GROWTH AND HEAT RESISTANCE OF RATS SUBJECTED TO REPEATED EXPOSURE TO HEAT IN EARLY ONTOGENY

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UDC 612.591.1

The effect of 10 daily exposures to heat from the 1st to the 10th, 10th to the 20th, and 20th to the 30th days of life, respectively, on subsequent growth and resistance of the animals to high temperatures was studied. Growth and survival of the rats were found to depend on the conditions of heat exposure. Animals aged 10-20 days were the most susceptible to the action of high ambient temperatures. In these rats, heat resistance was increased to the greatest degree during the period of sexual maturity, whereas the rate of growth was slower than in animals exposed to heat at the other age periods.

KEY WORDS: postnatal ontogeny; heat resistance; dynamics and rate of growth.

Various stressor agents, if acting in the early stages of postnatal development, can modify growth and development of the animal and also its resistance to unfavorable external environmental factors. The influence of stress agents on the body is known to be mediated through the nervous and endocrine systems, which respond differently at different stages of early ontogeny. It was therefore interesting to discover the age period at which animals would be most sensitive to repeated exposure to high temperatures, capable of modifying the heat resistance of the animal in the period of sexual maturity [3, 6, 12, 13].

In this investigation the effect of 10 daily exposures to heat for 1 h at different stages of early ontogeny of rats on the subsequent rate of growth of the animals and their resistance to high ambient temperatures was studied.

EXPERIMENTAL METHOD

Experiments were carried out on 60 albino rats divided into four groups. All the animals except the rats of the control group were kept for 1 h daily for 10 days in a hot chamber at 40°C with relative air humidity of 28-30%. The rats of group 1 were exposed to heat from the 1st to the 10th day, those of group 2 from the 10th to the 20th day, and of group 3 from the 20th to the 30th day after birth. Later, until the age of 60-70 days, all the animals were kept under ordinary conditions in the animal house, where the control animals also were kept.

The dynamics of growth was studied by weighing the control and experimental animals every 5 days from birth until the age of 2 months. The following parameters were determined: 1) absolute weight, 2) absolute rate of growth, i.e., the increase in weight per diem, calculated by the formula $C = (V_2 - V_1)/(T_2 - T_1)$, 3) the growth constant, calculated by the formula $K = (\lg V_2 - \lg V_1)/(\lg T_2 - \lg T_1)$, where V_1 and V_2 are the animal's weight (in g) and T_2 and T_1 its age (in days).

Heat resistance was judged from the time between placing the animal in the hot chamber under the conditions described above and the onset of the stage of heat shock (when the rectal temperature rose to 42°C). This test was carried out once only, when the rats reached the age of 60-70 days.

The experimental results were subjected to statistical analysis by the Student–Fisher method.

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(Presented by Academician V. N. Chernigovskii.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 83, No. 5, pp. 537-539, May, 1977. Original article submitted September 3, 1976.

TABLE 1. Dynamics of Increase in Weight (in g) of Control and Experimental Animals (M ± m)

Age of animals, days	Control animals	Exposed to heat in early ontogeny		
		from 1st to 10th day	from 10th to 20th day	from 20th to 30th day
1	5,715±0,14	5,42±0,15	5,806±0,17	5,92±0,12
P		>0,1	>0,5	>0,1
5	10,68±0,41	9,79±0,24	10,24±0,33	10,11±0,6
P		<0,1	>0,25	>0,25
10	15,42±0,53	16,07±0,6	14,27±0,32	14,69±0,47
P		>0,25	>0,05	>0,25
15	21,10±0,68	22,57±0,47	18,12±0,61	19,42±1,07
P		>0,1	>0,01	>0,1
20	28,127±1,3	30,9±1,85	24,25±1,08	24,73±0,88
P		>0,1	<0,001	>0,05
25	40,38±1,8	41,07±1,03	35,98±1,25	33,95±2,01
P		>0,5	<0,001	<0,05
30	48,25±2,1	52,5±1,09	46,01±0,9	39,49±2,01
P		>0,05	<0,01	<0,02
60	100,17±6,7	97,58±5,7	70,0±7,3	80,91±6,4
P		>0,5	<0,02	<0,05

