EFFECT OF THE CONDITIONS OF ADAPTATION OF THE OPTIC ANALYZER TO THE FUNCTION OF THE THERMORECEPTORS OF THE HUMAN SKIN

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(Presented by Active Member AMN SSSR V. V. Parin)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 57, No. 3,
pp. 3-6, March, 1964
Original article submitted

The starting point for this study of the functional relationship between the optic and skin-temperature analyzers was the general biological principle of the close relationship between heat and light, which, in the natural conditions of existence of the animal world, are derived from the same source – the sun. We have previously shown [7, 11] that, in constant conditions of adaptation of the eye (dark adaptation), the functional state of the optic analyzer undergoes regular changes during the action of temperature stimuli on the skin, and also that the character of these changes corresponds to that arising in response to the action of light on the eyes. It was thus established that temperature stimulation of the thermoreceptors of the skin is reflected in changes in the functional state, not only of the skin-temperature, but also of the optic analyzer.

The question arises whether changes in the functional state of the skin-temperature analyzer take place during the action of light on the eyes, and if so, in what form. No information directly bearing on this problem could be found in the literature. In a few papers [3, 4, 9], admittedly, the fact is reported that the level of cutaneous sensation is raised in persons exposed to illumination. K. M. Bykov and A. D. Slonim [2] described the great importance of influences from the optic analyzer on thermoregulatory processes. The same conclusion was reached by other authors [1, 2, 5, 8]. They agree that a bright light, which is usually associated with a raised temperature, may act as a signal for the thermoregulatory process coming from the cerebral cortex.

The object of the present investigation was to show what changes in the functional state of the thermoreceptor system of the skin take place in various conditions of adaptation of the optic analyzer. In the experiments the general intensity of illumination of the experimental room was not changed, but only the conditions of adaptation of the eyes.

EXPERIMENTAL METHODS

During the period of dark adaptation of the eyes, which was produced by fitting the subject with dark glasses covered with a layer of gauze, 15 cold spots were located on the medial surface of the forearm by means of a cold thermoesthesiometer with a thermoprobe 1 mm in diameter and a temperature of 0°. The areas of sensitivity to the cold stimulus were demarcated with ink to ensure that in successive investigations the same cold spots were tested. The observations were made in a naturally illuminated experimental chamber. The area of skin investigated was kept in constant conditions of illumination and at the constant temperature of the experimental room. The number of functioning cold receptors was determined 3 times in the course of 10 min. The number thus obtained characterized the initial level of mobilization of the thermoreceptors of the skin during dark adaptation of the optic analyzer. The dark glasses were then removed and the number of functioning cold receptors from among the 15 cold spots previously located was again determined in the same area of skin at intervals of 1, 5, and 10 min from the beginning of light adaptation of the optic analyzer. The change in the number of active cold spots determined during darkening and illumination of the eyes characterized the functional state of the cold analyzer in different conditions of adaptation of the optic analyzer.

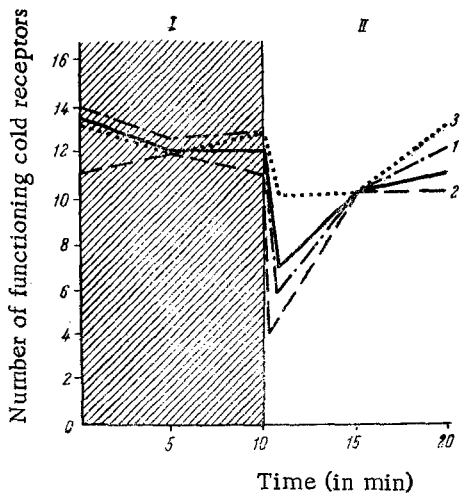

Fig. 1. Mean results of investigation of reflex reactions of the thermoreceptors of the skin during various conditions of adaptation of the optic analyzer. I) Dark adaptation; II) light adaptation. 1) Subject G; 2) subject B; 3) subject V.; 4) arithmetical mean for the 3 subjects.

