Specific Features in the Behavior of Rats with Different Genetic Stability to Stress

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The effects of acute and chronic immobilization stress on the behavior of NISAG and outbred rats with different resistance to stress were evaluated. In the acute stress model, NISAG rats did not differ from stress-resistant outbred rats in the majority of the studied parameters. Chronic stress exhausted adaptive potential of NISAG rats, and their behavior became similar to that of rats with low resistance to stress.

Key Words: *emotional stress; behavior; resistance to stress*

There is evidence that the resistance to stress varies in animals of different and the same genetic strains [8]. The animals can be selected by this parameter [7]. At the same time it is important to understand physiological mechanisms responsible for formation of stress resistance in animals and humans. The use of experimental animals with different functioning of physiological systems determining stress resistance can be helpful in the investigation of these mechanisms.

The purpose of the present study was to examine the effects of acute and chronic immobilization stress on the behavior of rats with different genetic resistance to stress.

MATERIALS AND METHODS

Experiments were performed on male outbred albino rats and on rats with genetically determined stress-induced arterial hypertension (NISAG). Stress was produced by a 2-h immobilization by fixing the legs (acute stress, AS) or 18-h restriction of mobility in an individual cage (chronic stress, CS). Before and after stress, motor and exploring activities were estimated in the open field test [6], the ability to extrapolating avoidance [1] was evaluated, and the threshold electrostimulation pain (vocalization threshold) was determined. The rats were divided according to their resistance to stress as described previously [5] proceeding from parameters measured before acute and chronic stress.

In the first series of experiments we studied behavioral dynamics under conditions of zoosocial (pair) interaction [2]. The test was carried under monochrome red light on isolated platform (area 1 m^2) with drinking bowl, feeding box, box with sawdust, and individual "shelter", which were located in the corners and were designed for one animal. Before the test the rats were deprived of food and water for 48 h. Individual and zoosocial behavior under competitive conditions was estimated visually by the main motor acts and postures. The data were pooled into 12 behavioral and emotion-motivation categories (vectors), on the basis of which the processes of the higher nervous activity were estimated in points by "a scale of judgements". The direction and intensity of changes were determined as the ratio between the mean value of each vector during the poststress period to its original value.

RESULTS

Preliminary tests revealed differences in the behavior of rats with different resistance to stress. Rats with

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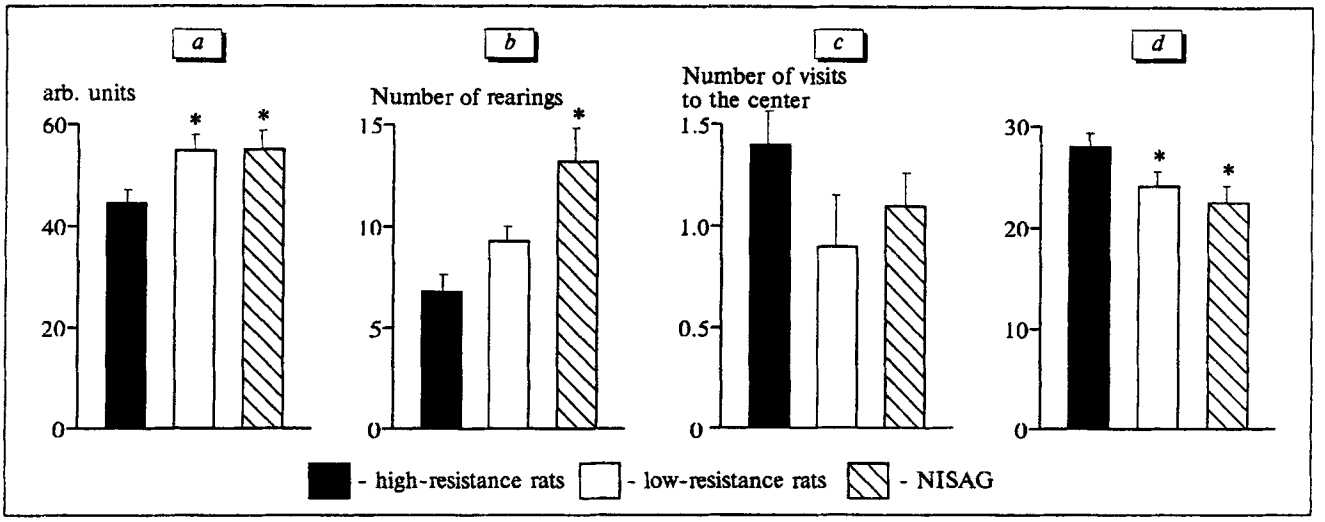

Fig. 1. Parameters of the initial behavior of rats with different resistance to stress. Here and in Fig. 2: a) motor activity; *b)* exploring activity; *c)* visits to the central zone; d) vocalization threshold. *$p<0.05$ in comparison with rats with high resistance to stress (Mann—Whitney test).

low resistance to stress had higher motor activity and low pain sensitivity threshold. NISAG rats were also characterized by higher motor and exploring activities and low vocalizations threshold in comparison with stress-resistant rats (Fig. 1).

