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Cortical modulation of neuronal activity in the cat's lateral geniculate and perigeniculate nuclei

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Abstract

The cortico-thalamic influence on spontaneous and visually evoked activity of single cells in the dorsal lateral geniculate (LGN) and perigeniculate (PGN) nuclei were examined in unanesthetized cats with pretrigeminal brainstem transections by means of reversible cooling of cortical areas 17 and 18. The spatio-temporal characteristic of cells' RFs was tested with light spot randomly presented at different points along the receptive field axis. The cessation of cortical input decreased spontaneous activity of most of the LGN cells (64%; as compared to 36% with increased background firing). Similarly, their visually evoked responses were reduced (70% cells; compared to 24% with increased response) and extent of central excitatory domains diminished. In contrast, the majority of PGN neurons increased their spontaneous activity (62%; compared to 38% with decreased firing rate). Cortical cooling resulted also in a decrease of the ON and OFF central responses of most PGN cells (55%; as compared to 20% with increased responses). The described effects were more pronounced within the population of cells in X than in Y pathway. Although the removal of descending cortical excitation disturbed the balance of activity within the network of thalamic cells the gain of the geniculate relay was preserved. We conclude that the main role exerted by the cortico-thalamic pathway serves facilitation of the ascending retino-cortical flow of visual information at the level of lateral geniculate nucleus.

Keywords: Cat; Dorsal lateral geniculate nucleus; Perigeniculate nucleus; Receptive field response planes; X-cells; Y-cells; Cortical inactivation; Cortico-thalamic projection; Gain of thalamic relay

Introduction

The dorsal lateral geniculate nucleus (LGN) is the principal thalamic relay for retinal signals on their way to the cerebral cortex. It is now well established that the LGN functions more as a gate, which regulates retinal information transmitted to the visual cortex, rather than just as a simple relay station for the ascending retinal flow (Burke and Cole, 1978; Cudeiro and Sillito, 1996; Cudeiro et al., 2000; Funke et al., 1996; Granseth et al., 2002; Guillery and Sherman, 2002; Marroco et al., 1996; Lindström and Wróbel, 1990b; Montero, 2000; Sherman, 2001; Sherman and Guillery, 1996, 2002; Sillito et al., 1994; Singer, 1977; Steriade, 2001; Wörgötter et al., 1998). One of the key inputs that control the flow of retinal signals at thalamic level is excitatory feedback from layer 6 cells of the primary visual cortex (Ahlsén et al., 1982a; Gilbert and Kelly, 1975; Lindström, 1982; Robson, 1983). The number of cortico-geniculate synaptic contacts is estimated to constitute about a half (31–58%; Erisir et al., 1998; Guillery, 1969; Montero, 1991; Van Horn et al., 2000) of all buttons on relay neurons in the LGN and thus far outweighs the number of synaptic contacts formed by retinal ganglion cells (7–20%; Erisir et al., 1998; Montero, 1991; Van Horn et al., 2000).

Numerous cortical inputs also reach the two pools of interneurons (Erisir et al., 1998; Guillery, 1969; Montero,

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