# Consumption of a combined glucose-NaCl solution during normal and food deprivation conditions*

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A solution containing glucose and sodium chloride proved highly palatable to rats and in the majority of cases was preferred during food deprivation over a calorically equivalent solution containing saccharin and glucose.

Previous work by Valenstein, Cox, & Kakolewski (1967) demonstrated that certain combinations of glucose and saccharin, when combined in a solution, elicit much greater consumption than observed with a solution of glucose or saccharin alone. These results encouraged additional study of fluid intake of taste mixtures. The present study was designed to examine the palatability of a combined glucose-sodium chloride solution relative to a glucose-saccharin combination during normal and food deprivation conditions. A hypotonic solution of sodium chloride was combined with the same amount of glucose that had previously been employed to enhance the palatability of a saccharin solution. The resultant combination of salt and glucose yielded an isotonic solution that was judged to be neither sweet nor palatable by humans but proved to be highly palatable to rats.

## METHOD

The Ss were 10 female Holtzman albino rats (250 g). They were housed in individual cages and had no previous experience with taste solutions prior to testing. All animals were provided with Purina Lab Chow, and two bottles containing different fluids were placed on the front of the cages. Spilled fluid was retrieved in plastic cylinders mounted under each drinking tube. Distilled water was used to mix solutions, and concentrations are expressed in grams in a total of 100 ml of fluid (Pfaffman, Young, Dethier, Richter, & Stellar, 1954). Each day the 24-h fluid consumption was measured; bottles were washed and refilled with solutions that had been stored under refrigeration for 24 h.

The ten animals were provided for 7 days with a choice of 3% glucose plus .4% NaCl solution (G + N) and a bottle of tap water. Each 100 ml of the G + N solution contained 3 g of glucose and .4 g of NaCl. After this condition the animals were provided for 6 days with a choice of the G + N solution and a bottle containing a .25% saccharin plus 3% glucose solution (S + G). Each 100 ml of the S + G solution contained 3 g of glucose and .25 g of sodium saccharin (sodium-o-benzoic sulfimide). The S + G solution has been established in previous work (Valenstein et al, 1967) to be highly palatable to rats and is judged by humans to be very sweet. Finally, the animals were deprived of food for 3 days and provided a choice of the G + N and S + G solutions.

## RESULTS

As can be seen in Table 1, the consumption of the G + N solution, when paired with tap water, was relatively high. Previous work in our laboratory has established that rats consume approximately 60 ml per day of a 3% glucose solution and approximately 40 ml per day of a .4% NaCl solution. All the animals preferred the G + N solution to water, and four maintained this preference when exposed to a choice of the G + N solution and the S + G solution during ad lib feeding conditions. During food deprivation six of the animals preferred the G + N solution to the S + G solution, and one animal displayed an equal preference for the two solutions. Four of these animals preferred the G + N solution over the S + G solution during ad lib feeding as well. Three animals displayed a greater preference for the G + N solution during hunger than was displayed during ad lib feeding. Only three animals displayed a clear preference for the S + G solution over the G + N solution during food deprivation.

## DISCUSSION

Food-deprived rats increase their absolute consumption of most palatable saccharin solutions relative to tap water (Bacon, Snyder, & Hulse, 1962; Jacobs, 1967, 1969; Smith & Duffy, 1957; Valenstein, 1967). With very high though still palatable concentrations, saccharin preference may increase during food deprivation, though the absolute consumption of saccharin may actually decline (Wade & Zucker, 1969). In some conditions food-deprived rats will actually prefer a nonnutritive saccharin solution over a nutritive glucose solution (Valenstein, 1967) or sucrose solution (LeMagnen, 1954). These studies suggest that saccharin becomes a more compelling incentive during hunger and will in some instances take precedence over calories. It is generally assumed that rats respond to the property of saccharin that humans describe as sweetness. Both Gentile (1969) and Wade & Zucker (1969), as well as others, have suggested that rats respond to sweetness as an indication of caloric content. In this context the preference of the G + H solution over the S + G solution by a majority of the animals during food deprivation is of particular interest. The majority of food-deprived animals in the present study preferred the less sweet of two calorically equivalent solutions.

The consumption of the G + N solution during hunger would not appear to be determined by sodium chloride requirements. Six additional animals were provided with a choice of a 3% glucose solution vs a .4% sodium chloride solution during total food deprivation. The consumption of the glucose solution increased from a mean of 40 ml per day during ad lib feeding to 100 ml per day during hunger, whereas sodium chloride consumption declined from 20 ml per day to 10 ml per day.

