EFFECT OF ETHANOL ADMINISTRATION ON LIMBICO-RETICULAR RELATIONS IN RABBITS DURING MOTIVATION CONDITIONING

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This paper describes an attempt to analyze the effect of a single dose of ethanol on global electrical activity of the cerebral cortex and on the power of the principal rhythms constituting the EEG in various regions of the neocortex and to correlate them with changes induced by ethanol in hypothalamo-reticulo-hippocampal interrelations that form two different behavioral reactions in animals: goal-directed food behavior and the avoidance reaction.

EXPERIMENTAL METHOD

Experiments were carried out on unrestrained rabbits weighing 2.5-3 kg. The animals took part in the experiments after feeding. Global electrical activity (EEG) of the neocortical regions was studied and the power of the principal EEG rhythms analyzed. Global cortical activity was derived by means of needle electrodes fixed to the skull and recorded on an EEG-80 8-channel electroencephalograph (Medicor, Hungary). The power of the principal EEG rhythms in the range from 1.5 to 70 Hz was recorded and studied on a wide-band EEG analyzer-integrator of the AN-EEG-8 type (Medicor) and in digital form by means of indicator tubes of "Nixie" type. The background EEG and changes in it during the formation of food behavior and the avoidance reaction, and during stimulation of certain limbico-mesencephalic formations, were studied.

The methods of observing goal-directed food behavior and of studying the influence of dorsal regions of the hippocampus and mesencephalic reticular formation on these behavioral reactions were described by the writers previously [4].

A 40% solution of ethanol made up in physiological saline in ampuls was injected in a dose of 0.5 g/kg body weight into the marginal vein of a rabbit's ear. The background EEG and its changes during stimulation of the deep brain structures chosen for study, together with correlation with behavioral reactions evoked by electrical stimulation of the corresponding hypothalamic motivation centers, were analyzed 15 min after intravenous injection of ethanol.

The results were subjected to statistical analysis. The location of the subcortical electrodes was determined histologically by examination of brain sections 50-100 μ thick.

EXPERIMENTAL RESULTS

Threshold stimulation of the lateral region and ventromedial nucleus of the hypothalamus, evoking food behavior and an avoidance reaction in the rabbits, respectively, were accompanied by specific power patterns of the principal EEG rhythms in the frontal and occipital regions of the cortex. Differences in powers of the β-, α-, θ-, and δ-rhythms composing integral activity on the EEG of the frontal cortex in response to stimulation of the lateral and ventromedial hypothalamus, relative to the original background activity, can be clearly seen in Fig.

It was stated previously [6] that the limbico-mesencephalic formations play an important role in mechanisms of excitation ascending from the hypothalamic motivational centers to the cerebral cortex. Electrical stimulation of the dorsal hippocampus was found to have a mainly inhibitory effect on the development of food behavior and the avoidance reaction in animals, whereas electrical stimulation of the mesencephalic reticular formation, on the other hand, facilitated the formation of these behavioral responses [3].

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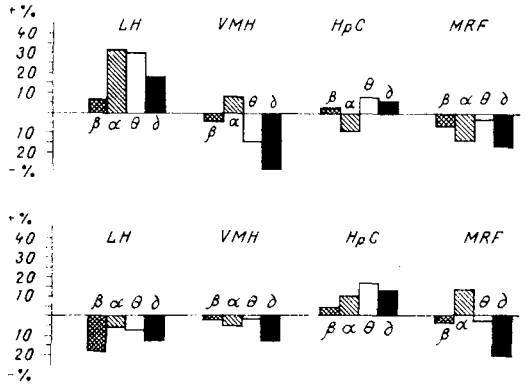

Fig. 1

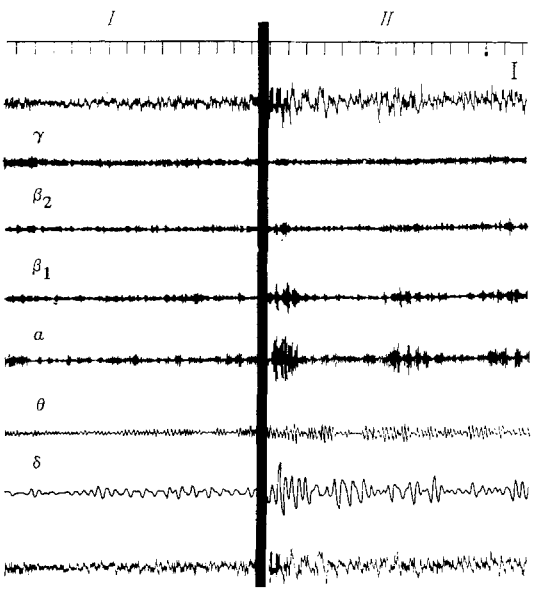

Fig. 2

Fig. 1. Changes in power of principal EEG rhythms in frontal cortex (in % relative to background) in response to threshold stimulation of lateral (LH) and ventromedial hypothalamus (VMH), and also to electrical stimulation of dorsal hippocampus (HpC) and mesencephalic reticular formation (MRF) before (above) and after (below) intravenous injection of ethanol (0.5 g/kg). Parameters of stimulation of dorsal hippocampus: 5 V, 50 Hz, pulse duration 1 msec.; of mesencephalic reticular formation 3 V, 50 Hz, 1 msec.

