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Task-related coding of stimulus and response in cat motor cortex

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Summary. In a previous study in the cat, we have reported that motor cortex neurons discharging before the initiation of an aimed forearm response (lead cells) are better timed to movement of a display (stimulus) than to the response. The present study was done to distinguish the coding of stimulus and response features in the discharge patterns of such early activity in motor cortex. Single neurons were recorded in the arm area of motor cortex in three cats performing the same pair of responses (forearm flexion and extension) but to display movements in either of the two directions by changing display polarity. The modulation of lead cell activity was contingent on the occurrence of the learned motor response and timed to the stimulus in all conditions. The majority of lead cells (88%, $n = 50$) fell into one of two distinct classes. In one class of neurons, *force-direction* (56%, $n = 32$), activity was contingent on a single direction of forelimb response (flexion or extension) and was thus independent of the direction of the display stimulus. The only muscles whose patterns matched the activity of this class of response-related neurons were forelimb flexors and extensors. In these neurons, the onset of modulation was timed to one or the other of the two stimuli according to the stimulus direction which elicited the appropriate response. Thus, the display-related input to these neurons varied according to the response required. In the second class of neurons, *stimulus-direction* (32%, $n = 18$), modulation was associated with a specific stimulus direction rather than the response direction. The pattern of activity of these neurons was similar to the pattern of EMG signals of shoulder and neck muscles during the different task conditions. The contraction of proximal and axial muscles corresponded to a second response elicited by the stimulus, namely attempts at head rotation towards the moving display and was independent of the conditioned forelimb response in both time of onset and direction. To test the possibility that stimulus-direction neurons participated in the control of head rotation we trained two of the animals to also produce isometric changes in neck torque in the direction of the moving display without making the forelimb response. The activity of stimulus-direction neurons was similarly modulated during performance of the neck task. By contrast, force-direction neurons examined during the neck task were either unmodulated or discharged after the neck response. These data suggest that force-direction neurons participate in response initiation and that their activity is triggered by stimuli specific for the task. The reorganization of the inputs to motor cortex is likely to result from gating mechanisms associated with behavioral set. Such neural gates could provide for the efficient transfer of any member of an array of behaviorally relevant stimuli to restricted sectors of the somatotopically organized motor areas.

Key words: Cat – Motor cortex – Single unit activity – Tracking – Input switching

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Introduction

In a previous study we showed that the arm area of the cat motor cortex includes two distinct functional subregions located rostral and caudal to the cruciate sulcus, respectively (Vicario et al. 1983). Populations of neurons recorded from these two subregions during performance of a tracking task differed both in the timing of activity during task performance as