

REFLEX REACTIONS OF THERMORECEPTORS

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Studies of the function of the skin-temperature analyzer have shown [2, 3, 4] that the character of the reaction of the thermoreceptors varies depending on whether the temperature stimulus acts locally or reflexly on the subject. It has been observed that the character of the reactions is determined by the duration of the action of the temperature stimulus and by the area of the skin surface stimulated.

The object of the present study was to determine what duration of the action of a temperature stimulus is necessary so that reflex reactions of the thermoreceptors may be observed. Experiments of this type are also necessary because in clinical practice, in order to judge the course of development of a pathological process, the best of all the objective physiological criteria that can be used are, in fact, the reflex reactions of the thermoreceptors.

Investigations were carried out on human subjects. The results of 220 experiments conducted on 12 persons are described.

EXPERIMENTAL METHOD

The function of the thermoreceptors was studied by the method of previously found points. The medial surface of the forearm was chosen as the test object. In this area of skin, from 10 to 15 points responding to a cold stimulus were found by contact with a cold thermoesthesiometer, and these were marked with ink. After adaptation to the temperature of the experimental room (10-15 min), the number of functioning cold spots from among those previously found was recorded, and during the next 10 min the results were verified three times, to enable the initial functional level of the thermoreceptors to be established. The skin in another part of the body was then heated (on the back or the symmetrically opposite area of skin of the other forearm or the leg) for 2, 4, 6, or 10 min. The number of functioning points was then tested again, from which the character of the reflex changes in the thermoreceptor system of the skin of this part of the body as a result of heating another area of skin could be judged. After cessation of heating, the functional level of the thermoreceptors was again determined. Switching off the heating apparatus did not stop the action of the temperature stimulus, because the subsequent radiation cooling is a stimulus for the thermoregulatory system just as is heating. The heating apparatus used consisted of a lamp with an infrared radiator.

EXPERIMENTAL RESULTS

During heating of the skin of the back for 2 min with the infrared lamp, situated 1 m from the skin surface, changes were observed in the level of mobilization of the thermoreceptors of the tested area of skin of the forearm, not directly exposed to temperature stimulation. However, these changes varied greatly in character in different subjects, so that the action of the temperature stimulus for this duration cannot be regarded as long enough to demonstrate the reflex reactions of the thermoregulatory system. Similar results were obtained during the action of the temperature stimulus on the skin of the back for 4 min.

The reflex changes in the thermoregulatory system of the skin were most marked in cases in which the heating apparatus was placed 1 m from the subject's back and the heat was applied for 6 or 10 min. Our observations thus showed that to detect the reflex reactions of the thermoreceptors the above-mentioned conditions must be observed. Corresponding reflex changes in the functional level of the thermoreceptors were observed after switching off the heating apparatus. In this case the level of mobilization of the cold receptors was raised, to reach the highest initial functional level at the 10th minute (Fig. 1).

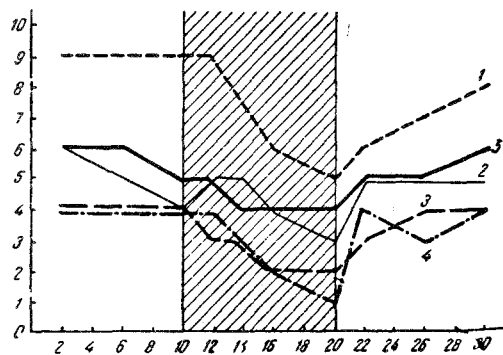


Fig. 1. Changes in reflex mobilization of cold receptors of the skin of the forearm during heating and subsequent radiation cooling of the skin of the back for different time intervals. Along the axis of abscissas – time (in min). Along the axis of ordinates – level of mobilization of (number of functioning) cold receptors in the tested area of skin. Shaded area) period of heating. 1) subject P. (20 experiments); 2) subject N. (27 experiments); 3) subject G. (24 experiments); 4) subject M. (6 experiments); 5) mean results of 81 experiments on 5 subjects.

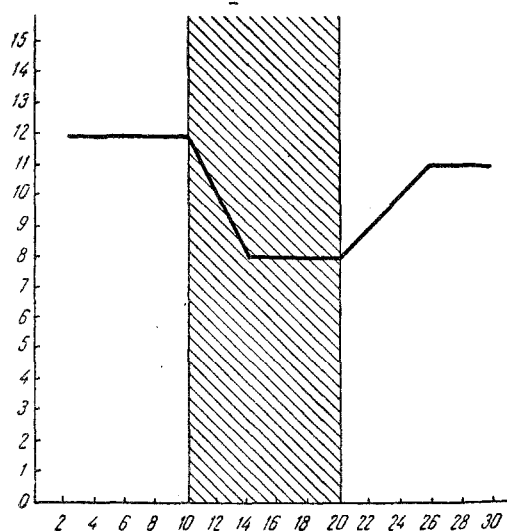


Fig. 2. Change in reflex mobilization of cold receptors of the skin of one forearm during heating and subsequent cooling of the symmetrical area of skin of the opposite forearm. Continuous line – mean results of 73 experiments on 9 subjects. Remainder of legend as in Fig. 1.

lower limb to be heated, to a distance of 50 cm. The results of the study of these reflex influences from the lower limb on the upper limb are shown in Fig. 3. The character of the reflex reactions of the thermoreceptors of the skin of the upper limb during heating and cooling of the lower limb remained the same as during heating and cooling of the opposite upper limb.

