

Extrapyramidal Activation of Muscles from the Sensori-Motor Cortex in Cats

Experiments on animals with the pyramidal system destroyed have shown that they are capable of performing different movements, supposedly of cortical or at least supraspinal origin^{1,2}. This fact agrees with the data obtained on anaesthetized and pyramidectomized animals in which isolated movements can be evoked by stimulation of the sensory-motor cortex^{1,3}. In the experiments to be described, the conditions under which such movements can be obtained were analysed in more detail.

All the experiments were done under light nembutal anaesthesia on cats in which the pyramidal tract was transected, 3 to 4 months previously, at the level of the trapezoid body: unilaterally in 7 cats and bilaterally in 2 cats. The completeness of the lesion was always checked histologically. When stimulating the sensory-motor cortex, the movements were watched and records made of either the EMG of the posterior biceps femoris or the activity from the nerve branch to this muscle. In the latter case, the animals were paralysed with Flaxedil. For stimulation, square wave impulses with frequencies of 50 c/s and 1 msec duration, or 10–30 c/s and 3 msec duration were used. Strength of the current usually varied between 0.5 and 2.0 mA.

The movements evoked by cortical stimulation. The movements evoked from the side on which the pyramidal tract was sectioned (the pyramidectomized cortex) and from the intact side were of the same kind and resembled those obtained by TOWER⁴ from cats under deep ether anaesthesia. The movements consisted of flexion of the contralateral limb, sometimes accompanied by crossed extension. When using a slightly suprathreshold stimulus, the amplitude of the movements increased slowly, after an initial delay of 1 to a few seconds, until it reached its maximum for the given strength of stimulation. The limbs contralateral to the intact cortex were maximally flexed

during the entire period of stimulation. In contrast, the limbs contralateral to the stimulated pyramidectomized cortex showed movements which were present only for a few seconds and then subsided despite the continued stimulation. The same phenomenon of fading away of the effects of cortical stimulation was observed both in the EMG of the posterior biceps and in the activity from the nerve to this muscle, as shown in Figure 1B.

Thresholds. All the effects evoked by the stimulation of the pyramidectomized cortex needed much stronger current than those from the intact cortex. The difference in thresholds was usually about 50%.

The activity recorded from the peripheral nerves. Figure 1A shows the responses recorded from the nerve to the posterior biceps muscle when the intact cortex was stimulated at a frequency of 30 c/s, contralaterally to the nerve. As can be seen, each shock is followed by a distinct burst of activity. When stimulating the cortex at a low frequency, e.g. 16 c/s, two main groups of spikes can be distinguished in the nerve following each stimulus (Figure 2A). The latency of the first group (the early responses)

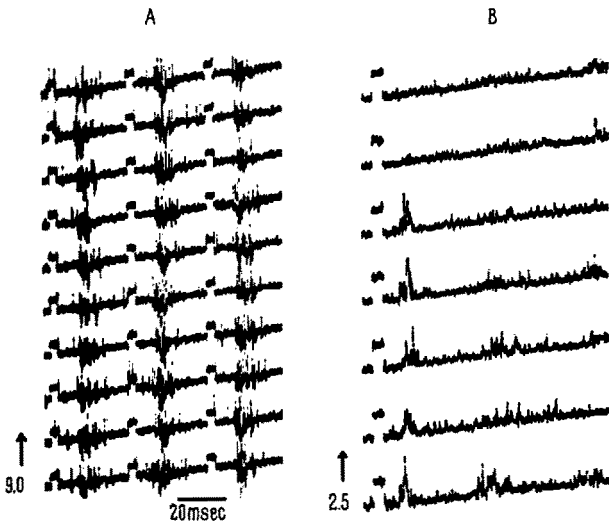


Fig. 1. Action potentials recorded from the nerve to the posterior biceps muscle during continuous tetanic stimulation of the sensory-motor cortex contralateral to the side of recording. In A the intact cortex and in B the pyramidectomized cortex was stimulated at 0.8 mA, 30 c/s and 1.6 mA, 16 c/s respectively. The records were taken at different times from the beginning of the stimulation, marked in sec on the left of each column. All the records should be read from the bottom to the top.

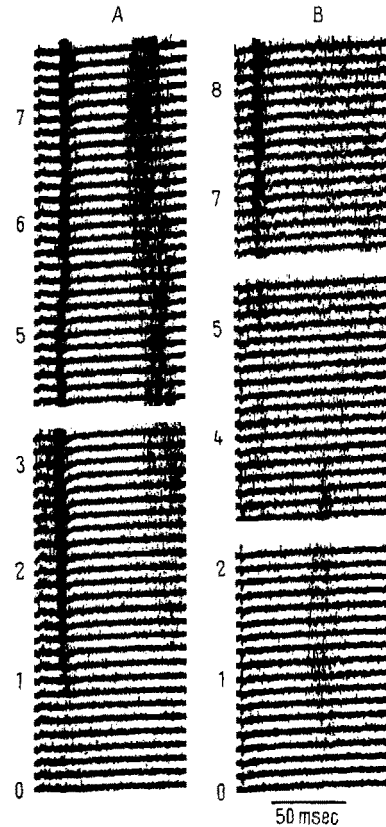


Fig. 2. The same as in Figure 1. A. Discharges evoked from the intact cortex (1.0 mA, 16 c/s). B. Discharges from the pyramidectomized cortex (1.5 mA, 16 c/s).