Acute stress suppressed activity of rats in the open field test, as evidenced by low motor activity and decreased number of visits to the center and of grooming acts. Changes in these parameters were more pronounced in animals with low resistance to stress. The behavior of NISAG rats practically did not differ from that of outbred rats with high resistance to stress (Fig. 2).

Chronic stress inhibited behavioral reactions in all rats groups to a greater extent. The decrease in motor and exploring activities and in the vocalization threshold was the greatest in rats with low resistance to stress. In NISAG rats, behavioral changes induced by CS were more pronounced than those induced by AC; their absolute values approximated those of the corresponding parameters of rats with low resistance to stress (Fig. 2).

In the second series of experiments we studied the ability of rats to extrapolative avoidance of aversive environment. It was found that rats with high resistance to stress spent less time for taking the optimal decision, indicating a better preservation of the ability to chose correct strategy under stress. In rats with low resistance to stress and in NISAG rats, the number of unsuccessful attempts increased, while

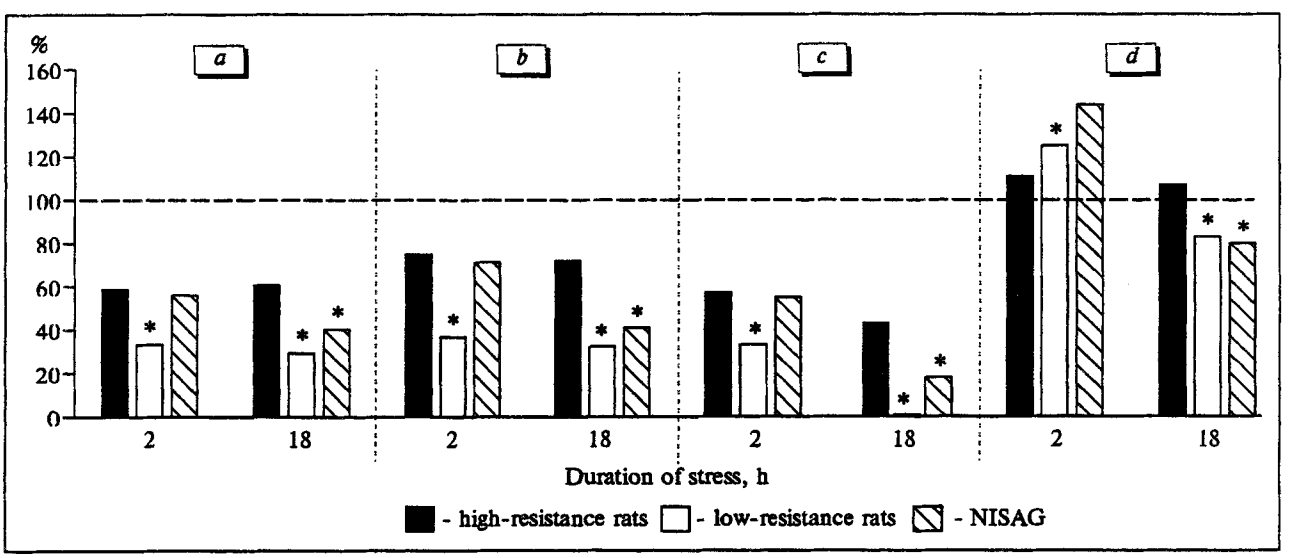

Fig. 2. Changes in the behavior of rats with different resistance to stress and NISAG rats under conditions of acute and chronic stress. Dashed line indicates the initial data.