The results described above indicate that during the action of temperature stimuli on one part of the skin receptor surface, reflex reactions appear in the thermoreceptors in other parts of the skin, not exposed to direct thermal action. It must be remembered that reflex changes in the thermoreceptor system take place only during the action

After the skin of the back had been heated for 2 min, the functional level of the cold receptors of the forearm remained practically at its initial value. After heating for 4 min, on the average the level was lowered. It must be remembered, however, that in some subjects this level remained unchanged. After 6 min, it was established at a lower value, at which it remained, or fell still further until the 10th minute of action of the heating apparatus. When the heating was discontinued after a period of 10 min, as a result of the radiation cooling effect the level of mobilization of the cold receptors began to rise after 2 min, and after 10 min it had regained its initial values.

During the action of the temperature stimulus of the back, reflex reactions develop in the symmetrical skin areas of the opposite forearms. It is most important to remember this in clinical neurology, for asymmetry is frequently observed in a number of diseases [7, 8].

When heat is applied to the skin surface of one upper limb, besides its local action, reflex effects on the thermoreceptors of the skin of the opposite upper limb, not exposed to the direct action of the temperature stimulus, may be observed. In these cases, however, in order to detect the reflex changes, the intensity of action of the temperature stimulus must be increased, for the area of the skin surface to be stimulated is smaller than when the skin of the back is heated. The results obtained showed that reflex changes in the thermoreceptor system of the skin of the upper limbs may be detected if the heating apparatus is placed 50 cm from the heated skin surface of the opposite limb. The duration of heating remains the same as when the skin of the back is heated (Fig. 2). In these conditions a reflex lowering of the level of mobilization of the cold receptors of the skin of the opposite upper limb was observed. The radiation cooling of the upper limb taking place after switching off the heating apparatus caused a reflex raising of the level of mobilization of the cold receptors of the tested area, just as in the case of radiation cooling of the back.

Reflex changes in the thermoreceptor system of the skin may also be observed in cases when the lower limb is heated and the medial surface of the forearm is tested. In these conditions, temperature stimulation of the skin receptors of the lower limb caused a reflex reaction of the thermoreceptors of the skin of the upper limb. As in the case of the reflex influences from one upper limb to the other, before these reflex changes could be detected it was necessary to bring the heating apparatus nearer to the skin surface of the

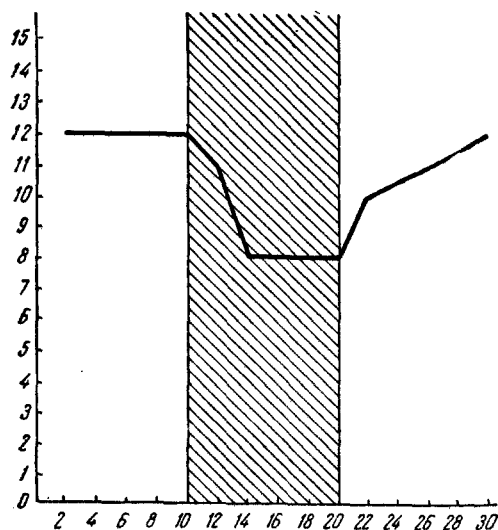


Fig. 3. Changes in reflex mobilization of the cold receptors of the skin of the forearm during heating and radiation cooling of the skin of the lower limb. Continuous line — mean results of 45 experiments on 6 subjects. Remainder of legend as in Fig. 1.

of a temperature stimulus of sufficient intensity, which in turn is determined by the area and duration of its action. When heat from an infrared lamp is applied to the skin of the back from a distance of 1 m, the area of heated surface is relatively large, and heating for a period of 6-10 min is sufficient to produce reflex changes in the thermoreceptor system. When the surface exposed to the temperature stimulus is small, as in the case of heating the upper or lower limb, before reflex changes in the thermoreceptor system can be detected it is necessary to increase the duration of action of the heating apparatus or to bring it closer to the skin surface. The first of these alternatives is undesirable, for it means a corresponding increase in the duration of the investigation. For investigations carried out in this manner it is, therefore, better to bring the apparatus nearer to the skin (to a distance of 50 cm) and to apply heat for 6-10 min. The methods described above have already been applied to the clinical examination of patients with neurological and stomatological conditions and with internal diseases.

SUMMARY

Experimental conditions under which the study of the reflex thermoreceptor reactions is possible are studied.

The intensity of temperature stimulation (duration and area) required for detection of these reactions is indicated.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. Some or all of this periodical literature may well be available in English translation. A complete list of the cover-to-cover English translations appears at the back of this issue.
