EFFECT OF HYPOTHERMIA ON SUMMATION OF EXCITATION IN THE CENTRAL APPARATUS OF THE UNCONDITIONED REFLEX

V. A. Smotrov

UDC 612.833.8:612.592

Moderate hypothermia (body temperature 32°) in rabbits caused increased lability and reflex excitability of the central mechanisms of the shaking and flexor reflexes. At a body temperature of 25°, excitability and lability of the central mechanisms of the shaking reflex and excitability of the flexor reflex were reduced. The lability of the flexor reflex showed no consistent change.

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In this investigation the effect of different depths of hypothermia (32 and 25°), produced by application of rubber ice bags to the animals, was studied on the course of summation processes in the central apparatuses of the shaking reflex of the ear and flexor reflex of the rabbit's hind limb.

EXPERIMENTAL METHOD

The rectal temperature was measured by a TSM-2 electrothermometer at a depth of 6-7 cm. Summation of subthreshold excitation was obtained by application of rhythmic stimuli (5-500/sec) from an ISE-1 stimulator through a Bourguignon shunt to the skin of the lateral border of the upper third of the concha auriculae when studying the shaking reflex and to the plantar skin of the hind limb when studying the flexor reflex. Thresholds of reflex excitability for single and repetitive stimulation were determined. At the optimal frequency (with the lowest threshold of reflex excitability), the latent period of the reflex response evoked by the sum of the subthreshold stimuli was recorded; summation time was judged from the magnitude of the latent period. Changes in latent period were produced by an RRM-59 reflexometer and recorded on a kymograph.

Lapique's summation constant (z), reflecting the rate of extinction of local subthreshold excitation in the interval between stimulating pulses, was also calculated.

EXPERIMENTAL RESULTS

Under moderately hypothermic conditions (32°) a significant decrease was observed in the thresholds of reflex excitability for both single and repetitive stimulation in the case of both reflexes, and at the same time the difference between the single threshold and the thresholds of repetitive stimulation (amplitude or width of summation) was also reduced.

The optimal frequency of stimulation, which was 20-30/sec for both reflexes before hypothermia, shifted toward higher frequencies (60-100/sec) after lowering of the body temperature to 32° (Table 1).

On recovery of the initial body temperature the thresholds of reflex excitability and optimal frequencies of stimulation came close to the corresponding values before hypothermia. The summation time for the optimal frequency during moderate hypothermia showed a significant decrease for both reflexes ($P = 0.001$; Table 2).

The summation constant z at the optimal frequency of stimulation changed variously under hypothermic conditions (32°): it decreased significantly and then returned almost to its initial values during recovery. The significance of these changes was confirmed by statistical analysis (Table 2).

Department of Normal Physiology, Donetsk Medical Institute (Presented by Academician V. V. Parin).
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 66, No. 8, pp. 12-14, August, 1968. Original article submitted July 4, 1967.

TABLE 1. Effect of Moderate Hypothermia on Reflex Excitability (M ± m) and Distribution of Optimal Frequencies

Reflex and number of experiment	Body temperature	Mean value of thresholds (in V)		Optimal frequencies (per second) of those used			
		for single stimuli	for optimal frequency	number of experiments			
				20	30	60	100
Shaking 25 experiments	Initial, 37-38°	8.5 ±1.75	3.3 ±0.85	13	9	3	0
	During hypothermia, 32°	5.2 ±1.20	1.3 ±0.35	0	1	10	14
	In period of recovery, 37-38°	8.2 ±1.85	3.3 ±0.70	12	9	4	0
Flexor 20 experiments	Initial, 37-38°	71.1 ±16.3	37.5 ±8.6	11	7	2	0
	During hypothermia, 32°	42.0 ±9.6	19.3 ±4.8	0	0	10	10
	In period of recovery, 37-38°	67.5 ±14.2	36.2 ±8.9	10	10	0	0

TABLE 2. Changes in Summation Constant and Summation Time at Optimal Frequency under Influence of Moderate Hypothermia (M ± m)

Reflex	Mean value of constant			Mean values of summation time		
	body temperature					
	37–38°	32°	37–38°	37–38°	32°	37–38°
Shaking	0,07±0,01	0,03±0,01	0,06±0,01	0,37±0,09	0,22±0,06	0,36±0,09
Flexor	0,06±0,01	0,02±0,005	0,05±0,01	0,92±0,24	0,36±0,09	0,87±0,26

TABLE 3. Effect of Hypothermia (25°) on Reflex Excitability (M ± m) and Distribution of Optimal Frequencies

Reflex and number of experiment	Body temperature	Mean value of thresholds (in V)		Optimal frequencies (per second) of those used			
		for single stimuli	for optimal frequency	number of experiments			
				20	30	60	100
Shaking 25 experiments	Initial, 37-38°	13.1 ± 3.4	5.7 ±1.6	6	10	3	1
	During hypothermia, 25°	28.1 ± 6.7	13.8 ±3.7	5	10	5	0
	In period of recovery, 37-38°	12.8 ± 3.2	5.4 ±1.3	7	10	3	0
Flexor 20 experiments	Initial, 37-38°	58.5 ± 11.3	21.7 ±5.9	6	12	1	1
	During hypothermia, 25°	89.2 ± 18.5	45.9 ±11.2	17	3	0	0
	In period of recovery, 37-38°	63.5 ± 13.5	22.4 ±5.4	6	12	2	0

At a temperature of 25° the thresholds of single and repetitive stimulation of both reflexes increased considerably, and the amplitude of summation also increased ($P < 0.001$; Table 3).

The decrease in excitability of the central mechanisms of these reflexes was accompanied by lowering of the optimal stimulation frequencies, although for the shaking reflex this decrease was not statistically significant ($P > 0.05$). After reheating, excitability and the optimal frequencies returned close to their initial value (Table 3).

TABLE 4. Changes in Summation Constant and Summation Time under Influence of Hypothermia (25°), M ± m

Reflex	Mean values of constant			Mean values of summation time		
	body temperature					
	37–38°	25°	37–38°	37–38°	25°	37–38°
Shaking	0,06± 0,01	0,04± 0,01	0,057± 0,01	0,36± 0,09	0,76± 0,17	0,40± 0,12
Flexor	0,09± 0,02	0,12± 0,03	0,09± 0,02	0,56± 0,15	1,31± 0,39	0,56± 0,17

Changes in the summation time of both reflexes under hypothermic conditions (25°) and during recovery were consistent: a significant increase in summation time took place during cooling with a decrease almost to its original value after reheating (Table 4).

The changes in the summation constant of the investigated reflexes during hypothermia of 25° were variable in direction and not statistically significant: for the shaking reflex z remained low, but for the flexor reflex it was increased compared with its initial value. After reheating almost to the original temperature, the values of the summation constant returned almost to their initial level ($P > 0.2$) (Table 4).