

CHAPTER 5

GENERAL DISCUSSION AND CONCLUSIONS

The present study deals mainly with the role of visual reference system, feedback, and task complexity in short-term memory of voluntary preselected and constrained movements. Efforts were concentrated to ascertain as to how these variables contribute to the coding, storage, and retrieval of motor response. The effect of movement cues, target length in memory of movement have also been investigated.

In this connection, 3 experiments have been conducted. Experiment I primarily deals with the role of preselected and constrained movements under active and passive modes of movement in reproduction of location and distance cues, and short and long sectors.

In Experiment II, an attempt has been made to ascertain the role of feedback in motor learning.

In Experiment III, the effect of response complexity on short-term recall of a linear movement has been investigated.

The results emerged from all the 3 experiments show that the role of visual reference system, feedback conditions, and task complexity have different effects in the processing, storage, and retrieval of movement information, target length, and preselection for the two groups, i.e., blind, and sighted.

The results obtained in the 3 experiments are discussed in the following sections.

5.1 MOVEMENT CUES

A simple voluntary movement involves two types of cues, viz., location and distance. It has been suggested that location information is coded in motor perceptual reference system, i.e., in terms of muscles, joints, and receptors. The results obtained in AE, VE, and CE analysis of Experiment I show that location information is better retained than distance information. Moreover, location information show less variability across mode of movement, i.e., active and passive, and also across preselection, i.e., preselected and constrained conditions. Diewert⁴⁹ reported that location cue is more precisely coded than distance cue. His variable error analysis and interference tasks revealed that location cue is coded into an integrated store based on vision and kinesthesia. Better retention of location cue than distance cue have also been reported by Laabs,⁶⁴ Hermelin and O'Connor,⁸⁸ Kool⁹² and Pathak.⁹³

In the main analysis of Experiment I, information x sector interaction effect is significant. This interaction is significant for all the three error analysis. This result shows that short movement has better representation in memory probably due to the involvement of spatial cue in it. Stelmach and McCracken⁷⁰ reported that location and distance informations are interdependent and coding of distance depends upon the relative involvement of the two informations available in a movement situation. Similar to this Summer, Sommer, Sharp, Levey, and Murray⁹⁹ reported that kinesthetic cues from the criterion movement are rendered difficult to directly use for reproduction purposes. In such conditions the recall of movement is based on an abstract movement code.

Roy,⁸⁰ Hermelin and O'Connor⁸⁸ reported that distance cue is coded in non-motor perceptual reference system, i.e., vision. Kool⁹² compared the performance of blind and sighted subjects on linear response. He found that the recall accuracy of the blind group was poorer than the sighted group on distance task. He also suggested that the distance information is coded in visual terms. However, he did not deny the supportive role of kinesthetic system in movement coding.

5.2 ACTIVE AND PASSIVE MOVEMENTS

In Experiment I, movement was presented either in active mode or in passive mode to find out as to how the resulting efference from active movement facilitates the coding of movement.

Main analysis and subsequent simple main effects analyses show that active movement is better reproduced and less variable than passive movement. In experiment I, movement information is also manipulated under active and passive modes of movement for the blind and sighted groups. All the three (i.e., AE, VE and CE) error analysis show that the recall accuracy of the former group was more affected in the absence of direct sensory information from the moving limb, while the latter group makes effective use of visual imagery in the absence of sensory information for the coding of movement.

The groups x modes of movement x sectors interaction effect shows that the error of the two groups increased with increase in target length irrespective of modes of movement presentation. However, recall accuracy of the sighted group is better in short sector than long sector under both active and passive modes of movement. The recall accuracy of the blind group increased in passive long movement as compared to active long movement.

These results suggest high reliance of the blind subjects on kinesthetic modality for movement coding which decays as a function of time. Posner⁵⁸ compared visual location and kinesthetic distance. He reported that visual location is better reproduced than kinesthetic distance.

Marteniuk,⁶⁸ Jones,⁹⁵ Kool and Pathak,⁸¹ and Stelmach and Kelso,¹¹⁰ also reported that active movement is better reproduced than passive movement. Active movement is more attention demanding by nature than passive movement.⁶⁸

5.3 SECTORS

Effect of movement length has also been noted in short-term memory of movement. Movement length has been recognized as one of the important variable which contributes in memory of movement. Studies have shown that the two movement sectors, i.e., short or long differ in their retention characteristics. It has been reported that short movement is more precisely coded than long movement.

In all the three experiments, it has been found that short movement is more precisely coded than long ones. It has also been noted in the CE analysis of sectors in Experiments I, II, and III that short movements are invariably overshoot and long movements are undershot.

