INTERACTION BETWEEN UNIT RESPONSES OF THE CAT CEREBELLAR CORTEX DURING PAIRED STIMULATION OF THE FORELIMBS

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Interaction between spike responses of 41 cerebellar cortical neurons to electrical stimulation of the two forelimbs with different intervals between stimuli were studied in cats anesthetized with chloralose and pentobarbital. The responsiveness of neurons with a phasic type of discharge to testing stimulation of the limb was reduced for 300-500 msec or longer after conditioning stimulation of the other limb. Interaction between the responses was less clear in neurons with a tonic type of response. Interaction was absent or was summating in character if the stimuli were applied at the same times. Only if the intertrial intervals were 50-150 msec was regular inhibition of the responses of tonic type to the testing stimulus observed. It is postulated that the nucleus of the inferior olive participates in the interaction between phasic unit responses during simultaneous stimulation of the two limbs or to stimulation separated by short intervals (under 30 msec). With longer intervals between stimuli, interaction between responses of either type is connected with involvement of the lateral reticular nucleus. In the process of interaction competitive relations may develop between responses caused by impulses reaching neurons of the cerebellar cortex along climbing and mossy fibers.

INTRODUCTION

Many types of information are processed in the cerebellum, as a center of integrative and coordinating activity, through interaction between trains of afferent impulses converging on the cortical neurons. Since the cerebellum has an extremely important role in the regulation of motor functions, the analysis of the effects of impulses from receptors of the locomotor system is particularly interesting.

The object of the present investigation was to study interaction between unit responses in the cerebellar cortex to temporally spaced afferent impulses from two different limbs.

EXPERIMENTAL METHOD

Adult cats were anesthetized intraperitoneally with a mixture of chloralose (40 mg/kg body weight) and pentobarbital (15 mg/kg). Unit activity was recorded extracellularly in the cerebellar cortex by glass microelectrodes filled with 3 M KCl solution. The technique of the preparatory operation and of the experiments was described previously [2]. Interaction between unit responses was investigated during paired electrical stimulation of the two forelimbs or, by way of additional analysis, of the lateral reticular nucleus (as conditioning stimulus) and of one limb (as testing stimulus). The stimuli (square pulses, 0.3 msec in duration) were applied through different channels of the stimulator at intervals of 0, 30, 50, 100, 150, 300, and 500 msec. The strength of stimulation of both limbs was the same, namely 2.5-3 times the threshold.

RESULTS

Responses of 41 cerebellar cortical neurons, recorded in the region of a simple folium in the midline, were analyzed. Data for the responses (showing the number of spikes) of all neurons to testing...
Fig. 1. Distribution of cerebellar cortical neurons by number of spikes in response to single and paired stimulation of nerves to the forelimbs. Abscissa, number of spikes; ordinate, number of neurons. Intertrial intervals, msec, shown above. Sim.) Simultaneous stimulation of both limbs, Cont.) control (separate) stimulation of limbs.

Fig. 2. Interaction between phasic responses of a cerebellar cortical neuron during paired stimulation of both forelimbs — left (conditioning) and right (testing): 1) stimulation of right; 2) of left forelimb: 3-9) combined stimulation of both limbs. Intertrial intervals, msec, shown on the right. Stimulus duration 0.5 msec, voltage 4 V. Markers of stimulation above (here and in other figures the shorter stroke denotes the testing, the longer stroke the conditioning stimulus).

stimulation of one forelimb at various intertrial intervals (ITI) after stimulation of the other limb, are shown in Fig. 1.

In response to simultaneous stimulation of the two limbs the responses of most neurons contained the same number of spikes as to stimulation of one limb only, indicating the blocking of a large proportion of the afferent flow. This applied chiefly to neurons whose responses consisted of a few (under 10) spikes. As regards neurons which responded to control (separate) stimulation of the limbs by a comparatively large number of fast spikes (25-75/sec), the responses to combined stimulation were increased to 25-100 spikes or more.

If the testing stimulus was applied 30 msec after the conditioning stimulus, all neurons responded to it by fewer spikes than to isolated stimulation of the same limb. The number of neurons with responses consisting of 10-25 or, less frequently, of 5 spikes was reduced. This indicates a further increase in the occlusion, which reached its maximum when the ITI was 50, 100, and 150 msec. The number of neurons responding to the testing stimulus by a single spike increased, but the number with responses consisting of 5, 10, and 25 spikes was reduced. It was more difficult to detect any general rule as regards the change