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.

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NOTES

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

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

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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 food when the interval normally expired extinguished the salivary response. Pavlov, furthermore, showed that extinction was not due simply to forgetting or fatigue, but was due instead to an active inhibitory process. With repeated extinction trials, fewer and fewer unreinforced responses were needed to bring about complete extinction.

It was assumed for the present study that the rat, during acquisition of lever-pressing and response to pellet delivery on a CRF schedule, learns to salivate in anticipation of food pellets. When changed to the intermittent schedule, i.e., SIP, many anticipatory salivary responses would not be reinforced and would, therefore, be extinguished. Drinking, then, during SIP would alleviate a dry mouth resulting from conditioned inhibition of salivation established by Pavlovian conditioning. If the rat in the SIP situation is polydipsic as a result of inhibited salivation, then any stimulus which provokes salivation should reduce polydipsia. Since it is well established that heat exposure causes salivation

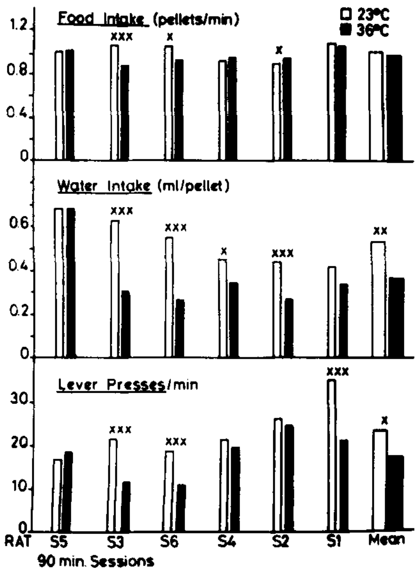

Fig. 1. Food intake (pellets/minute), water intake (milliliters/pellet), and lever-presses/minute during schedule-induced polydipsia (SIP) sessions with ambient temperature 23 deg C (open bars) or 36 deg C (cross-hatched bars). Narrow bars are means for each of six rats based on five (Rats 1 to 4) or nine (Rats 5 and 6) daily sessions at each ambient temperature. The wide bars are the combined means of the individual means. All tests of statistical significance were done by Student's t test with paired comparisons (X, $p < 0.05$; XX, $p < 0.025$; XXX, $p < 0.005$).

(Hainsworth & Epstein, 1966), it was chosen as the stimulus for salivation in the present experiment.

METHOD

Six experimentally naive male albino rats (Wistar), weighing from 474 to 597 g prior to food restriction, were gradually reduced by food rationing to 70%-75% of free-feeding body weight. Body weight was maintained at this level by daily rationing of Purina Lab Chow and by food pellets obtained during lever-pressing sessions. Water was available ad lib 24 h per day except during acquisition of lever-pressing. The rats learned to lever-press for food pellets (Noyes, 45 mg) within four to six 30-min sessions with continuous reinforcement (one pellet/lever-press). Following this, the rats were given three to seven 90-min sessions on a 1-min variable-interval (VI 1-min) schedule of food reinforcement. (Two operant conditioning boxes were used; three of the rats were run in Box A, VI 0.852 min, and the other three in Box B, VI 0.995 min.) To prevent association of drinking with pellet delivery, water was never available during these acquisition sessions. Following acquisition sessions, the rats remained on the VI 1-min schedule for 90 min each session for the next 26-27 sessions, but with water available. Polydipsia developed rapidly in the first 5-10 sessions and remained stable over the last 15 sessions. All sessions during this series were run at an ambient temperature of 23.0 ± 1.0 deg C.

Once polydipsia had become well established, four rats (Nos. 1, 2, 3, and 4) were given five daily, 90-min sessions on the VI 1-min schedule with the ambient temperature at 23.0 ± 1.0 deg C and five sessions at 35.5 ± 0.5 deg C. The remaining two rats (Nos. 5 and 6) were given nine daily sessions at the lower temperature and nine sessions at the higher temperature. Each daily session at 23 deg C was alternated with a daily session at 36 deg C. Each lever-press and pellet delivered during a session was recorded. Water intake was measured by difference in weight of the water before and after each session and was corrected for spillage.

RESULTS AND DISCUSSION

Figure 1 compares the mean water intake/pellet, lever-press rate, pellet-delivery rate for each rat, and the combined means of the individual means for these measures. The combined means show that heat exposure significantly reduced the water/pellet ratio ($t = 3.20$, $df = 5$, $p < 0.05$) over that at 23 deg C. Similarly, lever-pressing rate was significantly reduced ($t = 2.35$, $df = 5$, $p < 0.05$) during heat exposure although the rate of pellet delivery was not significantly changed ($p > 0.10$). It should be borne in mind that most of the lever-presses are not reinforced on the VI 1-min schedule and, therefore, a reduction in rate of lever-pressing may only reduce the number of nonreinforced responses without altering the number of pellets produced.

The individual means show that five of the six rats reduced water intake in the heat over that at the lower temperature (Fig. 1). This reduction was significant for four of the six rats. Five of the six rats also had reduced lever-pressing rates during heat exposure; the reduction was significant in three, and of these, two showed a significant reduction in rate of pellet delivery. Since two rats showed an increase in rate of pellet delivery and concomitant decrease in the water/pellet ratio during heat exposure, it appears that reduction of pellet delivery cannot account for the reduction in water intake/pellet.

In order to estimate the relative strengths of salivary inhibition, the data of the rats represented in Fig. 1 are arranged from left to right in order of decreasing polydipsia at 23 deg C. The strength of polydipsia suggests a negative correlation with lever-pressing rate at 23 deg C. This correlation would be expected if it is assumed that a low lever-pressing rate (inhibition of lever-pressing) is indicative of the strength of inhibition of salivation.

From these results, it is concluded that SIP occurs as a response to a dry mouth which is a consequence of conditioned inhibition of salivation. During acquisition on a continuous reinforcement schedule, the rat salivates in anticipation of a pellet. When the VI schedule is instituted, the salivary response is often not reinforced and the response extinguishes. The response is repeatedly reinforced and extinguished during each VI 1-min session.

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NOTE

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