EFFECT OF ACOUSTIC STIMULATION ON THE PITUITARY – ADRENAL SYSTEM IN HEALTHY RATS AND RATS GENETICALLY HIGHLY SENSITIVE TO SOUND

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Hypertrophy of the pituitary and adrenals was found in male rats whose parents had audiogenic epilepsy. Acoustic stimulation of healthy rats led to an increase in weight of the pituitary and adrenals. However, acoustic stimulation had no effect on the weight of these glands in rats with audiogenic epilepsy.

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General nonspecific adaptation to stimuli of various kinds is effected through the hypothalamus–pituitary–adrenals system. Of the various physical stimuli, it was decided to investigate strong acoustic stimulation, giving rise to numerous biological and pathological responses [1].

Among rats living in ordinary animal houses, about 10% respond to strong acoustic stimulation by intense motor excitation and convulsions. In Professor L. V. Krushinskii's laboratory, a special line of rats responding to acoustic stimulation by fits has been bred by close inbreeding of these highly sensitive rats (98% of rats in a litter show audiogenic epileptic fits). This increased sensitivity to acoustic stimulation is transmitted from one generation to the next.

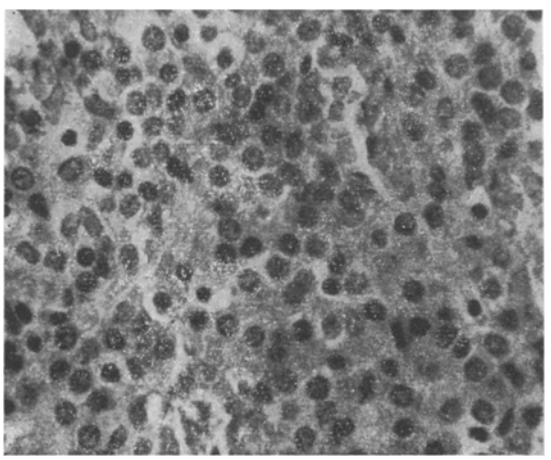

Fig. 1. Adenohypophysis of intact noninbred rats. Compact arrangement of all types of cells and intermediate forms. Trichrome–PAS reaction, 200 ×.

Since acoustic stimulation in this case can be regarded as a stressor agent, the present investigation was carried out to study the state of the pituitary–adrenal system in these rats highly sensitive to sound.

EXPERIMENTAL METHOD

Experiments were carried out on 44 male rats weighing 160-300 g divided into four experimental groups: groups 1 and 2 consisted of healthy, noninbred, rats from the Rappolovo Animal Nursery, and groups 3, and 4 consisted of rats with audiogenic epileptic fits, obtained from Professor L. V. Krushinskii's laboratory and bred in the animal house of the Bekhterev Institute by close inbreeding. As a rule rats of the same litter were included in groups 3 and 4. The rats of groups 1 and 3 acted as controls, and those of groups 2 and 4 were exposed 10 times to acoustic stimulation for up to 1.5 min each time in a special chamber, in a strength of 102 dB once every 3-4 days. The rats of group 2 did not respond by movements to acoustic stimulation, but those of group 4 responded with motor excitation and

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TABLE 1. Effects of Acoustic Stimulation on Weight (in mg) of Pituitary and Adrenals of Albino Rats

Group of animals	Pituitary		Adrenal	
	number	weight (confidence limits)	number	weight (confidence limits)
Noninbred rats				
Control (group 1)	10	7,3(5,5—8,9)	20	14,9(13,9—16,0)
Experiment (group 2)	9	9,5(8,2—10,7)	20	18,5(17,1—19,9)
Inbred rats				
Control (group 3)	7	10,9(8,3—13,4)	15	20,0(16,4—23,6)
Experiment (group 4)	16	9,6(8,3—11,0)	31	22,7(21,3—24,1)

Note. Differences significant only between groups 1 and 2 and groups 1 and 3 ($P < 0.05$); difference between groups 3 and 4 not significant ($P > 0.5$).

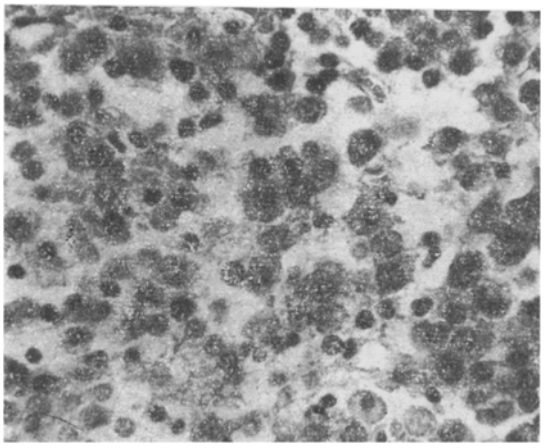

Fig. 2. Adenohypophysis of noninbred rats exposed 10 times to acoustic stimulation. Disintegration of cell complexes and scattered arrangement of cells, many of them retaining their large size. Trichrome—PAS reaction, 200 ×.

clonico-tonic convulsions. The rats were sacrificed with ether 24 h after the last exposure. After craniotomy, the animals' heads were fixed in 10% neutral formalin solution. The pituitary was removed and weighed immediately after craniotomy.

