A comparison of two procedures for breaking the response-reinforcement contingency in discriminated barpress avoidance*

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Rats were conditioned to prevent shock in a standard discriminated barpress avoidance situation and then were extinguished by either of two procedures: (1) classical extinction (CE), or (2) a nondifferential punishment procedure (OE). Results indicated faster extinction and lower terminal response levels with the CE procedure. An interpretation was offered implicating, as an important factor, the number of discriminative cues present during the extinction series.

Rescorla & Skucy (1969) have stated that extinction of instrumental behavior maintained by positive reinforcement can be accomplished by any procedure that serves to break the response-reinforcement relationship. They argue that the removal of positive reinforcement is only one means of disrupting this relationship. Another way is to present food according to some externally derived schedule in which reinforcements are given independent of the S's behavior. Animals exposed to this latter procedure were more resistant to extinction than were animals exposed to the traditional procedure, which involved the elimination of food reinforcement, both in terms of lower rate of decline and higher terminal levels of responding.

Following a similar line of reasoning, a number of Es have suggested the need for redefining extinction in aversive conditioning situations (MacDonald, Levine, & Amsel, 1965; Davenport & Olsen, 1968; Davenport, Coger, & Spector, 1970). In regard to instrumental behavior involving avoidance contingencies, Davenport & Olsen (1968) argue for the use of an extinction procedure more like that commonly employed in instrumental appetitive situations. If, as is generally assumed, the primary source of reinforcement for avoidance behavior is the absence of shock, the appropriate extinction paradigm should remove this source of reinforcement and present shocks regardless of the occurrence of the instrumental act. On the other hand, the usual procedure for avoidance extinction, the presentations of CS alone, corresponds to the free-food condition of Rescorla and Skucy, since the presentation of reinforcement (i.e., shock omission) is independent of the instrumental act. Note, however, that both extinction paradigms involve the presentation or omission of a reinforcing stimulus independently of the S's behavior, and thus each represents a Pavlovian process.

The present study was an attempt to compare directly the relative effectiveness of two procedures for extinguishing avoidance behavior when the sources of reinforcement (shock prevention and CS termination) were presented independently of the animal's behavior. The procedures used were (1) traditional (classical) extinction, defined by removing all shocks, and (2) the procedure outlines by Davenport and Olsen, defined by leaving all shocks in and eliminating the response-reinforcement relationship (operant extinction). Note that the present design utilizes only two of many possible procedures for breaking the response-reinforcement relationship. Extinction of avoidance could be accomplished by the use of any externally derived schedule of shock reinforcement in combination with immediate or delayed CS termination. The relative effects of each procedure on the rate and terminal level of extinction were compared.

SUBJECTS

The Ss were 18 experimentally naive male albino rats obtained from the Holtzman Company. The animals were 60 days of age at the start of the experiment.

APPARATUS

The test chambers were two modified operant conditioning units with Plexiglas top and sides, a wooden front, and stainless steel backing. Each unit measured 9 x 8½ x 7½ in. The manipulanda were standard rat levers, located 3 in. from the floor of the chamber, extending ½ in. into the unit, and mounted on the front panel. The 18 grids were made of stainless steel rods spaced 5/8 in. apart from center to center. The unit was enclosed in a light- and sound-attenuating styrofoam chamber.

Two amber 24-V dc pilot lights, located at the rear of the unit, served as discriminative stimuli. Shock was supplied by two constant current shockers (LVE 1531) running through two auxiliary scanners. Shock intensity was measured across the grids and revealed a variability between .4 and .8 mA, with shock duration held constant at .45 sec. CS duration was 15 sec, with a constant 30-sec intertrial interval (CS onset to CS onset). A series of counters, cumulative recorders, and electromechanical devices located in an adjoining room served to program and record all events automatically. A white masking noise (approximately 81 dB) was sent into the experimental room by a Lehigh Valley noise generator (Model 1524).

PROCEDURE

All Ss were trained to barpress for food reinforcement and were given 1 h of continuous reinforcement each day for 4 days in order to increase the probability of the desired operant. Avoidance training was begun on the fifth day.

