CHOLINESTERASE ACTIVITY IN DEAFFERENTED OPTIC LOBES AFTER DFP INJECTION, IN THE CHICK

E. STRUMIA, G. FILOGAMO and G. GABELLA

Istituto di Chimica biologica dell'Università di Torino

SOME investigations carried out by Nachmansohn[1] have shown that no appreciable quantitative changes in the cholinesterase activity (ChE) of the optic lobes, in the pigeon, are detectable 27 days after eye extirpation.

It is not known, however, whether or not the ChE demonstrated is the pre-existing one and whether in the absence of synapses the cells of the deafferented lobe are still capable of synthethizing the enzyme.

In the present investigations we have planned to suppress by means of DFP injections, the ChE content in growing chicks some days after the removal of one eye, and to follow the ensuing behaviour of the enzymatic activity both in the optic lobe which is normally connected with the retina, and in the deafferented lobe. Since, as in known, the decussation of the optic nerve is complete in birds, one is under the best experimental conditions for studying the influence of the optic fibres on their respective lobes.

MATERIAL AND METHODS

The left eye was extirpated in 4-day-old chicks. One half of the operated specimens were subjected to the injection of 4 mg of DFP (i.m.) three days later. The other half served as controls. The Che activity of the optic lobes was measured at regular time intervals in all the animals. The ChE activity was estimated by the titrimetric technique. The optic lobes were homogenized in 7 ml. of a 1·17% KCl solution. Each time 3 ml. of the homogenate were used.

Sample composition:

homogenate	3 ml.
0·11 M acetylcholine	1·5 ml.
0·1 M NaCl + 0·4 M $MgCl_2$	5·5 ml.
cresol red 0·1%	7-8 drops

The pH was maintained constant at about 8 by adding 0·01 N NaOH. Duplicate analyses were made at 37° C and lasted 30 min.

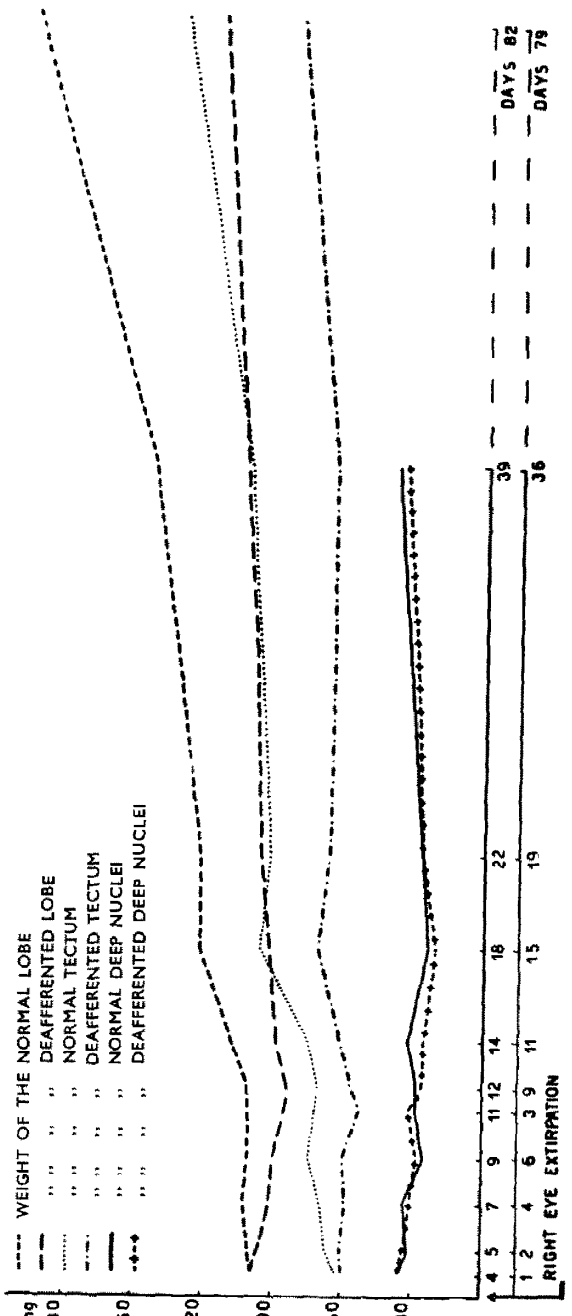

FIG. 1. Weight increase of normal and deafferented optic lobes after right eye extirpation.

In some operated animals the enzymatic activity was evaluated in the intact lobe; in some others the cortices were separated from the deep nuclei and the enzyme was evaluated separately in the two fractions.

Koelle's histochemical technique was also employed.

RESULTS

After the extirpation of one eye in growing chicks a clear cut decline in the weight increment of the controlateral optic lobe occurs. Above all the cortex is affected, rather than the deep nuclei (Fig. 1).

The overall ChE amount in the lobe which is normally connected with the eye rises gradually in parallel with the weight increase; on the contrary the enzyme increases at a very low rate in the deafferented lobe (Fig. 2).

