Cool water suppression of water intake: One day does not a winter make*

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Previous reports demonstrate that water intake in rats is suppressed when the water is cool. In those studies, however, water temperature was changed every day. In this study, each water temperature was presented on 5 consecutive days. Water-deprived rats drank for 20 min per day. Cool water suppression of water intake persisted over repeated 5-day series of testing. Thus, in nature seasonal shifts in water temperature should cause seasonal shifts in water intake. This may have survival value.

Mouth cooling during the drinking of cool water appears to be a short-latency satiety mechanism that anticipates (precedes) postconsummatory shifts in cellular and extracellular hydration. Kapatos & Gold (1972) have suggested that the suppression of water intake that occurs when the available water is cool would produce seasonally appropriate levels of water intake, with more water consumed in summer and less in winter.

Cool water continues to suppress water intake when daily drinking sessions are varied in length from 20 to 100 min, when the water is presented to the rat in an open bowl instead of a sipper tube, and when cellular hydration is delayed by using isotonic saline instead of water (Gold, Kapatos, Prowse, & Quackenbush, 1973).

In previous work demonstrating cool water suppression of drinking, a different temperature of water was used every day. In nature, however, winter and summer do not alternate daily. The present study demonstrates that the suppressant effect of cool water endures when cool water is drunk every day for many days, as might be the case in a naturalistic setting during the winter season.

METHOD

Subjects

The Ss were four Carworth CFE female albino rats. All Ss weighed between 250 and 260 g at the start of testing, and all had previous exposure to both warm and cool water.

Apparatus

In each 18 x 35 x 18 cm open-bowl testing chamber, the rat reached water, which was in an 8-cm-diam glass bowl, by putting his head through a 3.6-cm-diam hole in the wire-mesh floor of the test chamber. The water surface was always 2.5 ± 0.2 cm below the floor of the cage. For cool water ($6 \pm 2^\circ\text{C}$) the water bowl rested in an ice bath. For warm water (body temperature, $37 \pm 1^\circ\text{C}$) the bowl rested on a small potentiometer regulated heater. Except at the access hole, the water bowl and ice bath or

heater were surrounded by styrofoam insulation such that the temperature in the test chamber, except inside the water access hole itself, always remained at ambient temperature ($23 \pm 1^\circ\text{C}$). Water intakes were determined by difference in weights of the water bowls.

Procedure

For 23-2/3 h/day the individually housed Ss had ad lib access to a high-fat diet (Gold, 1970) but no water. For 20 min/day throughout testing, each rat had access to water in the open-bowl testing chamber. Once testing began, water was never available except in the testing chamber. Water intakes and body weights were stabilized by a series of 10 days during which the water in the testing chamber was at ambient ($23 \pm 1^\circ\text{C}$) temperature. The rats were then matched into two groups on the basis of body weight and ambient water intake. For the next 5 consecutive days, half the Ss received warm water in the testing chamber and half received cool water. Since intakes appeared to have stabilized after 5 days of warm or cool water, the conditions were then reversed, so that the rats that had received warm water got cool water and vice versa. These conditions continued to be reversed every 5 days until each group had had two 5-day series of both warm and cool temperature water. Finally, all Ss received ambient temperature water for 2 days.

RESULTS AND DISCUSSION

Mean daily water intakes are seen in Fig. 1. As previously reported, each time the water temperature changed to cool, water intake was suppressed. Cool water intakes remained suppressed, as compared to warm water, throughout each 5-day test series (all p s $< .05$, Mann-Whitney U test).

While 5 days do not a whole summer or winter make, these data nevertheless suggest that cool water suppression of water intake persists even without frequent water temperature contrasts. In nature this could lead to seasonally appropriate levels of water

Fig. 1. Water intake as a function of water temperature.

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intake, with more water consumed in summer and less in winter.

The effect of water temperature on water consumption is reported as a suppression of intake when the water is cool, rather than as an enhancement of water intake when the water is warm. The reason for this is that the warm water is at body temperature, which presumably neither warms nor cools the rat.

It was feared that the reduced intake on the first cool water day would increase deprivation and, as a result, intakes would be greater on the cool water days that followed. Conversely, it was feared that intakes would be diminished on warm water days that followed other warm water days.

The first prediction (cool water intake increases) proved correct, but the magnitude of the effect was small. Mean cool water intake on the first day of each series was 9.4 cc, as compared to a pooled mean of 11.0 cc for the 4 subsequent cool water days ($p < .05$, sign test).

The second prediction (warm water decreases) was reversed, as warm water intakes actually rose slightly over successive presentations. No reason for this reversal is apparent. Mean warm water intake on the first day of each series was 15.4 cc, as compared to a pooled mean of 16.5 for the 4 subsequent warm water days ($p < .05$, sign test).

Water intakes rose slightly over successive presentations of either warm or cool water. As a result, the warm-cool water intake differential did *not* diminish significantly across the 5 days within each constant-temperature series. The mean warm-cool differentials for each of the 5 days were 6.1, 5.5, 5.0, 5.9, and 5.7 cc, respectively.

It appears from the literature that even the small amounts of cool water consumed on cool water days were sufficient to bring cellular hydration and extracellular volume at least to ad lib values (Hatton &

Bennett, 1970). Water intakes that exceeded those values may soon have been lost in a diluted urine. As a result of the presumed inability to retain the greater warm water intake, the level of deprivation at the time of testing may not have been influenced greatly by differences in the amount of water consumed during the previous day's drinking session. This conclusion is supported by the rather stable body weights as measured before each day's drinking session. Following cool water days, the mean body weight was 250 g, as compared to 252 g following warm water days.

As for an explanation of why cool water suppresses water intake, Kapatos & Gold (1972) suggest that cool water satiates more efficiently than warm water. An alternative explanation is that cool water is relatively aversive. Whatever the explanation, it is clear that cool water suppression persists over a series of days. The warm-cool intake differential appears to have been of no particular benefit to these rats. In nature, however, a large drink of cool water on a cool day might suppress body temperature dangerously, while on a hot summer day extra water is needed for the saliva spreading by which the rat cools himself (Hainsworth, 1967).

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