CENTRIFUGAL EFFECTS ON THE CAT ELECTRORETINOGRAM AFTER SECTION OF ONE OPTIC NERVE

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ABSTRACT

In twelve cats the ERG was examined prior to and after severance of one optic nerve. The neurally isolated eye displayed enhanced ERG b-waves as compared to preoperative recordings and to recordings from the fellow eye. The concept of an inhibitory control of retinal function via centrifugal fibers within the optic nerve which rivals retinal sensitivity is discussed. Photic stimulation superimposed upon background illumination did not produce differences in the ERGs. During recovery from light adaptation the ERG was often equal in both eyes during the photopic phase of dark adaptation. Thereafter the isolated eye exhibited enhanced retinal responses. These findings are in accordance with those from patients with optic nerve lesion. When intermittent stimulations at different intensities were used the positive amplitudes of the first response in the isolated eye were always higher than those in the fellow eye. The steady states were achieved later in the isolated eye than in the fellow eye and decreased at a faster rate in the former. This suggests a decreased ability of the isolated eye to maintain its performance as compared to the eye under cerebral control.

INTRODUCTION

The question of centrifugal neural connections in the visual system of mammals

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and their function was for many years speculative, and in fact still is to a large extent. It even came into disrepute because there was no unambiguous physiological evidence available, let alone an anatomo-histological foundation (Brindley & Hamasaki, 1962, 1966). This was in contrast to the avian visual system. Here efferent fibers could be demonstrated in the optic nerve which synapse with the retinal amacrine cells, but about their functional significance relatively little is known (Cowan, 1970; Ogden, 1966/1968).

The position changed very much when efferent fibers were found in the optic nerve and retina of cats and primates by means of light and electron microscopy (Brooke et al., 1965; Wolter, 1965; Honrubia & Elliott, 1968, 1970). Still, however, evidence is missing as to their synaptical contacts with retinal neural cells, although some evidence from physiological experiments have accumulated over the years (Horsten, et al., 1970; see literature in Feinsod et al., 1971).

As in other systems the efferent fibers to the retina in the mammalian visual pathways should be inhibitory in nature. Centrifugal inhibitory effects on the afferent discharge have been shown for instance in the auditory system in the organ of Corti and the vestibular system (Fex, 1962, 1967; Wersäll et al., 1965; Wersäll, 1966/1968; Rossi, 1966/1968). Centrifugal responses could even be evoked from the optic nerve by auditory and somatic stimuli (Spinelli, Pribram & Weingarten, 1965).

Some indirect information on centrifugal effects was obtained in 69 patients with bilateral and unilateral optic nerve atrophy (Feinsod et al., 1971). In 42% an enhanced positive wave of the electroretinogram (ERG) was found in the absence or the diminished presence of the visual evoked potential (VEP) following photic stimulation of the eye involved. The negative (late receptor) potential was, however, generally within the normal range. In keeping with opinions of other authors, we explained this finding by the absence of an inhibitory central control of retinal function normally exerted via the centrifugal fibers in the optic nerve and rivaled by the retinal sensitivity which increases in the dark. The more than 50% of cases in the same study displaying subnormal ERGs seem to result from a progressive degeneration involving the intraretinal circuitry including the receptor cells. This is even strengthened by one case among the 69 in which the supernormal ERG became subnormal during the years the patient was observed by us. This is perhaps substantiated by the findings of Borg & Knave (1971) on long-term changes in the ERG of rabbits after optic nerve section. The initially increased ERG in the eye whose optic nerve was sectioned remained constant for at least eight months and decreased thereafter.

Since the work in humans suggested the presence of an inhibitory centrifugal influence, we carried out parallel compatible animal experiments in which the