing in 18-30 year old males and found right visual field asymmetry in letter discrimination tasks with respect to reaction time strategies. Jones (1978) reported of no difference between the visual fields in detection of single letters. Walters and Zatorre (1978) studied laterality difference for word identification in bilinguals and stated that a left hemispheric advantage was present for processing both Spanish and English, regardless of which language was learned first. Silverberg et al. (1979) studied the visual field preference for English words in native Hebrew speakers and found that left visual field preference was present in the youngest group and right visual field preference in the oldest group.

Obler et al. (1982) had presented a precise report on the methodological issues in determining the cerebral lateralization in bilinguals, with respect to stimuli, language set, practice effects, perception, word length, recall, etc. Elman et al. (1981) reported that adjectives and verbs were processed more rapidly and correctly in right visual field. Soares (1984) tested Portuguese-English bilinguals and a group of English monolinguals on a series of concurrent activity, on time sharing tasks. There were no lateralization differences across the bilinguals and monolinguals and equal levels of left hemispheric dominance was found. Albanese (1985) reported that growing bilingual proficiency does increase left ear/right hemispheric participation, but in intralingual situations only. Vaid (1987) did a tachistoscopic study on rhyme and syntactic category judgement in monolinguals and fluent early and late bilinguals. A right visual field superiority was obtained for both types of tasks and this effects was more pronounced in late bilinguals and monolinguals. Paradis (1990) reported that both languages of bilinguals are subserved by the left hemisphere in the same proportion as in unilinguals.

There have been a couple of tachistoscopic studies in the Indian context using Kannada-English bilingual subjects. Bharathi (1987) did a tachistoscopic study on Kannada English bilingual adults with concrete nouns, presented bilaterally and found that subjects identified more words correctly in the left visual field. Radhika (1987) did a tachistoscopic study in Kannada monolingual adults with abstract and concrete nouns in Kannada, presented bilaterally. The results showed no visual field differences in terms of concrete and abstract nouns.

However, no studies on language processing in monolingual or bilingual children in the Indian context have been reported. In this context the present study was planned. The aim of the present study was to investigate the effects of hemispheric processing in monolinguals and bilinguals.

## **Method**

### **Subjects**

Subjects were 10 monolingual and 10 bilingual children, in the age-range of 8 to 10 years. Monolinguals were selected on the basis that they are continuing their education in the school, where Kannada is the medium of instruction and they use extensive Kannada in all situation. Similarly, 10 bilinguals were selected who are continuing languages Kannada and English. The mother tongue of all the subjects was Kannada. The bilingual group was checked on their fluency, comprehension and expression in the second language, English. The subjects were all right handed and had no family history of left handedness. They all had normal threshold of visual acuity. The subjects were screened for their language competency in the acquired language, except their mother tongue. The screening was based on interview with the school teachers regarding their proficiency on fluency, comprehension and expression in the language. They were not exposed to tachistoscope testing procedures earlier.

**Material:** The stimulus materials were prepared on white cards (4 x 6") in size. 20 stimulus cards were in Kannada-Kannada, 20 in Kannada-English and 20 in English were prepared with the following criteria.

- 1) Stimulus words were high frequency concrete nouns. In English, the words were bisyllabic and four lettered, (adapted from Walters and Zatorre's study). In Kannada, high frequency concrete nouns were selected from the work of Ranganatha (1982).
- 2) Each word appeared in each visual field only once.
- 3) The same word pair was not repeated anywhere.

Four extra word pairs were prepared for the practice. Each card contained two words and a randomly assigned central digit one through nine. The letters presented horizontally were approximately 2.2 cm. in size and prepared in black colored stencils (upper case). A fixation card was employed, having the picture of a wheel.

**Method:** The subjects were instructed Kannada and they were asked to concentrate on the visual field inside the instrument (gerbrands 3 channel tachistoscope, model 1/32, T-3, B-2). They were first asked to look at the wheel on the fixation card. As they looked into the central field of vision, the subject was instructed to set the concentration on either side of central field, as words were presented. They were asked to report the central digit first and then the words, as quick as possible. The subjects were asked to guess the words after each presentation period and the order of reporting of the words was not specified. The fixation card was projected for 90 msec. and the stimulus card appeared in the channel for 40 msec. and then a blank flash card was presented for 1 sec. 90 msec (considered as it was found optimal for ensuring that the information is relayed to only one hemisphere at a time) was chosen for the duration of fixation card, based on the studies by Hines (1975), Handyck (1978) and, Bharathi (1987) and Radhika (1987) and 40 msec. was chosen as the duration of exposure of stimulus based on studies by Bharathi (1987) and Radhika (1987). Familiarization before the test was done with four practice cards. Two channels were used, one for fixation and the other for presenting the stimulus material. Subject's responses were recorded verbatim, on a tape-recorder.

