Saccharine and H_2O consumption as a function of H_2O deprivation

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In a saccharine H_2O choice, H_2O deprived rats consumed more H_2O than saccharine during the first 90 min. The opposite was true of undeprived Ss. By 48 h deprived and undeprived Ss consumed more saccharine.

Mean intake of saccharine (sac) plus H_2O by undeprived rats in a continuous choice between 0.1% sac and H_2O was found to be approximately the same on the first two days of exposure as that by Ss presented with 1% sac and H_2O. However, 24 h sac/total intake ratios differ: 60/64 and 43/66 for the 0.1% and 1% groups, respectively.[2]

The present experiment was conducted to determine how relative consumption of sac and H_2O are affected by H_2O deprivation. Young & Green (1953) found that rats deprived of H_2O for 24 h selected H_2O more frequently than 1.2% sac but chose .15% sac more frequently than H_2O. They used the *brief exposure* method whereas the writers employed *continuous choice.*

This study also related to the experiment by Sheffield & Roby (1950) in which food deprivation made for increases in rat's intake of .13% sac presented in a choice with H_2O. Since either H_2O or food deprivation reduces considerably the rat's intake of the alternate commodity (Falk, 1961; Bolles, 1961; among others), H_2O deprivation should result in some sac increments, if only due to the self-imposed food deprivation. And if "...a normal rat treats a saccharine solution as either a food or a fluid depending upon the state of deprivation" (Teitelbaum, 1961, p. 58), then the likelihood of an increment of the consumption of sac over H_2O should be quite high.

Method

Subjects. The Ss were 48 male, Sprague-Dawley, 110-day old albino rats.

Apparatus and Procedure. For each rat, housed singly in a 10 x 7 x 7.5 in. ordinary living cage, there were two Richter tubes. One contained deionized H_2O, the other 0.1% or 1% sac. Both tubes were inserted simultaneously following forced sampling.

There were three H_2O deprivation groups—0, 24, and 48 h—half of which received the 0.1% solution and half the 1%. The six groups[3] are designated as 0-.1, 24-.1, 48-.1 and 0-1, 24-1, 48-1. Intakes were recorded after 24 and 48 h. During the first 90 min they were recorded at 10 min intervals.

Results

Figure 1 shows the mean sac and H_2O consumptions per 10 min interval. Consumption of H_2O in the 0-.1 group was significantly lower than that of sac by 90 min. In the 24-.1 group H_2O was consumed through 40 min but then it dropped abruptly and almost to zero, whereas sac remained fairly steady throughout the 90 min. By 90 min the intakes of the two solutions were the same. In the 48-.1 group, again H_2O intake exceeded that of sac. It started even higher than the level at which Group 24-.1's H_2O began, dropped, but at no 10 min interval point was the mean intake zero. By 40 min sac and H_2O converged. Thereafter their decline rates were about the same.

Figure 1 (top) shows that H_2O consumption was an increasing function of hours of deprivation. Furthermore, sac intake was significantly higher in the 24 and 48 h groups than in the 0 h group.

The lower half of Fig. 1 shows that the 0-1's mean H_2O intake was exceeded by, but did not differ significantly from, the group's mean sac intake. The H_2O consumption for the 24-h group started high and dropped to zero, later in the 90 min period. For the 48-1 group the H_2O started even higher and did not reach zero. Sac intakes by the 24-1 and 48-1 groups were negligible.

Following are some interconcentration comparisons: Within the 24-h groups the H_2O-sac difference in the 1% group was greater (9.8 cc) than the difference in .1% (-0.4 cc). Similarly, within the 48-h groups the H_2O-sac difference was greater in the 1% (17.3 cc) than in .1% (4.5 cc). Thus, with hours of deprivation constant, relative consumptions of H_2O increased with sac concentration.

In all deprived groups there was, subsequent to their initial total liquid intake, a drop followed by a sharp increase, mostly of H_2O. These "fluctuations" correlated with the selection and sustained H_2O drinking leading to vigorous eating (hence the drop), and a "second" return to the tubes selecting again mostly

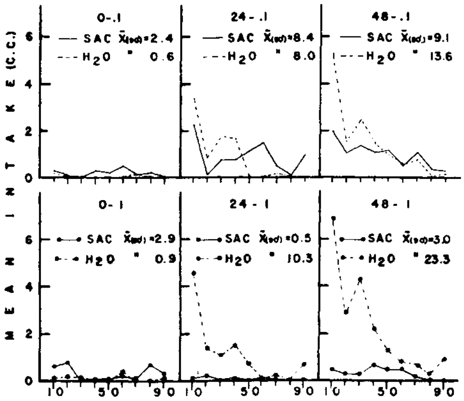

Fig. 1. Mean 90 min .1% and 1% saccharine and H_2O consumptions, per 10 min intervals, by 0, 24, and 48 h deprived rats.

