A quick method for determining fluid preference: Saccharin preference in water-deprived rats as a function of time on deprivation schedule[1]

DANIEL FALLON, State University of New York at Binghamton, Binghamton, N.Y. 13901

A simple method of assessing fluid preference within a single 60-min period, with position preferences counterbalanced between and within Ss, is described. After 10 days of water deprivation, and at 80% of their predeprivation body weights, Ss preferred .1% saccharin to water. The preference for saccharin was even greater 21 days later. It is suggested that the preference for saccharin under water deprivation may be an index of concurrent hunger which grows with the increasing cumulative food deficit accompanying water deprivation.

In a variety of learning and motivation experiments, an assessment of preference for a given fluid can often be of value, even if the assessment is tangential to the experiment's principal aims. Probably in part because most commonly used preference-testing methods require either at least 24 h or inconvenient apparatus, the measurement of fluid preference has not been common in experiments where it might serve only a secondary, although useful, purpose. The technique described in the present report was initially developed to measure shifts in preference for a reward incentive in a learning experiment as a function of experimental treatments (Fallon, 1968). While providing a reliable and stable measure of fluid preference, it offers the further advantage of requiring only 1 h to administer simply, and with no elaborate equipment.

In the present experiment, the technique was used to measure the relative preference for saccharin solution vs water in water-deprived rats at two stages of water deprivation. The data are of interest since relatively little is known about saccharin preference under conditions of water deprivation (cf. Strouthes & Navarick, 1967; Young & Green, 1953).

SUBJECTS

The Ss were 50 experimentally naive male Sprague-Dawley rats, approximately 105 days old at the time of the first preference test. Between Tests 1 and 2, 40 Ss participated in a learning experiment in which the tested saccharin solution served as positive reinforcement (Fallon, 1969). The remaining 10 Ss were maintained under the same condition of deprivation in their home cages, but were exposed to the saccharin solution only during preference testing.

APPARATUS

Two standard animal cages, 9.5 x 7 x 7 in., of the type in which Ss were housed, were modified to permit the mounting of two inverted drinking tubes, calibrated in milliliters to 100 ml, equidistant from the cage walls and 3 in. apart. In one cage, the tube containing saccharin solution was on the right side and the water-filled tube was on the left side, while in the other cage the position of the two tubes was reversed.

PROCEDURE

Upon arrival from the supplier, Ss were individually housed and placed on a schedule of ad lib feeding and drinking. During daily maintenance, food and water were replenished and Ss were handled and weighed. After 5-7 days, Ss were deprived of water continuously for 3 days, and then given variable amounts of water daily until they reached 80% of their average predeprivation weights. All Ss reached this level within 6 days of the beginning of the deprivation procedure, and were maintained by water deprivation at 80%, ±1%, of predeprivation body weight throughout the experiment. Preference Test 1 took place 10 days after the initiation of water deprivation, and Preference Test 2 took place 21 days after Test 1.

Each test began 24 h after S's last water ration had been administered, and each S was at its appropriate body weight at the beginning of the test. The S was placed in the preference cage for 5 min during which it could drink either from a tube containing .123% saccharin by weight in deionized water, or from a tube containing plain deionized water. The position of the saccharin tube on this first exposure was counterbalanced between Ss. The saccharin solution was prepared 1 day in advance and the water was drawn at the same time to insure no difference in freshness or temperature between the two fluids. Dry food, always available in the home cage, was not present in the preference cage. At the conclusion of the 5-min drinking period, S was returned to its home cage for 10 min and intake from the two tubes was recorded. This procedure was repeated for a total of four successive 5-min drinking periods separated by 10-min intervals in the home cage. The position of the two tubes was reversed for each S on alternate drinking periods, and the use of different preference cages for the different tube positions allowed two Ss to be tested concurrently. Moreover, it was possible to test another two Ss during the 10-min home-cage interval of the first Ss. Thus, a complete saccharin preference test, with position preferences counterbalanced between and within Ss, was administered to four Ss during one 60-min period.

