elation or positive contrast effect in the first minutes of testing, the rate rapidly returns to nominal preshift levels. This may account for the discrepancy between the results reported here and those using intake data (Ashton, Gandelman, & Trowill, 1970a).

Of further interest is the differential effect of response ceiling between Experiments 1 and 2. Assuming that rats lick at a rate of 6 per second (Stellar & Hill, 1952), the per minute rate could be as high as 360 licks. Preshift rates in Experiment 1 were well below this rate, and both groups showed marked contrast effects. In Experiment 2, however, preshift rates were higher and, even though the absolute level of postshift responding was considerably greater than in Experiment 1, the relative contrast effect was smaller. Different baselines and response ceiling effects also affected the two groups within Experiment 2 such that the increases in response rate were greater for the nondeprived animals (although these only approached statistical significance). These data compliment those of Panksepp & Trowill (1969, 1970, in press), which indicated that manipulations that alter baseline responding (e.g., deprivation conditions) also affect contrast effects. It

might also be suggested that the ability to obtain elation effects could depend strongly on the solution concentrations selected.

REFERENCES

- ASHTON, A., GANDELMAN, R., & TROWILL, J. A. Effect of food deprivation upon elation of saccharin drinking following a temporary shift to water. *Psychonomic Science*, 1970a, 21, 5-6.
- ASHTON, A., GANDELMAN, R., & TROWILL, J. A. Effects of reinforcement shifts upon subsequent sucrose consumption. *Psychonomic Science*, 1970b, 21, 8-10.
- BOLLES, R. C. *Theory of motivation*. New York: Harper & Row, 1967.
- GANDELMAN, R., & TROWILL, J. A. Effects of reinforcement shifts upon subsequent saccharin consumption. *Psychonomic Science*, 1969, 15, 25.
- PANKSEPP, J., & TROWILL, J. A. Positive and negative contrast effects with hypothalamic reward. *Physiology & Behavior*, 1969, 4, 173-175.
- PANKSEPP, J., & TROWILL, J. A. Positive incentive contrast with rewarding electrical stimulation of the brain. *Journal of Comparative & Physiological Psychology*, 1970, 70, 358-364.
- PANKSEPP, J., & TROWILL, J. A. Positive and negative contrast in licking with shifts in sucrose concentration as a function of food deprivation. *Learning & Motivation*, in press.
- STELLAR, E., & HILL, J. H. The rat's rate of drinking as a function of water deprivation. *Journal of Comparative & Physiological Psychology*, 1952, 45, 96-102.

Responses to palatability shifts: Effects of varying the retention level

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Nondeprived rats were given a 1-h exposure to a sodium-saccharin solution for 28 consecutive days. A temporary shift to tap water then occurred for all Ss. The brief timeout (tap water) led to a positive contrast effect. Lengthy exposure to tap water (30 days) resulted in the possible forgetting of the comparison solution (sacc) or perhaps the response to that solution.

Recent studies (Gandelman & Trowill, 1969; Ashton, Gandelman, & Trowill, 1970a) have noted an immediate and durable elation effect when nondeprived rats are returned to a sodium-saccharin solution after being given a timeout from this solution. Typically, the procedure involved the presentation of a

sodium-saccharin solution for 1 h a day before and after a 3-day shift to tap water. Ashton et al (1970a) noted that the S probably has to sample a second solution (e.g., water) in order to show the elation effect. In addition, evidence was presented which demonstrated that the elated responding is masked by deprivation conditions.

So far, no systematic manipulation of the duration of the timeout period has been made. It is possible that extended experience with tap water during a timeout

period would interfere with the retention of the ingestion response (sacc). Gleitman & Steinman (1964), using a runway paradigm, demonstrated that rats forget previously experienced reward magnitudes and perhaps their own responses to reward-magnitude shifts after interposition of a 2-month retention interval. The present experiment investigated the effect of varying the retention interval during which the rat sampled only tap water.

SUBJECTS

Twenty-four 90-day-old female albino rats, bred at the University of Massachusetts colony, were selected from a larger group prescreened as saccharin drinkers. All Ss were individually housed and maintained on ad lib food (Purina Lab Chow pellets) and tap water in a ventilated room under conditions of illumination from 7 a.m. to 7 p.m. All testing was done in the S's home cage from 11 a.m. to 12 noon.

