# Food Intake and Temperature Stress in the Monkey[1] (35228)

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(Introduced by J. R. Brobeck)

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In the heat, monkey and rat both decrease food intake although the temperature at which the two species significantly reduce feeding is higher for the monkey (ambient 38°) than the rat (32°). However, unlike the rat, the monkey does not increase food intake when exposed to a cold stress for 24 hr (5). The present study was based on the premise that perhaps a longer period of stress was needed for the monkey to demonstrate caloric adjustment in the cold.

*Methods. Subjects.* Five male monkeys (*Macaca mulatta*) weighing between 6.6 and 7.7 kg were used.

*Procedure.* This study investigated the response of the monkey to four different test temperatures and was conducted in a Hotpack constant temperature room with ambient temperature controlled to within ± 0.5°. Relative humidity was not directly controlled and ranged from 40% at 8° to 55% at 38°. The animals were maintained *ad libitum* on Purina Monkey Chow and water and kept individually in cages measuring 51 cm wide × 51 cm deep × 82 cm high, built especially for the room. Food and water consumption were measured daily. The monkeys were adapted to these conditions for 30 days at an ambient temperature of 25°, the control temperature. During the following 7 days base line data were collected, followed by the first temperature test, 7 days at 34°. Thereafter, the temperature tests at 38, 8, and 15° were performed in that order with 30 days of adaptation plus 7 days for collection of base line data at 25° before each temperature test.

*Results.* The general results are shown in Fig. 1. One animal died of unknown causes on day 6 of heat stress at the 38° temperature and for the rest of the monkeys the test was terminated on that day. In the succeeding tests, another male animal within the stated weight range was substituted.

The most significant finding was that at 8° the mean food intake was reduced to approximately 63% of the control intake at 25°. The 8° test was concluded early because on the fifth day one animal ate no food. All animals reduced food intake at 8° and the daily sequence of mean food intake was, from the first through the 5th day: 174, 146, 138, 128, and 123 g. There was no reason to believe that continuation of the cold stress would have revealed any change in the pattern of feeding.

The last temperature test (15°) was conducted not only as a parametric procedure but also to test the hypothesis that 8° was too stressful for the monkey. The results showed that, while the drop in mean food intake was not of any practical significance, there again was no increase. These prolonged tests, therefore, are similar to previous 24-hr tests, and show that the monkey does not respond to cold stress with an increase in food intake.

The data from the heat tests on the monkey are similar to, but not the same as those for the rat. At 34° ambient, there was no significant decrease in food intake in the monkey, a temperature at which the rat eats little or no food on the first day of stress (4). At 38° ambient the monkey decreased food intake, not only on the 24-hr test (5), but also over the prolonged test periods of this study.

Ambient 38° appears to be close to the $LD_{50}$ point for the monkey, at least in the laboratory. In the present work, one monkey

[1] The assistance of W. Spanakos in data collection is appreciated. This study was supported in part by Grant MH-10179 U.S. Public Health Service.

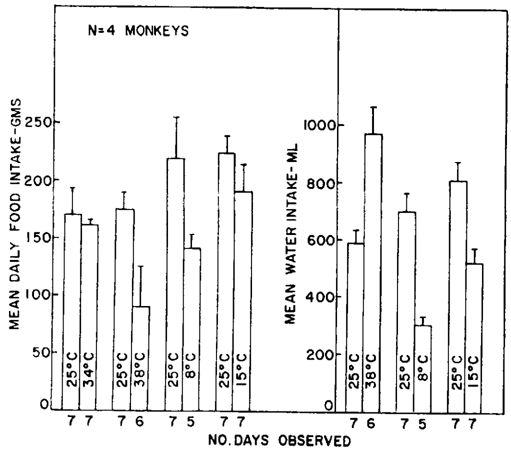


FIG. 1. Mean (± SE) food and water intake of monkeys kept at various ambient temperatures. (Water intake was not recorded at ambient 34°).

died after 6 days at 38°, and in our previous study two of four monkeys died when stressed at 40° for 24 hr (5). We do not know the cause of death in any of these animals since we were not monitoring body temperature. In our 24-hr study, we had included a hypothalamic, hyperphagic, obese monkey weighing 22 kg. At 34°, an ambient temperature the normal monkey tolerates well, the obese animal was severely stressed. At the end of the test period, he had a body temperature of 41.7° and was comatose. On being transferred to a cool environment he survived but did not resume normal feeding until a week later. The vulnerability of obese rats to heat stress was reported previously (4). There were no obese monkeys in the present study, but the death observed was probably from heat stroke.

Since these monkeys came from India one might wonder about the mortalities at temperatures of 38 and 40°. Such ambient temperatures are not unusual for that country during the summer months. However, the high temperatures are experienced only during the "heat of the day" and fall at night. In our laboratory the set temperature in the test room did not vary. It may have been the lack of variation that resulted in the death of the animals.

*Discussion.* Presently there are no data that might reveal the nature of the failure of the monkey to increase food intake in the cold. One factor may have been the early experience of these animals, experience that probably precluded prolonged exposure to cold. However, laboratory rats probably do not have previous experience in the cold either. Of particular interest is the drinking water available to the animals. In all cases it was at the test-temperatures. Figure 1 shows that in the cold, water intake was suppressed. Whether water intake was low because of a reduction in food intake or the reverse of that, is not clear. It is known that monkeys, like other mammals, reduce food intake when deprived of water (5). It may have been that drinking the cold water added to the animals' stress, they avoided it and as a consequence feeding was reduced. We have not tested this hypothesis by supplying the animals with warm drinking water during cold stress.

In addition to the above factors, the neurophysiological organization of the monkey brain involved with the interaction of temperature regulation and feeding may be different from that of the rat. However, the artificial heating or cooling of the preoptic area of the monkey yields results similar to those seen in rats under comparable conditions [baboons (3) and squirrel monkey (1, 2)]. There are no data available to show whether monkeys exhibit the close coupling between body temperature regulation and feeding that has been demonstrated in rats in a study in which animals with lesions of the preoptic area showed overeating in the heat and undereating in the cold (6).

To my knowledge, the monkey is the only mammal which, when tested in the laboratory, fails to increase food intake in the cold.

*Summary.* Four monkeys were maintained at a control temperature of 25° ambient and tested at environmental temperatures of 34, 38, 8, and 15° for periods ranging from 5 to 7 days with food and water intake as the dependent variables. The results showed an inverted U-shaped curve for food intake; as ambient temperature was raised or lowered from 25° the food intake declined. Water intake was directly related to ambient temperature.

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Received Sept. 2, 1970. P.S.E.B.M., 1971, Vol. 136.