

SPECIFIC RESPONSES ELICITABLE FROM SUB-DIVISIONS OF THE MOTOR CORTEX OF THE CAT¹

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Well controlled results from stimulation of the motor cortex are difficult to obtain for a number of reasons, and a certain amount of experience is necessary before one feels qualified to interpret the results of stimulation. Of the difficulties, the state of anaesthesia is probably the most serious. It can be shown that merely varying the depth of narcosis varies the responsiveness of the cortex; that is, the deeper the anaesthesia, the greater must be the strength of stimulus which will provoke a response. Other sources of difficulty are: damage to the delicate cortical layers resulting from trauma during the removal of the calvarium, drying and cooling of the areas exposed, and damage from the application of the stimulating electrode. This, however, does not complete the list, for when reasonable control of these factors is maintained there still remains what Sherrington and Graham-Brown called the instability of a cortical point, manifesting itself in the phenomenon of facilitation.

It has been the custom of investigators of the motor cortex to use a wandering electrode and to depend on visual memory for recording points on the brain, which were to be returned to later in the experiment. As we found this difficult to do accurately, a rack was constructed bearing several unipolar electrodes. These electrodes were constructed along the principle of a micro-manipulator and could be placed with accuracy on specific cortical points. When it was desired to stimulate one of these points a dial switch enabled the operator to send a current through any electrode at will. The cat's head was fixed in position by three thumb screws, two of which entered the auditory canals, while one pressed on the occipital bone so that the electrodes remained when placed in position.

The general procedure in the experiments consisted in first exploring the cortex with the wandering electrode, and then settling a fixed electrode on the point which produced some response we wished to study. Naturally, the weakest current that would produce an adequate response was used in each case and care was taken to distinguish between movements which seemed to be centered in some point and those produced by facilitation.

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In previous reports of experiments dealing with the motor cortex of brains of lower animals, most authors have been content with pointing out areas which on stimulation give rise to movements of major parts, such as fore-limb, hind-limb, head, and trunk. However, we observed in cats that the major divisions could be resolved into smaller, more specific areas which, when stimulated, seemed to be responsible for movements of separate muscles or groups of muscles.

Motor responses may be obtained in the contralateral fore-leg from an area extending over the middle and lateral portions of the anterior sigmoid gyrus, and over a part of the posterior sigmoid gyrus near the lateral end of the cruciate sulcus. Responses in the contralateral hind-limb may be obtained over the middle and medial portions of the posterior sigmoid gyrus and a part of the medial portion of the anterior sigmoid gyrus. The boundary between fore and hind limb areas is relatively sharp. The area in which movements of the face, tongue, and jaws were obtained was entirely beyond the limits of the sigmoid gyri, though of course we were not able to observe all the possible movements about the head and neck region because of the arrangement of the rack.

Out of these larger areas for limb movements could be resolved smaller areas which produced movements of smaller groups of muscles, and other small areas which produced well co-ordinated rhythmic activity of an entire limb. These specific movements were more easily obtained from the fore-limb than the hind-limb. Some examples of the individual movements follow: (1) a point just medial to the coronal sulcus in line with the end of the cruciate sulcus on stimulation produces pure flexion of the contralateral fore-foot. (2) Just anterior to this, stimulation produces pure extension of the contralateral fore-foot. (3) More medialward, about three millimeters anterior to the end of the cruciate sulcus, is a point which on stimulation produces rhythmic movements of the contralateral foreleg. The movements are best described by the term *batting*, and are like those which a cat uses in playing with a suspended ball. (4) Just medial to this point is another which on stimulation produces a rhythmic digging movement of the contralateral foreleg. Other movements, such as abduction of the leg, flexion of the shoulder, extension of the shoulder, flexion of the arm, extension of the arm, may be obtained at other separate points.

These various movements may be facilitated and the areas from which they are produced may be apparently enlarged by the process, but when care is taken to avoid facilitation they are quite localized and occur in similar relation to each other in different cats.