Positive contrast in instrumental learning from qualitative shift in incentive¹

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Rats shifted from food pellets to preferred 32%-sucrose pellets as reinforcers in instrumental (bar-press) learning showed a reliable positive contrast effect when compared to nonshifted control rats given 32%-sucrose pellets throughout training. Rats shifted from 8%-sucrose pellets to 32%-sucrose pellets did not differ from the controls. Positive contrast effects, very rare in the literature but of substantial theoretical importance, should be more readily obtained if sufficiently marked incentive differences are used.

This experiment demonstrates that positive contrast can be obtained in instrumental learning when a sufficient change in incentives is introduced. The qualitative change used in the present case was clearly effective whereas a quantitative change was not.

The effectiveness of a particular incentive as a reinforcer in instrumental learning has often been considered to be a function of the S's previous experience with other incentives rather than simply a function of the absolute value of the present incentive (Crespi, 1942; Zeaman, 1949). However, while a negative contrast effect (undershooting in performance following a downshift in incentive) is relatively easy to obtain, the evidence for positive contrast (overshooting in performance following an upshift in incentive) is tenuous indeed. In a recent report of negative results, for example, Schrier comments: "Although there have been trends in the right direction, there has not been a major study as yet which has shown a reliable positive contrast effect [Schrier, 1967, p. 490]." This remark is typical of current opinion (Dunham, 1968; Black, 1968).

The issue is important in contemporary behavior theory because the interpretation of contrast effects depends upon whether positive as well as negative contrasts can be demonstrated. Negative contrast can be explained on the basis of interfering emotional (frustration) responses associated with the downshift (Spence, 1956; Amsel, 1958), but such a view cannot readily be applied to the positive contrast effect. If positive effects can be reliably obtained, some other interpretation, such as a motivational one (Marx, 1966), or an

adaptation-level one (Helson, 1964), will be required.

EXPERIMENTAL DESIGN

The qualitative change used in this experiment was a shift from food pellets to 32% sucrose pellets, both 45-mg Noyes, the latter a more preferred incentive; the quantitative change was a shift from 8%-sucrose pellets to the preferred 32%-sucrose pellets. A control group was maintained throughout acquisition on 32%-sucrose pellets.

A second feature of the experimental design was the use of a very mild food-deprivation schedule. Ss were run after 2 to 3 h of deprivation. This procedure was instituted to increase the performance ceiling for the shifted animals. The rationale (Pereboom, 1957) was that in the typical experiment, conducted under high-deprivation and high-incentive conditions, the control Ss perform at close to their physiological limit, thus allowing insufficient room for upshifted Ss to show clearly superior (contrast) performance.

METHOD

The Ss were 30 experimentally naive 90-day-old female rats from the colony maintained in our laboratory (Long-Evans hooded extraction). On the very mild food-deprivation schedule, the animals showed essentially normal weight gains ($F = 27.052$, $df = 2,50$, $p < .01$, for increments over three weighings during the experiment). Although the group differences were small and statistically unreliable ($F < 1.0$), the final weights, recorded at the end of training, showed the food-pellet group to be slightly heavier (mean of 249.3 g) than either the 8% group (240.8 g) or the 32% group (243.3 g).

The apparatus was a set of eight controlled-operant conditioning boxes previously described (Marx, Tombaugh, Hatch, & Tombaugh, 1965).

Pretraining consisted of an incentive-priming phase, 3 days of magazine training, and 1 day of free-operant bar-press training. In priming, each rat was offered a sample of each of the three incentives in its home cage. The first day of magazine training came after a period of 24 h of food deprivation, to insure initial responsivity to the incentives. Twenty incentives were offered, one pellet per trial at a 60-sec interval, on this and the following day. On the third day, 15 trials were given. During the initial bar-press day, 20 reinforcements

were given. Failure of one S from each of the upshifted groups to train reduced their N to nine; no control Ss were lost.

All subsequent bar-press training was conducted with a discrete-trial procedure. The bar remained in the test cage until pressed, or for a maximum duration of 60 sec, after which it was retracted for an intertrial interval of 60 sec. Each bar press was followed by the movement of the magazine and the offering of a new incentive appropriate to the group: food-pellet, 8%-sucrose pellet, or 32%-sucrose pellet. These training trials were presented 12 per day, Monday through Friday each week, until the group appeared to be performing asymptotically. At that point, the appropriate shift was made, for the two upshifted groups, so that during the postshift test trials all groups were receiving 32%-sucrose pellets as incentives.

RESULTS

The major results are shown in Fig. 1, which depicts mean bar-press latencies for the 10 days immediately preceding and the 10 days immediately following the shift in incentive. The food-pellet and the 8% groups were shifted after 18 and 20 days, respectively; the imaginary "shift" point for the nonshifted controls, whose performance was already essentially asymptotic, was arbitrarily placed midway between the two actual shifts.

The preshift means were in accord with expectation, with a direct relationship between speed of performance (lower mean latency) and preference of incentive. Postshift mean latencies did not differ for the 8% and 32% groups ($F < 1.0$), but the food-pellet group showed reliably superior performance when compared with the nonshifted controls ($F = 4.280$, $df = 1,170$, $p < .05$). Neither days nor the interaction of

Fig. 1. Mean bar-press latency for the three groups during 10 days of preshift and 10 days of postshift training trials.

days and incentive gave reliable differences (both $F_s < 1.0$), nor did the 8% group show any initial tendency towards positive contrast when the day-by-day postshift data were examined. However, the persistence of the positive contrast effect with food-pellet groups is indicated by the fact that the food-pellet group surpassed the controls on 8 of the 10 postshift days.

