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RAPID COMMUNICATION

Influence of Ambient Temperature on the Effects of NPY on Body Temperature and Food Intake

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*Departments of Psychiatry and Pharmacology, Faculty of Medicine, University of Sherbrooke, Sherbrooke, Québec J1H 5N4; †INRS-Santé, University of Québec, Montréal, Québec H1N 3M5, Canada

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BOUALI, S. M., A. FOURNIER, S. ST-PIERRE AND F. B. JOLICOEUR. *Influence of ambient temperature on the effects of NPY on body temperature and food intake.* PHARMACOL BIOCHEM BEHAV **50**(3) 473–475, 1995. – Because thermoregulation and food consumption are interrelated, and because thermoregulation processes are influenced by ambient temperature, we examined the effects of neuropeptide Y (NPY) on both body temperature and food intake in various thermal environments after intracerebroventricular administration of 20 μg. Results reveal that the prominent effects of NPY on body temperature and food intake in relatively thermoneutral environments are drastically altered at more extreme ambient temperatures. NPY produced hypothermia in animals placed at 4, 12, and 21°C, and actually increased body temperature in animals subjected to 30 and 38°C temperature. On the other hand, in comparaison with ambient temperatures of 12 and 21°C, ambient temperatures of 4 and 30°C significantly reduced the stimulatory effect of NPY on food consumption. Moreover, at 38°C the effect of NPY on food intake was totally abolished. These data demonstrate that ambient temperature has a critical influence on central actions of NPY.

Neuropeptide Y Ambient temperature Food intake Body temperature Behavior

NEUROPEPTIDE Y (NPY) is a 36-amino acid peptide originally isolated from porcine brain and now considered to be a member of the family of pancreatic polypeptides (17). Widespread distribution of NPY in the central nervous system suggests that this peptide may act as a neurotransmitter or a neuromodulator (1,6,8). We have shown recently that, in addition to its well-known stimulating effects on food consumption (2,5,15,16), intracereboventricular administration of NPY produces a complex profile of neurobehavioral actions that include significant reductions in body temperature (3,13,14).

The functional relationship between food intake and thermoregulation is well known. Because consumed food ultimately constitutes the source of metabolic energy, and heat is a byproduct of metabolism, regulation of food intake and body temperature are closely interrelated. Because control of body temperature internally depends to a large part on ambient temperature in homeothermic animals, food intake is thus related to external temperature. For example, it is well known that food intake is markedly increased in animals placed in a cold environment, most probably to supply the calories needed for thermogenesis (10).

The purpose of the present study was to examine and determine the relationship between the effects of NPY on body temperature and food intake in animals placed at different ambient temperatures.

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METHOD

Animals

Male hooded rats weighing 250–300 g were used. They were housed individually in stainless-steel cages situated in a temperature-controlled room (21–23°C) with a 24-h light-dark cycle. Water and food (Purina rat chow, Sherbrooke, Canada) were available ad lib.

Procedures

Rats were anesthetized with an intramuscular injection of a ketamine (80 mg/kg)–xylazine (12 mg/kg) mixture and implanted with bilateral indwelling stainless-steel guide cannulae (23 gauge) placed 2 mm above the left lateral ventricle, according to our previously described procedure (12). After at least 4 days of recovery, rats were devided into groups of eight. Experimentats were performed at the following ambient temperatures: 4, 12, 21, 30, and 38°C. Each group was adapted for at least 2 h at these temperatures before experiments were initiated. Thereafter, separate groups were administered either 0.9% of saline solution (control animals) or 20 μg of porcine NPY synthesized, according to our previously described method (7), and dissolved in 0.9% NaCl. The volume of injection was 10 μl, given by means of a 30-gauge injection needle attached to PE-10 polyethylene tubing and protruding 2 mm beyond the guide cannulae into the left lateral ventricle. Immediately before and at 15, 30, 45, 60, and 120 min after injections, body temperature was measured by means of a flexible thermistor probe (Yellow Springs Instruments, Yellow Springs, OH) inserted 4 cm into the rectum. Food intake was measured by presenting a preweighed rat chow portion before injections, and weighing food after 1, 2, and 4 h. Food spillage was collected under each rat cage and included in the calculation of intake. Water was available ad lib.

Results obtained on food intake and body temperature were analyzed by separate two-way analyses of variance with repeated measures on the second factor (18). Factors included were treatments and time. After a significant main interaction, data obtained at each test period were examined using simple main effects followed by Dunnett test. Differences were considered significant if they had a probability of random occurrence of < 5%.

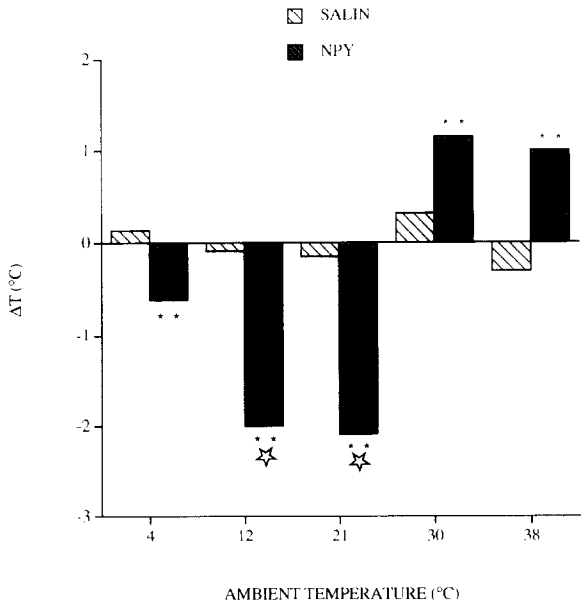

FIG. 1. Effects of injection of NPY (20 μg) on body temperature at different ambient temperatures. Significant differences from controls are indicated by asterisks (**$p < 0.01$). Significant differences between group of treated rats at 4°C, and those at 12 and 21°C are also indicated by ☆ (**$p < 0.01$).

