with potential anxiolytic properties and in the development of pathogenetic therapy of states of anxiety and phobia.

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Individual Differences of Responses to Acute Stress Associated with Type of Behavior. Resistance (Liability) to Disturbances of Behavior and Sleep

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The resistance of the organism to stress is known to be associated with individual specificities. For instance, it has been shown that under conditions of chronic stress the resistance of the cardiovascular system of rats of various genetic strains is different [9]. A different level of behavioral resistance to neurotizing effects has been discovered in the open field in rats with different levels of motor activity [7] and with different capabilities for elaborating the response of emotional resonance after P. V. Simonov [1].

The aim of the present work was to study resistance to acute stress (AS) in rats with different types of behavior in the open-field test and endurance swimming. The degree of stress resistance was assessed as the intensity of changes of the parameters of behavior and of the sleep-wakefulness cycle.

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MATERIALS AND METHODS

The experiments were carried out on 136 male albino rats. The type of animal behavior was determined with the aid of two tests: open field [2] and endurance swimming [10]. The rats were divided into groups as described previously [5]. Nine groups of rats were distinguished: two extreme groups with the active and passive type of behavior, one intermediate group, and 6 mixed groups (not used in the subsequent investigation). Within each of the three chosen groups (the two extreme groups and the intermediate one) the rats were divided into two subgroups: control and experimental. The rats of the control subgroups were subjected to two-time behavioral testing. Before the second test, the rats of the control subgroups were subjected to AS caused by unpredictable and ines-

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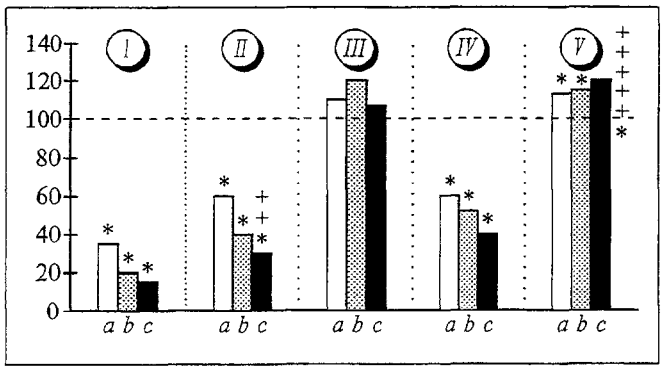

Fig. 1. Changes of parameters of behavior after AS in rats with different types of behavior. Abscissa: *1*) active type of behavior; *2*) passive type of behavior; *3*) intermediate group; ordinate: changes of parameters of behavior in % of control level (taken as 100% and shown by broken line). *I*) number of squares crossed; *II*) number of upright postures; *III*) number of groomings; *IV*) time of extinction of locomotor activity in open field; *V*) time of passive floating in Porsolt test. *: $p<0.05$ vs. control level; **: $p<0.05$ vs. group 1; ***: $p<0.05$ vs. group 2.

capable painful electrical stimulation of the paws (50 pulses, current 10 mA, duration of each pulse 0.5 sec, stimulation performed during one hour at randomly varied intervals). When the behavioral tests were finished, the electrodes for registering the sleep-wakefulness cycle were stereotaxically implanted in the rats of the control subgroups of all three groups (a total of 24 rats). A detailed description of the method is given elsewhere [4]. The initial parameters of the sleep-wakefulness cycle were recorded during 2 days (2 hours a day) in each rat and then (on the 3rd day) the same parameters were registered 1 hour after stress. Reliability of the differences between all the parameters studied was assessed according to Student's *t* test. The results were statistically processed on an IBM PC/AT with the aid of standard software.

RESULTS

The rats with different types of behavior initially demonstrated reliable differences with respect to such behavioral parameters as the number of squares crossed, the number of upright postures, the time of extinction of locomotor activity, and the time of passive floating. At the same time, no significant differences were initially revealed within each group between the control and experimental subgroups for each of the parameters studied (Table 1). The repeated testing showed a reliable decrease of locomotor activity (a smaller number of squares crossed, a decreased number of upright postures, and a reduced time of extinction of locomotor activity) and a reduced level of depressiveness (reduced time of passive floating). However, comparison of the parameters of behavior recorded during repeated testing of the control and experimental subgroups showed that AS caused marked suppression of locomotor activity (more pronounced than in the repeated test in the case of its natural extinction) and an increase (in contrast to the decrease observed for the repeated testing) of the time of passive floating. At the same time, the degree of intensity of these effects of AS was different in different groups: minimum in the rats with the active type of behavior, maximum in the rats of the intermediate group, while the rats with the passive type of behavior occupied a midpoint position (Fig. 1).

After AS, disturbances of the sleep-wakefulness cycle were observed in all rat groups: an increase of the period of alertness and a reduction of the period of sleep. However, the degree of intensity of this effect of AS also depended on the type of behavior: it was minimum in the rats with active behavior, maximum in the rats of the intermediate group, and in the rats with passive behavior the degree was intermediate (Fig. 2).