PROCEDURE

The 24 Ss were assigned randomly to four groups (6 Ss/group). A graduated water bottle (Wahmann LC-274) containing 0.25% (w/w) sodium-saccharin/tap-water solution (sacc) was attached to each cage for 1 h during 28 consecutive days. On the 29th day, tap water was substituted for the more palatable saccharin. Group 1 experienced tap water for 10 min and Group 2 experienced tap water for 1 h. Saccharin was returned to these two groups on the day following tap water for 7 days. Group 3 consumed tap water for 1 h on 3 consecutive days and was then returned to saccharin for 7 days. Group 4 ingested tap water for 1 h for 30 consecutive days and was then returned to saccharin for 7 days.

RESULTS AND DISCUSSION

Figure 1 shows the mean intake of saccharin and tap water over the entire experimental period. Visual inspection of the data for the first 28 days lead to the conclusion that there was no significant difference between groups. In a comparison between the 3 days preceding and the 3 days after the shift to tap water, Group 1 showed an elated postshift intake ($F = 15.11$; $df = 1,20$; $p < .001$). All six Ss of this group increased ingestion of saccharin during the postshift period (significant by a sign test according to Siegel, 1956, p. 68). Group 2 also demonstrated an elated intake effect ($F = 12.45$; $df = 1,20$; $p < .005$) but failed to meet significance for a sign test. A single S in this group consumed a mean of 2 ml less during the postshift period.

Group 3, which had 3 days of 1 h tap water, failed to meet significance on either the F ($F = 0.92$; $df = 1,20$; $p > .10$) or the sign test. This finding is inconsistent with

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Fig. 1. Mean intake of sodium-saccharin and tap water expressed in milliliters over the entire experimental period.

the data reported earlier by Gandelman & Trowill (1969) and Ashton et al (1970a). No explanation is apparent for this nonreplication since the data reported by the Gandelman and Trowill and Ashton et al studies agreed well. That this effect is not terribly robust has been pointed out by DiLollo & Meyer (1970) earlier, using a 5-day exposure to tap water.

Group 4, which was kept on tap water for 30 days, also failed to reach significance ($F = 3.86$; $df = 1,20$; $p > .10$), although it did approach significance at the .05 level. Data for this group suggests a possible depression followed by an elation.

It is possible that a larger N would have revealed postshift responding indicative of a group that was relearning their original response to the saccharin solution.

An analysis of variance for a repeated measurements design with groups as the between-Ss variable (Myers, 1966) was used to compare the 3 preshift days and the 3 postshift days to test for group differences in postshift responding. A significant Groups by Pre- and Postshift Responding interaction ($F = 5.47$; $df = 3,20$; $p < .01$) indicated that the group means differed over the levels of pre- and postshift responding (Fig. 2). The simple effects were examined to determine which groups were primarily responsible for this interaction. It was postulated, before testing, that Group 4 would differ significantly from Groups 1, 2, and 3 over the levels of shifting. However, a posteriori test of significance was used (Scheffe's multiple comparison method) to assure complete confidence in the postulated assumption. Significance using the Scheffe method (criterion $F = (3)F_{.025} = 7.58$; $df = 3,20$; $F_{\text{computed}} = 11.78$) implied that the difference of the average of the raw data for Groups 1, 2, and 3 differed from the mean of Group 4 over the levels of shifting. The different groups changed differently over the pre-postshift levels. We must conclude that the length of timeout period differentially affected the data. It is possible that the S is gradually forgetting the comparison solution (Sacc) or perhaps the response to that solution.

Fig. 2. Mean intake of sodium-saccharin expressed in milliliters before (3 days) and after (3 days) a shift to tap water.

These data lead to the conclusion that the length of the timeout (tap water) period does differentially affect the elated postshift responding when saccharin is returned to the Ss. While no magnitude effects were tested per se, the data suggests that within the limits here there is an inverse relationship between the timeout exposure and the magnitude of elation. Since most of the tap water ingestion occurs during the early portion of its initial presentation, the similarity of the groups given 10 min and 60 min of exposure is reasonable.

The unclear data for the group given tap water for 3 days was unexpected, although the pre-postshift saccharin ingestion for this group did increase as expected (Fig. 2). In any event, the data from the 10-min and 60-min groups suggests that three daily 60-min exposures of tap water (or removals of saccharin) may not represent the optimal conditions for producing elated postshift responding.