At the beginning of each avoidance session, S was placed in the apparatus for 5 min prior to the first CS presentation. The start of each trial was signaled by the onset of two jeweled pilot lights (CS) placed at ceiling height at the rear of the unit. A barpress during the CS terminated CS and prevented the occurrence of the shock programmed for that trial. A response during non-CS periods had no programmed effect. Each S received 200 trials per day (1 h, 40 min), and each session concluded with a 5-min "cooling-off" period in which no stimuli were presented. Due to the use of a brief shock on-time (.45 sec), opportunity for escape was eliminated.

Each animal was subjected to these contingencies until two behavioral criteria were attained. However, the first 100 trials of each session were precluded from analysis to control for recurrent warm-up effects. The avoidance criterion (AI) required an average avoidance rate of 75% for three out of the last four consecutive blocks of 25 trials on any given day and was computed by comparing the number of responses in CS with the number of CSs programmed. The discrimination criterion (DI) required each S to confine at least 70% of its total responses to the CS period and was computed by dividing the number of responses in CS by the total number of responses emitted during any given block of 25 trials. The DI was computed for the same three blocks, selected to meet the avoidance criterion. Although 29 animals were

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Table 1
Measures of Central Tendency During the Acquisition Phase

	DI		AI	
	CE	OE	CE	OE
Mean	9.1	7	2.7	2.2
Median	9.8	6.5	2	1.75
Mode	10	5-6	2	2
Range	4-14	5-10	1-9	1-7

initially placed on avoidance acquisition, only 18 met the two behavioral criteria and were used for further study. Three Ss failed to condition; the remaining 8 that were not used were discarded either for failure to reach the discrimination criterion after an unusual number of sessions or because of E error.

As the individual Ss met the behavioral criteria, they were assigned randomly to one of two groups. Eight Ss in one group (OE) were placed on extinction as defined by Davenport and Olsen. In this procedure, the avoidance response did not terminate the CS or prevent the occurrence of the US. The remaining Ss (CE) were placed on traditional extinction, i.e., the CS remained on for its full duration, regardless of the S's response, and was never accompanied by shock.

Each S received 200 extinction trials per session, with one exception. The first day of extinction for both OE and CE Ss consisted of 100 acquisition trials, followed immediately by 100 extinction trials. The data were analyzed in successive blocks of 25 trials.

Extinction was continued until stable performances were attained for five consecutive blocks of 25 trials, according to the following standard: the average deviation of the first two and last two blocks did not differ from performance on the middle block by more than 10 responses.

RESULTS

The general course of initial acquisition was similar for all but one S in each group. The avoidance criterion was usually met within a few days with the suppression of intertrial responding requiring additional sessions. The groups did not differ with respect to the mean number of days either to reach the avoidance criterion ($t = .42$; $df = 1,17$; $p > .05$) or to attain the discrimination criterion ($t = 1.55$; $df = 1,17$; $p > .05$). Table 1 summarizes measures of central tendency for each group during the acquisition phase.

Extinction

Analyses of variance for repeated measures over one factor were computed for both the discrimination and avoidance indices for the first five blocks of 25 trials. The analysis conducted on discrimination performance revealed a significant effect of treatment ($F = 5.28$; $df = 1,16$; $p < .05$), blocks ($F = 7.89$; $df = 4,64$; $p < .05$), and Treatment by Blocks interaction ($F = 3.23$; $df = 4,64$; $p < .05$). Inspection of the curves in Fig. 1a indicate that discrimination performance suffered immediately in the CE group. By the time they had reached stable terminal performances, only 10% to 20% of their responses occurred during CS periods. In contrast, discrimination performance remained quite high for some time for the OE Ss before it began to decline. Even after 100 trials, these Ss were still making 80% of their responses in the CS periods. During the remainder of the extinction series, their discrimination performance rarely fell below 50%.

