Environmental Temperature and Firing Rate of Hypothalamic Neurones

Current theories[1,2] of the central nervous control of body temperature suggest that information from skin thermoreceptors is combined with that from temperature-sensitive neurones in the hypothalamus. At the moment there is little direct evidence for this and most attempts[3,4] to record changes in firing rate in the hypothalamus when hot or cold stimuli were applied to the skin have not been successful. However, WIT and WANG[5] were able to show that hypothalamic units could be stimulated by infra-red heating of the skin after a delay of 2–5 min but before hypothalamic temperature rose; moreover the same units were further affected when hypothalamic temperature did rise. In the present experiments, unit activity has been studied in the anterior hypothalamus of rabbits while ambient or hypothalamic temperatures were changed independently.

Recording technique was similar to that described previously[6] except that glass micropipettes were used and the rabbits were sedated with urethane (400 mg/kg). Microelectrodes were inserted between 1 and 2 mm from the midline in coronal planes from 1 mm anterior to 3 mm posterior to the anterior commissure. The animals were placed in a wind tunnel where the temperature could be changed within 30 sec to any point in the range 10–40 °C. Initial recording of a unit was made at 25 °C and then the temperature was lowered to about 10 °C, raised to 40 °C, and returned to 25 °C. When time permitted the hypothalamic temperature was also raised and lowered through 1 °C using implanted thermodes[6].

Seventeen neurones (out of 150 tested) have been found which were affected when ambient temperature was changed. 13 of these only changed their firing rate to cooling, 3 responded to warming and cooling, and only 1 was affected by warming. Half of the units which responded to cooling did so by an increase in firing rate and half by a decrease. Figure 1 shows results from a neurone whose firing rate was more than doubled by cooling the environment to 10 °C, but whose rate at 40 °C was not apparently different from that at 25 °C. There was a delay of about 45 sec between initiating the temperature change in the wind tunnel and the increase in firing rate.

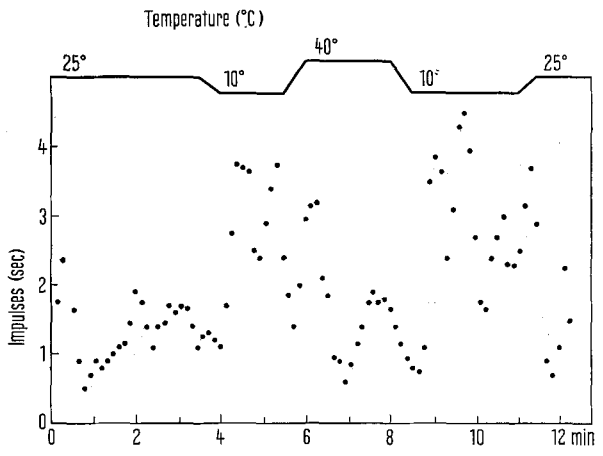

Fig. 1. Firing rate (taken over 8 sec periods) of a neurone excited by ambient cooling. Ambient temperature is shown at the top of the frame and the slopes give an indication of the rate of change of temperature.

It was possible to test the sensitivity of 6 of the 17 'cutaneous' units to changes of hypothalamic temperature and all 6 responded to this local thermal stimulus. An example is given in Figure 2 of a neurone which was slowed by ambient cooling, unaffected by ambient warming and also excited by hypothalamic warming. Other cells showed a different pattern of responses, one, for example, being accelerated by ambient cooling and by hypothalamic warming. From the small sample so far obtained no pattern has emerged.

These results show that thermal information from the periphery is relayed to the anterior hypothalamus and can there influence the behaviour of neurones which are also sensitive to local temperature. What part this information plays in the control of body temperature is not yet clear, but it should be possible to test HAMMEL's[1] adjustable set-point hypothesis when the sensitivity of a neurone to hypothalamic temperature can be determined at more than one ambient temperature.

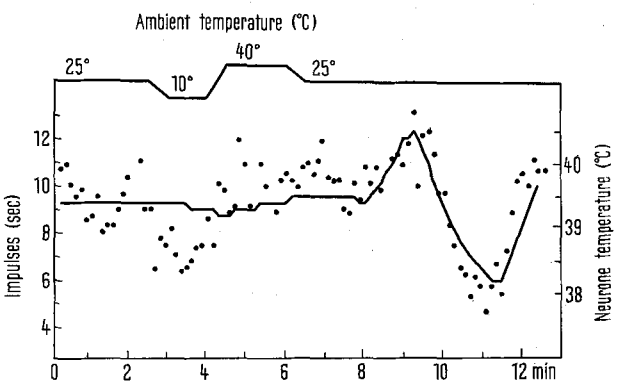

Fig. 2. Firing rate (taken over 8 sec periods) of a neurone sensitive to ambient and hypothalamic temperatures. Hypothalamic (neurone) temperature is shown by the solid line and ambient temperature at the top of the frame.

Zusammenfassung. Im vorderen Hypothalamus des Kaninchens wurden Neuronen gefunden, deren Impulsfrequenz bei schneller Änderung der Aussentemperatur auf 10 oder 40 °C zu- oder abnahm. Einige dieser Neuronen waren auch gegen kleine Veränderungen der Hirntemperatur empfindlich.

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