EFFECT OF LOCAL COOLING OF THE CORTEX ON EVOKED POTENTIALS IN THE RETICULAR FORMATION IN RESPONSE TO SOMATOSENSORY STIMULATION

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Potentials evoked in nuclei of the reticular formation by electrodermal stimulation of the limbs were investigated in acute experiments on unanesthetized, immobilized rats during cooling of the somatosensory cortex in the area of representation of one forelimb. Evoked potentials in the reticular formation were found to depend on the degree of cold inhibition of the cortical primary response to the same stimulation. The peak time of the main negative wave increased from 40-50 to 60-80 msec with a simultaneous decrease in its amplitude or its total disappearance in the case of deep cooling of the cortex. Cooling of the cortex had a similar although weaker effect on the earlier wave of the evoked potential with a peak time of 14 msec, recorded in the ventral reticular nucleus. In parallel recordings of potentials evoked by stimulation of other limbs they remained unchanged at these same points of the reticular formation or were reduced in amplitude while preserving the same temporal parameters. Cooling of the cortex thus selectively delays the development and reduces the amplitude of the response to stimulation of the limb in whose area of representation transformation of the afferent signal into a corticofugal volley is blocked. Consequently the normal development of both late and early components of the potential evoked in the reticular formation by somatic stimulation requires an additional volley, descending from the cortex, and formed as a result of transformation of the same afferent signal in the corresponding point of the somatosensory cortex.

INTRODUCTION

The principal features distinguishing the organization of nonspecific brain structures are extensive convergence of afferent inputs on them and diffuse responses to presentation of stimuli of different sensory modalities. The reticular formation (RF) of the brain stem is a typical example in this respect.

Of the factors limiting convergence in RF and other nonspecific brain structures and thereby controlling the development of the sensory response in them, corticofugal influences deserve the greatest attention. Functional inhibition of any cortical sensory area evokes a decrease in responses in RF to stimuli of the same sensory modality, whereas unilateral depression of the somatosensory cortex reduces responses to stimulation of the contralateral half of the body [7, 13]. Mainly sensory responses of the striatum have been used as the basis for the study of this phenomenon [2, 4, 9, 14]. During local blocking of the cortex it has been shown [4, 6, 9] that selective inhibition of the response to presentation of any stimulus within the limits of the same sensory modality may arise in the somatosensory area. These facts served as the basis for views on the mechanism of sensory specialization of responses of nonspecific brain structures [10]. According to these views, a selective change in the response to presentation of one stimulus takes place in a neuron net as a re-
sult of interaction between two afferent flows in it: an ascending flow, with excess of information because of convergence, and a descending flow, formed from the peripheral signal arriving in the cortex along specific sensory pathways.

The present investigation was undertaken to study the character of this interaction in RF, where the initial stages of convergence of sensory signals takes place and where some neurons have direct inputs from ascending fibers of spinal neurons and their collaterals.

**EXPERIMENTAL METHOD**

Experiments were carried out on 29 albino rats weighing 150-250 g. Surgical preparation of the animal, carried out under ether anesthesia, included tracheotomy, insertion of a catheter into the jugular vein, trephining the skull in the position where the recording electrode was to be inserted, and removal of the cranial bones above the somatosensory area of the cortex as far as the lamina vitrea. The animal was fixed in a stereotaxic frame, immobilized with D-tubocurarine, and artificially ventilated. The sensory projection area of one forelimb was determined by identifying the region of the focus of the primary responses (PR) to electrodermal stimulation of the corresponding limb. A special capsule for cooling the cortex was placed at this point. The capsule consisted of a metal cylinder (diameter 3 mm), through which water was passed at a temperature of 0-5°C. A silver electrode for recording PR was glued with BF-2 glue to the base of the capsule. The degree of cooling was controlled by varying the rate of flow of the water and monitored as the change in PR in the zone of cooling.

For electrodermal stimulation square pulses of current (3-10 V, 0.5 msec) were passed through needle electrodes inserted into the skin of the rat's limbs. The right forelimb, whose area of representation and in the cortex was cooled, and the left forelimb (or right hind limb) were stimulated alternately at intervals of 1.25 sec. Evoked potentials (EP) from RF were derived by means of a glass micropipet with a tip about 4-10 μm in diameter, filled with 4% Procion dye. The electrode was introduced into the nuclei of the medullary RF in accordance with stereotaxic coordinates [16]. Parallel cumulation of PR and EP was carried out in different parts of the memory of a statistical analyzer.

After the end of the experiment, to obtain a colored tag, a current of 15-20 μA was passed for 15-20 min through the electrode. The location of the electrode tip was determined from the position of the tag on histological sections.

**EXPERIMENTAL RESULTS**

Electrodermal stimulation of the rat's forelimb evoked the ordinary positive-negative PR in the somatosensory area of representation of that limb (Fig. 1a). The positive wave of PR reached a maximum after 11-14 msec, the negative after 18-22 msec. The temporal characteristics of the individual waves of PR and EP were measured from the time of stimulation to the time when the waves reached their maximal amplitude (at the peak time). The amplitude of PR varied from 300 μV to 1 mV depending on the intensity of the stimulus and the thickness of the lamina vitrea which remained.

A multicomponent EP was recorded in RF (Fig. 1, b, c). The main negative wave, stable and with high amplitude (peak time 40-50 msec, amplitude up to 300 μV), appeared at all points of derivation in response to stimulation of any of the rat's limbs. This main wave was followed by a less stable positive wave, which reached its peak amplitude after 80-120 msec. The whole of this complex could be preceded by several variable positive-negative, low-amplitude waves.

The amplitude and duration of PR in the zone of cooling varied depending on the duration and intensity of the flow of water through the capsule. In the initial period of cooling PR increased considerably in amplitude and was delayed a little. As the temperature fell the amplitude of PR also fell and its generation time was increasingly delayed. During prolonged cooling PR could be completely suppressed. EP in RF as a whole depended on the degree of change in PR. In the initial period of cortical cooling (before facilitation of PR) the peak time of the main negative wave of EP was shifted from 40-50 to 60-80 sec, and a complex of a negative wave with peak time of 14-30 msec and a positive wave, which did not always appear, and was intermediate between the negative waves mentioned above, was formed (Fig. 1b). During small shifts the amplitude of the wave with a peak time of 40-50 msec did not necessarily change at the beginning of cooling, but later it decreased, and as a result of deep cooling of the cortex this wave disappeared completely. In parallel recordings, potentials evoked by stimulation of the ipsilateral (relative to the cooled point of the cortex) forelimb or the contralateral hind limb of the rat were slightly reduced in amplitude, but their temporal parameters were