The Dorsal Spino-olivocerebellar System in the Cat
II. Somatotopical Organization

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Summary. The somatotopical organization of the projection through the dorsal spino-olivocerebellar path (DF-SOCP) to the c₃ zone in the cerebellar anterior lobe was studied by recording climbing fiber field potentials in the cerebellar cortex evoked on stimulation of peripheral nerves. The c₃ zone was shown to contain a detailed and systematic representation of the ipsilateral body half with the following characteristics:

1. Single nerves project to one or two sagittal strips of cortex which extend across several folia. The width of the strips varies between 0.2 and 1 mm and the length may be as long as 15–20 mm along the unfolded cortex.

2. The strips activated from different nerves occur in an order which usually follows the segmental innervation, the hindlimb being represented rostrally and the forelimb caudally in the zone.

3. The double representation of some nerves makes it possible to distinguish one medial and one lateral part of the c₃ zone with the projection areas organized approximately as mirror images.

Additional observations on other zones activated by the DF-SOCP system (Ekerot and Larson, 1979a) indicate that the c₁ zone has a somatotopical organization which is reminiscent of that of the c₃ zone, whereas the x and d₁ zones have different topographical organizations.

Key words: Dorsal spino-olivocerebellar paths – Cerebellum – Climbing fibers – Somatotopy

The olivocerebellar projection is characterized by a high degree of topographical specificity (Armstrong et al., 1974; Brodal and Walberg, 1977a, b; Groenewegen and Voogd, 1977; Groenewegen et al., 1979). Different parts of the inferior olive project to narrow sagittal zones in the cerebellar cortex. The zones in the anterior lobe are activated by a large number of spino-olivocerebellar paths (SOCPs), usually two or three projecting to each zone according to a highly specific pattern (Oscarsson, 1973, 1976; Oscarsson and Sjölund, 1977a, b; Ekerot and Larson, 1979a). As discussed in a previous paper (Ekerot and Larson, 1979a), the somatotopical organization is different.
in the different zones. Some zones have separate forelimb and hindlimb areas conforming to classical concepts with the forelimb projecting caudally and the hindlimb rostrally in the anterior lobe. In the present investigation a detailed study was performed on the somatotopy of the projection from the dorsal spino-olivocerebellar path (DF-SOCP) to one of these zones, the c3 zone (Ekerot and Larson, 1979a). It will be demonstrated that this zone contains a systematic map of the ipsilateral body surface. Additional observations on other zones activated from DF-SOCPs will also be reported.

Some of the findings of the present investigation were reported in preliminary notes (Ekerot and Larson, 1973, 1976).

Methods

The experiments were performed on nine cats under pentobarbitone anesthesia, paralyzed with gallamine triethiodide, and artificially ventilated. The spinal cord was transected in the third cervical segment sparing only the dorsal funiculi. The experimental animals were part of those reported in a previous paper (Ekerot and Larson, 1979a) which should be consulted for methodological data.

The following ipsilateral nerves and dorsal rootlets were dissected and mounted for stimulation (Reighard and Jennings, 1935): sciatic nerve (Sci); two or three filaments of the thirteenth (Th 13) and seventh (Th 7) thoracic dorsal roots; medial cutaneous nerve (MC); branches of the dorsal cutaneous branch of the ulnar nerve innervating the ulnar side of the fifth digit (Uln 5) and the contiguous sides of the fourth and fifth digits (Uln 4); branches of the superficial radial nerve innervating the contiguous sides of the third and fourth digits (SR 3), the contiguous sides of the second and third digits (SR 2), and the radial side of the second digit (SR 1); branch of the median nerve innervating the contiguous side of the second and third digits and the trilobed pad in the palm (Med 2); cutaneous branch of the musculocutaneous nerve (Mu cut); cutaneous branch of the suprascapular nerve (Ssc cut); dorsal branch of the fourth cervical nerve (Cerv 4). Some of the nerves were not available in all experiments. The stimulus strength was 20 times the nerve threshold and the frequency of stimulation about 1 Hz. In some experiments the stimulus consisted of 2–3 shocks at intervals of 2–3 ms. The repetitive stimulation was used to increase the stability of the responses but usually did not appreciably affect their amplitudes or latencies (Eccles et al., 1968a).

Extracellular field potentials were recorded from the surface of the anterior lobe with a small silver ball electrode (six experiments), or from the molecular layer of the superficial cortex with a glass-covered platinum microelectrode (three experiments). The recording positions were usually spaced at 150–300 μm intervals along the folia.

Results

The DF-SOCP projection zones were identified on the basis of the peripheral inputs, the response latencies, and the location in the cerebellar anterior lobe (Oscarsson, 1969a; Ekerot and Larson, 1979a). Our interest was focused on areas activated from forelimb nerves. Among the zones with short latency responses (a, x, b, c1, c3 and d2) the c3 zone was extensively studied, whereas the x and c1 zones were only explored in the caudal part of lobule V (Fig. 1A). The a and b zones which are activated exclusively from hindlimb nerves and the d2 zone which is usually not accessible at the cerebellar surface, were not studied. Among the zones with long latency responses (c2 and d1) only the d1 zone was investigated, since the transmission to the c2 zone was depressed in the present preparations which were anesthetized with pentobarbitone (Ekerot and Larson, 1979a).