ASSOCIATION CONNECTIONS OF THE CAT'S PARIETAL CORTEX

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Intercortical connections of primary sensory (visual, auditory, somatosensory) areas with the parietal association cortex were studied in cats by the retrograde axonal transport of horseradish peroxidase and the Fink-Heimer silver impregnation of degenerated fibers techniques. This combined study revealed the shape, size, and intracortical location of cells connecting the primary sensory areas monosynaptically with the parietal cortex and also the distribution of preterminals and terminals of the fibers of these cells in the parietal association cortex. The greatest number of cells forming connections with area 7 of the parietal association cortex was shown to occur in visual area VI, and with area 5 in somatosensory area SI. Besides pyramidal neurons tagged with horseradish peroxidase, which were located mainly in layers II-IV, a few tagged stellate and fusiform cells also were found. The results supplement and confirm data on afferent connections of the parietal association cortex in cats.

INTRODUCTION

Combined morphological and functional investigations of association structures of the brain have helped to give a fuller picture of the role of these formations in brain integrative activity. Influences from different parts (cortical and subcortical) of the visual, auditory, and somatosensory systems of the brain overlap in the parietal association region of the cortex. Connections responsible for their interaction have been identified in neuromorphological and neurophysiological experiments [1, 3, 4, 9, 11, 12]. Afferents from several subcortical and cortical structures are known [5, 6] to terminate in the parietal association cortex directly on small branches of dendrites and on their spines as axodendritic and axospinal synapses. Connections of projection areas with the parietal cortex have also been shown to be made principally by short U-shaped fibers. The length of these fibers in subprimates is limited, so that within the cortex they can only connect regions that are close together. Connections between the visual and motor cortex in cats are thus effected to a large degree by the parietal association cortex [2, 10].

However, it is not known which cells of the projection areas send their fibers into the parietal association cortex or how the terminals and preterminals of these fibers are distributed in the association region itself. To shed light on these problems, connections of the visual, auditory, and somatosensory areas of the cortex with areas 5 and 7 of the parietal association cortex were investigated by the retrograde axonal transport of horseradish peroxidase (HRP) method [8] and by staining degenerated fibers by the method of Fink-Heimer.

EXPERIMENTAL METHOD

Six adult cats and kittens were investigated by the retrograde axonal transport of HRP method. The cats were placed in a stereotaxic apparatus and, under pentobarbital anesthesia (40-50 mg/kg), they were given three or four consecutive injections of 1-2 μl of a 50% solution of HRP into area 5 or area 7 of the parietal association cortex. The minimal distance between neighboring injections was 1-2 mm. The cats were anesthetized again 2 to 3 days later and perfused through the heart with a mixture of 0.4% paraformaldehyde and 1.25% glutaraldehyde in phosphate buffer (0.1 M), pH 7.4. The brain was removed, postfixed for 3-4 h, and washed with 0.1 M phosphate buffer, pH 7.2-7.4, with the addition of 30% sucrose solution (4°C). Sections 60 μm thick were cut on a freezing microtome and kept in phosphate buffer (0.1 M) for 2-3 min. The sections were incubated in 10 ml of a 0.05% aqueous solution of 3,3'-diaminobenzidine with the addition of 0.1 ml of a 1%

Fig. 1. Neurons tagged with horseradish peroxidase and their degenerating axons in the cortex. a) Layer III of somatosensory cortex, HRP injected into area 5 of parietal cortex; b) layer III of visual cortex, enzyme injected into parietal area 7; c) spines on apical dendrite of pyramidal cell in layer V of visual cortex; d) stellate cell in layer II of visual cortex, enzyme injected into area 7 of parietal cortex; e) degenerated axons in area 7 after extirpation of part of visual cortex, f) in area 5 after extirpation of part of somatosensory cortex. Magnification: 140x (for a, b, d) and 280x (for c, e, f).

solution of freshly prepared hydrogen peroxide (20–60 min). The sections were counterstained with thionine and mounted in balsam.

Experiments to study the distribution of fibers entering the parietal association cortex from primary sensory areas were carried out on kittens aged from 2 to 6 months. Under pentobarbital anesthesia part of one of the cortical projection areas was extirpated at a place where the largest number of HRP-tagged cells had been found previously after microinjection of the enzyme into the association cortex. Under anesthesia the animals were perfused 2 or 3 days later through the heart with physiological saline followed by 10% neutral formalin solution. The brain was removed and kept in formalin of the same concentration for 1–2 months, after which sagittal and frontal sections were cut from the middle suprasylvian gyrus and stained by the Fink–