RESULTS

Preliminary analysis revealed that there was no real difference in intakes of the 40 Ss who experienced the saccharin solution as a positive reinforcer between preference tests and the 10 Ss without this experience (all $Fs \leqslant 1.05$). Therefore, the preference-test data summarized in Fig. 1 were obtained by collecting means over all 50 Ss. Saccharin is the preferred substance ($F = 54.20$, $df = 1/45$, $p < .001$), with much greater preference being shown on Test 2 than on Test 1 (Substance by Test interaction; $F = 44.59$, $df = 1/45$, $p < .001$). More total fluid was consumed on Test 2, 30.2 ml, than on Test 1, 25.4 ml ($F = 77.33$, $df = 1/45$, $p < .001$), and within both tests there was a decline in fluid intake over the four 5-min drinking periods ($F = 100.42$, $df = 3/135$, $p < .001$). Because relatively less fluid was consumed on the very first placement in the cage, on Test 1, than during the comparable initial 5-min period of Test 2, there was a significant interaction of Tests by 5-min Periods ($F = 5.22$, $df = 3/135$, $p < .005$).

It should also be noted that the preference-testing procedure, which alternates 5-min drinking periods with

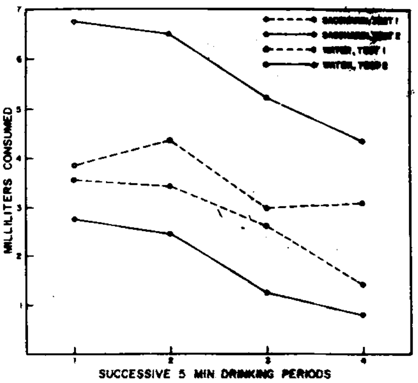

Fig. 1. Mean quantity of fluid consumed by 50 water-deprived rats at 80% of predeprivation body weight on four successive 5-min drinking periods separated by 10-min intervals in the home cage with dry food. Fluids available during each drinking period were .123% saccharin by weight in deionized water, and plain deionized water. Test 1 took place 10 days after the initiation of deprivation, and Test 2 took place 21 days after Test 1.

10-min exposures to the home cage and dry food, results in a high degree of consummatory behavior generally. This was reflected in body weight increases during the 1-h preference test. For both tests, the mean weight at the beginning of the testing procedure was 220.1 g. During Test 1, the mean 1-h weight gain was 27.9 g, and during Test 2 it was 33.7 g.

DISCUSSION

The finding that water-deprived rats prefer a dilute saccharin solution is in agreement with the report by Young & Green (1953), who used a brief-exposure choice method of determining preference. However, both the present data and the Young and Green experiment contradict the finding by Strouthes & Navarick (1967) that 24-h water-deprived rats drink more water than .1% saccharin for the first 40 min of exposure to the two fluids. In the Strouthes and Navarick experiment, Ss had continuous access to dry food at the same time that the fluids were present, whereas in the present experiment, Ss were isolated from nutritive dry food during periods when fluid preference was being assessed. While this may appear to be an important difference, Strouthes has found the same initial preference for water when Ss are exposed to the fluids in the absence of food.[2]

A plausible hypothesis for the differing reports of saccharin preference in water-deprived Ss may be found in motivational differences. An S at 80% of its predeprivation body weight after 10 days of water deprivation is certainly under more severe conditions of thirst motivation, as well as having made a physiological adjustment to the deprivation procedure, than an S after 24 or 48 h of continuous water deprivation. It is possible that as thirst motivation increases, an initial preference for water changes to a preference for saccharin. The present study provides some indirect support for this suggestion inasmuch as saccharin preference was much greater on Test 2 than on Test 1. That thirst motivation was greater on Test 2 than on Test 1 is indicated by the increased intake on Test 2, as well as by other experiments which typically show that keeping Ss at a fixed per cent of body weight over time results in gradually increasing conditions of motivation (e.g., Davenport & Goulet, 1964). Since it is well known that water deprivation is accompanied by a self-imposed restriction of food intake (e.g., Fallon, 1965), the hypothesis suggested here might be expanded to include the notion that a shift from water, to some saccharin, to much saccharin, preference with increasing thirst motivation might reflect the increasing cumulative food deficit which accompanies water deprivation. Therefore, for water-deprived Ss, a preference for water may indicate relatively little nutritive food deficit while a preference for saccharin may indicate a substantial concurrent hunger. This hypothesis is consistent with Teitelbaum's (1961) model which asserts that Ss treat saccharin as a fluid or as a food depending on conditions, i.e., thirsty Ss drink saccharin and hungry Ss eat it. Thus, when S is just thirsty it prefers water to .1% saccharin (Strouthes & Navarick, 1967), but when S is both thirsty and hungry, as was likely the case in the present experiment, it prefers .1% saccharin.