TABLE I

ChE quotient(1) *in the optic lobes, and in the "tectum" only, normal and deafferented.*

Days after deafferentation	QChE		Days after deafferentation	QChE	
	normal lobe	deafferented lobe		normal tectum	deafferented tectum
1	19·8	17	1	29·1	27·4
2	21·1	21·4	2	26·6	28·8
4	22·4	23·2	5	27	29·1
5	17·3	18·4	9	26·2	27·5
6	21·6	23	11	27	27·7
8	20·3	21·9	15	21·4	22·6
11	20·8	23·4	19	23·5	25·9
14	19·4	21	36	26·2	26·4
19	19·4	19·8			
34	19·2	22·7			
79	20	21·7			

(1) mg acetylcholine hydrolysed in 30 min per 100 mg tissue

If we consider the QChe (Che quotient: milligrams of acetylcholine hydrolysed by 100 mg of tissue in half an hour) we observe that this quotient remains almost constant both in the normal and in the deafferented lobes during such time interval. In the latter, however, and in the deafferented cortices respectively, the quotient is constantly slightly higher than in the lobes and cortices which are normally connected with the eye (Table I). This can be explained, since owing to the regression of the optic fibres, some negative cholinesterasic tissue is lacking in the deafferented lobes.

As a result of the injection of DFP the Che level is reduced by 85–95%. Subsequently, a rapid recovery is observable in the lobe which is normally connected with the retina, so that 11–15 days after the injection it attains the values of the normal lobes in the controls (Fig. 2).

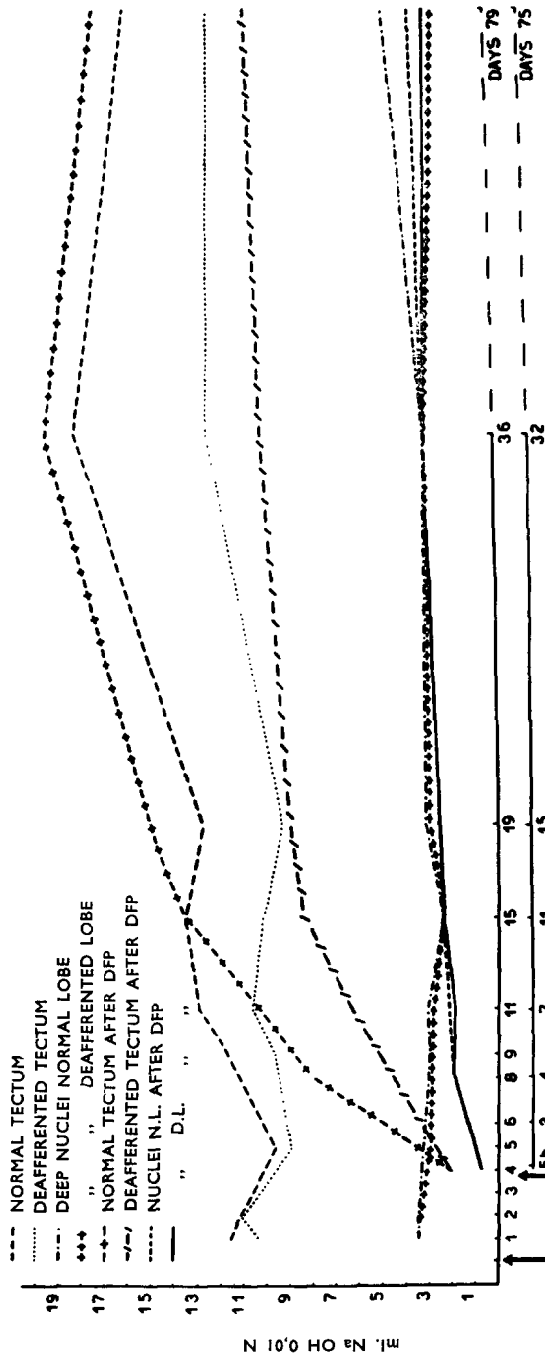

FIG. 2. Cholinesterase activity in normal and deafferented optic lobes after right eye extirpation and DFP injection.

Also in the deafferented lobes some resynthesis of the enzyme is seen to occur, but it increases at a slower rate and its final amount is lower. Sixty days after DFP injection the overall enzyme concentration in the deafferented lobes does not attain the values exhibited by the enzyme in the deafferented lobes of controls (Fig. 2).

Furthermore, if we consider the ChE quotient in DFP treated animals we find that it increases progressively both in the normal and deafferented lobes (Table II); but in the latter it is constantly and definitely lower than in the normal lobes.

TABLE II

ChE quotient(1) *in the optic lobes, and in the "tectum" only, normal and deafferented, after injection of* DFP

Days after deafferentation	Days after DFP	QChE		Days after deafferentation	Days after DFP	QChE	
		Normal lobe	Deafferented lobe			Normal tectum	Deafferented tectum
4	5h	2·2	2·2	4	5h	4·6	5·4
5	1	5·1	4·2	6	2	10·4	8·6
6	2	12·2	10·9	8	4	17·3	13·6
8	4	14·6	12·2	11	7	21·8	16·5
11	7	17·8	14·6	15	11	23·4	20·2
14	10	17·4	15·7	19	15	25·8	21·4
19	15	21·9	17·1	36	32	29·9	24·6
34	30	17·9	16·6				
64	60	20·2	16·8				

(1) mg. acetylcholine hydrolysed in 30 min per 100 mg. tissue

CONCLUSIONS

In accord with Nachmansohn's findings in the adult pigeon, removal of the eye in growing chicks does not seem to entail a decrease of the ChE level per unit of tissue; as a matter of fact this level is higher in deafferented lobes and cortices. This can be explained, since, owing to the regression of the optic ifbres, some negative ChE tissue is lacking in the deafferented lobes.

It has been demonstrated by the present investigations that in spite of the marked reduction of synapses (it must be borne in mind that extirpation of the eye does not result in a complete deafferentation) enzyme synthesis still occurs. Under these conditions, however, the synthesis is slower and does not lead to the values measured at the beginning of the experiment.

REFERENCE

1. Nachmansohn D,; *C. R. Soc. Biol.* **128** 599 (1938).