Fig. 2. Integral EEG and graphic representation of its component γ-, β_2-, β_1-, α-, θ- and δ-rhythms in frontal cortex composing it before (I) and after intravenous injection of ethanol in a dose of 0.5 g/kg (II). Time marker 1 sec, calibration 100 μV.

Analysis of the power patterns of the principal EEG rhythms of the frontal and occipital regions of the cortex showed that both inhibitory hippocampal and facilitatory reticular influences were accompanied by a specific pattern of cortical electrical activity. It will be clear from Fig. 1 that electrical stimulation of the mesencephalic reticular formation mainly reduced the power of all EEG rhythms studied in the frontal region of the cortex and, in particular, the α- and δ-rhythms, whereas electrical stimulation of the dorsal hippocampus was accompanied by an increase in power of the β-, θ-, and δ-rhythms but a decrease in power of the α-rhythm.

A single injection of ethanol into the animals in a dose of 0.5 g/kg into the marginal vein of the ear was followed by changes in spontaneous cortical electrical activity. Data on changes in both integral activity in the frontal cortex of a rabbit and the power of the principal EEG rhythms before and after injection of ethanol into the animal, based on the results of a concrete experiment, are shown in Fig. 2.

The generalized results of this experiment showed that in animals receiving ethanol the powers of all EEG rhythms were increased in the frontal cortex, especially the β-rhythm (45.3%), α-rhythm (36.7%), and θ-rhythm (27.1%). A single intravenous injection of ethanol caused a reduction by almost 10% in the power of the β-rhythm in the occipital cortex, accompanied by a simultaneous increase in the power of the α-rhythm by 81.3% and the θ-rhythm by 20.9% ($P < 0.05$).

As already stated [4], in the concentration mentioned above ethanol had different effects on excitability of the hypothalamic motivation centers. Moreover, after injection of ethanol neither inhibitory hippocampal nor facilitatory reticular influences on the formation of food behavior and the avoidance reaction were present in the rabbits.

The different patterns of the principal EEG rhythms during electrical stimulation both of the hypothalamic motivation centers themselves and of individual limbico-mesencephalic formations that participate directly in the formation of the behavioral reactions studied pointed to profound reorganization of the central mechanisms responsible for motivation behavioral re-

actions after a single intravenous injection of ethanol. The new power patterns of the principal EEG rhythms in the frontal cortex after a single intravenous injection of ethanol into the animals are illustrated in Fig. 1.

The investigations described above filled in some of the details in the observations made by workers who described changes in integral cortical electrical activity in cats [1], rabbits [11, 12], and rats [5, 7, 8, 11] under conditions of alcoholic intoxication. A study of the powers of the rhythms forming the EEG showed that besides an increase in the slow rhythms, under the influence of ethanol intensification of high-frequency activity also takes place. However, the very small increase in power of the high-frequency rhythms compared with the power of slow electrical activity leads to predominance mainly of slow high-amplitude waves on the integral neocortical EEG.

Like other workers [2, 5], we found changes in the motivation-behavioral reactions of animals under the influence of ethanol, in agreement with observations showing considerable changes in unit activity in the hypothalamic motivation centers under the influence of ethanol [14].

The absence of inhibitory hippocampal and facilitatory reticular influences, in rabbits under the influence of ethanol, on the formation of motivation reactions of different biological quality, and the correlation thereupon observed with the new power patterns of the principal EEG rhythms agree with observations by workers who found sharp changes in unit activity in various limbic structures and formations of the mesencephalon under the influence of ethanol [8-11, 13], and also with investigations [1] which revealed considerable disturbances of limbico-mesencephalic relations by ethanol during the formation of motivational behavioral reactions in cats.

The new patterns of cortical electrical activity observed in this investigation, compared with previous observations on the chemical mechanisms forming goal-directed food behavior and the avoidance reaction in rabbits [3], can be explained by profound disturbances of brain metabolism, and especially metabolism of cholinergic, adrenergic, and dopaminergic structures under the influence of ethanol.

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