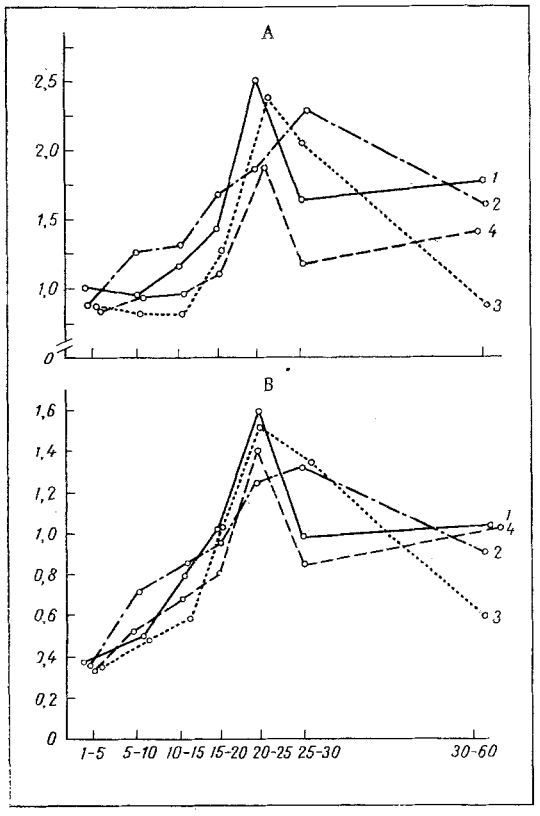

Fig. 1

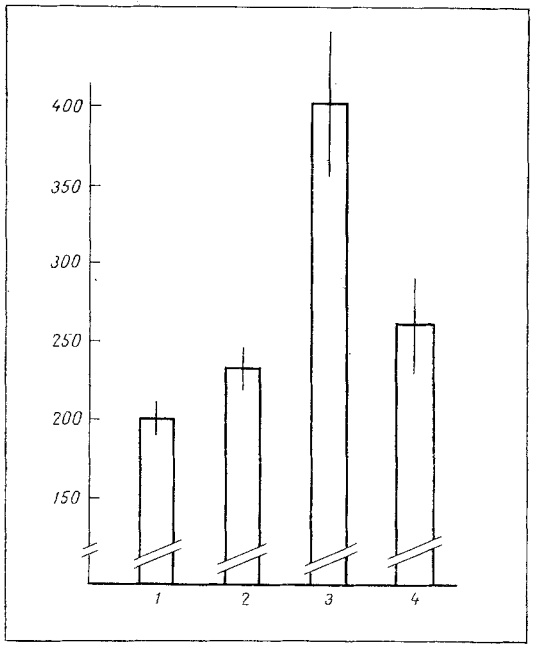

Fig. 2

Fig. 1. Dynamics of growth of rats of control group (1) and after exposure to heat from 1st to 10th (2), 10th to 20th (3), and 20th to 30th (4) days of postnatal development. Abscissa, age (in days); ordinate, growth constant (A) and absolute rate of growth (B) (in conventional units).

Fig. 2. Changes in resistance to high temperatures of rats during period of sexual maturity depending on time of exposure to heat in early ontogeny. Ordinate, time (in min). Remainder of legend as in Fig. 1.

EXPERIMENTAL RESULTS

As Table 1 shows, exposure to heat could produce some inhibition of growth in the rats, evidently as a specific response of the growing organism to high temperature [2, 4, 10, 11, 14]. Meanwhile, in animals exposed to heat at different stages of early ontogeny, some difference was found in the dynamics of the increase in weight. For instance, in rats exposed to heat from the 1st to the 10th days of postnatal development, stimulation of growth was observed, judging from the gain in weight.

In the animals exposed to heat from the 10th to the 20th and from the 20th to the 30th days after birth, no such increase in the rate of growth during the period of exposure to heat was observed, but after the end of these exposures definite activation of growth was observed (Table 1).

At the age of 2 months the weight of the rats of experimental group 1 (exposure to heat from the 1st to the 10th day after birth) and of the control group was about the same, whereas the mean weight of the animals of experimental groups 2 and 3 (exposed to heat from the 10th to the 20th and the 20th to the 30th days after birth, respectively) was considerably below the control.

Characteristic changes were observed on analysis of the growth constant and rate of growth (Fig. 1). The absolute rate of growth and the growth constant of the rats of the control and second and third experimental groups reached a maximum on the 20th-25th day of postnatal life, whereas in the rats of the first experimental group these indices continued to rise until the 25th-30th day. However, the maximal value in the rats of none of the experimental groups reached the control maximum (Fig. 1).

Resistance to prolonged overheating was increased in the animals of all the experimental groups: by 10% in the rats of group 1, by 100% in group 2, and by 30% in group 3 (Fig. 2). Exposure to heat in early ontogeny evidently promotes the development of a specifically increased resistance of the body to a high ambient temperature, and this continues into the later stages of ontogeny. The period from the 10th to the 20th day of postnatal development, when the mechanisms of thermoregulation are formed in rats [1], must be specially mentioned. Exposure to a high temperature during this period is accompanied by changes in physiological functions which, during the period of sexual maturity, considerably increased the heat resistance of the animals compared with the control, although the rats of this group were retarded in weight behind the control rats.

Periodic exposure to heat at different stages of early ontogeny thus has a definite effect on subsequent growth and development of the animals and the formation of their thermoregulatory mechanism, and these effects are also reflected in the resistance of the animal to prolonged overheating. These results confirm the views of many developmental physiologists regarding the existence of critical periods of development, characterized by increased lability of metabolic processes and high reactivity in response to external factors [8, 9]. Animals between the ages of 10 and 20 days, i.e., in the period of maturation of neuroendocrine mechanisms [5, 7] responsible for the regulation of the physiological functions of the organism, were found to be most susceptible to the effects of a high temperature.

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