REPRESENTATION OF THE INTERNAL ORGANS IN THE CEREBRAL AND CEREBELLAR CORTICES OF CATS AND DOGS

PART V. Individual Differences in the Specific Cortical Projection Areas

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny
Vol. 49, No. 5, pp. 3-6, May, 1960
Original article submitted April 24, 1959

When studying the specific projection areas of various visceral nerves by making electrical recordings, we found considerable individual variations in their disposition on the cortical surface [2].

We have previously described [2, 3] the specific projection areas of the pelvic nerves on the cortical surface in cats and dogs, and we found that these areas occupy definite positions in the cortex. They are found in the same position in most animals and this may therefore be considered to be the "basic variant" position. However, in some of the experiments we have encountered considerable deviations.

Dogs show greater variations than cats, though the arrangement of gyri and fissures is more variable in the latter.

Thus, for instance, I. Filimonov [1], in considering only the coronary and sypreasylvian fissures, distinguishes ten variations in cats and dogs. In both animals, the commonest type is shown in the atlas published by the State Brain Institute [1]. This atlas also gives the "basic variant" of the area of representation of the nerves we have studied [2, 3].

It appears that no attention has been paid to the considerable and very important variations in localization, as we have found no published information on this point.

The results described below give some idea of the possible individual differences in the site of the specific projection areas and on the nature of the cortical structure associated with these variations.

RESULTS

Cats. Most frequently, the first area of representation of the pelvic nerves lies on the posterior cruciate gyrus, enclosing a small portion of the adjoining anterior cruciate gyrus. Within this zone, the focus of maximal acitivity (FMA, i.e., the cortical area from which primary electrical potentials having the smallest latent period and greatest amplitude may be recorded) as a rule lies on the posterior cruciate gyrus, where it can be seen to spread along the cruciate fissure.

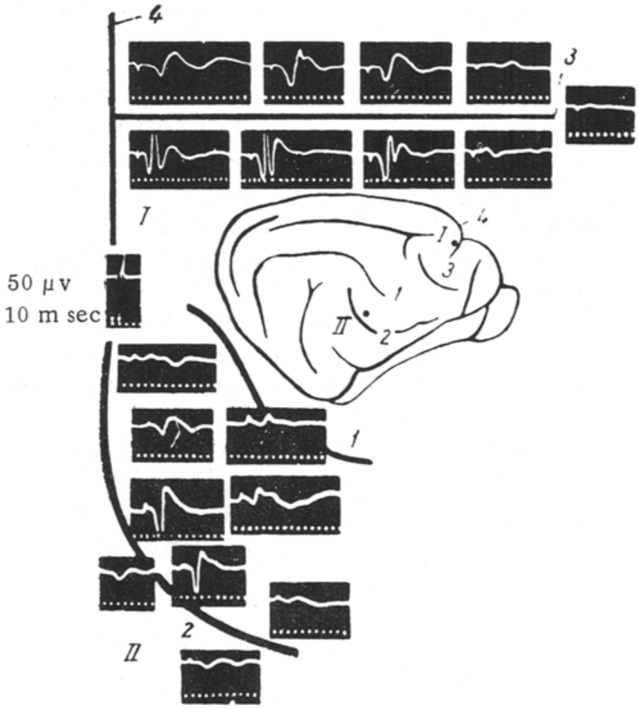

Fig 1. Disposition of the primary (I) and secondary (II) areas of representation of the pelvic nerves. The black circles indicate foci of maximal activity (FMA). The records of the potentials illustrate the responses from the first and second representational areas. 1) Anterior suprasylvian gyrus; 2) anterior ectosylvian gyrus; 3) cruciate gyrus; 4) longitudinal fissure. Chloralose anesthesia.

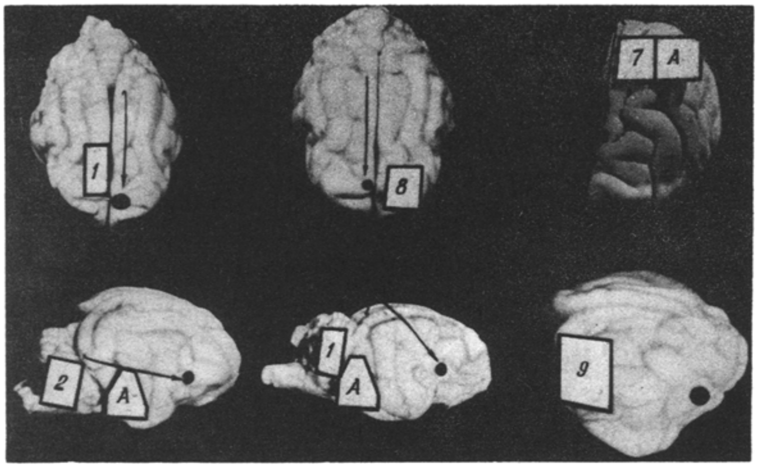

Fig. 2. Variations in the representation of the first (preparations 1, 8, and 7A) and the second (preparations 2A, 1A, and 9) contralateral cortical areas of representation of the pelvic nerves.

Figure 1 shows the results on an experiment in which one of the commonest positions of the FMA of the pelvic nerves occurred in the primary projection area. As can be seen, it lay at a short distance from the median portion of the cruciate fissure. Figure 2 shows some variants of this position which we observed within the area (preparations 1, 8, and 7A).

Thus, in preparation 1, the area lies on both sides of the cruciate gyrus and extends somewhat further than usual on to the anterior cruciate gyrus.

In preparation 8, the area is displaced onto the caudal portion of the posterior cruciate gyrus, while in preparation 7A it has been moved forward to the anteriomedial portion of the lateral gyrus.

