PHYSIOLOGICAL RESPONSES OF THREE LINES OF RATS TO STRESS

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Psychoemotional stresses may lead to the onset and development of ulcers in the gastrointestinal tract, neuropsychopathies, and cardiovascular and other diseases [6, 7, 10, 11]. In addition, there is experimental and clinical evidence of individual reactivity to the action of stressors. In particular, not all persons or animals in the same stress-inducing situation will develop somatic or autonomic disturbances [4, 8, 9]. It was therefore decided to study levels of hereditary resistance to exposure to extremal factors at the level of the whole body and individual systems and organs.

The resistance of different lines of rats to emotional stress was compared with respect to autonomic reactions and taking account of differences of emotional reactivity.

EXPERIMENTAL METHOD

Experiments were carried out on adult male rats of the same age and belonging to the Wistar, August, and Fisher lines. Rats of each line were divided into groups: 1) control animals; 2) rats immobilized for 2 h; 3) immobilized for 24 h. All the rats were subjected to preliminary open field testing. The level of emotionality of the rats was judged as the ratio between parameters of investigative activity and autonomic reactions [1]. The criteria of resistance to stress were changes in body weight and in the weight of the adrenals and thymus, the state of the gastric mucosa [5], mortality associated with immobilization, and electrical stability of the heart. The latter was estimated in the animals of groups 1 and 3 on the basis of thresholds of onset of bradycardia and arrhythmias in rats under pentobarbital anesthesia (45 mg/kg) in response to stimulation of the right vagus nerve (duration of each pulse in burst 0.5 msec, duration of burst 1 sec, interval between bursts 1 sec). The consequences of 24 h of stress were evaluated in terms of the heart rate (HR) and the number and mass of fecal boli deposited. The numerical results were subjected to statistical analysis by nonparametric tests [2].

EXPERIMENTAL RESULTS

Preliminary open field testing of the rats revealed different levels of emotionality in the three lines of rats. The lowest relative index of emotional reactivity was found in Wistar rats (0.06 relative unit – r.u.), compared with 0.11 r.u. in August rats and 0.15 r.u. in Fisher rats.

Comparison of the morphological and physiological parameters reflecting the rats' adaptive powers revealed interlinear differences in the control animals for most characteristics. The relative mass of the adrenals in the Wistar rats was significantly lower than in August and Fisher rats (Table 1). The relative mass of the thymus did not differ significantly in rate of the three lines. The gastric mucosa of the Wistar and August rats had no particular features,

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TABLE 1. Physiological Parameters of Stress in Rats of 3 Lines (M ± m)

Line	Wistar			August			Fisher		
group	1	2	3	1	2	3	1	2	3
Absolute body weight, g	n=21 273±7,4*		n=16 224±6,1*	n=29 193±3,8*		n=15 176±4,7	n=26 287±4,0*		n=14 192±5,7*
K — relative decrease in body weight			1,4±0,6*			9,3±0,4			7,9±0,5
Relative mass (n)	8	8	9	7	7	7	6	6	6
Adrenal	0,140±0,01*	0,130±0,016*	0,203±0,003*	0,171±0,015*	0,164±0,008*	0,228±0,011*	0,167±0,032*	0,170±0,005*	0,21±0,028*
Thymus	4,5±0,28	4,6±0,25	4,4±0,11	4,7±0,22	5,26±0,18	4,8±0,17	4,2±0,24	4,4±0,15	3,47±0,15
(n) Boli			9			9			9
mass (mg)			2012±384*			1241±149*			937±132*
number			21,4±2,34			11,0±1,95			9,6±1,66
HR (beats/min) (n)	6		8	6		8	7		6
under anesthesia	407±46,3		425±31,6	437±11,5		449±44,8	417±16,4		392±17,6
without anesthesia		9 568±8,0	9 557±11,3		9 591±5,3	9 584±5,2		9 547±12,4	9 550±10,0
Thresholds, V (n)	6		6	6		6	7		7
bradycardia	0,98*±0,07		0,50±0,05	0,63±0,02		0,58±0,08	0,54±0,05*		0,50±0,04
arrhythmia	1,02±0,21*		1,05±0,33	1,15±0,28		1,05±0,30	0,71±0,10*		0,65±0,14
Index of emotional reactivity (n)			14 0,06±0,005*			16 0,11±0,013			11 0,15±0,016

whereas in most of the Fisher rats a clear vascular pattern could be distinguished. Significant interlinear differences in body weight were found.

HR under anesthesia was lower in Wistar than in August rats ($p < 0.05$). Thresholds of onset of bradycardic and arrhythmic responses, characterizing the electrical stability of the heart, were lower in Fisher rats than in the other lines.

Immobilization for 2 h evoked a significant increase in the relative mass of the thymus in August rats ($p < 0.025$) and a tendency to increase in Wistar and Fisher rats (Table 1). No significant changes in relative mass of the adrenals or in the gastric mucosa were observed in animals of the three lines.

Immobilization for 24 h led to a significant change in all parameters (Table 1). A significant interlinear difference was found in the loss of body weight and in the number and mass of fecal boli deposited. Values of these parameters were highest in Wistar rats. In the August and Wistar lines the mass of the thymus fell to its initial level. The fall in weight of the thymus in the Fisher line was significantly below the control level, possible evidence that the adaptive reserves were nearing exhaustion.

Differences in the degree of increase of the relative mass of the adrenals compared with the control were found (by 45% in Wistar, by 33% in August, and by 25% in Fisher rats).

A visual study of the gastric mucosa revealed the greatest changes in Fisher rats: multiple petechial and large hemorrhages were present. No large hemorrhages were found in Wistar and August rats. None of the rats of these lines had any ulcers or erosions of the mucous membrane of the gastric wall.

Immobilization for 24 h did not cause death of any of the Wistar or August rats, but 2 of 14 rats of the Fisher line died.

Electrocardiographic analysis showed that 3 types of response of HR to stress were observed in rats of all three lines: an increase, a decrease, or no change. The greatest amplitude of individual fluctuations of HR occurred in Fisher rats, the smallest in August rats (18 and 5% respectively). Determination of the electrical stability of the heart revealed a tendency for the threshold of the bradycardic reaction of the heart to be lowered in rats of all 3 lines, probably due to an increase in sensitivity of the sinus node to vagal inhibition [3]. No significant changes in the threshold of arrhythmias were found.

Rats of all three lines studied thus exhibited unequal resistance to stress, as shown by the different degrees of abnormality of somatic regulation. Since the lowest percentage increase in weight of the adrenals, involution of the thymus, large multiple hemorrhages in the stomach, a higher amplitude of HR fluctuations, and cases of death were observed in rate of the Fisher line in response to immobilization for 24 h, it can be concluded that these animals have lower resistance to stress than rats of the other two lines. Their index of emotional reactivity was the highest.

The greater relative increase in mass of the adrenals of Wistar rats in response to stress than of August rats, despite the absence of any marked differences with respect to other classical parameters, indicates that rats of this line have higher reserve powers of their sympathoadrenal system. Our results suggest that the relationship of anabolism to catabolism in response to stress differs in rats of different lines. The degree of reduction of body weight and the level of defecation of Wistar rats indicate the need for greater energy expenditure than by the other two lines in order to achieve higher resistance. The index of emotional reactivity was lowest of all in Wistar rats. Rats of the August line occupied an intermediate position as regards both resistance to stress and the level of emotionality.

The results indicate correlation between the characteristics of emotional reactivity of animals and their ability to adapt to severe stress.

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