RESPONSES OF SPONTANEOUSLY ACTIVE SPINAL NEURONS
TO TEMPERATURE STIMULATION OF THE SKIN


Changes in spontaneous unit activity in the dorsal zones of the spinal cord in response to temperature stimulation of the skin of the thigh and leg were investigated in acute experiments on cats lightly anesthetized with pentobarbital. Two groups of neurons were distinguished by the character of their response. The firing rate of the first group of neurons was changed only in response to cold or warmth. The neurons of the second group responded in opposite ways to the two types of stimulation. Frequency characteristics of spontaneous activity of temperature-sensitive units located in both white and gray matter were determined. In all the lumbar segments their depth was not below the 5th layer of gray matter. Mechanisms of the changes in spontaneous activity and the possible pathways of conduction of temperature sensation are discussed.

INTRODUCTION

The various elements of the spinal cord and brain that participate in temperature regulation have often been investigated [8, 10, 11, 13, 14]. The temperature sensitivity of peripheral receptors has also been studied in detail. However, few attempts have been made to study the activity of spinal neurons during adequate stimulation of peripheral temperature-sensitive elements [4, 5], despite the fact that such a study could shed light on the organization of the conducting pathways of temperature sensation and also on the integrative function of the corresponding neurons.

The investigation described below was carried out to study changes in spontaneous unit activity in the dorsal part of the spinal cord in the lumbar segments as a result of cooling and warming the skin of the thigh and leg in cats and to examine the character of their responses to alternation of these stimuli.

EXPERIMENTAL METHOD

Adult cats were anesthetized with pentobarbital (45 mg/kg body weight, intravenously). Anesthesia was induced by inhalation of ether.

Laminectomy was performed in the region of segments L-7 in the usual way. After the preparative operation the animal was securely fixed to a type ŠETZh-2 frame. The temperature of the animal's body and spinal cord was kept at 38°C throughout the experiments by means of heaters. The systolic blood pressure varied between 100 and 130 mm Hg.

Spontaneous activity was recorded with glass microelectrodes filled with 2.5 M KCl and K2SO4 solutions. The resistance of the electrodes was 30-70 MΩ.

To select units connected with the stimulated limb they were identified by electrical stimulation of divided muscular and intact cutaneous nerves. Tactile stimulation of the skin also was used. Active units unconnected with the region stimulated were excluded from the study.

The direction of the microelectrode track was determined histologically and the positions of the units were identified by measuring the depth of insertion of the electrode from the dorsal surface of the spinal cord on the indicator of the micromanipulator.

Temperature stimulation was applied by means of a special cuff fixed to the previously shaved skin of the outer surface of the thigh and leg. Three thermostats were used to stabilize the temperature: +10 to +13°C (cold), +30°C (neutral temperature), and +45°C (warm). Water from the thermostats was supplied to the cuff by means of a specially constructed switching device. The gradient of the temperature change was 1°C/sec.

The apparatus for the experiments consisted of a two-channel stimulator, cathode follower with input resistance of 1 GΩ, amplifiers with amplification of up to 3000 and a transmission band of between 10 Hz and 30 kHz, and double-beam cathode-ray oscilloscopes.

Spontaneous activity was recorded by means of an amplitude discriminator using the circuit of a Schmidt's trigger, the output of which was connected to a frequency meter. Activity was counted every 10 sec at intervals of 2 sec for 1 min.

RESULTS

In 32 experiments spontaneous activity of 117 spinal units was recorded intra- and extracellularly. If the activity changed during the time of action of the temperature stimulus, the source of activity was classed as temperature-sensitive. This group contained altogether 98 units. They were recorded in all seven lumbar segments in different sagittal and horizontal planes of the spinal cord.

The spontaneous firing rate in the absence of temperature stimulation of the skin varied within wide limits, sometimes reaching 80/sec. Usually, however, in the group of temperature-sensitive units it did...