BEHAVIOR OF THE SKIN-TEMPERATURE ANALYZER DURING THE ACTION OF PHOTIC STIMULI ON THE EYES AND SKIN

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The study of the changes in the function of the skin in various conditions of illumination has been the subject of a few reports in the literature [3, 4, 6-8, 15, 17]. At the same time, it is well known that light is a factor which exerts a powerful influence on the functioning of many systems of the body, including the thermoregulatory system [1, 2, 9, 16, 22]. P. P. Lazarev emphasized the embryological affinity of the nervous system, the organ of vision, and the skin, and assumed that a close analogy exists between the biophysical laws governing the action of light on the skin and the organ of vision.

The present study of the relationship between the optic and the skin-temperature analyzer was based on the following general biological considerations. First, these analyzer systems have a common origin and have become separated in the process of evolutionary development of the animal world; second, stimuli adequate for each of these systems are situated close together in the spectrum of solar emission, and the infrared (or thermal) part of the spectrum is not very clearly demarcated from the visible part by the intervening smooth transitional zone. In previous studies [5, 10, 11-13, 19] of this problem it has been shown that adequate temperature stimulation of the skin surface causes changes in the sensitivity of the photoreceptors of the dark-adapted retina, isolated from the action of the stimulus. These changes in sensitivity are strictly dependent on the cooling or warming of the skin surface. The reactions of the rods and cones of the retina preserve reciprocal relationships, as when an adequate photic stimulus acts on the eyes. If sources of heat with different characteristics of their emission spectrum (Sollux, infrared) are used, and if their thermal action on the skin surface is equalized, the level of sensitivity of the photoreceptors of the retina changes to a degree which increases as the emission spectrum of the heating apparatus moves closer to the visible spectrum. It has been suggested that the cutaneous receptor surface in man reacts not only to temperature stimuli but also to the action of the rays of the visible spectrum.

The object of the present investigation was to demonstrate the character of the influence of photic stimuli on the cutaneous receptor surface, as judged by the strength and direction of the reaction of its thermoreceptor system.

EXPERIMENTAL

Observations were made on human subjects. As photic stimulus, the eyes were illuminated with an AM-1 adaptometer, and the exposed surface of the skin (of the forearm, hands, and face) was illuminated by the daylight lamps used to light the experimental room. The intensities of illumination in the adaptometer and in the experimental room were the same (300-350 lx). The strength of the reaction of the cutaneous receptor surface was judged by the change in the number of functioning cold spots on the palmar surface of the skin of the forearm detected by means of a cold thermoesthesiometer, having a thermoprobe 1 mm in diameter. The temperature of the experimental room remained constant during the experiment.

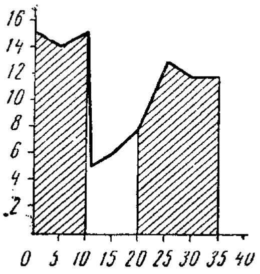

Fig. 1

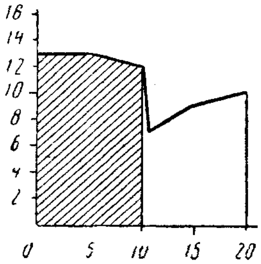

Fig. 2

Fig. 1. Change in the functional tuning of the skin-temperature analyzer depending on the conditions of adaptation of the optic analyzer (mean data). Abscissa) time (in minutes); ordinate) number of functioning cold receptors. Shaded areas) dark adaptation; unshaded areas) light adaptation.

Fig. 2. Functional tuning of the skin-temperature analyzer in different conditions of illumination of the experimental room (mean data). Designation of axes as in Fig. 1. Shaded area) experimental room in darkness; light area) room illuminated by a daylight lamp.

The scheme of the experiments was as follows. Fifteen cold spots were found on the palmar surface of the skin of the subject's forearm. Next, his skin surface and eyes were adapted to darkness for 25-30 min, after which the number of active cold spots of the 15 previously found was determined twice in red light. The eyes were then illuminated for 10 min by means of the adaptometer, and after the light had acted for 1, 5, and 10 min the number of active cold spots was again determined. In this case the skin surface remained throughout the experiment in constant conditions of dark adaptation. In the other experiments, conversely, the optic analyzer remained in conditions of constant dark adaptation (a dark bandage was placed over the eyes), and the exposed skin surface, preliminarily adapted to darkness, was illuminated for 10 min. After the action of light for 1, 5, and 10 min on the skin, the change in the number of active cold spots by comparison with the original level in darkness was determined.

Experiments were also carried out in which the change in the functional activity of the cold receptors was determined in a similar way in different conditions of general adaptation of the eyes and the skin surface (during general illumination and darkness of the experimental room). Altogether 120 observations were made on six subjects.