EXPERIMENTAL RESULTS

Microscopic examination of the adenohypophysis of intact noninbred rats (group 1) showed that its structure was compact and it contained both types of chromophils. Oxyphils—with all intermediate physiological forms of gland cells, from chief cells to overmature hyalinized—were somewhat more numerous. The capillaries were moderately congested with blood.

The adenohypophysis in the intact inbred animals of group 3 was compact in structure. The gland cells were distinguished by a cytoplasm of considerable size and by pale nuclei. Hardly any chief cells in a resting state were found. Basophilic cells with a massive, granular cytoplasm, in close contact with the capillary wall, were predominant. Hyperemia of the gland was absent. This pattern of hypertrophy reflects a state of preparation for function, not yet in operation, mainly of the basophils.

Microscopic investigation of the adenohypophysis of noninbred rats of group 2, exposed 10 times to acoustic stimulation, revealed disintegration of the normal cell complexes (dyscomplexation [2, 3]), characteristic of the state of stress and previously described by the writers. It is characterized by a diffuse arrangement of the gland cells, with a slightly increased volume of cytoplasm, which had discharged the whole of their secretion, lost their granules, and become separated from the rest (Figs. 1, 2, 3). This picture corresponds to an increase in weight of the pituitary, small yet significant when compared with the control, accompanied by marked hyperemia of the gland. These changes indicate a marked response of the glandular complex of the pituitary when in a state of active function and having given up the whole of its internal secretion.

Dyscomplexation of the pituitary against the background of marked basophilia and absence of chief cells, characteristic of these animals, was found in the inbred rats of group 4 after 10 exposures to acoustic stimulation. However, compared with the inbred control animals, the volume of cytoplasm of the cells was slightly less than that observed in the cells of the adenohypophysis of noninbred rats. This picture of mobilization of the gland without hypertrophy corresponded fully to the absence of increase in weight of the pituitary of the inbred rats after 10 exposures to acoustic stimulation (Table 1).

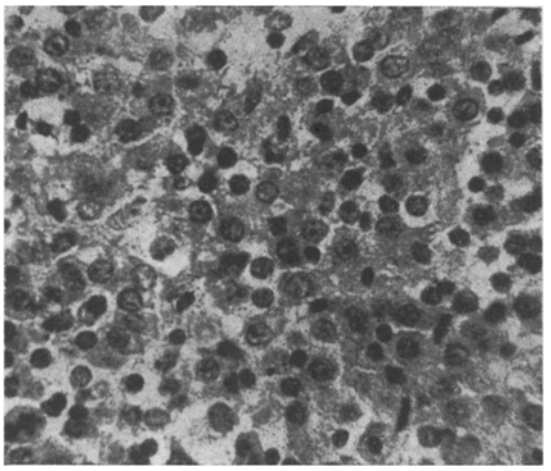

Fig. 3. Hypertrophy and compact arrangement of cells of adenohypophysis, with predominance of basophils, in inbred rat exposed 50 times to acoustic stimulation. Hematoxylin-eosin, 200 ×.

As Table 1 shows, the weight of the pituitary and adrenals of rats with convulsions and not exposed to acoustic stimulation (group 3) was significantly ($P < 0.05$) greater than in intact noninbred animals (groups 1 and 2). It may be postulated that hypertrophy of the pituitary and adrenals in audiogenic rats is an inherited characteristic, because it is observed in animals not exposed to acoustic stimulation, but born from parents with audiogenic epilepsy. However, the final solution to this problem requires examination of several generations. Inheritance of increased sensitivity to the hypertensive action of chemical stimulants (sodium chloride, cortisone) in rats, like that of genetically determined hypertrophy of the pituitary and adrenals, has been established by a number of workers [6, 8-11, 14]. Acoustic stimulation (10 times, 102 dB) in the course of 1.5 min led to an increase in weight of the pituitary and adrenals only in healthy rats (group 2), and stimulation of the same strength and duration had practically no effect on the weight of these endocrine glands in the audiogenic rats (group 4). Hence, the weight of the pituitary and adrenals was about the same in both groups after 10 exposures to acoustic stimulation, despite the fact that the rats of group 2 did not react to sound, while those of group 4 developed a convulsion. Possibly changes in the pituitary–adrenal system in audiogenic rats require stronger and more prolonged stimulation.

Other workers also have observed hyperplasia of the adrenals [13, 16] and an increase in adrenocorticotropic activity [12] under the influence of acoustic stimulation. Exposure of mice to acoustic stimulation in a strength of 100 dB for periods of 15-45 min over a period of 12 weeks had been shown [4] to lead to eosinopenia and to hypertrophy of the adrenals, without changes in the weight of other internal organs, and the eosinopenia was more marked in mice responding with fits than in those insensitive to acoustic stimulation [5]. According to existing evidence [15], a combination of acoustic and electrical stimulation produces much greater hypertrophy of the adrenals and a much greater increase in their ascorbic acid content than are produced by electrical stimulation alone. In healthy persons and patients with psychoses, acoustic stimulation increases the excretion of 17-hydroxysteroids and 17-ketosteroids [7]. The present results, like those published previously, thus suggest that prolonged exposure to acoustic stimulation causes increased function and hypertrophy of the pituitary–adrenal system.

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