- ¹ H. D. PATTON and V. E. AMASSIAN, in *Textbook of Physiology* (Washington 1960), vol. II, p. 837. – R. JUNG and R. HASSLER, in *Textbook of Physiology* (Washington 1960), vol. II, p. 868.
- ² T. GORSKA and E. JANKOWSKA, *Bull. Acad. polon. Sci., Ser. Sci. biol.*, in press.
- ³ G. S. BRINDLEY and R. P. LEWIS, *J. Physiol., Lond.* 170, P 25 (1964).
- ⁴ S. S. TOWER, *Brain* 59, 408 (1936).

was on average about 15 msec. The latency of the second group (late responses) was about 50 msec. The early responses always appeared first, and only after maintained stimulation were they followed by the late ones. The latencies of the first few early responses were usually longer (about 18 msec) than those of the subsequent ones. The decrease of the latencies was of the order of 30% and similar to that found in monkeys when the same kind of stimulation was used⁵.

When stimulating the pyramidectomized cortex, two similar groups of spikes appeared (Figures 1B and 2B). A comparison of the latencies of the early responses evoked from the normal and pyramidectomized sides did not reveal any distinct differences. The early and the late responses evoked from the pyramidectomized cortex appeared either with the same or a reversed sequence as those from the intact cortex. Figure 2B gives an example of a record from a cat in which the late responses appeared after a shorter time of maintained stimulation than the early ones.

The similarity of the effects from the normal and pyramidectomized cortex gives further support to the view⁶ that in the intact animal movements of cortical origin are evoked by impulses travelling in at least two parallel systems, each of them being able to act independently. The short latencies of the responses elicited in the peripheral nerves by the stimulation of the pyramidectomized cortex suggests that they utilize pathways with a conduc-

tion time comparable to those belonging to the pyramidal system. Further investigations are required to identify the extrapyramidal pathways involved⁷.

Résumé. Les effets de la stimulation du cortex sensorimoteur sont étudiés ici chez le chat, après section des faisceaux pyramidaux. A part des seuils plus élevés et une tendance accrue à la fatigue, les mouvements, le EMG des muscles fléchisseurs et les décharges enregistrées dans les nerfs périphériques se sont montrés pareils à ceux provenant du cortex intact.

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⁵ C. G. BERNHARD, G. BOHM, and I. PETERSEN, *Acta physiol. scand.* 29, Suppl. 106, 79 (1953).
⁶ P. BUSER, P. ASCHER, J. BRUNER, D. JASSIK-GERSCHENFELD, and R. SINDBERG, *Progr. Brain Res.* 7, 294 (1963). – J. M. BROOKHART, *Res. Publ. Ass. nerv. ment. Dis.* 30, 157 (1952). – P. C. BUCY, *Brain* 80, 376 (1957).
⁷ This work was supported in part by an equipment grant by the Rockefeller Foundation.

Sex Ratio and Sex Digamety in
Echinorhynchus truttae

Information regarding sex determination of Acanthocephala is very scarce as yet. Acanthocephala carry on their life cycle in two hosts. The intermediate host is generally a water invertebrate and the primary host is a vertebrate animal.

Echinorhynchus truttae, which is found in the juvenile stage with a certain frequency as a parasite of *Gammarus pungens padanus* on the Po river, and, in the adult stage, lives on several fish species, has been studied with special regard to sex ratio and sex chromosomes.

Gammarus populations were collected almost daily at Carignano near Turin from February 10 to March 5, 1965. The infestation index of *Echinorhynchus* in the *Gammarus* population has shown marked variations during this period, ranging from 60% in the first two weeks of collection to a medium 5% towards the end of collection. The degree of infestation is rather low, with a maximum of six parasites per *Gammarus* found in five instances only among the 1463 *Gammarus* examined. The parasites have been sexed on the basis of sexual characters which are quite evident in the juvenile stage.

The Table shows the relative frequencies of males for each of the five degrees of infestation found. It is evident that sex ratio remains 1:1 in each degree of infestation with no significant differences between the categories. Among the 2015 parasites which were found, 47.4% (N = 955) were males and 52.6% (N = 1060) were females. The sex ratio in the whole population of *Echinorhynchus* is therefore very near the theoretical value of 1:1.

The sex ratios observed both in every degree of infestation and in the whole population markedly differ from those of the few species of unisexual parasites which are found in different numbers in single parasitized individuals and have suitably been studied in this connection. In the Nematode *Paramermis contorta*, which is a parasite of *Chironomus* larvae, sex ratio shows wide variations as it is largely influenced by environmental factors such as crowding (degree of infestation), size of the host, and sexualizing action of the first parasite upon the parasites that have entered subsequently¹⁻³. Similar observations have also been made in *Mytilicola*⁴, which is a Copepod parasite of *Mytilus*.

Degree of infestation	No. of parasites	Females	Males	% ♀♀	% ♂♂
1	1085	571	514	52.7	47.3
2	546	300	246	55	45
3	234	114	120	49	51
4	60	29	31	48.4	51.6
5	60	28	32	46.7	53.3

¹ U. PARENTI, *Arch. Zool.* 47, 209 (1962).
² U. PARENTI, *Boll. Zool.* 29, 453 (1962).
³ U. PARENTI, *Nature*, in print (1965).
⁴ G. BACCI, M. BALATA, and M. L. ROMANI, *Rend. Acc. Naz. Lincei* 25, 557 (1958).