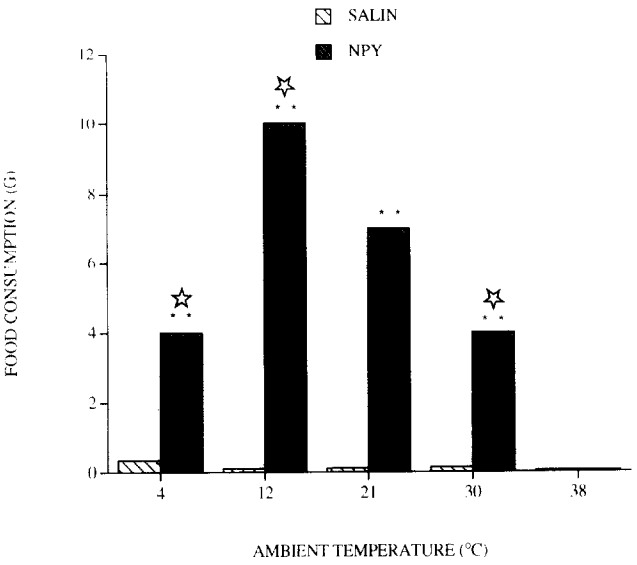

FIG. 2. Effects of intracerebroventricular injection of NPY (20 μg) on food intake at different ambient temperatures. Significant differences from controls are indicated by asterisks (**$p < 0.01$). Significant differences between group of treated rats at 21°C those at 4, 12, and 30°C are indicated by ☆ (**$p < 0.01$).

RESULTS

Data analysis revealed that the prominent effects of NPY on body temperature and food intake in a thermoneutral environment are drastically altered at different ambient temperatures. As expected, NPY produced hypothermia with a mean maximum fall of 2°C in rats maintained at an ambient temperature of 21°C. This decline in core temperature was almost equal when the rats were exposed to a temperature of 12°C, and was significant in both cases at 15, 30, 45, and 60 min after injection. However, the hypothermic effect of NPY was significantly reduced when animals were placed at 4°C. At 30 and 38°C, NPY induced hyperthermia with a mean maximal rise of 1.16 and 1°C, respectively, and the effect was significant at the 15, 30, 45, 60, and 120 min test periods. Body temperature of control saline rats at 4, 12, and 30°C were not statistically different from those of rats maintained at an ambient temperature of 21°C, but significant hyperthermia was recorded with the group of animals maintained at 38°C. Figure 1 presents the effects of NPY on body temperature at different ambient temperatures.

For feeding, NPY increased food intake to the same extent at ambient temperatures of 4 and 30°C, but resulted in prominently more quantities of food consumed at 12 and 21°C. At 38°C, food intake was totally abolished. Figure 2 presents the effects of NPY on food intake at different ambient temperatures.

DISCUSSION

The objective of the present study was to examine the influence of ambient temperature on the effects of NPY on body

temperature and food intake. Our results indicate that NPY produces hypothermia in animals placed at 4, 12, and 21°C, and actually increases body temperature in animals subjected to 30 and 38°C temperature (Fig. 1). These results suggest that increased thermogenesis generated by cold peripheral stimulation in animals placed at 4°C was able to counteract the hypothermic effect of NPY. Relatively warmer peripheral input not only antagonized the hypothermic effect of NPY, but actually changed the nature of the influences of the peptide on thermoregulation, in that animals became hyperthermic after the injection of the peptide. This hyperthermic effect was seen with animals placed at a more extreme warm temperature, which in itself induced hyperthermia. The strong, cold peripheral input, which was not as potent, or was absent, at more neutral temperatures of 12 and 21°C, did not interfere with NPY's hypothermic action (Fig. 1). It is known that skin cooling increases the firing rate of cold sensitive neurons in the preoptic area, which results in metabolic heat production as well as heat retention behavior (4). It is thus possible that this process was able to override the hypothalamic effects of the peptide. Therefore, it appears that NPY inhibits the thermoregulatory mechanisms that respond to relatively warmer environment favoring heat loss.

For feeding, a significant effect was obtained at an ambient temperature of 4, 12, and 21°C, but decreased at 30°C; unexpectedly, at 38°C, food intake was totally abolished (Fig. 2). Several works demonstrate that food intake is inversely related to temperature. Thus, an increase in temperature from 28 to 32°C results in a decrease in both food and water intakes, resulting in a loss of body weight (9,11). This relationship between temperature and food intake was seen in the present study, in that NPY's stimulation of food intake was decreased at 30°C, compared with that obtained at a more thermoneutral temperature, and was totally absent at 38°C. Therefore, it appears that both NPY-induced and spontaneous food consumption are similarly modulated by relatively high ambient temperatures. We observed that the animals that were placed in a 38°C environment and that did not consume food for 2 h after NPY administration, ate vigorously as soon as they were brought back into a 21°C environment.

On the other hand, the inhibitory influence of relatively cold ambient temperatures is difficult to explain, because it has been shown previously that prolonged exposure to a cold environment results in increased food intake. As discussed earlier, cold peripheral stimulation resulted in the activation of a thermogenesis process (4). It is possible that this increased metabolic activity is responsible for the decrease in NPY's stimulation of food intake.

The exact mechanisms underlying these effects remain uncertain. Our results demonstrate that the effects of NPY on body temperature and food intake are complex, and that ambient temperature is a critical variable when assesing the central actions of the peptide.

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