Amobarbital sodium and instrumental performance changes following reward reduction

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Amobarbital sodium eliminated the depression effect and rapid performance decrement found in normal animals after a reduction in reward. The rapid decline is generally attributed to a rapid shift in incentive motivation but these data indicate that it is dependent on the aversive consequences of conditioned emotional responses.

In general the changes in behavior that occur in appetitive instrumental learning paradigms are asserted to be determined by two independent but interacting excitatory processes; one of these (habit) represents the changing association between the stimulus cues and the instrumental behavior, whereas the second (incentive motivation) conceptualizes the association between either these cues and the reward or the behavior itself and the reward (Spence, 1956). Although both are associative processes the first is assumed to be relatively permanent and independent of subsequent reward changes, whereas, in contrast, the second is assumed to be transitory and determined only by contemporary reward value. In large measure the desirability of these two assumptions was dictated by the immediate performance disruptions that occur when reward value is decreased (e.g., Crespi, 1942). Such experiments demonstrate that (a) the performance of a shifted group rapidly drops to the level of a non-shift control group, often within one or two trials and (b) continues to decline thereafter so that the shifted group responds, for a time, less vigorously than the control group. This subsequent "depression effect" is attributed to the aversive consequences of an emotional response (frustration) resulting from the reward decrement, and the initial rapid adjustment is taken as indicative of an isomorphic rapid shift in incentive motivation. The present experiment investigated the possibility that both observations result from aversive emotionality and that, in fact, incentive motivation might be the relatively permanent excitatory process expected because of its associative basis. The depressant drug amobarbital sodium appears to have a specific attenuating effect on the emotional inhibitory responses associated with noxious events (Miller, 1964) and little or no effect on excitatory processes associated with reinforcement (Ison & Rosen, 1967), and, thus, it appears to be an appropriate tool for assessing this possibility.

Subjects and Apparatus

The Ss were 48 male albino rats obtained at 90 days of age from Blue Spruce Farms, Altamont, New York. The apparatus was the 7-ft black runway de-

scribed in Rosen (1966). Photocells on the start door and 6 in., 54 in., and 62 in. down the alley, connected to Hunter clocks, provided start, run, and goal times. A baffle at the far end of the goal hid a glass coaster which contained the appropriate reward.

Procedure

The Ss were handled for 3 min and placed on a 23-h food deprivation schedule on each of eight days prior to running. One trial was given on each of the first two days of training, two trials on the third, and four per day thereafter. The Ss were run in squads of four producing an intertrial interval of 4 min.

A daily injection of amobarbital sodium (IP, 20 mg/kg) was given to 24 Ss 10 min before running, and 24 received an equal injection of placebo (isotonic saline). In the first 36 trials (Phase I) 12 Ss within each injection condition received 15 food pellets (Noyes Formula A, 37 mg) on each trial (Group D-15 and Group P-15) and 12 received one pellet (Group D-1 and Group P-1). In the subsequent 24 trials (Phase II) all Ss received one pellet reward. The S was removed from the goal box immediately after consuming the reward.

Results

Figure 1 presents total runway speed (the conversion to speed of the sum of the start, run and goal times) for Phases I and II. In Phase I performance clearly depended on the reward magnitude and additionally there was an interaction between the injection condition and stage of training. Groups D-15 and D-1 were superior to Groups P-15 and P-1 in the early days of training but not in the later days. In Phase II it is apparent that the consequences of the reward decrement were markedly reduced by the drug. Group P-15 dropped

Fig. 1. Total runway performance in blocks of four trials (Days) for each of four groups receiving 15 or 1 food pellets in Phase I, and amobarbital sodium or placebo saline injections in both Phases I and II.

to the level of Group P-1 and exhibited a small depression effect thereafter, whereas Group D-15 slowly moved towards Group D-1 and had not yet achieved this level at the termination of training.

These data as well as each of the three separate performance measures were submitted to analyses of variance; only analyses of total speed will be reported except where separate measures yield additional information. In Phase I the Magnitude (M) main effect ($F=87.91$, $df=1/44$); the Trials (T) main effect ($F=51.19$, $df=35/1540$); the M by T interaction ($F=10.62$, $df=35/1540$); and the Drug (D) by T interaction ($F=3.30$, $df=35/1540$), were all significant at beyond the .01 level. Over the first three days of Phase II the Magnitude effect remained significant ($F=6.59$, $df=1/44$, $p < .05$), and significant effects at beyond $p < .01$ were noted for Trials ($F=9.61$, $df=11/484$); the T by M interaction ($F=6.01$, $df=11/484$); and the T by D by M interaction ($F=2.93$, $df=11/484$). Analyses of the last day of Phase II yielded significant effects only on start speed, for the Drug main effect ($F=12.01$, $df=1/44$, $p < .01$) and the D by M interaction ($F=7.14$, $df=1/44$, $p < .05$). Group D-15 was different from Group D-1 on this day ($p < .05$). Analyses of Group P-15 vs Group P-1 in Phase II indicated that the depression effect was not significant ($p > .10$) either on the third day or the last four days.

Discussion

If it is assumed that amobarbital sodium does not affect the rate of change of excitatory processes—an assumption supported by Phase I performance as well as by data provided by Ison & Rosen (1967)—then it follows that the post-shift performance of Group D-15 reflected the change in incentive motivation relatively uncontaminated by emotional factors. The data obtained

in Phase II are clearly consistent with the hypothesis that decrements in reward value produce rapid performance adjustments only because of their noxious emotional consequences and not because of a rapid decrement in incentive motivation. This demonstration of relatively permanent effects of reinforcement magnitude is compatible with demonstrations of a savings effect of reward magnitude after multiple reward shifts (Wagner & Thomas, 1966), as well as the slow changes in performance following decrements in the concentration of sucrose rewards (Rosen, 1966). There now seems no necessity for maintaining within neo-Hullian theory the proposition that the instrumentally conditioned associative process, habit, has different characteristics from the classically conditioned associative process, incentive motivation.

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Note

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