### Analysis

Recorded responses were transcribed verbatim and then analyzed. For the purpose of analysis, data from those stimulus cards, where the central digit was either missed or reported wrong, was not taken. The recorded responses were categorized as follows:

- 1) Accurate if correctly reported;
- 2) Inaccurate if these were omitted or substituted. A maximum score of one could be achieved in each visual field.

Mean raw scores, standard deviation and mean percentage scores of performance of all the groups in the three test lists were listed.

Independent t-test was used to see the difference between Kannada monolinguals and bilinguals on Kannada word pairs. Paired t-test was used to test the difference between RVF and LVF in monolinguals and bilinguals separately. Repeated measure ANOVA was used for testing significance between inter-lingual lists in bilinguals and Bonferroni's test was done for pair wise comparisons.

### Results

The response of the Kannada monolingual children and Kannada-English bilingual children, ranging in age from 8-10 years were analyzed in terms of correct responses and incorrect responses (omissions and substitutions). Table-1 shows the distribution of subjects in terms of age and sex.

| Subjects                   | No. of Subjects          | Age Range  | Mean Age  |
|----------------------------|--------------------------|------------|-----------|
| Kannada-English Bilinguals | Males = 6<br>Females = 4 | 8-10 years | 8.8 years |
| Kannada monolinguals       | Males = 7<br>Females = 3 | 8-10 years | 9.2 years |

Table-1: Age and Sex distribution of subjects

Table-2 shows the performance of ten Kannada monolingual children on Kannada word pairs in terms of correct words reported and errors in the form of substitutions and omissions. The result reveal a better left visual field scores ranging from 15-20 as compared to those of right visual field (Range: 3-16). Even, the number of substitutions and omissions were more in right visual field (4.2 & 8.4) than the left visual field (1.1 & 0.7).

| Sl. No. | Left visual field             |   |                                      | Right visual field            |   |                                      |
|---------|-------------------------------|---|--------------------------------------|-------------------------------|---|--------------------------------------|
|         | Correct No. of words reported | Incorrect responses No. of substitution | Incorrect responses No. of omissions | Correct No. of words reported | Incorrect responses No. of substitution | Incorrect responses No. of Omissions |
| 1       | 20                            | 0                                       | 0                                    | 3                             | 5                                       | 12                                   |
| 2       | 20                            | 0                                       | 0                                    | 5                             | 8                                       | 7                                    |
| 3       | 18                            | 2                                       | 0                                    | 4                             | 3                                       | 13                                   |
| 4       | 16                            | 4                                       | 0                                    | 6                             | 7                                       | 7                                    |
| 5       | 17                            | 2                                       | 1                                    | 8                             | 5                                       | 7                                    |
| 6       | 16                            | 3                                       | 1                                    | 9                             | 4                                       | 7                                    |
| 7       | 20                            | 0                                       | 0                                    | 16                            | 4                                       | 0                                    |
| 8       | 20                            | 0                                       | 0                                    | 7                             | 1                                       | 12                                   |
| 9       | 20                            | 0                                       | 0                                    | 10                            | 2                                       | 8                                    |
| 10      | 15                            | 0                                       | 5                                    | 6                             | 3                                       | 11                                   |
| Mean    | 18.2                          | 1.1                                     | 0.7                                  | 7.4                           | 4.2                                     | 8.4                                  |
| S.D.    | 2.04                          | 1.52                                    | 1.56                                 | 3.71                          | 2.14                                    | 3.83                                 |

Table-2: Showing the performance of Kannada monolinguals on the Kannada word pairs, in terms of correct words reported, the number of substitutions and the number of omissions.

Table-3 shows the bilingual and monolingual children’s mean performance (on Kannada-Kannada list). The mean percentage score (e.g. 91%, 74%) reveals a better performance by monolinguals than bilinguals. Also, the left visual field was found to be superior.

| Subjects    | LVF     |              |          | RVF     |              |          |
|-------------|---------|--------------|----------|---------|--------------|----------|
|             | Correct | substitution | omission | Correct | substitution | omission |
| Bilingual   | 81.5%   | 12%          | 6.5%     | 15.5%   | 25.5%        | 59%      |
| Monolingual | 91%     | 5.5%         | 3.5%     | 37%     | 21%          | 42%      |

Table-3 Showing the bilingual and monolingual children Average percentage performance on Kannada

Table-4 shows the bilingual children’s performance on English-English word pairs, including correct responses and incorrect responses (omissions and substitutions). Substitutions and omissions were comparatively less in the left visual field, (ranging from 0 to 4) than in the right visual field (ranging from 1 to 15) as noted.

