EFFECT OF MICROINJECTIONS OF INSULIN INTO THE HYPOTHALAMUS ON CORTICAL EVOKED POTENTIALS

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Insulin, in a dose of 0.025 unit/kg, was injected into the anterior and posterior zones of the hypothalamus in cats anesthetized with urethane. Injection of insulin into both zones of the hypothalamus led to an increase in the amplitude of the primary positive and primary negative waves of potentials in the motor and auditory cortex and to inhibition of responses to flashes in the visual cortex. Heterogeneity of the effect of insulin injection into the hypothalamic structures on the various phases of the evoked potentials was observed.

The effects of hormones on hypothalamo-cortical relations have not been adequately studied. Accordingly, in the investigation described below, changes in evoked potentials (EPs) in different areas of the cortex during microinjection of insulin into the anterior and posterior zones of the hypothalamus were studied.

EXPERIMENTAL METHOD

Cats were deprived of food for 15-18 h and anesthetized with urethane (1.5-2 g/kg, intraperitoneally). Cannula-electrodes for injection of the substance and recording the potentials were inserted stereotaxically in accordance with the coordinates of Jasper and Ajmone-Marsan's atlas [8] into the paraventricular and posterior hypothalamic nuclei. The position of the electrode tips was subsequently verified histologically. Crystalline insulin, in a dose of 0.025 unit/kg in 0.02 ml physiological saline (pH 7.3), was administered in one operation by means of a microinjector. EP's were recorded by monopolar nichrome electrodes through the pared cranial bones from the motor, auditory, and visual areas of the cortex. From each cortical area EP's were recorded only to presentation of the adequate stimulus: in the motor cortex EP's were recorded in response to electrical stimulation of the sciatic nerve, in the auditory cortex in response to clicks, and in the visual cortex in response to flashes. The output stages of a type RGE-1 (East Germany) electroencephalograph were used as amplifiers, and the signals were led from their output to a type S-1-18 oscilloscope. The EPs were recorded by superposition of 10-12 single arrhythmic waves per minute. Insulin was injected into the side on which the EPs were recorded. In control experiments an equal volume of physiological saline was injected.

EXPERIMENTAL RESULTS

The latent period of responses in the motor cortex to electrical stimulation of the sciatic nerve before injection of insulin into the hypothalamus was 7-11 msec and the amplitudes of the primary positive and primary negative waves were 80-150 and 30-60 μV, respectively. The corresponding characteristics of the EP's to clicks in the auditory cortex under the same conditions were 8-12 msec and 50-80 and 20-40 μV, and those of the EP's in the visual cortex to single flashes were 14-20 msec and 40-100 and 15-30 μV. As a rule the secondary components of the EP were absent. Similar results were obtained by other workers using animals anesthetized with urethane [2, 4, 5].

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Under the influence of the microinjection of insulin into both the anterior and posterior zones of the hypothalamus marked changes in the amplitude of the primary positive and primary negative waves of the EP in response to adequate stimulation occurred in the motor, auditory, and visual cortex. The EP's in the motor and auditory cortex were increased in amplitude, while those in the visual cortex were inhibited.

The amplitude of responses evoked in the motor cortex by electrical stimulation of the sciatic nerve was reduced during the first 5-10 min after injection of insulin into the anterior or posterior hypothalamus (in 14 of 16 experiments). However, from 12 to 15 min after injection of the hormone, the EP showed recovery and its amplitude continued to increase for 25-30 min, when it was 15-50% of the control level (in 12 to 16 experiments).

Microinjection of insulin into the anterior or posterior hypothalamus led immediately to facilitation of the EPs to clicks in the auditory cortex (in 13 of 15 experiments). The increase in amplitude of the response following injection of insulin into the hypothalamus persisted throughout the period of recording (30 min), and it amounted to 20-40% of the control.

Conversely, injection of microdoses of insulin into the paraventricular or posterior hypothalamic nucleus inhibited the responses to flashes in the visual cortex almost immediately (in 11 of 14 experiments). This inhibition was slight in degree (15% of the control level) and it was observed throughout the period of recording (30 min).

After microinjection of insulin into the posterior hypothalamus the changes in EPs in the cortical areas selected for investigation occurred sooner and they were more stable and more marked than after injection of the hormone into the paraventricular nucleus.

Facilitation of EP's in the anterior zones of the neocortex in response to stimulation of anterior and posterior structures of the hypothalamus has also been observed by other investigators [3, 5, 9, 10]. The inhibitory action of this stimulation on responses in the visual cortex [6], however, has received less study.

The results described above also demonstrate the heterogeneous character of hypothalamic effects on the various cortical zones. EP's recorded in the motor and auditory cortex in response to stimulation of the sciatic nerve and to clicks, respectively, for instance, were increased in amplitude at the same time as responses to flashes in the visual cortex were reduced in amplitude. Heterogeneity of hypothalamic effects on the neocortex was also seen in relation to the different phases of the EP's, as shown by the distinct independence of the changes in these phases.

It can be assumed on the basis of the generally accepted theory of genesis of the different phases of the EP [1, 7, 11], that the hypothalamic zones investigated in these experiments act in different ways on the superficial and deep layers of the cortex.

These results thus demonstrate the complex effect of insulin, when injected into the hypothalamus, on the functional state of the different regions and layers of the cerebral cortex.

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