THE ROLE OF CENTRAL THERMAL SIGNALS IN MODULATING THERMOEFFECTOR FUNCTIONS

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The body temperature of homeothermic animals is regulated by systems that utilize multiple behavioral and autonomic effector responses. The thermoreceptors that provide inputs to the regulatory systems are distributed throughout the body. Although the regulatory aspects of this multiple-input/output system are largely nervous, knowledge about the "neuronal circuit" for thermoregulation remained rather stagnant for several decades. However, the last few years have brought new approaches that have led to new information and new ideas about neuronal interconnections in the thermoregulatory network (Kanosue et al. , 2000). This is especially true for efferent pathways from the preoptic area. Recent studies utilizing chemical stimulation of the preoptic area revealed that not only heat loss but also heat production responses are controlled by warm-sensitive neurons in the preoptic area. These neurons send excitatory efferent signals for the heat loss and inhibitory efferent signals for the heat production. The warm-sensitive neurons that control these two opposing responses are different and work independently. Recent analysis revealed many crucial sites along efferent pathways from the preoptic area to various thermoregulatory effector organs. The efferent systems for skin vasomotion and nonshivering thermogenesis have been especially studied in detail. As for skin vasomotion, vasoconstrictive and vasodilative neurons were found in the ventral tegmental area and the rostral part of the periaqueductal grey (PAG), respectively (Zhang et al. , 1997). Both of them receive inputs from the preoptic area. In the medulla oblongata premotor neurons are located in the raphe nucleus (Rathner and McAllen, 1999), which send axons to the spinal cord. As for nonshivering thermogenesis, tonically inhibitory mechanism was identified in the area including the nuclei of the retrorubral field (Shibata et al. , 1999). And we have recently found the neurons in the caudal part of the PAG sending excitatory signals to the brown adipose tissue. In the medulla oblongata, the raphe nucleus (Morrison, 1999) and the inferior olive (Uno and Shibata, 2000) have been suggested as the crucial sites for the control of nonshivering thermogenesis. Even though many neruons and connections in the efferent pathways remain unidentified, recent advances in experimental techniques promise a much more detailed understanding of the neuronal circuit underlying thermoregulation in the near future.

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