Effect on Food Intake in the Pig of Heating and Cooling the Spinal Cord

Interactions between body temperature and food intake are poorly understood. Evidence which supports the idea that food intake can be influenced by the temperature of the preoptic region of the hypothalamus was provided by the studies of ANDERSSON et al.[1,2] who reported that heating this region in the goat reduced food intake, while cooling increased consumption. These observations provide substantial evidence for the thermostatic theory of BROBECK[3,4], but in subsequent studies effects opposite to those noted by ANDERSSON et al.[1,2] have been observed. Food intake was reduced when the hypothalamus was cooled and increased when it was warmed in the rat[5,6] and in the pig[7]. Since heating or cooling the hypothalamus affects body temperature as well as food intake[8], one possibility which has been suggested[7] is that in some species extrahypothalamic core temperature receptors may override the signal produced by changes in hypothalamic temperature. Thus the fall in deep body temperature during heating of the hypothalamus may provide the stimulus for extrahypothalamic temperature sensors which in turn mediate an increase in food intake. The spinal cord is one extrahypothalamic site for which thermal sensitivity has been demonstrated, and its importance in temperature regulation has become increasingly evident in recent years[9,10]. The present study examined whether changes in temperature induced locally in the spinal cord influenced food intake.

Method. The apparatus was similar to that described previously[7]. The pig was provided with a harness so that it could be lightly restrained in a metal-frame stall. An 8 cm square plate mounted on a panel was positioned in front of the pig at snout height (30 cm). Pressure on the plate activated a solenoid which allowed 2.2 gm of pellets to fall into a pan positioned beneath the response plate. Each response was rewarded, and the pigs were allowed to work until satiated once per day. No supplementary feeding was given. The criterion for satiation was that the pig lay down, which happened usually after 60 min. The apparatus was placed in a temperature-controlled room maintained at 24 $\pm$ 0.5 °C. Measuring and control equipment were located outside the room.

Seven pigs of the Large White breed aged between 6 and 10 weeks and weighing 11 to 17 kg were used. They were adapted to the harness and restraint, then trained to work for food reinforcement. Anaesthesia was induced with Halothane following pretreatment with phencyclidine hydrochloride (Sernylan). During surgical procedures, which were carried out under sterile conditions, thermodes consisting of a double loop of 2 mm O.D. polyethylene tubing were inserted into the epidural space of the vertebral canal at T_{10} and pushed rostrally to C_1 with the position checked radiographically. A blind-ended catheter which accepted a thermojunction was also inserted alongside the thermode. 4 days were allowed for recuperation from surgery, and observations were then made within 2 weeks to ensure that the position of the thermode did not change appreciably as the pig grew. Each week the thermode over the spinal cord was cooled to 10 °C during one test and heated to 43 °C during another test by perfusion of warm or cold fluid. On the remaining days the temperature of the thermode was not changed.

Results and discussion. An estimate of the rate of increase of food intake over time was obtained by fitting a regression line to the control data by the method of least squares. The rate of increase was 24.5 g/day. The data were analysed for individual pigs and for the group by finding the difference between control tests and treatment test or by obtaining the difference in food intake during treatment from the pig's rate of increase. In either case, no effect of spinal temperature on food intake was noted. An analysis of variance similarly failed to reveal any significant effects.

Spinal cord temperature does influence respiratory frequency[11], peripheral blood flow[12], oxygen consumption[13], and thermoregulatory behaviour[14] in the pig. Thus the absence of an effect of spinal cord temperature on food intake cannot be attributed to a general unresponsiveness in this species. SPECTOR and CORMARÉCHE[15] reported that cooling the spinal cord had little effect on food intake in the dog while warming decreased intake. In the rat, LIN, YIN and CHAI[16] found that heating the cord decreased food intake and cooling the cord increased it. These results on warming and cooling the cord are consistent with the proposition that spinal sensors account for the changes in food intake during thermal stimulation of the hypothalamus in some species[5–7]. It is difficult to reconcile these results on heating the cord with those of the present study, and although the results on cooling the cord are consistent in both dog and pig they differ from those in the rat. It is possible that the present results may have been influenced by the use of pigs which were growing rapidly as opposed to adult dogs and rats, but food intake of pigs of the same age and rate of growth is influenced by thermal stimulation of the hypothalamus[7]. The present results offer no support for the idea that extrahypothalamic temperature sensors located in the spinal cord influence food intake in the pig.

Résumé. Le réchaufement ou le refroidissement du cordon médullaire du porc par perfusion des thermodes intravertébrales avec un fluide tiède ou froid ne change pas la quantité de nourriture consommée; ceci élimine le rôle des enregistreurs vertébraux de température en tant que médiateurs de la consommation de nourriture chez cette espèce.

H. J. CARLISLE[17] and D. L. INGRAM

A.R.C. Institute of Animal Physiology, Babraham, Cambridge (Great Britain), 9 April 1973.

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[17] On leave from Department of Psychology, University of California, Santa Barbara, California 93106, USA. Supported by Special Research Fellowship No. MH-51485 from USPHS.