Dog Behaviour as Related to Spinal Cord Temperature

M. CORMAR/ÈCHE-LEYDIER and M. CABANAC¹

Laboratoire de Physiologie, Université Claude Bernard, Faculté de Médecine Lyon Sud-Ouest, B.P. 12, F-69600 Oullins (France), 11 June 1975.

Summary. 3 dogs could behaviourally modify their own spinal cord temperature (T_{spinal}_{cord}). In a hot environment, dogs did not cool their spinal cord, 1 dog warmed it. The higher the environmental temperature, the higher the chosen T_{spinal}_{cord}. These results seem to imply that this latter dog tended, in warm environment, to behaviourally reduce: T_s > T_{spinal}_{cord} (T_s mean skin temperature). Data obtained previously support this explanation.

CORBIT has shown that direct thermal intracranial self-stimulation was possible in rats. Rats placed in a warm environment were able to cool their brains by self-stimulation. We considered that it would be interesting to offer the possibility of thermal spinal cord self-stimulation to animals, because: 1. Spinal thermal sensitivity has been shown to be of the same magnitude and efficiency as the hypothalamus in temperature regulation. 2. Heating of the spinal cord was shown to be followed by an appreciable proportion of the vessels must be very small to pass into the joint space). The intercapillary distance is only approximately estimated by our method, but a more exact one does not yet seem to be available. It is evident that the distances found here are some 10 times greater than those which can be derived from the values for the other sites, quoted earlier. Also the distribution is very wide so that an appreciable proportion of the vessels must be very widely separated indeed. This must have a very great effect on the slow removal of gas from the tissues around the knee, and hence indicates why this region is more prone to develop the bubbles which cause "the bends" during decompression. It is hoped that the present values, plus those for the capillary surface area, will be used in a model of this disease.

¹ This experiment has been supported by the Centre National de la Recherche Scientifique (L.A. No. 181 C.N.R.S.) and by the Institut National de la Santé et de la Recherche Médicale (N.S.E.R.M./A.T.P. No. 4-74-25).
³ C. JESSEN and E. T. MAIER, Pfliigers Arch. 324, 189 (1971).
⁴ C. JESSEN and E. SIMON, Pfliigers Arch., 324, 217 (1971).

¹ P. L. ALTZMANN, Handbook of Circulation (W. B. Saunders, Philadelphia and London 1959), p. 34.
Thermode self-control allowed

<table>
<thead>
<tr>
<th>Dog</th>
<th>Trials</th>
<th>$T_a$ (°C)</th>
<th>$T_{th}$ perfused (°C) ± SE</th>
<th>$T_{th}$ chosen (°C) ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raising of $T_{th}$</td>
<td>Buf</td>
<td>6</td>
<td>0-25</td>
<td>36.0 ± 1.2</td>
</tr>
<tr>
<td>(warning perfused water)</td>
<td>Kis</td>
<td>4</td>
<td>25-60</td>
<td>37.0 ± 1.1</td>
</tr>
<tr>
<td>Lowering of $T_{th}$</td>
<td>Kad</td>
<td>3</td>
<td>25-60</td>
<td>38.5 ± 0.2</td>
</tr>
<tr>
<td>(cooling perfused water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A solenoid resistor was placed around the afferent portion of the thermode at the entrance into the dogs’ bodies. Warming of the spinal cord was obtained when the dog interrupted the light beam with its snout, thus turning on the solenoid. The temperature of the water entering the thermode ($T_{th}$) could increase by up to 6 °C in less than 1 sec. Cooling of the spinal cord was obtained by permanently heating the inflowing water, the dog’s behaviour determining when to turn off the solenoid. The inflowing water would, thus, drop by as much as 6 °C in less than 1 sec.

![Fig. 1. Spinal thermode temperature chosen by dog Buf in various environmental temperatures.](image1)

Each behavioural transfer trial lasted 20 min and was preceded and followed by a 20 min period, during which the dog’s behaviour was rewarded by skin heating or cooling. The alternation of these periods was necessary to prevent extinction of the behaviour.

Dog Kad and Kis had their spinal cord thermode perfused by water at a cool ($35.5^\circ C < T_{th} < 38.0^\circ C$), a neutral ($38.5^\circ C$) or a warm ($38.5^\circ C < T_{th} < 42.5^\circ C$) temperature. They were allowed to cool their spinal cords by their behavioural adjustment during 19 trials in a warm or hot environment ($25^\circ C < T_a < 60^\circ C$).

Dog Buf had its spinal cord thermode perfused by water at a cool temperature ($35^\circ C < T_{th} < 37.5^\circ C$). It was allowed to warm its spinal cord by behavioural response during 6 trials in a cold environment ($0^\circ C < T_a < 25^\circ C$) and 6 trials in a warm or hot environment ($25^\circ C < T_a < 60^\circ C$).

The results shown in the Table represent thermode temperatures resulting from each dog’s behaviour.

**Discussion.** Contrary to what was expected, dog Kis and Kad, when placed in a warm environment did not use the thermode to cool their spinal cords. This can be explained by two possibilities: either the dogs had no temperature sensation in the spinal cord, or they had a sensation but did not find it rewarding. We would consider the latter to be correct. The operant response was inhibited after each trial, because it was necessary to recondition each dog between trials. Only dog Buf used operant behaviour to prevent cooling of its spinal cord or to warm it: in a cool environment, its behaviour was sufficient to maintain $T_{th}$ around $38.5^\circ C$; in a warm environment, the higher the environmental temperature, the higher the chosen thermode temperature. This paradoxical result is not shown in the Table, where results are averaged, but becomes apparent in Figure 1, where thermode temperature (behaviourally selected by the dog) is plotted against environmental temperature. The result imply that the dog had tried, by means of its behaviour, to reduce the difference between its ambient and spinal cord temperatures ($T_a - T_{th}$), when its spinal cord thermode was being perfused with cool water. The signal for thermoregulatory behaviour would, therefore, not be absolute temperature, but rather a temperature gradient. These results led us to re-examine the data obtained previously by measurement of behaviour during spinal cord cooling. In this previous experiment, the dogs were able to obtain external heat or cold by means of their behaviour. Spinal cord cooling, in this previous experiment (although accompanied by skin vasoconstriction) did not result in increased physical behaviour for infra-red skin heat but rather in unexpected skin cooling-motivated behaviour.

We had therefore concluded that the spinal cord did not possess a cold sensitivity capable of triggering a