SOME BIOCHEMICAL ASPECTS OF THE DEVELOPMENT OF AVIAN OPTIC CENTRES AND THE EFFECTS OF DEAFFERENTATION

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The optic pathway of birds, connecting the retina to the tectum mesencephali, has often provided a suitable model for studying the pattern of connection between two developing nervous centres. Also for studying the mutual influences between two populations of neuroblasts, the complex optic pathway–optic centres lends itself as a good study model because its structure is rather well known and its anatomical position allows easy accessibility to experimental manipulations during embryonic life. In particular, since the chick optic pathway is completely crossed and provides the largest supply of fibres to the tectum, the removal of one retina deprives the contralateral tectum of most afferent fibres but leaves the ipsilateral one quite unaltered for control purpose.

When the eye is removed at the stage of optic cup (i.e., between the 3rd and the 4th day of incubation in the chick embryo), the retina fails to form and the neuroblasts of the contralateral tectum will never be contacted by the terminals of the optic fibres; the tectum will thus develop being deprived of its physiological connection with the retinal ganglion cells.

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The whole work done in our laboratory during several years was aimed at investigating the maturation of a nervous centre in the absence of most transneuronal influence. In particular, this experimental approach had the final goal of identifying the influence of one neuron upon the development of a second neuron; the latter being the normal target of the axonal terminals of the former. Such an experimental situation may be fulfilled by the system formed by retinal ganglion cells and tectal neurons.

The initial experiment consisted in preventing one neuron to contact the other neuron by mechanically removing one optic cup (1,2). Very recently, a more refined type of experiment has been developed by which changes may be introduced in the metabolism of the retinal ganglion cell while leaving the retino-tectal connection anatomically unaltered; the effects of metabolic changes in one developing neuronal population may be thus analyzed also for their influence upon the maturation of the other one. Preliminary evidence has been obtained indicating that rather deep alterations may be induced in the tectum after blocking protein synthesis or axonal flow in the retinal ganglion neuron (3).

The work of Filogamo (1) provided early information about the effects of monolateral extirpation of chick embryo optic cup upon the development of tectum opticum structure. He excised the optic cup by means of sharpened needles between the 48th and the 52nd hour of incubation; then, he followed the maturation of the contralateral tectal layers by light microscopy. No apparent changes were found until the 12th day of incubation if one excludes the absence of retinal fibres: the thickness of the cellular layers and the cell number were not changed when compared to those of ipsilateral control tecta. After the 12th day, on the contrary, the thickness of the deafferented tectal layers decreased significantly. This finding was accounted for by the progressive underdevelopment of the nerve cell bodies; at hatching, a large proportion of the perikarya of the deafferented side had disappeared.