|      | Left visual field |               |          | Right visual field |               |          |
|------|-------------------|---------------|----------|--------------------|---------------|----------|
|      | Correct responses | Substitutions | Omission | Correct responses  | Substitutions | Omission |
| 1.   | 20                | 0             | 0        | 5                  | 1             | 14       |
| 2.   | 19                | 1             | 0        | 4                  | 3             | 13       |
| 3.   | 20                | 0             | 0        | 4                  | 2             | 14       |
| 4.   | 17                | 2             | 1        | 5                  | 4             | 11       |
| 5.   | 16                | 1             | 3        | 3                  | 2             | 15       |
| 6.   | 15                | 1             | 4        | 4                  | 3             | 13       |
| 7.   | 16                | 2             | 2        | 4                  | 3             | 13       |
| 8.   | 20                | 0             | 0        | 9                  | 1             | 10       |
| 9.   | 20                | 0             | 0        | 7                  | 2             | 11       |
| 10.  | 20                | 0             | 0        | 6                  | 3             | 11       |
| Mean | 18.3              | 0.7           | 1        | 5.1                | 2.4           | 12.5     |
| SD   | 2.05              | 0.82          | 1.49     | 1.79               | 0.96          | 1.64     |

Table-4: Table showing the bilinguals children’s performance on English-English word pairs, including correct responses and incorrect responses (omissions and substitutions).

Table-5 shows the bilingual children’s performance on Kannada-English word pairs. The mean of correct response was 18.4 for the left visual field, while it was only 3.4 for the right visual field. Substitutions and omissions were again relatively less in left visual field as compared to the right visual field.

|      | Left visual field |               |          | Right visual field |               |          |
|------|-------------------|---------------|----------|--------------------|---------------|----------|
|      | Correct           | Substitutions | Omission | Correct            | Substitutions | Omission |
| 1.   | 20                | 0             | 0        | 5                  | 5             | 10       |
| 2.   | 18                | 1             | 1        | 5                  | 6             | 9        |
| 3.   | 19                | 1             | 0        | 5                  | 5             | 10       |
| 4.   | 19                | 0             | 1        | 8                  | 3             | 9        |
| 5.   | 17                | 3             | 0        | 4                  | 4             | 12       |
| 6.   | 16                | 3             | 1        | 3                  | 4             | 13       |
| 7.   | 15                | 4             | 1        | 4                  | 7             | 9        |
| 8.   | 20                | 0             | 0        | 0                  | 5             | 15       |
| 9.   | 20                | 0             | 0        | 0                  | 6             | 14       |
| 10.  | 20                | 0             | 0        | 0                  | 8             | 12       |
| Mean | 18.4              | 1.2           | 0.4      | 3.4                | 5.3           | 11.3     |
| SD   | 1.83              | 1.54          | 0.51     | 2.67               | 1.49          | 2.21     |

Table-5: Showing the bilingual children’s performance on Kannada-English word pairs.

Table-6 shows the bilingual children’s performance on Kannada-Kannada word pairs. The mean of correct responses, (16.3 & 3.1, respectively) obtained in the left visual field was higher than that in the right visual field revealing that left visual field performance was better than that of the right visual field. Also the number of substitution and omissions were lesser in the left visual field, as compared to the right visual field.

|      | Left visual field |               |          | Right visual field |               |          |
|------|-------------------|---------------|----------|--------------------|---------------|----------|
|      | Correct           | Substitutions | Omission | Correct            | Substitutions | Omission |
| 1.   | 20                | 0             | 0        | 5                  | 3             | 12       |
| 2.   | 15                | 4             | 1        | 3                  | 4             | 13       |
| 3.   | 15                | 3             | 2        | 4                  | 5             | 11       |
| 4.   | 16                | 2             | 2        | 5                  | 6             | 9        |
| 5.   | 18                | 1             | 1        | 6                  | 6             | 8        |
| 6.   | 12                | 2             | 6        | 2                  | 5             | 13       |
| 7.   | 12                | 7             | 1        | 1                  | 7             | 12       |
| 8.   | 18                | 2             | 0        | 1                  | 7             | 12       |
| 9.   | 18                | 2             | 0        | 1                  | 6             | 13       |
| 10.  | 19                | 1             | 0        | 3                  | 2             | 15       |
| Mean | 16.3              | 2.4           | 1.3      | 3.1                | 5.1           | 11.8     |
| SD   | 2.79              | 1.95          | 1.82     | 1.85               | 1.66          | 2.04     |

Table-6: Showing the bilingual children’s performance on Kannada-Kannada word pairs.

