β-LIPOTROPIN AS A FACTOR IN FOOD MOTIVATION

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There is considerable experimental evidence in the literature on the role of biologically active substances in the formation of food motivational excitation [7, 11]. Recently the attention of many workers has been drawn to the study of the effect of endogenous oligopeptides on animal behavior: Peptides affecting mechanisms of memory and learning, analgesic peptides, and others, have been discovered among them. Many of these peptides have been shown to be derivatives of pituitary-β-lipotropic hormone [5, 10]. It has also been shown that β-lipotropin (β-LPH) influences metabolic processes *in vivo* and, in particular, that it raises the blood nonesterified fatty acid level and gives rise to hyperglycemia, hypercalcemia, and other effects [8, 9, 12]. Meanwile the action of β-LPH on the "food" behavior of animals has virtually not been studied.

The aim of this investigation was to study the effect of intracerebral injection of β-LPH on the food-getting behavior of rabbits with different levels of food motivational excitation.

EXPERIMENTAL METHODS

Ten male rabbits weighing 2.5-3 kg were trained beforehand in a special chamber to perform an instrumental reflex of pulling on a metal ring with their teeth in order to obtain food reinforcement; 10 untrained animals served as the control.

Before the experiments the animals were scalped, using 0.5% procaine as local anesthetic, after which cannulas 0.85 mm in diameter were inserted into the lateral ventricles (stereotaxic coordinates AP = 2.5, 1-2 mm [6]).

β-LPH and β-endorphin were isolated from bovine pituitary gland [4, 5]. The method of isolation included extraction of the pituitary glands with acid acetone, precipitation of the hormones with sodium chloride, desalting on Sephadex G-25, ion-exchange chromatography on CM-cellulose, and gel-filtration through Sephadex G-75 (for β-LPH) and Sephadex G-50 (β-endorphin).

β-LPH in a concentration of 91.5×10^{-6} μmole/μl, in a volume of 3-5 μl (in physiological saline) was injected by means of a microinjector through the long-term cannulas into the lateral ventricles of hungry and fed animals. The fact that the cannulas were located in the lateral ventricles was verified in histological sections by a rapid photographic method.

The dynamics of food-getting instrumental activity of the trained animals was first recorded in the satiated state, during natural hunger (starvation for 1 or 2 days), after intraventricular injection of 3-5 μl of physiological saline, and also after injection of β-LPH. Besides normal instrumental reflexes ending with the taking of food, instrumental reflexes characterized by incomplete performance, not ending with the taking of food, also were recorded. The behavioral reflexes of this type were interesting because their number increases considerably at extremal levels of food motivational excitation [1, 2].

The quantity of food taken by the untrained animals under these same conditions and their body weight also were recorded.

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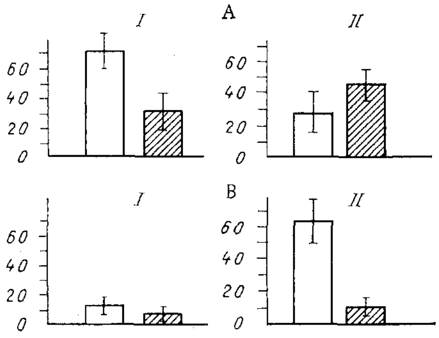

Fig. 1

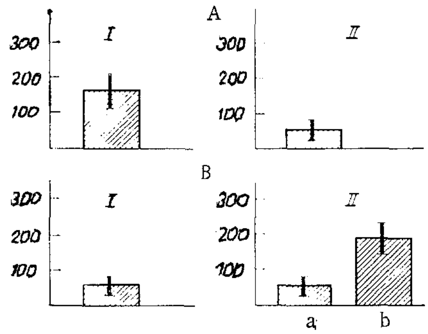

Fig. 2

Fig. 1. Food-getting instrumental activity of rabbits following intraventricular injection of β-LPH. Mean number of instrumental reactions during 1 h of observation. Unshaded columns — completed instrumental reactions; shaded columns — incomplete instrumental reactions not accompanied by the taking of food. A) Starvation for 2 days; B) fed animals. I) After injection of 3-5 μl physiological saline; II) after injection of 3-5 μl of β-LPH solution in a concentration of 91.5×10^{-6} μmole/μl.