RESULTS

In conditions of dark adaptation of the optic analyzer the functional level of the cold receptors of the skin is high. In the period of light adaptation of the optic analyzer, a clear decrease was observed in the number of active cold spots on the skin surface compared with that found in the conditions of constant dark adaptation. A change from light-adaptation to dark-adaptation of the eyes again caused an increase in the number of functioning cold spots. It may be seen in Fig. 1 that illumination of the eyes after adaptation of the subject to darkness for 30 min led to a considerable decrease (from 15 to 5, i.e., by $^2/_3$) in the number of functioning cold spots on the skin surface 1 min after the beginning of the action of light on the eyes, by comparison with the number found in darkness throughout the experiment. During the following minutes of light adaptation of the eyes a slight increase was observed in the number of active cold spots in the skin, which reached eight by the tenth minute. Repeated dark adaptation of the eyes led to restoration of the number of functioning cold spots almost to the original level.

If the eyes were kept in conditions of constant dark adaptation and the character of the illumination of the skin surface was changed, in this case the number of functioning cold spots was reduced during illumination of the skin after its preliminary dark adaptation (Fig. 2). The reaction of the cold receptors of the skin in this case was less intensive than during illumination of the eyes (Fig. 1). The number of active cold spots fell after illumination for 1 min from 13 to 7 (i.e., by $^1/_2$). This difference in the intensity of the reactions of cold receptors was particularly pronounced in cases when, as the experiment proceeded, the eyes alone were illuminated, after which the skin surface only was illuminated, and lastly, both the eyes and skin were illuminated together. Each of these stages was

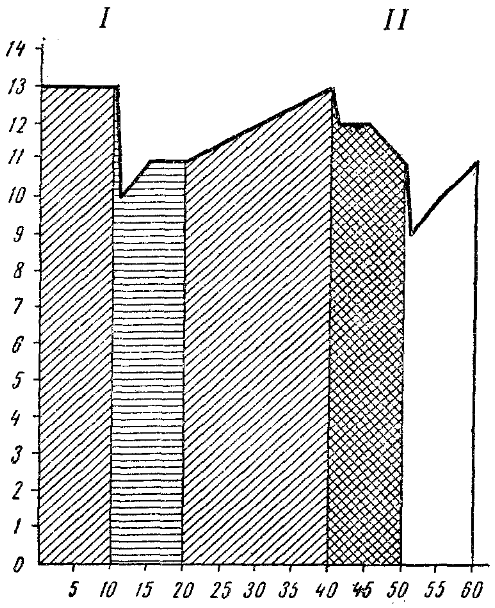

Fig. 3. Comparative characteristics of the functional level of the skin-temperature analyzer in different conditions of illumination, acting both through the optic analyzer and directly on the cutaneous receptor surface (mean data). Designation of the axes as in Fig. 1. Oblique shading) dark adaptation of optic analyzer and skin; horizontal shading) eyes illuminated, skin in darkness; crossed shading) skin illuminated, eyes in darkness; unshaded area) eyes and skin both illuminated. I) Experimental room in darkness; II) room illuminated by daylight lamps.

separated from the others by a preliminary period of adaptation of the subject to darkness for 30 min (Fig. 3). During illumination of the eyes the number of functioning cold spots of the dark-adapted skin surface fell by 33% by comparison with the number during dark adaptation of the eyes. During illumination of the skin surface only (with the eyes dark-adapted) the number of active cold spots fell by only 20%. If the eyes were illuminated against the background of illumination of the skin for 10 min, the number of functioning cold spots was reduced by a further 19%, i.e., by 39% compared with their number functioning in the conditions of darkness. Hence, the intensity of the reaction of the cold receptors to illumination reached its maximum in the period of combined action of the photic stimulus on the eyes and on the skin surface.

The results obtained demonstrate that the functional state of the skin-temperature analyzer bears a definite relationship to the action of photic stimuli on the body. The light may influence the functioning of the skin-temperature analyzer both through the optic analyzer and by its direct action on the cutaneous receptor surface, causing an appropriate adjustment in the tuning of the thermoreceptor system of the skin.

In cases when the conditions of adaptation of the optic analyzer were changed and the skin remain in constant conditions of temperature and in darkness, the possibility must be considered of reflex influences from the optic analyzer on the thermoreceptor system of the skin, as a result of which a change took place in the functional level of the thermoreceptors. A similar change in the functional state of the thermoreceptor system of the skin when kept in constant conditions of natural illumination, during a change in the conditions of adaptation of the optic analyzer, was described by the authors previously [14].

The present study also showed that, if the optic analyzer remains in constant conditions of dark adaptation (i.e., during exclusion of vision), a change from darkness to light and vice versa leads to a change in the reaction of the thermoreceptors of the skin. Hence, an adequate stimulus for the optic analyzer—visible cold light—is not indifferent for the organism even if it acts only directly on the skin surface.

The results of this investigation supplement earlier findings indicating a functional connection between the optic and skin-temperature analyzer systems.

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