METHOD OF STUDYING VESTIBULAR FUNCTION IN RATS

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Repeated exposure to accelerations for 1-2 h at normal and low external environmental temperatures (−20°) caused the rectal temperature of rats to fall by 10-15°. In animals previously cooled to 25-20°, no fall of body temperature followed exposure to accelerations.

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Single exposures to vestibular stimulation usually caused a fall in body temperature in man and animals [3, 11, 13]. This is usually disregarded when other vestibulo-autonomic reflexes are being studied.

When investigating vestibular function in rats we found that disturbances of thermoregulation may have secondary effects on the intensity of the nystagmus response. Special experiments were therefore carried out to study the relationship between postrotational nystagmus and fluctuations in the animal's body temperature.

EXPERIMENTAL METHOD

Two series of experiments were carried out on 65 rats. In series I (40 healthy animals) the effect of vestibular stimulation by radial accelerations, in the form of stop stimuli (rapid stopping after spinning at a particular angular velocity) on the rectal temperature was studied when the external environment temperature was 18-20°.

In series II the same stimuli were used but the rats were cooled to 25-20°. Cooling was carried out by a modified hypercapnia-hypoxia method, as the most physiological method and as one which has received considerable study as a means of minimizing the vital activity of rodents [7-9, 14, 15, 17, 19, 22].

The general condition of the animals was assessed from external signs (motor response, shivering) and the nystagmus response of the eyes to stop stimuli of increasing intensity (stopping within 1 sec after constant spinning at 18, 30, 60, 120, 180, 230, 300, 360, 480, 600, 720, 780, and 840 deg/sec) was determined. The animals were fixed to a revolving platform. Spinning in each case continued for 20 sec, with

TABLE 1. Duration of Postrotational Nystagmus in Rats with Normal Body Temperature and Cooled to 25°

Angular velocity of rotation (in deg/sec)	Duration of postrotational nystagmus (in sec)			
	before repeated opening	after spinning	before artificial cooling	after cooling
	36°	25°	36°	25°
120	3±0,7	1,0±0,66	3,76±0,46	0,94±0,6
240	4,5±1,2	2,4±1,5	—	—
360	9,6±1,2	4,7±0,8	11,9±0,78	6,41±0,54
600	12,2±1,6	6,8±0,93	14,38±1,03	6,64±0,77
720	12,5±1,5	7,7±1,32	14,19±1,01	8,72±0,84

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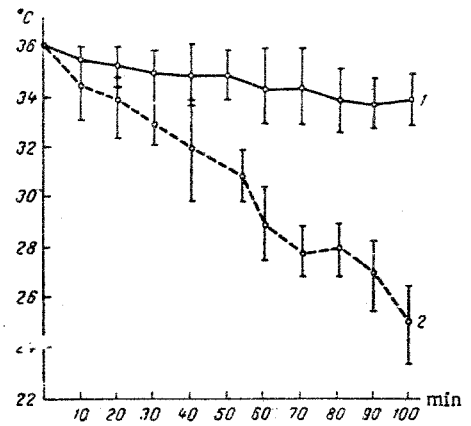

Fig. 1. Dynamics of changes in body temperature of rats depending on repeated vestibular stimulation at an environmental temperature of 18°. 1) Intact animals; 2) animals subjected to repeated accelerations of increasing intensity (from 18 to 840 deg/sec). Vertical lines show standard deviations (σ). Abscissa, time (in min); ordinate, body temperature (in deg.).

an interval of 2-3 min, and the experiment as a whole lasted from 1-2 h. Nystagmus was recorded on a type 4-ÉÉG electrocardiograph by means of electrodes placed at the outer corners of the eyes.

The experiments were carried out in a special chamber in which the environmental temperature could be maintained at any level between +56 and −20°. A lightproof hood was placed over the animal's head.

EXPERIMENTAL RESULTS

Repeated stimulation of the vestibular apparatus of the rats at a normal external environmental temperature for 1.5-2 h caused the rectal temperature to fall by the end of the experiment on the average from 36 to 25°. In control animals not subjected to rotation, no significant change took place in the body temperature during this period (Fig. 1).

More marked changes in body temperature were observed under the influence of repeated vestibular stimulation at low external environmental temperatures (−20°). In this case repeated spinning for 40-50 min lowered the body temperature of the animals on the average to 18°. In the control group of rats (not subjected to spinning) the rectal temperature did not fall below 27° during this period.

In the rats of series II, preliminarily cooled to 25°-20° by the hypercapnia-hypoxia method, prolonged stimulation of the semicircular canals did not cause any further decrease in the body temperature. On the contrary, despite repeated spinning, the body temperature gradually rose. A similarity between the behavior and changes in the nystagmus response was observed in the animals whose body temperature fell during spinning and as a result of hypercapnia-hypoxia. In both cases a slight decrease in the nystagmus reaction was observed when the rats were cooled to 27°. At a temperature of 25°, in the experiments of both series I and series II, a marked decrease in the postrotational nystagmus was observed. The animals' movements were slowed.

The results given in Table 1 show that the duration of nystagmus following stimulation of the vestibular apparatus by stop stimuli of different magnitude in rats cooled to 25° by the hypercapnia-hypoxia method and during cooling was approximately equal.

When the body temperature was 22°, nystagmus completely disappeared in response to vestibular stimulation by radial accelerations, and the animals' movements were inhibited. In rats cooled to 18°, shivering disappeared and adynamia developed.

We consider that the mechanism of the observed effect can be attributed to the direct action of vestibular stimulation on centers concerned with the regulation of the temperature reaction [16, 21, 23]. This hypothesis is confirmed by the absence of effect of vestibular stimulation on the temperature reaction of rats cooled to temperatures below 25°.

The possibility that the fall in blood pressure and changes in respiration which have often been during vestibular stimulation [6, 12, 20, 24] may have some influence on the observed temperature changes cannot be ruled out.

The sharp modification in temperature reaction of the rats may be attributed to imperfection of the thermoregulatory mechanisms in these animals.

The practical conclusion can be drawn from these findings is that when experiments are performed which involve vestibular stimulation in rats, a constant watch must be kept on the temperature reaction. To ensure constancy of the experimental conditions, the body temperature must be maintained artifically at the desired level.

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