A comparison of different types of intermittent shock schedules ¹

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Albino rats were assigned to four experimental conditions including an escape and three intermittent shock conditions. Ss were given 20 shock trials at 1.0 ma intensity in a straight alley maze, followed by extinction trials. Differences in RE were found among the intermittent shock groups, and the escape condition produced the same degree of resistance to extinction as two intermittent shock conditions. This latter finding is contrary to previous comparisons of escape and intermittent shock conditions.

One can generally find a statement in the literature that intermittent shock produces greater resistance to extinction (GRE) than continuous shock. This GRE was documented by Sheffield & Temmer (1950) & Jones (1953) for straight alley running responses. Several theoretical positions have been employed to explain the phenomenon: (1) discrimination hypotheses (Mowrer & Jones, 1945); (2) generalization decrement hypothesis (Sheffield & Temmer, 1950); (3) partial reinforcement (Solomon & Wynne, 1954); and (4) conditioning of fear to facilitatory and inhibitory proprioceptive feedbacks from the running response (Kleban, 1965, 1967).

It is not always true, however, that resistance to extinction (RE) is less under escape training. On a 6 in. grid, RE was just as strong for escape as for intermittent shock Ss (Kleban, 1967); and comparing escape procedures on 6 in. and 20 in. grids, RE was greater for the 6 in. grid. E hypothesized that subthreshold inhibitions to running were established for Ss on the 20 in. grid but not for Ss on the 6 in. grid.

In this experiment using a straight runway situation, shocks were arranged within intermittent shock schedules to allow Ss to develop (or not develop) required facilitating or inhibiting reactions to running. It was predicted that: (1) GRE would be found for those intermittent shock Ss not forming inhibitory reactions to running, and (2) RE would be less for the escape conditions than for the intermittent shock groups (this is the traditional assertion, under scrutiny in this experiment, that intermittent shock produces GRE than continuous shock).

Method

A novel electric grid was constructed. The grid was 26 in. long, and was subdivided into thirteen independent 2 in. subsections. The programmer was arranged so that the subsections would come on (and stay on) in sequence. Thus the electric grid could step the current in two directions, stepping it: (1) from the startbox toward the end of the grid, Front-to-Back shock sequence (FB); and (2) from the end of the grid back

toward the startbox, Back-to-Front shock schedule (BF). The stepping took 2 sec in either direction.

The maze was a 42 in. straight runway. The startbox was the first 6 in. of the grid, and the goalbox was 16 in. long, containing a wooden floor. Running speed was automatically timed between the startbox and goalbox. The electric shock inducing apparatus consisted of 0-100 Variac wired to a 750 V step-up transformer with a 220,000 ohm, 1 W, fixed resistor.

The experimental design had a 2 by 2 factorial arrangement. The main effects were the FB and BF shock schedules and two conditions of shock onset: (a) 0 sec delay (grid starting to step with the raising of the startbox guillotine door) and (b) 10 sec delay (grid starting to step 10 sec after the raising of the door). These provided four experimental conditions: (1) 0 sec delay/FB shock schedule (escape schedule); (2) 0 sec delay/BF shock schedule; (3) 10 sec delay/FB shock schedule; and (4) 10 sec delay/BF shock schedule. Each group had 20 Ss (Sprague-Dawley female albino rats, 60-75 days old).

The Ss were randomly assigned to experimental conditions. Ss were run in groups of three with shock and extinction training being completed on the same day. At first, each animal was given a three minute exploratory period. The 20 shock training trials followed immediately. The current was 1.0 mA intensity. The three Ss were run consecutively until the shock trials were completed. On each trial, they were removed from the goalbox after 20 sec. The no-shock extinction trials also followed without delay. The criterion of extinction was not running off the grid for 60 sec. Ss were run until they either extinguished or completed 40 extinction trials.

Results

Running speed. Running speeds were analyzed for the training trials, and were measured in groups of five trials (Table 1). The F tests for the FB vs BF and interaction conditions were all nonsignificant. Large differences in running speeds were expected between the 0 sec delay and 10 sec delay shock conditions. As expected,

Table 1. Running Speeds in Seconds

Trials	0 sec delay group				10 sec delay group			
	FB		BF		FB		BF	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
1-5	3.13	2.49	4.19	1.55	11.41	3.30	12.53	2.33
6-10	1.10	.24	1.83	.62	4.78	3.44	5.68	3.94
11-15	.98	.19	1.49	.69	3.26	3.25	4.04	2.97
16-20	.92	.20	1.38	.68	3.67	2.79	4.54	3.69

