EFFECT OF VISUAL DEPRIVATION ON COMPOSITION OF STRUCTURAL PROTEINS OF THE RABBIT CENTRAL VISUAL SYSTEM

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The composition of membrane proteins of the visual cortex and superior colliculus of normal and visually deprived (for 2.5 months after birth) rabbits was studied by disk electrophoresis in polyacrylamide gel. Membrane proteins were extracted consecutively with 1% solution of Triton X-100 and 0.1% solution of sodium dodecylsulfate. One fraction, consisting of high-molecular-weight proteins, was not found in the membrane proteins of the central visual system of the light-deprived rabbits, and the relative percentage of proteins in the various fractions also differed from normal. It can be concluded from these results that visual deprivation gives rise to considerable quantitative and qualitative changes in the composition of the brain membrane proteins, with some specificity toward the central visual structures.

KEY WORDS: visual deprivation; central visual system; structural proteins; disk electrophoresis in polyacrylamide gel.

When changes taking place in the animal brain in response to changes in function of the sensory systems are studied the visual system is particularly interesting, for its adequate stimulation can be blocked simply by depriving the animals of light from birth. There is no doubt that the morphological and functional changes in the visual system of the brain after exclusion of visual stimulation [1, 2, 7] are based on biochemical changes and, in particular, changes in protein metabolism. However, biochemical data relating to the study of brain protein metabolism during prolonged visual deprivation are few in number [3] and are concerned mainly with determination of the amino-acid reserves [11] or the intensity of protein metabolism [10, 12]. The writers previously observed changes in the electrophoretic pattern of brain membrane proteins extracted with sodium dodecylsulfate (DDS) in congenitally blind mice. It has also been shown [4] that two protein fractions are missing from the brain tissue of such mice.

The object of this investigation was an electrophoretic study of the membrane proteins of the central visual system of rabbits subjected to prolonged visual deprivation.

EXPERIMENTAL METHOD

Rabbits were kept in total darkness for 2.5 months after birth. Rabbits of the same age reared under ordinary lighting conditions acted as the control. The rabbits of the experimental group were killed in the dark chamber. Tissue from the visual cortex, superior colliculus, and "remaining" cortex (frontal and parietal cortex together) was investigated in each experiment. All homogenization procedures and the consecutive extraction of the residues with 1% Triton X-100 and 0.1% DDS solution and disk electrophoresis of the DDS extracts in polyacrylamide gel were carried out as described previously [4]. The IFO-451 microphotometer with an attachment of the writers' own design [5] was used for densitometry of the stained gels. The protein concentration was determined by the method of Lowry et al. [8].

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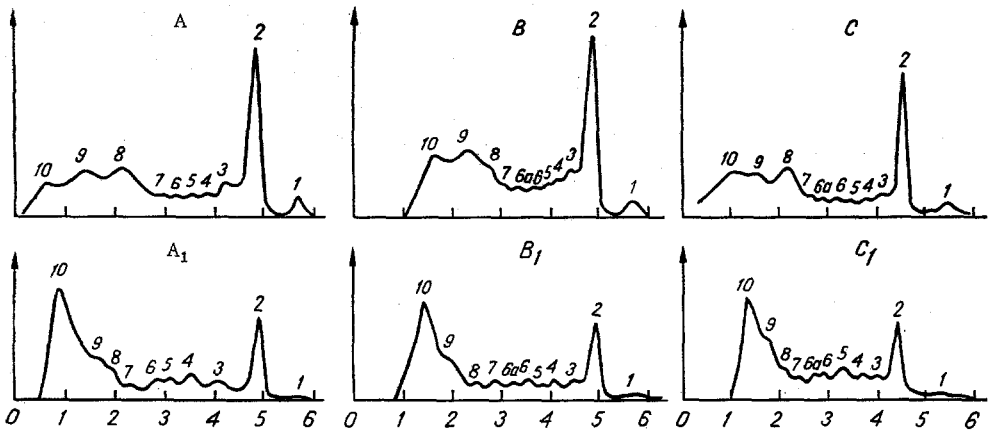

Fig. 1. Densitograms of proteins of DDS extracts, fractionated by electrophoresis, from tissues of various parts of brain of normal (A, B, C) and visually deprived (A_1, B_1, C_1) rabbits. A and A_1, B and B_1, and C and C_1) Densitograms of proteins of DDS extracts of tissue from visual cortex, "remaining" cortex, and superior colliculus respectively. Ordinate, relative absorption; abscissa, length of gel (in cm); arrow indicates direction of movements during electrophoresis.