The great variability for the group given tap water for 30 days prevents any simple conclusions. However, at some point the duration of the tap water period should get so long that a relearning of saccharin consumption is obtained when saccharin is re-presented to the animal. The data found here suggests that such may be the case after 30 days without saccharin, although a greater number of Ss will be required to provide a definitive answer.

The reliable contrast observed here, taken with the earlier reports of Gandelman & Trowill (1969) and Ashton et al (1970a), further serve to confirm the reliability of the effect. The use of 28 preshift testing days in this study and in that of Ashton et al (1970a) should negate the explanation by DiLollo & Meyer (1970) that the Gandelman & Trowill (1969) results represent preasymptotic response increases rather than elated intake. Furthermore, short-term contrast of licking has also been reported following a similar paradigm (Ashton & Trowill, 1970).

The major perplexity of this research program remains the failure to find similar results for sucrose when either intake (Ashton et al, 1970b) or licking rate (Ashton & Trowill, 1970) are measured. This is particularly surprising since within-session positive contrast of licking has been found in our laboratory (Panksepp & Trowill, in press) when sucrose concentration is shifted upward. No clarification of this difference between saccharin and sucrose is yet apparent.

Regardless of the specific details, positive contrast seems to be a reliable effect, whether measured in a within-session (Panksepp & Trowill, 1969,

1970, in press) or a between-session (Gandelman & Trowill, 1969; Ashton et al, 1970a; Ashton & Trowill, 1970) paradigm. In each case the effect has been most prominently observed in Ss who are non- or lowly-deprived of food. In fact, the addition of substantial food deprivation seems to obscure the effect primarily due to the energizing influence of deprivation on control response levels. The phenomenon of positive contrast then might best be described as a manifestation of the organism's discovery of improved reward conditions when other motivational conditions are such as to not produce maximal responding.

REFERENCES

- ASHTON, A. B., & TROWILL, J. A. Effects of reinforcement shifts upon lick rate. *Psychonomic Science*, 1970, 21, 8-10.
- ASHTON, A. B., GANDELMAN, R., & TROWILL, J. A. Effect of food deprivation upon elation of saccharin drinking following a temporary shift to water. *Psychonomic Science*, 1970a, 21, 5-6.
- ASHTON, A. B., GANDELMAN, R. J., & TROWILL, J. A. Effects of reinforcement shifts upon subsequent sucrose concentration. *Psychonomic Science*, 1970b, 21, 7-8.
- BLACK, R. W. Shifts in magnitude of reward and contrast effects in instrumental and selective learning: A reinterpretation. *Psychological Review*, 1968, 75, 114-126.
- DiLOLLO, V., & MEYER, P. N. Variations in fluid intake following shifts between water and saccharin solution. *Psychonomic Science*, 1970, 18, 55-56.
- DUNHAM, P. J. Contrasted conditions of reinforcement: A selective critique. *Psychological Bulletin*, 1968, 69, 295-315.
- GANDELMAN, R., & TROWILL, J. A. Effects of reinforcement shifts upon subsequent saccharin consumption. *Psychonomic Science*, 1969, 15, 25.
- GLEITMAN, H., & STEINMAN, F. Depression effect as a function of retention interval before and after shifts in reward magnitude. *Journal of Comparative & Physiological Psychology*, 1964, 57, 158-161.
- MYERS, J. S. *Fundamentals of experimental design*. Boston: Allyn & Bacon, 1966.
- PANKSEPP, J., & TROWILL, J. A. Positive and negative contrast effects with hypothalamic reward. *Physiological Behavior*, 1969, 4, 173-175.
- PANKSEPP, J., & TROWILL, J. A. Positive incentive contrast with rewarding electrical stimulation of the brain. *Journal of Comparative & Physiological Psychology*, 1970, 70, 358-364.
- PANKSEPP, J., & TROWILL, J. A. Positive and negative contrast in licking with shifts in sucrose concentration as a function of food deprivation. *Learning & Motivation*, in press.
- SIEGEL, S. *Nonparametric statistics*. New York: McGraw-Hill, 1956.

ERRATUM

GRIGG, P. Lever holding and avoidance in the rat, with constant current and constant voltage UCS. *Psychonomic Science*, 1970, 20 (3), 133-134.—Page 133, column 3, lines 9-10 should read: "However, since the first four Ss assigned to the 25-V group did not avoid or escape the" instead of what is now there.