THERMORECEPTION AND TEMPERATURE REGULATION IN MAN

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THERMORECEPTION AND TEMPERATURE SENSATION

The study of thermal physiology in man includes the investigation of temperature sensation and thermal comfort, recording of afferent impulses from thermoreceptors as well as the study of autonomic temperature regulation and thermoregulatory behavior. Thermal sensors in man are not only involved in conscious temperature sensations but also play an important role in autonomic and behavioral responses of the organism to its thermal environment. In order to account for this variety of functions, the concept of "Thermoreception" was introduced.[1] In 1974 the Encyclopedia Britannica adopted this term,[2] defining it "as a process in which different levels of heat energy (temperature) are detected by living things".

Temperature sensations can be described as a continuum of a dual or polar character: cold pain - very cold - cold - indifferent - warm - hot - heat pain. The intensity of a temperature sensation depends both on the absolute temperature and on the rate of temperature change. Whereas the influence of the rate of change has long been known from our everyday experience and from numerous investigations, the role of absolute temperature has been studied only recently.

Constant thermal stimuli were applied to various skin areas of 75 cm^2 for at least 30 min. At the end of this period, when the temperature had reached a steady state, the subject was asked to estimate his static temperature sensations, either in ^oC or in a magnitude scale between heat and cold.[3] All subjects were able to discern constant temperatures between 25-38^oC (Fig 1). The magnitude estimates were approximately proportional to the constant stimuli temperatures, the static discrimination for forehead and abdomen decreasing in the range between 29-25^oC.

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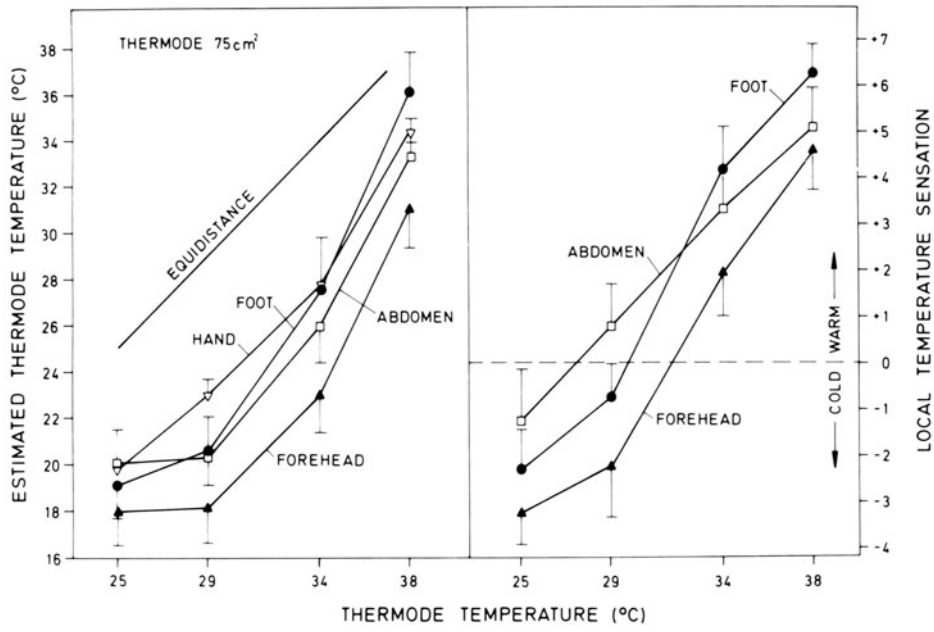

Fig. 1. Static temperature estimates as function of constant temperature of palm, forehead, abdomen and foot. Left: estimates in °C; "Equidistance" line indicates identity between physical and estimated temperature in °C. Right: estimated intensity of thermal sensations. Thermode 75 cm². Average values from 12 subjects; bars indicate standard error of mean. (From Issing and Hensel[3]).

Temperature estimates in °C for abdomen, forehead, hand and foot were lower than the corresponding stimuli temperatures and produced a nonlinear curve. In the range between 29-25°C, the discrimination decresed for the foot and became zero for abdomen and forehead, that is, the subjects could not discern between 29 and 25°C.

HUMAN THERMORECEPTORS

Considerable progress has recently been achieved in recording afferent impulses from single thermosensitive fibers in human subjects by means of microelectrodes (Fig 2). In the hairy skin of the human hand, specific warm receptors[4,5,6,7] and cold receptors[7,8] have been identified. The warm receptors were supplied by unmyelinated fibers with conduction velocities of 0.5 to 1.0 ms^{-1}. It can be assumed that the cold receptors are supplied both by thin myelinated fibers and unmyelinated fibers. All warm and cold fibers had spot-like receptive fields, whereas the receptive fields of fibers supplying polymodal