TABLE 1. Distribution of Individual Fractions among Proteins of DDS Extracts of Tissue from Various Parts of Brain of Normal and Visually Deprived Rabbits (in % of total area of densitogram)

Fraction No.	Visual cortex		"Remaining" cortex		Superior colliculus	
	normal	deprivation	normal	deprivation	normal	deprivation
1	3,8	—	1,8	—	2,8	—
2	28,6	17,6	26,9	19,2	22,5	20,7
3—7	19,0	26,4	26,5	25,4	18,6	29,3
8	19,0	5,9	5,8	2,1	19,7	4,5
9	16,7	5,9	20,2	16,0	14,1	11,4
10	9,5	41,2	19,5	33,8	21,7	35,9

EXPERIMENTAL RESULTS AND DISCUSSION

As Fig. 1 and Table 1 show, under normal conditions proteins of DDS extracts of the visual cortex and superior colliculus were subdivided into ten fractions, of which fractions Nos. 3-7 were minor and accounted for only 19% of the total protein. The study of the proteins of the DDS extracts from the superior colliculus showed that an additional fraction (No. 6a) appeared among the minor fractions. Both visual structures had virtually the same distribution pattern of the main protein fractions of DDS extracts. Such differences as were found were only quantitative in character and applied chiefly to fraction No. 10.

Proteins of the DDS extract of the "remaining" cortex had basically the same character of distribution as proteins of the corresponding extracts from the visual structures. However, there were significant differences between them. For example, the relative percentage of total proteins of minor fractions and of fraction No. 9 in proteins of the DDS extracts of the "remaining" cortex were higher, and the protein content in fraction No. 8 was almost two-thirds lower. It can be concluded from these findings that the functional composition of structural proteins of the central visual formations differs quantitatively by a marked degree from that of other regions of the cerebral cortex.

Fraction No. 1 (the high-molecular-weight protein fraction, Fig. 1) was not found in the composition of the membrane proteins of the central visual structures of rabbits visually deprived from birth until the age of 2.5 months. Table 1 shows that DDS extracts of the visual cortex and superior colliculus of visually deprived animals had a higher relative percentage of proteins in the minor fractions and fraction No. 10 (the change was

more marked in the visual cortex), and a considerable decrease in the content of protein fraction No. 8 also was observed. Certain differences also were found between these two central visual formations. For instance, in fractions Nos. 2 and 9 in the superior colliculus the relative percentages of proteins were practically unchanged, whereas in the visual cortex the protein content in fraction No. 2 fell by about 40%, and in fraction No. 9 by almost two-thirds. Fraction No. 1 likewise could not be found among the proteins of the DDS extracts of the "remaining" cortex of the visually deprived rabbits. Meanwhile, unlike in the visual cortex and superior colliculus, the protein content of the minor fractions was unchanged. The quantitative changes in the protein content in other fractions of DDS extracts of the "remaining" cortex likewise were less severe than in the formations of the visual system.

Early visual deprivation thus causes considerable changes in the spectrum of brain structural proteins extractable by the detergent DDS, with some specificity for the central visual structures. It can be concluded from these results that during visual deprivation quantitative and qualitative changes take place in the composition of the brain membrane proteins. Evidence that this is so is given by the results of a study of mediator-receptor interaction undertaken by the writers with respect to serotonin and tryptamine binding by synaptosomes [6]. Differences in the protein content of certain protein fractions (especially high-molecular-weight) of structural proteins of the visual system were found in normal and visually deprived cats by disk electrophoresis by Mitros et al. [9]. However, these authors used a different method to extract the structural proteins. Rose and Sinha [12] found that incorporation of labeled precursors into the water-insoluble protein fractions of brain neurons of dark-reared rats was specifically inhibited in the visual, but not in the motor cortex.

It can be concluded from the results of the present experiments and from data in the literature [2, 6, 9, 12] that the reception of impulses generated by photic stimuli is connected with the existence of specialized protein or glycoproteolipid complexes in the membranes of the synaptic structures of the visual system, the morphochemical differentiation of which takes place in postnatal development and depends on specific impulses reaching the neuron at the right time.

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