Similar results have been reported in almost all the studies related to short-term recall of movements. Overestimation and underestimation of motor response has been assessed by CE analysis and this effect has been termed as 'central tendency effect',^{64,114} or 'range effect',^{53,115}

CE result of all the 3 experiments support the notion of 'central tendency' or 'range effect'.

Klapp¹¹² reported that short movements are centrally represented, while long movements are under feedback control.

Roy and Kelso⁶³ reported that both location and distance provide equally precise information at short targets, but location is more precise than distance at the long targets. The results of Experiments I, II, and III show that at short targets the sighted subjects did derive support from visual reference system in the processing of location. This conclusion is further supported in the groups x sectors interaction effect which is significant in Experiments I, II, and III.

5.4 PRESELECTION

Preselection is a common variable in Experiments I and II. In both these experiments, it has been one of the major thrusts to examine as to how visual reference system helps in the processing, coding, and storage of voluntary preselected movement. Results of Experiments I and II show

that preselected movement has better access to central store of memory and it is more precisely coded with the help of visual imagery.

In Experiments I and II, the groups x preselection effect has been found significant. In Experiment I this interaction effect is significant for CE analysis while in Experiment II it is significant for VE analysis. In simple main effects analysis this interaction effect emerged significant for all the three response measures, i.e., AE, VE and CE.

There are several explanations to the superior recall of preselected movements. These views may be categorised as motor view and cognitive view. Jones^{95,100} suggested that the superior recall of preselected movements is due to the central monitoring of efference, but this view is no more acceptable to others. Stelmach, Kelso and Wallace⁹⁴ reported that preselection functions are a corollary discharge mechanism. In a comparative study of active and passive distance, Roy⁸⁰ noted that the recall accuracy of active and passive distance do not differ significantly in preselected condition. He suggested that rather than efference, prior information about the termination of movement is an important determinant of precision in preselected condition. Roy's⁸⁰ explanation of preselection differs from Jones,⁹⁵ Stelmach, Kelso and Wallace.⁹⁴

In Experiment I it is noted that blind subjects failed to utilize the facility of preselection in memory of movement as compared to the sighted subjects. This finding suggests that preselection can be effectively utilized only with the availability of visual imagery. Similar results have been reported by Singh.³⁹

5.5 FEEDBACK

Role of feedback has been noted in short-term memory of movement. Stelmach¹²¹ reported that kinesthetic feedback is more useful for long movements as compared to short movements. A multitude of studies have reported the facilitatory role of feedback in motor memory.^{14,23,27,122,123,124,212}

In Experiment II, it has been noted that augmented feedback condition facilitates learning and performance. One of the most interesting finding of Experiment II is groups x feedback interaction effect which is significant for AE and CE. Performance of the blind group, is better, in augmented feedback condition. It was adversely affected in attenuated feedback condition. Among all feedback channels, role of vision has been found most important. Studies have shown that, visual modality plays an important role than other sensory system in the effective processing, storage and retrieval of motor response. Adams, Marshall and Goetz²⁷ manipulated A, P, and V feedback channels. They

reported that vision has a more facilitatory role in memory of movement than other sensory modality. Similar findings have been reported by others also.^{58,124}

5.6 TASK COMPLEXITY

Each parameter of a movement has different retention properties. Henry and Rogers²³⁰ reported that target length is one of the important parameters of a motor task. By increasing the movement length, task complexity can be raised.

In Experiment III, it has been found that the motor response performed in horizontal plane is better reproduced by both blind and sighted. A movement which was same during both criterion learning and reproduction shows better reproduction in memory. AE analysis shows that the blind group could not derive support from kinesthetic system in learning the movement which differ in criterion and reproduction, while the sighted group is found clearly superior to the blind group in all experimental conditions except in horizontal-horizontal experimental condition. This result suggests that for effective use of kinesthetic system, the availability of visual reference system is necessary. It is suggested here, that vision plays an important role even in the recording of complex movement. However, kinesthetic system performs a supportive role for effective utilization of visual reference system.

The results of all the 3 experiments present a coherent view, suggesting that the visual reference system play very crucial and significant role in memory of movement. Role of feedback in motor learning is not denied. Task complexity affects movement retention in several ways. Further, some parameters of a movement are more benefitted by the availability of visual reference system than others.

In the end, it is suggested that the central mechanism helps in planning the movement, and this plan is implemented through the peripheral system. Vision helps in controlling the movement. It is wrong to emphasize the importance of any one of the sensory systems in memory of movement. Each of them play, perhaps, equally important role in movement planning, execution, and control at different stages.

In the present study simple linear task having unidirectional movement has been utilized and hence, it is difficult to say much about the planning aspect of a movement. Now, it is an open question to examine the planning part of movement using multidimensional motor task having choice reaction time as a dependent measure. It may be perhaps a good exercise to arrive at a more authentic answer to the unresolved questions related to movement planning.