A Treatment by Blocks analysis conducted on the avoidance indices revealed a significant effect of treatment ($F = 4.57$; $df = 1,16$; $p < .05$), blocks ($F = 23.82$; $df = 4,64$;

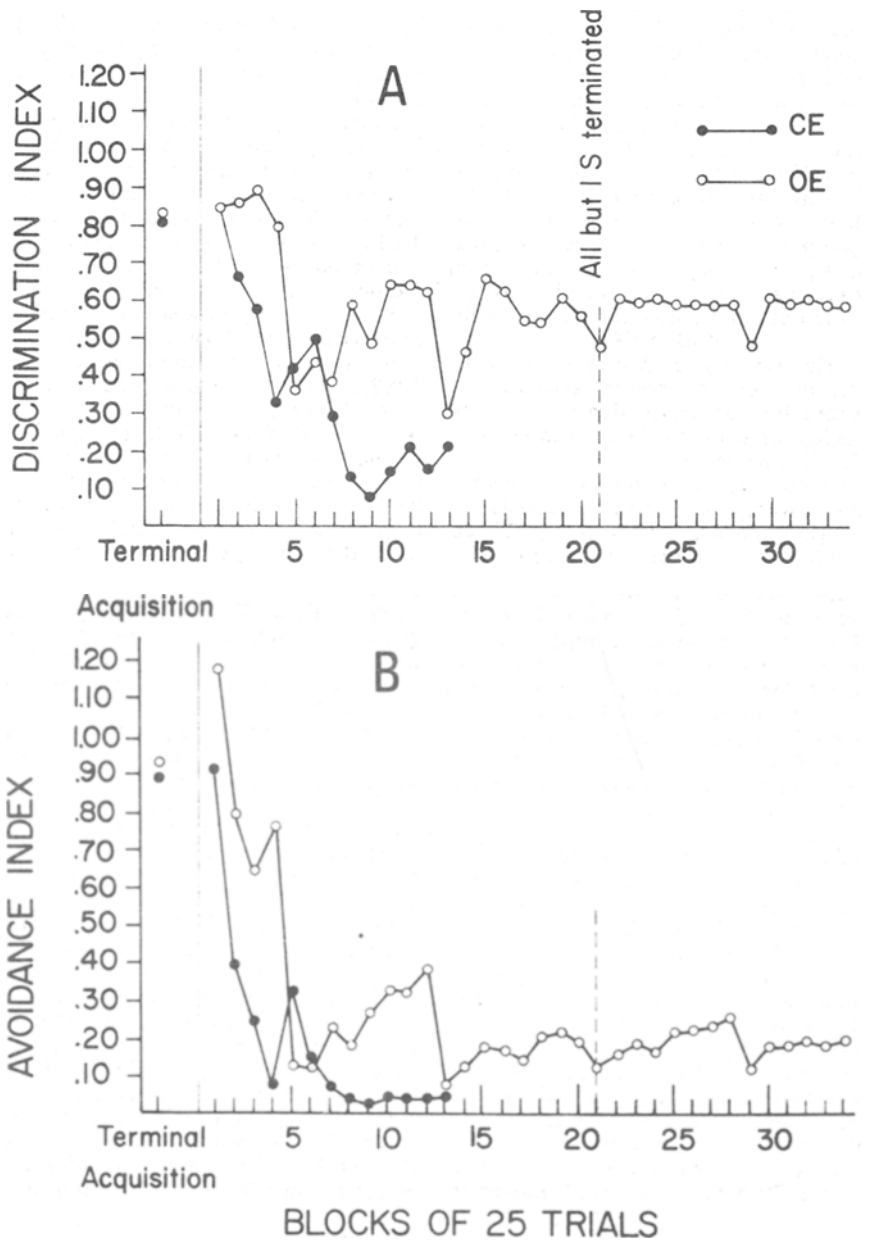

Fig. 1. Mean discrimination (a) and avoidance (b) indices for the two experimental groups during the extinction series.

$p < .01$), and Treatment by Blocks interaction ($F = 26.90$; $df = 4,64$; $p < .001$). From the curves presented in Fig. 1b, it can be seen that the CE group showed a small initial rise in avoidance performance during the first 25 extinction trials. This slight enhancement was followed by a sharp decline in responding by the fourth block of trials. By the end of the second session, these animals' rates remained typically close to zero, with little observable deviations from this level occurring from S to S. The OE Ss, on the other hand, revealed a large initial increase in responding early in extinction. During the first 25 trials, these animals were observed to emit multiple responses during CS periods, thus accounting for the indices of greater than 1.00. In contrast, no multiple responses during CS periods were observed for any of the CE Ss.