REFERENCES

DAVENPORT, D. G., & GOULET, L. R. Motivational artifacts in standard food-deprivation schedules. Journal of Comparative & Physiological Psychology, 1964, 57, 237-240.

FALLON, D. Effects of cyclic deprivation upon consummatory behavior: The role of deprivation history. Journal of Comparative & Physiological Psychology, 1965, 60, 283-287.

FALLON, D. Resistance to extinction following learning with punishment of reinforced and nonreinforced licking. Journal of Experimental Psychology, 1968, 76, 550-557. (See Erratum, Journal of Experimental Psychology, 1968, 77, p. 500.)

FALLON, D. Resistance to extinction following partial punishment of reinforced and/or nonreinforced responses during learning. Journal of Experimental Psychology, 1969, 79, 183-185.

STROUTHES, A., & NAVARICK, D. J. Saccharine and H_2O consumption as a function of H_2O deprivation. Psychonomic Science, 1967, 9, 523-524.

TEITELBAUM, P. Disturbances in feeding and drinking behavior after hypothalamic lesions. In M. R. Jones (Ed.), *Nebraska symposium on motivation.* Lincoln: University of Nebraska Press, 1961.

YOUNG, P. T., & GREEN, J. T. Relative acceptability of saccharine solutions as revealed by different methods. Journal of Comparative & Physiological Psychology, 1953, 46, 295-298.

NOTES

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2. A. Strouthes, personal communication, June 1969.

Schedule-induced polydipsia: Conditioned inhibition of salivation[1]

J. E. GRACE, The University of Western Ontario, London, Ont., Canada

The polydipsia which results when food-restricted rats are feeding on an intermittent food-reinforcement schedule is attenuated during heat exposure. This attenuation of schedule-induced polydipsia (SIP) indicates that heat exposure, by stimulating salivation, offsets conditioned inhibition of salivation (dry mouth) established by the intermittent schedule.

Rats, maintained at 70%-80% of their normal free-feeding weight, become polydipsic when water is available during periods of intermittent reinforcement with small food pellets (Falk, 1961). Polydipsia is observed whether the rat is working to obtain pellets or the pellets are automatically delivered on an intermittent schedule. The amount of water consumed per pellet is a function of the inter-pellet time (schedule), pellet size, and diet composition (Falk, 1964). The polydipsia does not appear to be secondary to impairment of renal concentrating ability, since rats, polydipsic on intermittent pellet delivery, show normal water intakes whenever the diet is available ad lib. Furthermore, injection of hydrochlorothiazide, which alleviates diabetes insipidus and polydipsia in hypophysectomized rats, does not reduce water intakes of rats with schedule-induced polydipsia (Falk, 1964).

Previous explanations of schedule-induced polydipsia (SIP) appear inadequate. It has been suggested that SIP is a result of adventitious reinforcement of drinking by its temporal contiguity to pellet delivery, but Falk (1964) and Stein (1964) ruled out this possibility by demonstrating that SIP occurred when the reinforcement schedule prevented such contiguity. It was suggested, also, that SIP results from prandial drinking, i.e., each pellet represents a meal and the rat drinks after each meal (Falk, 1964). This, however, is descriptive rather than explanatory.

One possible explanation for SIP is suggested by Pavlov's (1960) observations on salivary conditioning in dogs. Salivary conditioning to the temporal characteristics of reinforcement occurred when food was presented at regular intervals. Once conditioning had occurred, withholding of