Fig. 2. Food behavior of untrained rabbits after intraventricular injection of β-LPH. Mean quantity of food consumed (in g) during 1 h of observation. a) Animals not subjected to food deprivation; b) previously starved animals. Remainder of legend as to Fig. 1.

To determine the specificity of the effect of β-LPH, one of its derivatives (β-endorphin) was injected in a concentration of 269×10^{-6} μmole/μl in a volume of 3-5 μl (in physiological saline) into the lateral ventricles under the same experimental conditions.

The experimental results were subjected to statistical analysis.

EXPERIMENTAL RESULTS

The experiments showed that the effect of intraventricular injection of β-LPH largely depends on the level of the animals' motivational excitation.

In hungry animals (after deprivation of food for 2 days) a significant decrease ($P < 0.001$) in instrumental food-getting activity by 30-50% (compared with the number of instrumental reactions after natural starvation for 2 days) was observed 5-10 min after intraventricular microinjection of β-LPH. Meanwhile there was a significant increase ($P < 0.001$) in the number of behavioral reactions unaccompanied by the taking of food, which were characterized by stereotyped repetition of individual stages of the instrumental behavioral act (Fig. 1). In the untrained hungry animals injection of β-LPH reduced the consumption of freely accessible food by 50-67% (Fig. 2). These changes lasted 40-50 min.

Marked activation of instrumental food-getting behavior was observed in the unfed rabbits 5-10 min after injection of β-LPH for a period of 40-50 min. Comparison of the number of instrumental reactions after starvation for 24 h with the background instrumental activity showed no significant differences. Practically no instrumental reactions were observed to be performed in the wrong order or unaccompanied by the taking of food, even in the case of rabbits which demonstrated many such incomplete reactions during preliminary testing in a hungry state (Fig. 1).

The effect of intraventricular injection of β-LPH on the fed, untrained animals depended on the feeding program before the experiment. In rabbits deprived of food for 2 days on three or four occasions in the course of 16 days, intraventricular microinjection of β-LPH gave rise to a marked food response after 5-10 min. The quantity of food taken under these circumstances corresponded to the amount taken after starvation for 1 day. In animals which received food ad lib. for 16 days only a sedative effect was observed.

A sedative action of β-LPH on hungry and satiated animals was found 50-60 min after its injection and took the form of depression of general motor activity, the appearance of stereotyped movements, washing and grooming, and drowsiness. Catatonic movements of the trunk and head, arising involuntarily without any external provocative stimuli, were very characteristic.

Intraventricular injection of β-endorphin (269×10^{-6} μmole/μl, in a volume of 3-5 μl) did not cause the appearance of the changes described above in the character of the rabbits' food-getting behavior.

With an increase in the dose of β-LPH the more rapid appearance of the sedative effect was observed, for it now develops 30-35 min after injection of 3-5 μl of a solution in a concentration of 183×10^{-6} μmole/μl, and 15-20 min after injection of 3-5 μl of a solution in a concentration of 274.5×10^{-6} μmole/μl. Under these conditions the almost total sensation of food-getting activity was observed in the hungry animals, whereas the satiated animals demonstrated only a temporary increase in food-getting activity.

These results are evidence that β-LPH has a marked effect on the formation of food motivation in rabbits. The character of the effect of β-LPH on food-getting behavior depends on the initial motivational state of the animals and on the characteristics of the initial "hormonal and metabolic background" of the brain on which this substance acts. In hungry animals β-LPH predominantly inhibits, whereas in satiated rabbits it activates food-getting behavior. The absence of any effect of β-LPH on the "food" behavior of rabbits which have never been deprived of food must also be noted.

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