A t test conducted on the means of the last five extinction blocks also revealed a difference which could not be attributed to chance ($t = 8.50$; $df = 1,9$; $p < .001$). Not only did the OE group stabilize at a higher terminal level, but inspection of individual records suggested much greater variability in responding for these Ss.

DISCUSSION

The findings of the present study clearly indicate greater resistance to extinction of discriminated barpress avoidance with the OE as compared to the CE procedure.

According to two-process theory, the avoidance response consists of (1) the classical conditioning of an emotional state through the contiguous pairing of a CS with an aversive US, and (2) escape from the CS (an operant component), a response maintained by the conditioned aversive properties of the CS. A classical extinction procedure would therefore operate directly on the Pavlovian component but only indirectly on the operant component of the avoidance response. With the classical procedure, motivation increases concommittantly with an increase in CS-US pairings, but responses are now ineffective and extinction of the operant component begins to take place.

An alternative to a two-process explanation of the data relates the discriminative properties of the relevant stimuli present during extinction to maintenance of avoidance behavior. These stimuli are the *presence* of shock, which informs S that it is in an avoidance situation, and response-contingent *termination of the CS*, which provides feedback to the animal that its response was effective in avoiding shock. Since both of these cues are removed by the CE procedure, S has essentially been taken out of the avoidance situation, making the avoidance and exitnction conditions readily discriminable. With the OE procedure, shocks persist, informing S that it is still in an avoidance situation. However, responses are now ineffective and the process of extinction begins. In summary, the position can be stated as follows: resistance to extinction of avoidance is a direct function of the similarity between acquisition and extinction conditions. This formulation is essentially a restatement of the discrimination hypothesis (Mowrer & Jones, 1945). Additional evidence supporting this position is found in the difference in discrimination performance between the two groups during extinction. The CE group showed an immediate decline in discrimination performance, as would be expected if the Ss were removed from the avoidance situation. This rapid attenuation in discrimination performance, however, did not occur in the OE Ss.

When drawing the analogy to similar studies employing positive reinforcement (Rescorla & Skucy, 1969), an immediate discrepancy arises. Their results indicated that the removal of food produced quicker extinction than did the alternative procedure of presenting it independently of S's responses. From their data, then, one would predict that the OE group (reinforcement removed) would have a faster rate of decline than the CE group (free reinforcement). This discrepancy can be explained, however, if the procedures are compared in terms of the number of relevant cues present during the extinction phase rather than in an attempt to make comparisons calling for a redefinition of "reinforcement." Then the Rescorla and Skucy food-absent group would correspond to the CE condition of the present study (food or shock absent), and the group that was given response-independent food would correspond to the OE condition of the present study (food or shock present). A simple motivational interpretation, however, could also easily incorporate both sets of data. Food-present and shock-present (OE) conditions both involve the persistence of events which serve to maintain incentive motivation, while the removal of food or shock (CE) each eliminate the motivation for response maintenance. To determine which of these alternative mechanisms (discriminative or motivational) is operating during extinction of avoidance, we are currently using a design that allows for different predictions based on each of the theoretical alternatives. Two conditions are identical to those used in the present study, while the third presents shocks randomly following 50% of the CS presentations. A motivational interpretation would predict greater resistance to extinction for the OE group, and a discriminative interpretation would predict greatest resistance to extinction for the shock-random group. In addition, a comparable design is currently being attempted in a two-way shuttlebox situation where place cues are as irrelevant as they are in the operant chamber. Although Bolles, Moot, and Grossen (1971) recently found greater resistance to extinction of avoidance with classical as compared to a nondifferential punishment procedure (OE), they employed a one-way shuttle response which occurred in a situation in which place cues were *not* irrelevant.

In conclusion, it is our contention that resistance to extinction of discriminated barpress avoidance is a direct function of the similarity of the acquisition to the extinction series. The present formula not only accounts for the data obtained in appetitive situations, but also enables specific predictions to be made concerning resistance to extinction of avoidance behavior without resorting to hypothetical motivational states' maintaining discriminative avoidance conditioning.

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