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Bidirectional contrast as a function of rate of alternation of two sucrose solutions

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Reliable positive and negative contrast effects in lick-rate were obtained when the same rats were exposed on some days to both a 32% and a 4% sucrose solution and on control days to only the 32% or only the 4% solution. Daily test sessions were 270-sec long, and the tubes containing the sucrose solutions alternated every 15 sec in one group and every 45 sec in another group. The rats in the 15-sec alternation condition licked more in a daily session, but the degree of contrast, both positive and negative, was uninfluenced by rate of sucrose alternation.

Rats exposed to more than one sucrose concentration often respond differently than rats exposed to only a single concentration. For example, rats shifted from a 32% sucrose solution to a 4% solution lick less of that solution than rats always maintained on 4% sucrose, a result termed a negative contrast effect (Flaherty, Capobianco, & Hamilton, 1973; Vogel, Mikulka, & Spear, 1968.) In a recent paper (Flaherty & Largen, 1974), a procedure was used which allows for the reliable demonstration of both decrements in lick rate (negative contrast) and enhancement of lick rate (positive contrast) within the same subjects. The basic procedure consists of exposing rats to a situation where two drinking tubes containing sucrose solutions are alternated each minute. On control days, both tubes contain the same sucrose solution (e.g., either 32% or 4%) but on test days the tubes contain different solutions, 32% on one side and 4% on the other (positions are counterbalanced.) Each subject experiences each condition and, thus, serves as its own control for evaluating both positive and negative contrast effects. Using this technique, it has been found that rats lick more 32% on comparison days and less 4% on comparison days than on noncomparison days. Both the positive and negative contrast effects appeared to be stable (occurred over repeated 4-day cycles) and highly reliable, both with alternating 1-min access periods for a 6-min test session and with alternating 30-sec access periods for a 3-min test session.

In the present paper, we further investigate the magnitude of these within-subject bidirectional contrast effects as a function of rate of alternation of the two concentrations. Specifically, degree of contrast obtained with 32% and 4% sucrose solutions was examined when the two solutions were alternated every 15-sec versus when the two solutions were alternated every 45-sec, with session length held constant at 270-sec.

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METHOD

Subjects

Twelve naive male 90-day old Sprague-Dawley rats purchased from Carworth labs were used as subjects.

Apparatus

Testing was conducted in a Plexiglas chamber measuring 30 x 25 x 25 cm. On one side of the chamber there were two centrally located 1.5-cm diam holes spaced 21.7 cm apart and 4 cm above the wire mesh floor. Outside of the chamber, two graduated cylinders were mounted so that, in the drinking position, the orifice of the glass drinking spouts were centered in the 1.5-cm diam holes and flush with the outside wall of the chamber. The graduated cylinders were mounted on cam operated magazines (BCS Manufacturing Company) which, with associated relay programming equipment, could be used to present or retract each tube from the drinking position. Pilot lights, mounted on either side of the chamber, were lighted when the proximal tube was in the drinking position. One side of a contact relay circuit was connected to the wire-mesh floor and the other side of the circuit was connected to a wire immersed in the solution contained in each bottle.

Procedure

The rats were randomly assigned to one of two groups of six rats each. Subjects in both groups were deprived to 85% of their free-feeding weight and were maintained at that level. Water was always available in the home cage.

Testing was conducted in the following manner. For one group (45 sec) on each test day the rat was placed in the apparatus with two graduated cylinders containing sucrose solutions. The left tube was in the drinking position and remained available for a 45-sec period starting at the time of the subject's first lick. At the termination of this 45-sec period, the left tube retracted and the right tube moved into the drinking position and remained there for a 45-sec access period starting from the time of the first lick. At the end of this 45-sec period, the right tube retracted and the left tube again became available. This procedure of alternating tubes was continued for a total of three presentations of each tube (270 sec available licking time).

The procedure for the second group (15 sec) was identical to that of the first group except that each tube was available for a period of 15-sec licking time. The procedure of alternating tubes was continued for a total of nine presentations of each tube (270 sec available licking time).

The sucrose solutions contained in the drinking bottles were varied systematically over 4 testing days, each of the 4 days spaced 3 days apart. On 2 days, both bottles contained the same solution, 32% on one day and 4% on the other. On the remaining

2 days, one bottle contained the 32% solution and the other contained the 4% solution. On one of these days, the 32% solution was in the left bottle and on the other day it was in the right bottle. Two cycles were presented with a 3-day break between them. Within each 4-day cycle, the actual sequence of sucrose conditions was randomized. The solutions were prepared by weight (solute/solute + solvent) from commercial grade cane sugar and tap water. New solutions were prepared every 3 days and were presented at room temperature.

