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Specialized Subregions in the Cat Motor Cortex: Anatomical Demonstration of Differential Projections to Rostral and Caudal Sectors

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Summary. (1) Ipsilateral cortico-cortical and thalamo-cortical projections to the cat motor cortex were determined from the locations of retrogradely labeled neurons following single small intracortical injections of HRP in area 4γ. These projections were also examined by studying the distribution of anterogradely transported axonal label following multiple injections of HRP or of tritiated amino acids in areas 1–2 of SI and in area 2pri (SII). (2) The number of retrogradely labeled cells in areas 1–2 and in area 2pri differed markedly between HRP injection sites located in the precruciate (anterior sigmoid gyrus) and postcruciate (posterior sigmoid gyrus) subregions of area 4γ. These associational projections from primary and secondary somatosensory cortices were dense to postcruciate subregions but weak to the precruciate subregions. (3) The associational projections from areas 1–2 and from area 2pri to the postcruciate subregion of area 4γ were topographically organized, but no clear topographic organization could be demonstrated for the precruciate projection. (4) Anterograde terminal labeling following injection of either HRP or tritiated amino acids into areas 1–2 and area 2pri confirmed the preferential projection of somatosensory cortex to the postcruciate subregion of motor cortex. The projection from somatosensory areas 1–2 was uniform over its terminal field, but that from area 2pri was more patchy and complex. (5) HRP injections in area 4γ gave rise to lamellae of labeled neurons in the ventrolateral nucleus of thalamus (VL). A topographic relationship was found between the site of injection and the location of the lamella of labeled neurons. (6) The percentage of retrogradely labeled neurons in the shell zone surrounding the border of the ventrolateral nucleus and the ventrobasal complex (VB) was greater following postcruciate than precruciate injections, whereas fewer retrogradely labeled neurons were found in central lateral nucleus (CL) after postcruciate injections than after precruciate injections. (7) These observations support the hypothesis that differential cortical and thalamic projections to different subregions of area 4γ may give rise to the different physiological properties of neurons observed in these subregions (Vicario et al. 1983; Martin et al. 1981).

Key words: Motor cortex – Thalamocortical – Corticocortical – HRP – Cat

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Introduction

Until recently, the primary somatosensory (SI) and motor (MI) cortices of higher mammals have been considered to be organized as unique representations of the body. This simple view was first challenged by the observations of Merzenich and his co-workers (Paul et al. 1972; Merzenich et al. 1978), who found separate representations of the body in cytoarchitectonic areas 3b, 1 and 2 of SI in the monkey. These separate representations receive input from slowly adapting cutaneous mechanoreceptors, rapidly adapting cutaneous mechanoreceptors and joint afferents, respectively. In addition, area 3a has been found to be specifically influenced by muscle afferents (Oscarsson and Rosen 1966; see Jones and Porter 1980 for review). Paralleling these physiological observations are anatomical demonstrations of differences in thalmo-cortical and cortico-cortical connections to the same sensory subregions of monkey cortex (Vogt and Pandya 1978; Jones et al. 1978). Studies of the functional organization of the motor cortex in both the monkey (Strick and Preston 1978a, b; Kwan et al. 1978) and the cat (Pappas and