Thus, the resistance (liability) to disturbances of behavior and sleep caused by AS is associated with the type of behavior. The strongest resistance to AS was encountered in the rats with the active type of behavior, the lowest one was exhibited by the rats of the intermediate group, and the rats with the passive type of behavior occupied an in-

TABLE 1. Initial Parameters of Behavior in Rats with Different Types of Behavior ($M \pm m$, $n = 9-10$)

Parameters of behavior (during 10 min)	Rats with active type of behavior (1st group)		Rats with passive type of behavior (2nd group)		Intermediate group (3rd group)	
	control	experimental	control	experimental	control	experimental
I	108.4±4.0	111.1±11.2	36.3±6.1*	35.4±6.1*	81.1±5.9**,***	70.6±6.2**,***
II	24.5±2.1	31.8±4.4	8.3±1.6*	10.5±1.7*	14.7±1.9**,***	19.8±1.9**,***
III	7.5±1.4	9.0±2.1	5.5±0.9	7.1±2.5	9.3±1.4***	7.0±1.2
IV	10.0±0.0	9.9±0.1	6.6±1.0*	6.7±0.5*	9.5±0.2***	8.5±0.6**
V	434.5±15.4	435.5±10.6	505.0±7.5*	500.5±10.1*	473.3±2.2**,***	471.5±4.2**,***

Note. I) number of squares crossed; II) number of upright postures; III) number of groomings; IV) time of extinction of locomotor activity, sec; V) time of passive floating, sec. Asterisks indicate reliable ($p<0.05$) differences: * – between groups 1 and 2; ** – between groups 1 and 3; *** – between groups 2 and 3.

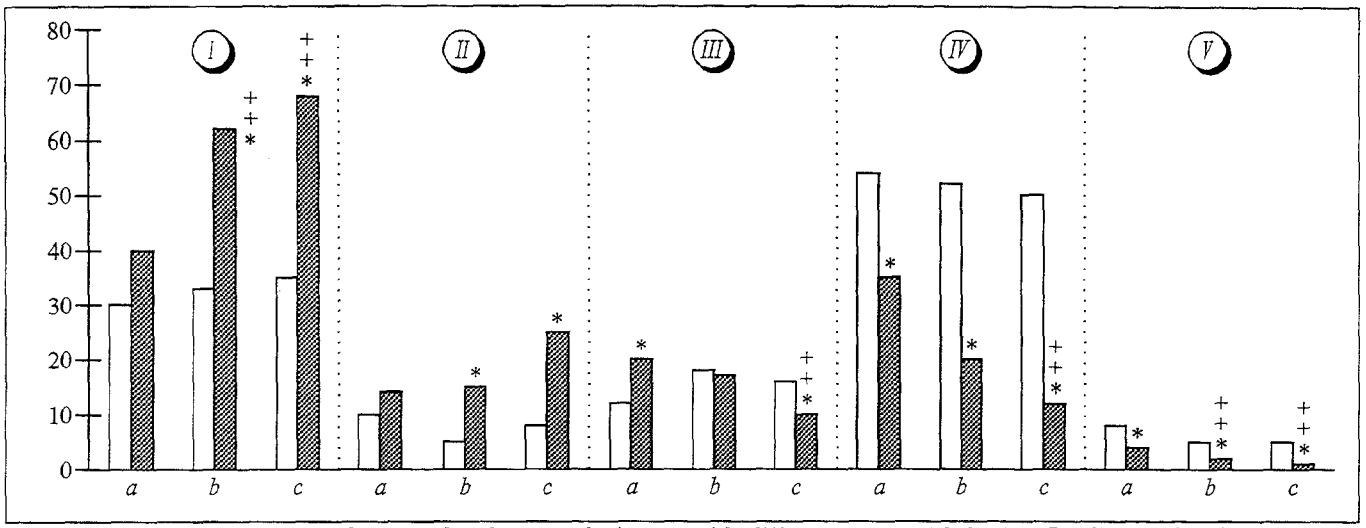

Fig. 2. Duration of stages of sleep–wakefulness cycle in rats with different types of behavior. Black bars: baseline; hatched bars: after AS. Abscissa: rat groups; ordinate: duration of stages, min. *I*) active alertness; *II*) passive alertness; *III*) slow superficial sleep; *IV*) slow deep sleep; *V*) REM sleep. Other notation as in Fig. 1.

termediate position. Comparison of these results with previously obtained data [5] indicates a positive correlation between the resistance to AS and the resistance to circulatory hypoxia of the brain. As was previously established by us [6], in a stress situation the local blood flow and the level of oxygen tension in the brain of rats with active behavior increase (the oxygen supply by the blood flow overcompensates for its increased demand), whereas in the rats with passive behavior and in those of the intermediate group, the oxygen tension in the brain drops in a similar situation (the oxygen supply does not compensate for its increased consumption) despite the increased local blood flow. Since the development of cerebral hypoxia is prompted by a stress situation, the mechanisms of adaptation to hypoxia on the level of cell metabolism may to a large extent predetermine the resistance to stress. The increased activity of the succinate dehydrogenase pathway of substrate oxidation in the brain of rats with the active type of behavior [3,6] is obviously an additional factor underlying their strongest resistance both to hypoxia [5] and to stress. The increased activity of the NADH oxidase pathway of oxidation in the brain of rats with the passive type of behavior [6] probably accounts for their intermediate resistance to hypoxia [5] and stress. The rats of the intermediate group, in which a clear prevalence of a certain type of behavior is absent, as is a predominant activity of a certain oxidative enzyme in the brain [6], prove to be the least resistant to both hypoxia [5] and stress. The fact that "intermediate" rats represent the group at increased risk for both circulatory hypoxia of the brain and stress, provides evidence that the absence of a pronounced individuality is not only less socially attractive, but also biologically unsound. The correlation between a certain type of behavior and specificities of brain oxidative metabolism may serve as a universal mechanism whereby, according to Simonov's hypothesis [8], the poorly adapting individuals are eliminated during the process of natural selection and a constant qualitative composition of the population is maintained.

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