RESULTS

Mean cumulative licks as a function of concentration and access period are presented in Figure 1. The data shown are from Cycle 2 only. The results obtained in the first cycle were similar but more variable due to the small number of licks made by some animals on their first exposure to the apparatus.

Analysis of cumulative licks in the last access period (Period 3 for the 45-sec group and Period 9 for the 15-sec group) indicated a reliable positive contrast in both groups ($F = 27.74$, $df = 1/10$, $p < .005$) with no difference in the size of contrast as a function of exposure duration ($F < 1.00$). Exposure duration did influence total number of licks made; the 15-sec alternation group licked more than the 45-sec alternation group ($F = 15.68$, df - 1/10, $p < .005$).

A similar analysis of the 4-4 and 4-32 data indicated a reliable negative contrast ($F = 11.80$, $df = 1/10$, $p < .01$) that did not differ as a function of duration of access. In the case of the lower concentration, there was no difference in total number of licks as a function of exposure duration ($F < 1.0$). Examination of Figure 1 indicates that the contrast effects developed early with either access duration. Analysis of the cumulative lick data obtained after 45 sec of exposure (Period 1 for the 45-sec group and Period 3 for the 15-sec group) showed a reliable positive contrast effect in both groups ($F = 9.1$, $df = 1/10$, $p < .025$) that did not vary as a function of exposure duration. However, even by this early period in the daily session, the 15-sec alternation group had made more total licks than the 45-sec alternation group ($F = 8.9$, $df = 1/10$, $p < .025$). A similar analysis on the lower concentration conditions indicated a reliable negative contrast effect ($F = 11.8$, $df = 1/10$, $p < .01$) that did not vary as a function of duration of access. Again, as in the terminal lick data, there was no difference in total number of licks as a function of access duration.

On control days (32 vs 32, or 4 vs 4) both groups always licked more for the 32% solution than for the 4% solution (sign tests, $p < .02$).

DISCUSSION

In this experiment positive and negative contrast effects were found with both 45-sec and 15-sec access periods. The size of the contrast appeared to be uninfluenced by the duration of the access period. However, access period did influence total number of licks made in a daily 270-sec test session; rats in the 15-sec group made more licks than rats in the 45-sec group. Contrast effects developed rapidly under both access conditions and were reliably present after only 45-sec total exposure.

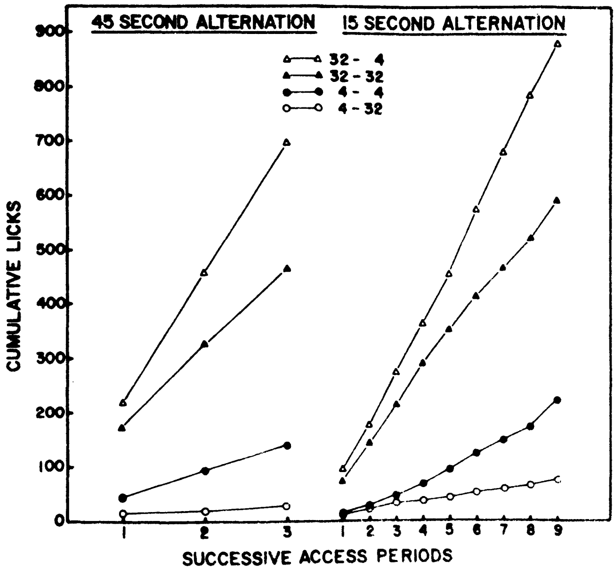

Figure 1. Mean cumulative licks as a function of sucrose presentation condition. The curve labeled 32-4 refers to lick rate for 32% when the alternative tube contained 4%, the curve labeled 32-32 refers to lick rate for 32% when the alternative tube also contained 32%, etc. Sucrose concentration conditions were varied within-subjects, rate of alternation of the sucrose solutions was varied between-subjects.

These results taken in conjunction with those of Flaherty and Largen (1974) show that bidirectional contrast can be obtained with the present paradigm over a wide range of access durations (15-, 30-, 45-, and 60-sec).