DISCUSSION

The results thus provide persistent and statistically reliable evidence for positive contrast with qualitative incentive changes in instrumental appetitive acquisition. Moreover, they suggest that at least some of the earlier failures to find such clear evidence of positive contrast were due to the failure to use a sufficiently marked incentive contrast, as seen here in the failure of the 8% to 32% shift to produce positive contrast. The role of the lower-than-usual deprivation schedule remains in doubt, in view of the failure of the 8% group to show contrast even with it, but it is nonetheless possible that low drive contributed to the substantial contrast shown by the group shifted from food pellets to sucrose pellets. Finally, this positive result cannot be interpreted as an artifact of differential weight loss, as Dunham & Kilp (1969) have recently shown may well be the case for the statistically reliable contrast effects earlier reported by Collier & Marx (1959). Not only were the slight weight differences unreliable, they were in the direction opposite from that required by this interpretation with the positive contrast group showing more rather than less weight gain.

Operant conditioning in the Mongolian gerbil¹

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Mongolian gerbils learned to press a response button to obtain food reward. Responding under three reinforcement schedules was then observed: first, reinforcement occurred after every response; responding was then reinforced on a 15-sec variable-interval schedule; finally, responding was reinforced on a 1-min variable interval.

REFERENCES

- AMSEL, A. The role of frustrative non-reward in non-continuous reward situations. *Psychological Bulletin*, 1958, 55, 102-119.
- BLACK, R. W. Shifts in magnitude of reward and contrast effects in instrumental and selective learning: A reinterpretation. *Psychological Review*, 1968, 78, 114-126.
- COLLIER, G., & MARX, M. H. Changes in performance as a function of shifts in the magnitude of reinforcement. *Journal of Experimental Psychology*, 1959, 57, 305-309.
- CRESPI, L. Quantitative variation of incentive and performance in the white rat. *American Journal of Psychology*, 1942, 14, 467-517.
- DUNHAM, P. J. Contrasted conditions of reinforcement: A selective critique. *Psychological Bulletin*, 1968, 69, 295-315.
- DUNHAM, P. J., & KILPS, B. Shifts in magnitude of reinforcement: Confounded factors or contrast effects? *Journal of Experimental Psychology*, 1969, 79, 373-374.
- HELSON, H. *Adaptation-level theory: An experimental and systematic approach to behavior*. New York: Harper & Row, 1964.
- MARX, M. H. The activation of habits. *Psychological Reports*, 1966, 19, 527-550.
- MARX, M. H., TOMBAUGH, T. N., HATCH, R. S., & TOMBAUGH, J. W. Controlled operant conditioning boxes with discrete-trial programming for multiple experimental use. *Perceptual & Motor Skills*, 1965, 21, 247-254.
- PEREBOOM, A. C. A note on the Crespi effect. *Psychological Review*, 1957, 64, 263-264.
- SCHRIER, A. M. Effects of an upward shift in amount of reinforcer on runway performance of rats. *Journal of Comparative & Physiological Psychology*, 1967, 64, 490-492.
- SPENCE, K. W. *Behavior theory and conditioning*. New Haven: Yale University Press, 1956.

NOTE

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METHOD

Four gerbils (three females and one male) from the Tumblebrook Farm stock, 9 weeks old at the beginning of the experiment, were 24 h food and water deprived during conditioning and were maintained thereafter at between 80% and 85% of their normal body weights.

The experimental chamber was a Masonite operant conditioning chamber (6 x 10 x 10 in.), containing a Gerbrands Dipper Feeder (cup size .025 cc) and a Gerbrands pigeon key (0.5-in.-diam button). A 7-W green bulb transilluminated the response button which was located 1.5 in.

above the floor and 3 in. to the left of the feeder cup. Each response on the button produced a feedback click from a relay mounted behind the front panel. Reinforcement consisted of 3-sec access to chocolate milk in the feeder. During reinforcement, the response button was darkened and inactivated. A 7-W overhead houselight provided continuous illumination. The experiment was automatically controlled by relays, switches, timers, etc., and responses and time were automatically recorded. Each session terminated after 40 reinforcements.

The gerbils were first shaped (i.e., taught) to press the response button to get access to chocolate milk. The shaping procedure was as described by Skinner (1938). After the animals learned to respond, three different reinforcement schedules were presented: first, eight experimental sessions during which each response produced access to reinforcement (fixed-ratio 1 response, or FR 1); second, 12 sessions during which responses were reinforced on the average of every 15 sec, with the interreinforcement intervals randomly distributed (a variable-interval 15-sec, or VI 15-sec); finally, 11 sessions of a 1-min variable-interval schedule, where reinforcements were available on the average of once a minute.

Fig. 1. Rates of responding during every experimental session. Rates were calculated by dividing total number of responses in a session by total session time (excluding reinforcement time). The lines connect the medians of the four gerbils' rates of responding.