Table 2. Extinction Scores

Groups	N	M	SD	F
Shock schedules:				
FB Ss	40	24.90	13.87	.47, n.s.
BF Ss	40	26.95	13.18	
Delay periods:				
0 sec delay Ss	40	27.95	14.04	1.84, n.s.
10 sec delay Ss	40	23.90	12.75	
Interaction:				
0 sec/FB Ss	20	23.80	14.80	4.38, $p \leq .05$
0 sec/BF Ss	20	32.10*	11.87	
10 sec/FB Ss	20	26.00	12.77	
10 sec/BF Ss	20	21.80*	12.38	

*0 sec/BF 0 sec/FB, $p \leq .05$, $M_D = 8.40$.

these F tests were all significant. The pain experience and the amount of delay Ss have before the onset of shock determine running speeds. The direction of current stepping does not influence running speeds.

Extinction scores. Refer to Table 2 for a listing of the extinction data. As seen, the interaction is the only significant relationship. The difference between the 0 sec delay/BF and 10 sec delay/BF group is significant ($M_D = 10.30$, $p < .05$). Analysis of covariance tests were performed between the extinction scores and the running speed trials. The F tests for interactions among the extinction scores were significant; they were, respectively, for Trials 1-5 ($F = 4.42$, $df = 1/75$, $p < .05$), 6-10 ($F = 4.36$, $df = 1/75$, $p < .05$), 11-15 ($F = 4.71$, $df = 1/75$, $p < .05$), and 16-20 ($F = 4.68$, $df = 1/75$, $p < .05$). The difference between the extinction scores for the 0 sec delay/BF and 10 sec delay/BF remained significant for all blocks of five trials. The mean differences for statistical significance between the 0 sec delay/BF and 0 sec delay/FB groups were 8.39 (1-5), 8.32 (6-10), 7.68 (11-15), and 7.42 (16-20). Thus by Trials 11-20, the 0 sec delay/BF group also produces GRE than the 0 sec delay/FB group.

The reason for the emergence of significance between these two groups can be seen with respect to the rank order correlations between extinction and running speed scores (Table 3). Significant correlations occur only in the 10 sec delay groups, and these running speeds influenced the strength of the extinction scores in the 10 sec delay conditions.

Table 3. Rank Order Correlations between Speed & Extinction Scores

Trials	Delay Groups			
	0 sec delay		10 sec delay	
	FB	BF	FB	BF
1-5	-.19	-.28	.27	.01
6-10	-.22	-.02	.45*	-.05
11-15	.20	.12	.67**	.41*
16-20	.31	.22	.47*	.65**

* $p \leq .05$

** $p \leq .01$

Discussion

The results can be explained without resorting to an assertion that a greater degree of fear is produced by the 0 sec delay/BF shock schedule. During training, the 10 sec delay Ss paused and hesitated more than the 0 sec delay Ss before the fear mobilized sufficiently to propel the avoidance running (thus the first hypothesis was not really tested, since all 10 sec delay Ss developed inhibitory responses to running). Pausing itself through conditioning can make S fearful and instigate avoidance running. During extinction, when the fearfulness about pausing is lessened, the 10 sec delay Ss already had available these pausing actions which are inhibitory to running. The 0 sec delay/BF Ss had not developed these pauses during shock training. Thus, when extinction training began, these Ss had no pausing responses, and had to develop them before extinction could be achieved. Thus the 10 sec delay/BF Ss required more trials to achieve extinction.

Escape Ss extinguish running responses rapidly once shock is terminated. The 0 sec delay/FB Ss showed GRE than typical escape Ss. This difference can be explained by the same principles. In typical escape training, Ss get shocked over the entire grid. Although running is rapid and no pauses occur, an inhibition is developed against running forward into shock. Thus during extinction, Ss rapidly stop their running behavior. The 0 sec delay/FB Ss also ran fast in response to the shock, but running was not inhibited because it produced cessation of pain as Ss traversed the grid. These Ss had to develop inhibitions to running before extinction could occur, thus producing GRE than usually found for escape Ss.

These data do not support the discrimination hypothesis which emphasizes the importance of the consistency of the shock experiences; that is, Ss should extinguish running when they have determined that shock has really terminated. The 0 sec delay/FB Ss had very clear perceptions of the termination of shock, but nevertheless, they showed as much RE as the 10 sec delay intermittent shock Ss. These data illustrate that it is not the greater consistency of the escape schedule that results in less RE; it is the presence or absence of inhibitory conditions to running which determines the degree of RE.

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