
VESTIBULAR RESPONSES OF FAST AND SLOW DEITERS' NEURONS
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Deiters' nucleus consists of cells of different sizes, some giant, others smaller. All send axons into the spinal cord [1]. The axons of most neurons of Deiters' nucleus form the lateral vestibulo-spinal (VS) tract. Neurons of Deiters' nucleus, together with neurons of the medial vestibular nucleus, also participate in the formation of the medial VS tract [2]. The velocity of conduction of impulses along VS fibers varies from 24 to 140 m/sec [6]. We can thus speak of "fast" and "slow" VS neurons. According to Ito et al. [6], the fast fibers are axons of giant cells whereas the slow fibers are axons of small cells. Fast and slow VS fibers have been shown to differ in their effect on spinal neurons [2]. Fast fibers form excitatory synapses on spinal neurons [2, 3, 5]. As regards slow fibers, at least for the medial VS tract, it has been shown that they form inhibitory synapses on spinal neurons [8, 9].

VS neurons receive afferent signals (directly and via the cerebellum) from the vestibular apparatus [1]. Previous experiments on cats with an intact cerebellum showed that tilting the animals in the frontal plane as a rule evokes dynamic responses of VS neurons [4]. Most neurons were excited by tilting to the ipsilateral (relative to the neuron recorded) side, but some cells were excited by tilting to the contralateral side.

In the present investigation the relationship of the character of vestibular responses of VS neurons to the velocity of conduction of excitation along their axons was studied.

Experiments were carried out on thalamic (division of the brain stem at level A-12 after Horsley and Clarke) cats. VS neurons were recorded extracellularly in Deiters' nucleus and identified by their antidromic responses to stimulation of the anterior funiculus of the spinal cord at level L1. The method described by Orlovskii and Pavlova [4] was used to stimulate vestibular receptors. Cats fixed in a stereotaxic apparatus were periodically tilted in the frontal plane by ±5° from the midline with a frequency of about 1 Hz; the center of rotation was 50 cm below the animal's head (Fig. 1c). The angle of tilting was approximately a sinusoidal function of time. Tilting in this way evokes mainly a response of the otolith receptors [7].

Altogether 51 VS neurons were recorded. Spontaneous activity with a frequency of 1-2 to 40 spikes/sec was observed in most cells; the mean frequency (including neurons without spontaneous activity) was 9.8 spikes/sec. The relative velocities of conduction of excitation along axons of VS neurons were judged from the latent periods of antidromic responses to stimulation of the spinal cord. The latent periods varied within wide limits -- from 1.5 to 7.8 msec, roughly corresponding to conduction velocities of 142 to 28 m/sec. A histogram of the latent periods of the antidromic responses is illustrated in Fig. 1c.

In 39 of 51 VS neurons recorded, marked responses to tilting of the animal were observed. As a rule unit activity was increased (up to 40-100 spikes/sec) on tilting to one side and reduced (often to zero) on tilting to the other side. Examples of vestibular responses of VS neurons are given in Fig. 1a and b. Activity of one neuron (a) increased during tilting to the ipsilateral and decreased during tilting to the contralateral side. Activity of the other neuron (b), on the other hand, increased on tilting to the contralateral side and decreased on tilting to the ipsilateral side. The indicator of the character of response of
the VS neurons was the phase of tilting when the firing rate of the cell reached a maximum. To determine the phase of maximal discharge, unit activity was averaged over 4 or 5 cycles. Most neurons (28 of 39) reached maximal activity when the animal was tilted to the ipsilateral side. Activity of the remaining neurons reached a maximum when the animal was tilted to the contralateral side.

Dependence of the character of vestibular response of VS neurons on the relative velocity of conduction of excitation along their axons is illustrated in Fig. 1d. In this graph the phase of maximal activity of VS neurons is plotted along the abscissa (beginning of tilting of the animal to the ipsilateral side is taken as zero) and the latent periods of antidromic responses along the ordinate. Neurons with the shortest latent periods were mainly excited on tilting to the ipsilateral side, whereas neurons with the longest latent periods, on the other hand, were excited on tilting to the contralateral side. In neurons excited during tilting to the ipsilateral side the mean latent periods were thus shorter (2.8 ± 0.7 msec) than those of neurons excited during tilting to the contralateral side (4.6 ± 2.0 msec). The difference between the mean latencies of antidromic responses of these two groups of VS neurons was statistically significant (P < 0.001).

The results are evidence that fast and slow VS neurons respond basically differently to stimulation of vestibular receptors. This conclusion is in agreement with data in the literature [2], according to which fast and slow neurons of Deiters' nucleus can differ in their effect on spinal neurons.

LITERATURE CITED