The ease with which contrast effects may be obtained with the present paradigm and the rapidity with which these contrast effects develop cannot be readily explained by current theories of contrast (e.g., Black, 1968; Capaldi, 1972). These data may indicate a primary sensory contribution to contrast effects such that experience with one concentration of sucrose alters the taste of the other concentration. Data indicating that such sensory effects may occur have been obtained in other contexts (McBurney, 1972; Bartoshuk, 1968). However, short-term sensory effects cannot be the sole explanation for contrast obtained in sucrose solutions since contrast effects may be obtained when several days elapse between exposures to different sucrose solutions (Flaherty, Capobianco & Hamilton, 1973). The present paradigm may provide a means for assessing the relative contributions of sensory, emotional, and associative factors to the occurrence of contrast effects.

REFERENCES

Bartoshuk, L. M. Water taste in man. Perception & Psychophysics, 1968, 3, 69-72.

Black, R. W. Shifts in magnitude of reward and effects in instrumental and selective learning: A reinterpretation. Psychological Review, 1968, 75, 114-126.

Capaldi, E. J. Successive negative contrast effect: Intertrial interval, type of shift, and four sources of generalization decrement. Journal of Experimental Psychology, 1972, 96, 433-438.

Flaherty, C. F., Capobianco, S. & Hamilton, L. W. Effect of septal lesions on retention of negative contrast. Physiology and Behavior, 1973, 11, 625-631.

Flaherty, C. F. & Largen, J. Within-subjects positive and negative contrast effects in rats. Journal of Comparative and Physiological Psychology, in press.
McBurney, D. H. Gustatory cross adaptation between sweet-tasting compounds. Perception & Psychophysics, 1972, 11, 225-227.
Vogel, J. R., Mikulka, P. J., & Spear, N. E. Effects of shift in sucrose and saccharine concentrations on licking behavior in the rat. Journal of Comparative and Physiological Psychology, 1960, 66, 661-666.

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The influence of preoperative learning on the recovery of a successive brightness discrimination*

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The recovery of a successive two-choice brightness discrimination following posterior neodecortication is significantly impaired if the reinforcement contingencies of the postoperative task are the reverse of those learned preoperatively. These results replicate a simultaneous two-choice brightness discrimination.

Of the many possible mechanisms that may mediate behavioral recovery following neurological insult, two have received some recent attention and specification with regard to the recovery of learned brightness discriminations following neocortical insult. One of these has been outlined by Cooper and his associates (Bauer & Cooper, 1964; Goodale & Cooper, 1965; Bland & Cooper, 1970; Cooper, Blochert, Gillespie, & Miller, 1972) and suggests that the recovery process is essentially a relearning process. The second has been detailed by Meyer (1972) and suggests that the recovery process may be a reaccessing process. The two notions differ inasmuch as one, the relearning position, suggests that what is occurring pre- and postoperatively is essentially the same basic process, while the other notion, the reaccessing position, suggests that the pre- and postoperative processes are qualitatively quite different. In this latter instance, postoperative behavioral recovery occurs because the preoperatively learned behavior was spared by the neocortical damage, with the recovery process representing a reactivation or reaccessing of the spared behavior patterns. Both of these postulations have amassed a certain amount of empirical support, but much of this support is quite indirect and none of it provides a direct test of the two positions.

Recently, however, LeVere and Morlock (1973) directly tested the relearning and reaccessing concepts with a procedure where the two positions would make opposing predictions. The experimental design was quite straightforward and simply involved preoperative training of two matched groups of rats on a simultaneous two-choice brightness discrimination and, subsequent to posterior neodecortication, retraining one group of rats on the original brightness problem while retraining the other group on the reversal of the original brightness problem. The logic was that if the Ss were recovering the discriminative behavior through a process of relearning, i.e., establishing new and independent memory engrams, then it should matter little whether the rats were retrained on the original brightness task or on the reversal of the original brightness task. However, if the animals were not relearning postoperatively and if the preoperative experience was somehow involved in the recovery process, as suggested by the reaccessing notion, then the animals trained on the reversal of the original brightness discrimination should be significantly impaired during postoperative training. This was argued because in the reversal group which was learned preoperatively was the antithesis of the behavior required postoperatively. The results indicated that the postoperative reversal group was, in fact, significantly impaired in their mastery of the reversed brightness discrimination. LeVere and Morlock (1973) thus concluded that a strict interpretation of the relearning position was somewhat untenable.

However, in deference to the data suggesting the viability of the relearning conceptualization, it would seem appropriate to attempt a systematic replication before wholeheartedly espousing the conclusions of LeVere and Morlock (1973). The present report describes this replication using a successive brightness discrimination procedure instead of the simultaneous task used by LeVere and Morlock. The successive task was chosen because, while it is obviously a learned visual

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