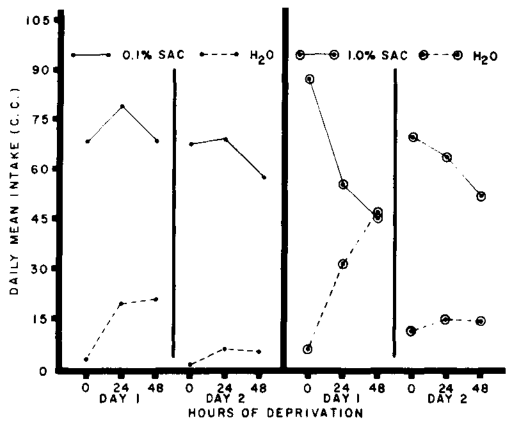

Fig. 2. Daily means of .1% and 1% saccharine and H_2O consumptions on two consecutive days by 0, 24, and 48 h H_2O deprived rats.

H_2O. This is further evidence that more H_2O than sac is drunk by deprived Ss.

Figure 2, which depicts daily mean intakes, indicates that only the 48-1 Ss failed to drink more sac than H_2O on Day 1. The sac and H_2O intakes of the 24-1 group were significantly different. On Day 2 all groups had higher sac intakes than H_2O. Furthermore, on both Days 1 and 2, relative consumption of H_2O within the 24- and 48-h groups was higher among 1% Ss. Secondly, relative intake of H_2O by 1% Ss on Day 1 increased with hours of deprivation.

Discussion

The present study has demonstrated that H_2O deprivation has the initial effect of reversing the sac-H_2O intake relationship typically exhibited by undeprived rats. This reversal interacts with sac concentrations. Ss offered 1% sac have higher relative H_2O intakes than Ss offered .1% sac. Previous unpublished data obtained by the senior author indicate that under nondeprivation conditions, and over an extended period, relative H_2O intake is also higher among Ss on 1% sac than among Ss on .1%. Concentration, therefore, has essentially the same effect on relative H_2O intake under thirst and nonthirst conditions. In addition, concentration determines the length of time required by thirsty Ss to "switch back" to the normal sac-H_2O intake relationship. A higher concentration postpones this switch.

There exists a double incongruity between the present findings and those of Young & Green (1953) who employed brief exposure. Comparisons made between consumptions during the first half of the 90 min test, that which more reasonably if at all approaches resemblance to their procedure, show that the 24-.1 rats in this study consumed more H_2O than .1% sac (Fig. 1), whereas their Ss selected .1% sac considerably more frequently than H_2O. Only subsequent to the 40 min did the rats in this study drink more .1% sac than H_2O. Likewise, there is both agreement and disagreement with respect to 1%. During the 90 min test the 24-1 rats in this study consumed H_2O almost exclusively. Their rats also preferred H_2O to 1.2%. However, subsequent to the 90 min in this study more 1% sac than H_2O was consumed. Brief exposure, therefore, whatever else it may test, may not be a reliable index of sac consumption in a continuous choice. It is conceivable that the brief exposure procedure might involve, primarily if not exclusively, oral factors, whereas consumption in a longer term choice situation may be largely controlled by post-ingestion factors.

That H_2O intake initially exceeds sac intake in H_2O deprived Ss is in sharp contrast to the Sheffield and Roby finding that consumption of sac by hungry Ss in the first 2-1/2 h of exposure is about 90% of the total liquid intake. The present results agree with their findings, however, to the extent that absolute intake of .1% sac is apparently higher under H_2O deprivation conditions than under nondeprivation conditions. The discrepancies in sac consumption by hungry and by thirsty rats in the two studies respectively are irreconcilable.

Given the particular sac concentrations, neither the 90 min test nor the two day consumption data lend support to Teitelbaum's position (1961), maintaining that rats drink sac when thirsty and eat it when hungry. The rats did not drink more sac during the 90 min test. On the contrary, they avoided it. If they did consume more sac than H_2O later, this is normal ad lib rat behavior.

There are three possible determiners, any one or a combination of which may be responsible for the higher H_2O consumption during the first 90 min. (1) H_2O deprivation may affect the gustatory mechanism so as to render sac less "palatable" than H_2O. (2) Rats may receive immediate feedback on the osmotic pressures of the liquids and may be naturally disposed to consuming more of the one with the lower pressure. (3) Rats may tend to consume more H_2O in response to thirst, certainly in the earlier stages, because of prior associations of H_2O with thirst reduction.

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Notes

1. A paper based on this investigation was read at the 1967 EPA meeting. We thank the Spring Term 1966 Experimental Psychology: Motivation class for their assistance.

2. Strouthes; unpublished data.

3. The groups are referred to by the hours of H_2O deprivation and % sac concentration. H_2O, always presented as a choice, is not included in the group designation.