Table 1
Mean Consumption of Solutions by Individual Animals

| | | | With Food | | Without Food | |
|---|---|---|---|---|---|---|
| S | G + N | $H_2O$ | G + N | S + G | G + N | S + G |
| SM-11 | 156.3 | 1.4 | 2.5 | 207.5 | 2.7 | 108.3 |
| SM-12 | 274.4 | 2.3 | 59.5 | 238.3 | 239.0 | 194.0 |
| SM-13 | 153.6 | 2.6 | 47.3 | 163.8 | 164.3 | 163.7 |
| SM-14 | 212.8* | 18.2* | 226.7 | 24.5 | 410.3 | 65.0 |
| SM-15 | 249.0 | 3.1 | 176.2 | 90.3 | 269.7 | 168.7 |
| SM-16 | 124.7 | 8.9 | 7.2 | 229.2 | 192.7 | 152.7 |
| SM-17 | 140.9 | 1.9 | 21.5 | 235.7 | 12.3 | 226.0 |
| SM-18 | 218.1 | 2.1 | 197.2 | 30.0 | 264.7 | 136.3 |
| SM-19 | 245.9 | 4.3 | 250.8 | 59.2 | 320.3 | 181.0 |
| SM-20 | 131.7 | 20.3 | 33.2 | 149.0 | 58.3 | 317.7 |
| $\bar{X}$ | 190.7 | 6.5 | 102.2 | 142.8 | 193.4 | 171.3 |

**Mean based on one less day due to inadvertent spillage.*

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# The effect of ACTH administration upon activity-related self-starvation*

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All Ss lived on a 23-h food-deprivation schedule. Two experimental groups lived in activity wheels while two control groups lived in laboratory cages. One experimental and one control group received subcutaneous injections of ACTH, while the other two groups received injections of physiological saline. The ACTH injection had no effect on the self-starvation phenomenon, and the results are in opposition to the hypothesis of adrenocortical involvement in the phenomenon.

It has been reported by Routtenberg & Kuznesof (1967) that rats confined to activity wheels and living on a 23-h food-deprivation schedule show an increase in activity, a decrease in body weight, and a food consumption less than that of control Ss living in standard laboratory cages on the same deprivation schedule. This "self-starvation" phenomenon was replicated by Strutt & Stewart (1970). Routtenberg (1968) proposed that two factors are operative in this phenomenon, "deprivation stress" and "novelty stress," and hypothesized that the endocrine system, in particular the adrenal cortex, may play an important role in the response of Ss to these stressors.

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Strutt & Stewart (1970) hypothesized that the proposed adrenocortical response of experimental Ss might involve an increased output of glucocorticoids that would, by means of gluconeogenesis, make glucose available which would perhaps facilitate running and suppress food consumption (Mayer, 1953). The blood glucose levels of experimental Ss did not follow the predictions concerning an adrenocortical response-driven phenomenon and were found to be significantly lower in the active Ss.

To test the hypothesis of adrenal involvement more directly, an attempt was made in the present study to produce an increased adrenocortical response by exogenous administration of ACTH. If this physiological mechanism was "driving" the self-starvation phenomenon, then those Ss injected with ACTH should show an earlier and perhaps more dramatic increase in activity and suppression of eating when compared to saline-injected experimentals. This would lead to much quicker self-starvation in the ACTH-injected experimental Ss.

## METHOD

Thirty-two male Sprague-Dawley rats, bred in the Franklin and Marshall laboratory, served as Ss. They were 81-93 days of age and weighed 292-439 g at the beginning of the experiment. Water was available ad lib to all Ss.

Sixteen Wahmann activity wheels, the home room, feeding room, and diet were identical to those reported by Strutt & Stewart (1970). The home-room temperature was maintained at 72° ± 4°F.

The preexperimental treatment procedure was the same as described by Strutt & Stewart (1970). Six days before the onset of the experimental procedures the Ss were divided into two equal groups, balanced according to body weight and litter affiliation. One group received 0.5 USP units of corticotropin injection (ACTH)/100 g of body weight. The ACTH was placed in a 12.5% concentration in physiological saline and injected subcutaneously in the nape of the neck, .05 cc/100 g of body weight. The other group received control injections of physiological saline, also .05 cc/100 g of body weight. These injections were given 7 h after light onset and were continued

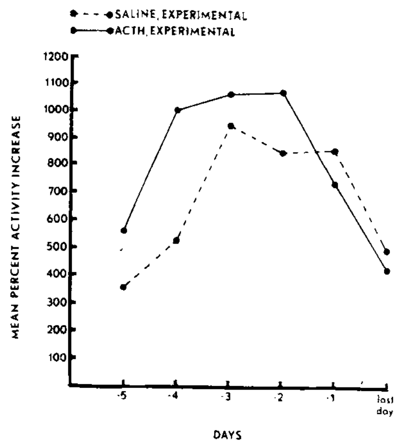


**Fig. 1. Mean percent of activity increase of the experimental groups over the last 6 days of the study for each S.**