

EFFECT OF ARECOLINE ON SINGLE
HIPPOCAMPAL NEURONS

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Intravenous injection of arecoline into cats increases the frequency of hippocampal unit discharge (extracellular recording) and causes the appearance of a theta rhythm in the hippocampus and EEG activation in the cortex. This effect still takes place despite preliminary administration of the peripheral muscarinolytic drug metacina.

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The muscarine-like properties of cholinergic hippocampal neurons has been inadequately studied [2, 3].

In this paper we give data showing changes in spike activity of single units and in global hippocampal electrical activity during action of the muscarine-like cholinergic drug arecoline.

EXPERIMENTAL METHOD

Extracellular action potentials of single units of the dorsal hippocampus were recorded through Pyrex micropipets with a tip 1-3 μ in diameter (3M NaCl) on a tape recorder, automatic electronic counters, and on an electroencephalograph, and simultaneous recordings were made of the hippocampal and cortical EEG. The depth to which the microelectrodes were introduced was verified histologically in accordance with the atlas of Snider and Niemer [4]. In some experiments the cortex above the hippocampus was sucked out and the microelectrode inserted under visual control.

The drugs used in the investigation—arecoline hydrobromide and metacina (oxyphenonium) iodomethylate—were injected intravenously.

EXPERIMENTAL RESULTS

Intravenous injection of arecoline (0.3 mg/kg) into a curarized cat caused a distinct increase in frequency of hippocampal unit discharges. During the first minute after injection their frequency rose sharply from 5-20 to 40-80 spikes per sec. This increase in frequency reached a maximum 2-3 min after injection (Fig. 1). As a rule, this maximum resembled a pointed peak, and the frequency thereafter immediately began to fall steadily. This effect of an increase in spike frequency lasted on the average for 8-15 min. Later the spike frequency sometimes continued to decrease. Recovery of the initial frequency of unit discharges was observed by the 15th-30th min, and sometimes the level fell below its initial value. These changes were seen particularly clearly if the initial unit discharge frequency was low (0.5-1 spike/sec).

A parallel was observed between the increase in frequency of hippocampal unit activity and the appearance of an EEG activation

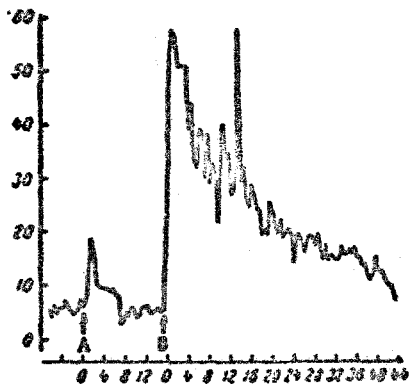


Fig. 1. Effect of arecoline on hippocampal unit activity in cat. A) intravenous injection of metacina (0.3 mg/kg); B) intravenous injection of arecoline (0.3 mg/kg). Ordinate, mean spike frequency (per sec) calculated for 30 sec; abscissa, time (in min).

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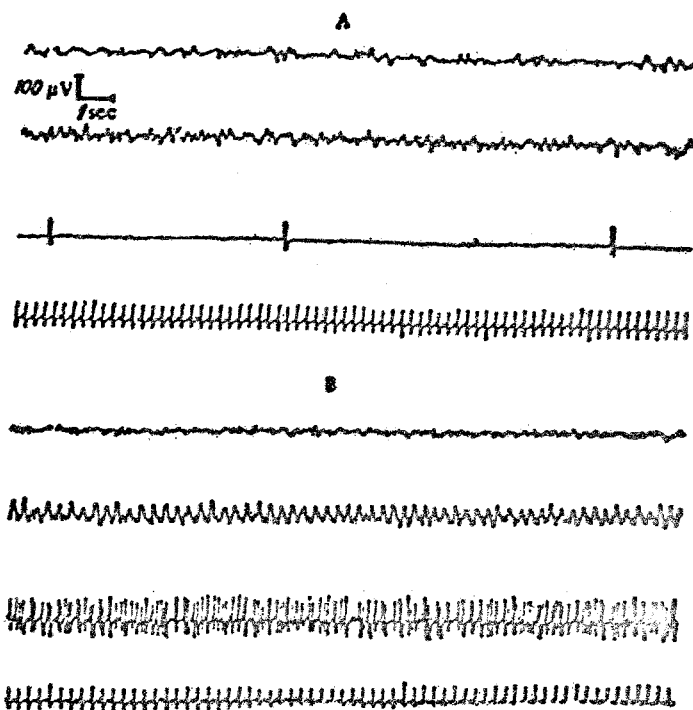


Fig. 2. EEG and single hippocampal unit activity in cat during action of arecoline. From top to bottom: EEG of left visual cortex and right hippocampus; pulses of generator synchronized with every 4th left hippocampal unit spike; ECG. A) Before injection; B) 5 min after intravenous injection of arecoline (0.3 mg/kg).

A parallel was observed between the increase in frequency of hippocampal unit activity and the appearance of an EEG activation response in the hippocampus (theta rhythm) and in the cortex (low-amplitude fast activity; Fig. 2).

A similar effect of arecoline was observed after preliminary intravenous injection of the muscarine-like anticholinergic drug metacin in a dose of 0.1-0.3 mg/kg, preventing only the peripheral action of arecoline.

It may be supposed that the definite increase in frequency of hippocampal unit discharges during the action of arecoline was the result of the effect of this drug on hippocampal choline-sensitive neurons. On this basis, the presence of muscarine-sensitive (M-cholinergic) neurons in the hippocampus may be postulated.

To cause the appearance of a theta-rhythm in the hippocampus, the medial portions of the septum must be intact [5], and the EEG activation in the cortex produced by the action of arecoline is the result of excitation of cholinergic neurons of the bulbar reticular formation [1]. Consequently, the changes in hippocampal and cortical electrical activity caused by arecoline may be due to its effect on M-cholinergic neurons in various functional systems of the brain.

LITERATURE CITED

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