ASSOCIATION FIBERS OF THE VISUAL CORTEX

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The association fibers of the visual projection area have been frequently described but until recently there has been no agreement on where these pathways terminate. The idea put forward long ago of the existence of numerous association connections of the occipital region (including long connections leading to the frontal lobes), but many investigators deny the existence of well-developed association pathways. For example, from studies on cats, Poliak [10] has observed that the longest associative connections of the visual cortex terminate in the posterior and middle portions of the octosylvian gyrus. Le Gros Clark [9] studying these connections in monkeys came to the conclusion that the main mass of associative pathways of Area 17 do not extend outside it, and that the longest of them can extend no further than adjacent Area 18.

In the experiments of Bonin, Garol and McCulloch [8] the association fibers of the visual cortex were studied by neuronography; different parts of this region were stimulated with a solution of strychnine and the potentials developing in response to this stimulation were recorded. The results obtained led the author to conclude that there were no long association fibers of the visual cortex.

The existence of long association fibers connecting various lobes of the vertebral cortex in higher mammals has been denied also by B. M. Klosovskii [4]. However, according to E. G. Shkol'nik-Yarros [7], in rabbits, cats and dogs there are extensive associative connections of Area 17. In dogs in particular such fibers extend as far as Area 5. S. B. Gzugaeva [2] have also pointed out the existence of long association fibers in the higher mammals. A. S. Iontov and V. Yu. Ermolaeva [3] have indicated the presence of bilateral association pathways between the occipital and temporal regions of the feline cerebral cortex.

We have taken up the study of this problem and besides the method of Marchi which was employed by almost all the authors mentioned, we have also used Mount's method, which enables more precise localization of the terminations of the degenerating fibers in the cortex and the different areas and layers to be achieved.

EXPERIMENTAL METHOD

The work was carried out on sight adult dogs.

A small region 10-40 mm^2 of cortical area 17 was removed sub-pially; to apply the Marchi method the animals were killed on the twelfth day after the operation, and for Mount's method on the ninth day. Serial sections were cut frontally starting at the operated site and studies were made of all the architectonic areas of the cerebral cortex.

EXPERIMENTAL RESULTS

In area 17 of the occipital cortex a large number of association fibers originate, but terminate not only in area 17 itself but also in areas 18, 19, 21, and 7 (the figures that occur in the sitoarchitectonic map of M. O. Gurevich and G. Kh. Phykhoskaya [1], Fig. 1).

The association fibers running towards area 18 are specially well-shown in the region directly adjacent to area 17 along the supraplanial and lateral sulci. Only a few association fibers run to the same regions of area 18 along a pathway in the caudal portion of the suprasplenial sulcus.

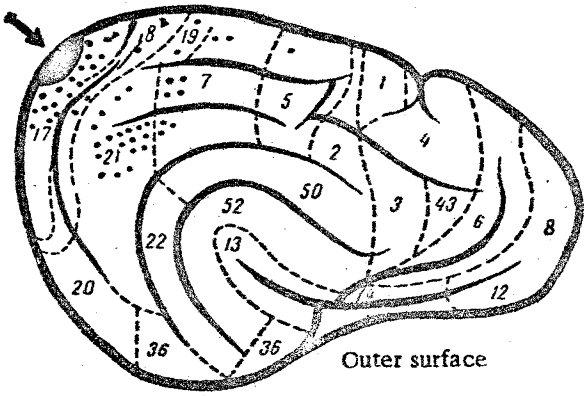

Fig. 1. Termination of the association fibers of area 17 in various portions of the cerebral cortex.

Fig. 2. Degeneration of nerve fibers in the cortex of area 21 of a dog after removal of a portion of the cortex of area 17. Treated by Naught's method. Magnification 861.

Association fibers directed towards area 19 are less well shown, their number falls off sharply in a rostral direction as area 7 is approached.

A large number of degenerating fibers from the damaged region are directed towards area 21 in the very part occupied by the posterior portion of the cortex of the suprasylvian gyrus (Fig. 2). Here they terminate at the apex of this gyrus, and they are also found in the regions of the base of the suprasylvian sulcus. Noticeably fewer association fibers run from area 17 to the portion of area 21 located on the lateral gyrus.

A number of association fibers running to area 7 is much smaller than the number directed towards areas 18 and 21. They terminate mainly in the caudal region of this area along the suprasylvian gyrus, and there are far fewer along the lateral and suprasplenial gyri.

Only after extensive destruction of area 17 could a small number of degenerating fibers be found running toward the cortex of area 5. This result indicates that only a small number of association fibers runs from the visual cortex toward the anterior parts of the cerebral hemispheres; to find these fibers extensive damage to the cortex is required. The results obtained by Naught's method agree in general with those obtained by Marchi's method.

Thus, association fibers leaving area 17 are not distributed evenly among the surrounding cortical areas, furthermore the irregular termination of the association fibers is also found within the different areas.

The fact that in our investigations no long association pathways were found running to the anterior parts of the cerebral cortex (in particular to the sigmoid gyrus) confirms the findings of many morphologists and physiologists. Nevertheless, the following points should be noted; Le Gros Clark was led by his own investigation to conclude that the visual cortex was isolated. Furthermore, many physiologists, when considering the presence in the visual cortex (and in other parts of the cerebral cortex) of well-developed descending projection pathways concluded that the organization of the nervous mechanisms underlying the complexity of visual function must be exclusively vertical. The results of the present investigation prevent us from agreeing with these conclusions. According to our results the canine visual cortex has well-developed association fibers extending for considerable distances beyond area 17. These pathways made make a two-way communication between the visual analyzer and both neighboring and remote cortical areas; in the latter case the nervous impulses should be relayed at intermediate cortical stations. We have made special investigations which have demonstrated the function or significance of such associative connections [5, 6].

LITERATURE CITED

1. N. O. Gurevich and G. Kh. Bykhovskaya, Med-biol. Zh. (1927), 2, 1, p. 58.
2. S. B. Dzugaeva, Some Theoretical Problems of the Structure and Activity of the Brain [in Russian], Moscow (1960), p. 63.
3. S. A. Iontova and V. Yu. Ermolaeva, Transactions of the V. M. Bekhtrew Psychoneurological Institute, Leningrad (1961), 21, p. 101.
4. B. M. Klosovskii, Abstract Reports of the Scientific Conference of the AMN SSSR, Moscow(1956), p. 21.
5. M. M.Khananashvili, Problems of the Physiology and Pathology of Higher Nervous Activity [in Russian], Leningrad (1960), p. 182.
6. M. M. Khananashvili, Experimental Studies of the Central Mechanisms of Visual Function [in Russian], Leningrad (1962).
7. E. G. Shkol'nik Yarros, Zh. Vyssh Nervn. Deyat (1958), 1, p. 123.
8. G. Bonin, H. Garol, and W. B. McCulloch, Biological Symposia, Lancaster (1942), 7, p. 65.
9. Le Gros, and W. E. Clark, J. Anat., London (1941), 75, p. 225.
10. S. Polyak, J. Psychol. Neurol. (1925-1926), 32, p. 170.

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.