DIURNAL RHYTHM OF COLD RECEPTOR ACTIVITY IN MAN

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The character of the diurnal rhythm of cold receptor activity was studied in the human skin. Curves showing the diurnal background activity of the cold receptors and the amplitude of their reflex responses to heating and to radiation cooling rise to a maximum at 5 PM and fall to a minimum at 1 AM.

About 40 physiological functions exhibiting definite cyclic changes with a period of about 24 h are now known [1]. For example, the activity of the cardiovascular, respiratory, and muscular systems, the basal metabolism, the number of eosinophils in the blood, the iron concentration in the plasma, the volume and composition of the urine, and so on, change periodically in the course of the 24 h [9-12]. Diurnal changes in visual function [6] and in the body and skin temperature [8] have been studied. Information has been obtained on the effect of photic stimuli on the course of thermoregulatory processes and on skin-temperature sensation [2, 5, 7]. However, the diurnal rhythm of activity of the thermoreceptors has not hitherto been investigated. The character of the response of the skin thermoreceptor system has been shown to change with the intensity of temperature stimulation (its local, reflex, or general action) [5].

These features reflecting the function of skin-temperature sensation in man under normal conditions and during fever determine several adaptive responses of the body [3-5].

The object of the present investigation was to study changes in the activity of the cold receptors of the skin during the 24 h.

EXPERIMENTAL METHOD

The medial surface of the forearm was investigated. The sensor of a thermoesthesiometer was applied in turn to each of 25 squares stamped on the forearm or to 20 previously located points in turn. Points from which, when touched, the person received a sensation of cold were taken as active. Activity of the cold receptor points was determined by the above methods throughout the 24-h period at several times: at 1, 5, and 9 AM and 1, 5, and 9 PM. The subject's body temperature was recorded at the same times. The reflex response of the cold receptors to temperature stimulation was determined at the same time of day. To judge the character of the reflex responses of the thermoreceptors, the number of active cold receptors was compared in the initial state, during reflex heating, and during subsequent radiation cooling by Kurilova's method [4].

The tests were carried out in a room with a constant intensity of illumination of 250 lx (daylight lamps). Altogether 144 tests were carried out during 4 days in December, 1969 and January, 1970 on 2 subjects aged 30 years and apparently healthy. As far as possible, the subjects' daily routine was normal.

EXPERIMENTAL RESULTS

The tests showed that from 9 AM until 5 PM the number of active cold points increased from 10.6 ± 0.99 to 15 ± 0.79 ($P < 0.05$). After this maximum had been reached the number of active cold points

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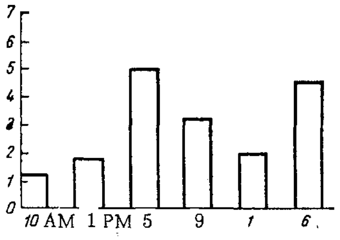

Fig. 1

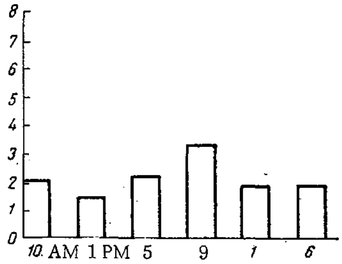

Fig. 2

Fig. 1. Amplitude of response of skin cold receptors to reflex heating at different times of day and night. Abscissa, time of day or night; ordinate, amplitude of response.

Fig. 2. Amplitude of response of skin cold receptors to reflex cooling at different times of day and night. Legend as in Fig. 1.

fell to reach 14 ± 1.19 by 9 PM and to reach its minimum (10.8 ± 1.18) at 1 AM. From 1 to 6 AM the number of cold points increased, almost to its maximum (14.3 ± 0.8). The character of the reflex responses of the cold receptors of the skin to heating and cooling depended on the time of day or night. In every case their response was adequate, i.e., the number of active cold receptors decreased in response to heat and increased in response to radiation cooling, in agreement with earlier observations [4]. However, the amplitude of this response differed with the time of day or night (Figs. 1 and 2). For instance, from 10 AM until 5 PM the amplitude of the response of the cold receptors to heating increased, reaching a maximum at 5 PM. By 9 PM it had fallen slightly, and by 1 AM it reached its minimum. The amplitude of the response was increased at 6 AM.

The amplitude of the reflex response of the cold receptors to radiation cooling differed somewhat from their response to heating. It was more gradual. The lowest amplitude was observed at 1 PM and the highest at 9 PM. However, the general trend of the responses was maintained.

The results indicate that the thermoreceptor system of the skin, like other systems of the body, has its diurnal rhythm. The number of active cold spots reached a minimum at 10 AM and 1 PM, when the intensity of illumination was at a high level, and reached a maximum at a time when the intensity of illumination and the external air temperature in winter were at a low level. At 1 AM under these conditions the number of active cold points was sharply reduced. At night, inhibitory processes in the central nervous system evidently had the predominant effect on their activity.

The results of these tests suggest the existence of a diurnal rhythm of function of the cold receptors which, together with other systems, bring about adaptation of the human body to the constantly changing external environmental factors.

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