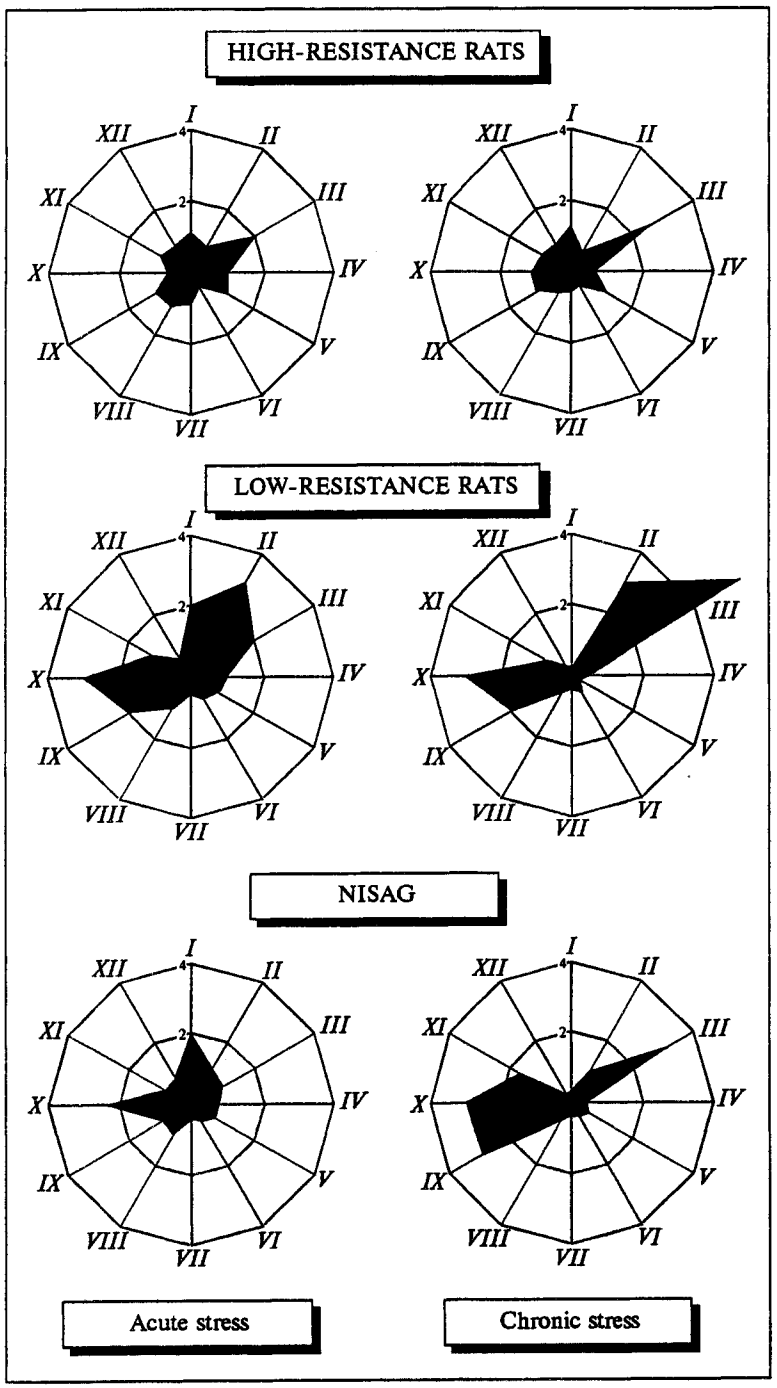

Fig. 3. Behavior of rats with different resistance to stress and NISAG rats under conditions of pair interaction in acute and chronic stress. *I)* aggressiveness; *II)* anxiety; *III)* negativeness; IV) exploring activity; *V)* self-maintenance; *VI)* positiveness; *VII)* comfort; *VIII)* motivation; *IX)* inadequate behavior; *X)* conflictness; *XI)* communication; *XII)* somatomotor elements of behavior.

that of correct choices decreased in comparison with animals with high resistance to stress (Table 1).

In the third series of experiments, the effect of stress on zoosocial behavior of rats was studied under conditions of pair interaction. Although this method is semiquantitative, it allows simultaneous estimation of the majority of emotional-motivation and somatomotor aspects of behavior [2].

In low-resistance rats, AS markedly suppressed motor and exploring activities as well as the self-maintenance behavioral components and increased anxiety and aggressiveness toward the intruder. The activity of rats with high resistance to stress was suppressed to a lesser extent (Fig. 3).

Chronic stress markedly decreased motor activity and practically all other vectors, which was accompanied by inadequate and ambivalent behavioral reactions and a more pronounced negative component. Similar to AS, CS induced greater changes in rats with low resistance to stress. The resistance

of NISAG rats to a short-term stress was greater than that of outbred rats. Chronic stress markedly inhibited most behavioral vectors, which confirms low resistance of these rats to a long-term (exhausting) stress (Fig. 3).

Previously, it was shown that NISAG rats, which are selected from an outbred population of Wistar rats by a pronounced hemodynamic reaction to stress, differ from the rest of the population in a number of neurochemical parameters. For instance, the total norepinephrine pool is decreased in the structures involved in the regulation of blood pressure (the solitary tract nucleus, anterior hypothalamus, and reticular formation) [3] and basal norepinephrine release is lowered [9] in the higher centers of autonomic regulation. Hence, it can be suggested that an increase in the number of α_1-receptors with a simultaneous decrease in the number of α_2- and β-receptors in these structures [10] is a compensatory reaction. Stressful factor induces much greater, as compared with the control, increase in the release of neurotransmitter [9], which is accompanied by intense hemodynamic reaction [4]. Presumably, CS exhausts reduced stores of the neurotransmitter.

Thus, the differences in the resistance to stress in outbred rats divided by some behavioral parameters have been confirmed experimentally. It was shown that the resistance of NISAG rats to AS is similar to that of high-resistance rats. It is likely that the resistance of these rats to short-term stress is similar to that of stress-resistant outbred rats. However, under conditions of CS the behavior of NISAG rats is similar to that of rats with low resistance to stress. It is likely that the adaptive capacity of NISAG rats provides active but short-term counteraction to an aversive stimulus.

TABLE 1. Behavior of Rats with Different Stability to Stress in the Extrapolating Avoidance Test *(M±m)*

Rats	Jumps	Time for solution, sec
High-resistance	0.3±0.2	16.8±2.8
Low-resistance	1.9±0.6*	29.2±3.7*
NISAG	2.4±0.4*	29.4±5.2*

Note. *$p<0.05$ compared with rats with high resistance to stress (Mann—Whitney test).

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