EXPERIMENTAL RESULTS

The observations made during dark adaptation of the eye showed that the level of mobilization of the cold receptors was higher than during light adaptation. The results of observations made on 3 subjects are given in Fig. 1. In all the subjects the initial level of mobilization of the cold receptors during dark adaptation of the optic analyzer was fairly high (on the average 12-13 functioning cold receptors from the 15 initially found. When the conditions of the optic analyzer changed from dark to light adaptation, a sharp decrease was observed in the level of mobilization of the cold receptors [6-4]. The greatest reaction was observed in the 1st minute, after which the functional level rose slightly, although remaining below the initial figure. Consequently, in these cases, too, we observed the phenomenon of biological "over-insurance," described by P. G. Snyakin [12, 10]. The essence of this phenomenon is that physiological systems respond initially to a considerable and rapid change in external environmental conditions with a slightly stronger reaction than the conditions required, or with a slight margin to spare. A short time later (which varies with different systems) complete agreement is reached between the strength of the acting environmental factor and the response reaction of the organism. We observed this phenomenon earlier, when studying the reflex effects of temperature stimulation of the skin (by means of an infrared lamp) on the functional state of the optic analyzer.

During the next change from dark to light adaptation of the optic analyzer and back again in the same experiment, a consistent reaction of the cold receptors of the skin was observed. During the change from light to dark adaptation of the optic analyzer the level of function of the cold receptors increased, and during the change from dark to light it decreased again (Fig. 2). It should be noted that when light adaptation of the optic analyzer was replaced by dark, the functional modification of the cold receptors of the skin took place much more inertly than when the opposite change was made. This is understandable because the optic analyzer becomes adapted to light much more rapidly than to darkness.

The results demonstrate that the conditions of adaptation of the optic analyzer are reflected in the functional state of the thermoreceptor system of the skin. This system reacts to changes in the conditions of adaptation of the optic analyzer by a suitable functional modification taking the form of a change in the level of mobilization of the cold receptors. The character of this modification is the same as that found during the action of temperature stimuli on the cutaneous receptor surface. In fact, during dark adaptation of the eye, the level of mobilization of the cold receptors is raised, as is the case during cooling of the skin. Light adaptation of the optic analyzer leads to a lowering of this level, as is observed during warming the skin [6]. In other words, darkening the eyes, a signal of cooling, leads to a corresponding modification of the cold receptors, as expressed by an increase in their functional level. Illumination of the eyes is a signal of warming and evokes a lowering of this level, i.e., what is apparently a modification to warming takes place.

The fact that the level of mobilization of the cold receptors was lowered in the first minute after a change from dark to light adaptation indicates the reflex mechanism of this reaction. In this case the photic stimulation did not act directly on the cutaneous receptor surface, but through the intermediary of the photoreceptors of the retina. We were thus dealing with reflex influences from the optic receptor system on the thermoreceptor system of the skin. The initial link of this reflex arc is formed by the photoreceptors of the retina and its final link by the thermoreceptors of the skin of the forearm, the required functional level of which is established under the influence of a centrifugal stream of impulses.

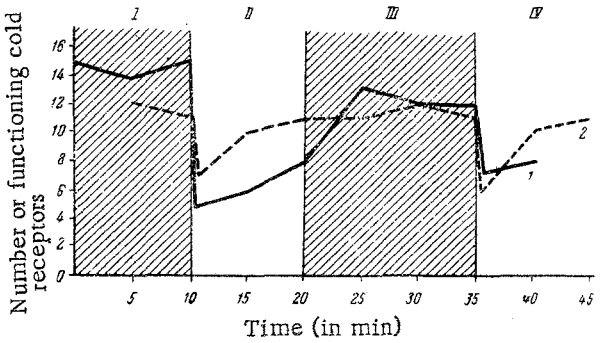

Fig. 2. Character of reflex reactions of the thermoreceptors of the skin to different conditions of adaptation of the optic analyzer. I, III) Dark adaptation; II, IV) light adaptation. 1) Subject G. 2) subject B.

SUMMARY

A discussion is presented of the effect produced by light stimulation applied to the optic analyzer alone on the function of the temperature analyzer. The cutaneous-temperature analyzer was kept on constant illumination and temperature. The light effects from the retinal photoreceptors on the cutaneous thermoceptor system led to reflex changes of the functional rate of the latter. Conditions of the optic analyzer of light adaptation caused reflex adjustment of cold receptors as to heating. Dark adaptation of the eyes changed the functional state of the cold receptors, corresponding to their adjustment to low temperatures.

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