Dog Behaviour as Related to Spinal Cord Temperature

M. CORMAROCHÈ-LEYDIER and M. CABANAC

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 (Tspinal cord). In a hot environment, 2 dogs did not cool their spinal cord, 1 dog warmed it. The higher the environmental temperature, the higher the chosen Tspinal cord. These results seem to imply that this latter dog tended, in warm environment, to behaviourally reduce: Tc > Tspinal cord (Tc mean skin temperature). Data obtained previously support this explanation.

Corbit4 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 regulation3,4. 2. Heating of the spinal cord was shown to be followed by an adequate corrective behavioural response in frogs8 as well as in dogs4. Cooling of the spinal cord was followed by a corrective operant response in pigs5 and by an adapted posture in pigeons4.

Methods and results. We used 3 dogs which were previously trained to interrupt a light beam in order to obtain environmental infra-red heat or cool air. Each of the 3 dogs was chronically implanted with a U-shaped epidural space, under general anesthesia, from C2 down to the caudal end of the vertebral canal. These dogs had been implanted and trained for another experiment, the results of which have been published4. The technique consisted in an attempt to transfer the operant behaviour heat or cold reward from the skin to the spinal cord. A

---

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 I.N.S.E.R.M./A.T.P. No. 4-74-25.
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>Buf</td>
<td>6</td>
<td>0–25</td>
<td>36.0 ± 1.2</td>
<td>38.6 ± 0.5</td>
</tr>
<tr>
<td>Kis</td>
<td>4</td>
<td>25–60</td>
<td>36.0 ± 1.6</td>
<td>40.4 ± 2.2</td>
</tr>
<tr>
<td>Kad</td>
<td>12</td>
<td>25–60</td>
<td>37.0 ± 1.1</td>
<td>Extinction of the behaviour</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>25–60</td>
<td>38.3 ± 0.2</td>
<td></td>
</tr>
</tbody>
</table>

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°C < $T_{th}$ < 38.0°C), a neutral (38.5°C) or a warm (38.5°C < $T_{th}$ < 42.5°C) temperature. They were allowed to cool their spinal cords by their behavioural adjustment during 19 trials in a warm or hot environment (25°C < $T_a$ < 60°C).

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