Table-7 shows the mean percentage performance of bilinguals on the 3 word lists viz. (Kannada-Kannada English-English). The mean percentage performance of Kannada-Kannada; English-English and Kannada-English lists in the left visual field was 81.5%; 91.5% and 92% respectively. This shows that the performance was better in the Kannada-English list. The performance in English-English list almost paralled with that of Kannada-English list. The mean percentage of performances in the right visual field in terms of Kannada-Kannada, English-English and Kannada-English lists were 15.5%, 25.5% and 17% respectively. This shows that the performance in English-English list was comparatively better than the other two lists in the right visual field. Again, the performance in Kannada-English list was better than the Kannada-Kannada list. Substitutions and omissions were again more in number in right visual field in case of all the three lists.

| Lists             | Left visual field |              |          | Right visual field |              |          |
|-------------------|-------------------|--------------|----------|--------------------|--------------|----------|
|                   | Correct           | Substitution | Omission | Correct            | Substitution | Omission |
| Kannada-Kannada   | 81.5%             | 12%          | 6.5%     | 15.5%              | 25.5%        | 59%      |
| English – English | 91.5%             | 3.5%         | 5%       | 25.5%              | 12%          | 62.5%    |
| Kannada – English | 92%               | 6.0%         | 2%       | 17%                | 26.5%        | 56.5%    |

Table 7: Showing the Average Percentage performance of bilinguals on the 3 word lists viz (Kannada, English and Kannada-English)

Table-8 shows comparison between groups. The difference between the mean of performance of Kannada monolinguals and bilinguals in Kannada-Kannada list was significant at both levels, in the combined visual field conditions. In both bilinguals and monolinguals, left visual field performance is highly significant at 0.001 level. Amongst the bilinguals, there was significant difference between the performances in the three lists. From Bonferroni's test it is evident that there was no significant difference between the performance of Kannada-English and English-English, whereas rest of the 2 pairs were significant.

| Groups of comparison  | Results of significance   |
|---|---------------------------|
| Kannada Monolinguals versus bilinguals on Kannada word pairs (Independent Test) | t (18) = 1.737, p < 0.05  |
| Amongst bilinguals inter-lingual lists comparison (Repeated Measure ANOVA)      | F (2,18) = 10.268, p<0.01 |
| RVF versus LVF performances in monolinguals (paired t-test)                     | t (9) = 8.672, p < 0.001  |
| RVF vs. LVF performances in bilinguals (paired t-test)                          | t (9) = 15.231, p < 0.001 |

Table-8: Table showing the results of significance based on group comparisons for correct responses

### Discussion

The results obtained indicate that the left visual field performance was superior, compared to that of right visual field regardless of language variation or subject categories (bilinguals and monolinguals). The fact that the left visual field recognizes concrete-nouns supports the earlier findings of Hines (1975, 1977), Genesee et al. (1978), Albert and Obler (1978), Silverberg et al. (1979), Albanese (1985), Bharathi (1987) and Radhika (1987). The finding that the group of monolingual and bilingual children show left hemisphere superiority in any of the tasks, might be because of the reading habits. According to Heron (1957), people tend to read from left most corner to the right. More over, Kannada and English do follow the left-to-right rule. Right visual field errors were more than the left visual field errors. It could have been reduced probably if the duration of exposure of the stimuli was little more than 40 msec. It would be interesting to investigate the reading like in Arabic and the pattern of performance of monolingual and bilingual when stimuli are presented vertically in contrast to horizontal pattern. More number of omissions in the right visual field may also be due to the fact that the test groups involved were children whose performance might have reduced because of attentional deficits. Another attribute for the poor performance in right visual field is that the subjects would have consumed more amount of time, in reporting the central digit and hence less attention was paid for right visual field stimulus, inspite of repeated instructions. More substitution and omission errors were made in the right visual field. Mostly, substitution occurred for words, which were visually more or less similar to the largest word in phonological form. For e.g. 'Mane' was substituted by 'Mara' and 'Ane' 'Gida' was substituted by Gudi. Mostly, addition errors were noticed in English-English and English-Kannada word lists, where the 'plural marker' /s/ was added. For e.g. lock was told as locks,

'Head' as 'Heads'. It might be due to over generalization of some of the words in the list ('Ears' 'Eyes', 'Cats', 'Dogs' etc.) were plurals which had already occurred earlier in the visual paradigm. Thus, no significant difference in terms of right visual field and left visual field processing of concrete nouns in bilingual children was found. Consistent superior performance in the left visual field appears to be more a function of testing variables than supporting right hemispheric language processing in either of the monolingual and bilingual groups.

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