There are individual differences in localization not only in the first field of common somatic sensitivity, but similar variations may also be observed in the second field.

Figure 1 (II) shows the results of an experiment which demonstrates one of the commonest positions of the FMA of the pelvic nerves encountered in the second cortical projection area. It lies at the front of the ectosylvian gyrus near the anterior portion of the anterior ectosylvian fissure.

Preparation 2A (see Fig. 2) shows the principal position of the second cortical representation area of the pelvic nerve. The Figure also shows preparations 1A and 9, which are two examples of an atypical disposition of the area.

The greatest displacement of the area is shown in preparation 9, and here the characteristic cortical structure should be noted, and it can be seen that it differs considerably from that of preparations 2A and 1A.

Dogs. In spite of the limited number of experimental animals [16], individual differences in localization of the area were found (Fig. 3).

Most frequently, the first representational area of the pelvic nerves in dogs lies over the presplenial gyrus, 1.5-2 mm more caudal and more medial than is the case in brain No. 1 of Fig. 3. In another experiment, the areas were found on the posterior cruciate gyrus in the middle portion of the anterior cruciate fissure (see Fig. 3, brain No. 2).

The most typical position of the second area (see Fig. 3) is shown in brain 2A, and by comparing this with preparation 1A it can be seen that there is a considerable displacement of the projection area.

In 1941, Marshall, Woolsey, and Bard [6] showed that in the first musculocutaneous sensory area in the cat, two foci of representation of the forelimb could be found. In their experiments, a weak tactile stimulus was applied to the hairs of the dorsal circuit of the front paw, which, besides causing a response from the second contralateral area, also elicited primary responses in two regions of the first contralateral area. They showed that each portion from which maximal primary responses could be obtained was surrounded by a characteristic border zone which gave submaximal responses. The same phenomenon was found in the ape brain, where stimulation of any part of the body always produced primary responses in two or more regions of the area representating that part of the body.

Adrian [4] has questioned these results, but Marschall [7] subsequently confirmed them in experiments on cats.

Amassian [5] has shown that the splanchnic nerve may have multiple cortical representations. In some experiments he made observations which supported this hypothesis, but reached no definite conclusions.

We found that in some of the animals, stimulation of the pelvic nerves, both in cats and in dogs, caused activity in two separate foci. This occurred in both the first and

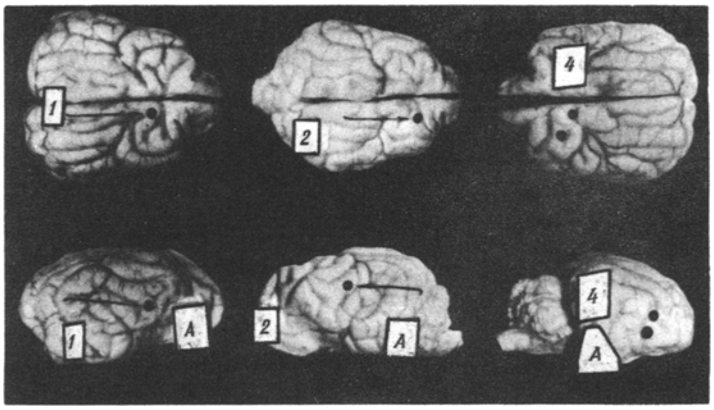

Fig. 3. Variations in the localization of the first (preparations 1 and 2) and second (preparations 1A and 2A) contralateral representational areas of the pelvic nerves in dogs. Preparations 4 (dog brain) and 4A (cat brain) show a case of double representation of the pelvic nerves in the first and second contralateral cortical areas.

second representational areas. Regions in which large electrical responses occurred might be close together, but were usually separated by some distance.

Figure 3 (brain No. 4) shows two foci in the first cortical representational area of the dog brain which responded to stimulation of the pelvic nerve.

Brain No. 4A shows a similar instance which occurred in one of the experiments on the cat. Stimulation of the pelvic nerve caused a primary response to develop in two regions of the second area, while in the first area only one sensitive region was found which was very small (smaller than usual).

It must be noted that this kind of multiple representation is most frequently encountered under light chloralose anesthesia.

These multiple foci indicate not only differences in localization, but differences in individual organization (in the broadest sense of the word) of cortical representation.

As has been shown, individual differences in cortical representation of the pelvic nerves may result, on the one hand, from a displacement in the representational area of the limbs. On the other hand, it is quite probable that this displacement is associated with a shift of the whole musculocutaneous representational area. This phenomenon was observed by us in the cat whose brain is shown as No. 9 in Fig. 2. In this experiment, simultaneous stimulation of the sciatic nerve showed that the area in which the primary responses occurred was equally displaced downwards and surrounded the area of the pelvic nerve, being stretched in the dorsocaudal direction.

It must be emphasized, in these cases, when it is required to give an accurate description of the localization of one or another cortical representational area, it is essential to make a careful choice of experimental animal with respect to weight, age, and breed in order that results obtained from animals with a common cortical structure may be obtained.

If it is required to make a preparation with electrodes chronically implanted into any particular sensory area, in order to avoid mistakes being made it is important first to accurately determine the topography of the areas on the surface of the cortex.

Such a determination may be made under sterile conditions at operation immediately before implanting the electrodes.

The same precaution applies also when any particular area is to be damaged or removed.

SUMMARY

It was shown that in different animals of the same species there were distinct differences in the positions of the representational areas of both visceral and somatic nerves. The differences were associated with the individual development and structure of the cerebral cortex. The results should be taken into consideration when performing various operations on the cortex such as implanting electrodes or extirpating certain areas.

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* Original Russian pagination. See C. B. Translation.