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The effects of prolonged thwarting on instrumental response extinction*

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To study the effects of prolonged frustration on extinction of a subsequently learned running response, one group of rats (CF) were subjected to a treatment in their individual home cages in which food was visible but unattainable for extended periods of time. A control group (NF) remained untreated. All Ss were then trained in a runway under conditions of continuous reinforcement followed by extinction. Both groups were then retrained in the runway with continuous reinforcement followed by a second extinction. In the second extinction, visible but unattainable food, rather than nonreward, was employed. Ss from Group CF extinguished faster and retraced more than did those from Group NF in the first extinction; in the second extinction, the differences were in the same direction but were not significant.

It is now a well-established finding that the introduction of an aversive event during the performance of an appetitively motivated instrumental response leads to a subsequent increase in the persistence of that response in the face of disruptive stimuli. Perhaps the best-known example of this phenomenon depends on the introduction of nonreward during the partial reinforcement procedure; but aversive events other than nonreward have been shown to enhance resistance to extinction following their introduction during acquisition. These include goal blocking (Glazer & Amsel, 1970), delay of reward (Rashotte & Surridge, 1969), electric shocks (Brown & Wagner, 1964), air blasts (Terris, German, & Enzie, 1969), and loud tones (Amsel, Glazer, Lakey, McCuller, & Wong, 1973). For purposes of the present experiment, the important procedural element these studies have in common is the introduction of brief aversive stimulation on some trials in the context of rewarded instrumental responding.

According to a persistence theory account of these and similar findings (Amsel, 1972), two competing response tendencies are set up in the organism, one related to the ongoing instrumental response, the other to a competing response elicited by the disruptive (aversive) stimulation. As long as the ongoing instrumental response is reinforced, even intermittently, the competition diminishes and the instrumental response becomes strong and persistent. The proposed mechanism for the conflict resolution and persistence is counterconditioning. In the special case of partial reinforcement, stimuli from anticipation of the aversive nonreward come to elicit the instrumental approach response.

The present experiment is a first attempt to reverse the operation of such a mechanism of persistence through prolonged periods of aversive stimulation in the absence of opportunity for counterconditioning such stimulation to approach. Introducing a piece of unattainable food to a hungry rat should set up a

conflict situation similar to the one described above. But attempts to reach and eat the food will always lead to frustration, and ultimately anticipatory frustration in the context of anticipatory reward will lead only to avoidance. It is proposed, then, that this manipulation will strengthen avoidance responding to anticipatory frustrative stimuli and thus decrease persistence in the extinction of a subsequently learned response. The following study was performed to test these predictions.

METHOD
Subjects
The Ss were 18 experimentally naive male albino rats, 21 days of age at the beginning of the experiment.

Apparatus
The test apparatus consisted of a runway constructed of plywood, painted flat black, and covered with clear Plexiglas. The components of the runway were an 11-in. startbox and a 42-in. runway, both measuring 2-7/8 in. wide and 3-7/8 in. high. Manually operated guillotine doors were used to separate the startbox from the runway and to form a 15-in. goalbox area. The food cup was a semicircular sheet-metal trough extending the total width of the goalbox, and was fixed on the end wall of the goalbox. The proximal lip of the food cup was approximately 2 in. above the floor. A heavy-gauge wire mesh insert could be placed inside the runway to block the S's approach response. Photoelectric circuitry was used to obtain three 1-ft measures of running time.

Procedure
For the first 5 days after arrival in the laboratory, Ss were kept under ad lib food conditions. Following this, Ss were put on a food deprivation schedule, which maintained them at about 80% of their ad lib weights.

Ss were divided into two groups, no frustration (NF) and continuous frustration (CF). For the Ss of Group CF, a 1-in.-long piece of Purina Lab Chow was suspended in front of the outside of the individual wire mesh home cages. The food, which could not be reached and eaten, remained in place for 23 h of each day, and was removed for 1 h during the daily feeding session. Ss in the NF group were maintained under the same food deprivation schedule and were housed in individual cages in the same rack, but were not otherwise treated. This phase continued for 15 days. Following a 3-day period of no treatment for both groups, all Ss were trained in the runway apparatus under conditions of continuous reinforcement (CRF) for 10 days, followed by 5 days of extinction. The last two phases of the experiment consisted of CRF reacquisition in the runway for both groups (4 days), followed by a second extinction (5 days). During this second extinction, a blocking procedure was used in which an inaccessible piece of Purina Lab Chow was suspended behind a wire mesh insert at the end of the runway.

Throughout runway training, a 300-mg Noyes pellet served as the reward. Four trials a day were used for all runway phases, with an intertrial interval of approximately 20 min. The order of running Ss was randomized over days, but held constant over the four trials within a day.

RESULTS AND DISCUSSION
Food Blocking
Ss in the CF group were observed carefully for the first 2 h following the initial introduction of the food-blocking manipulation, and continued to be observed each day, intermittently, for the duration of the first phase. The patterns of behavior observed were consistent across animals, and changed over time. Immediately after the food was suspended in front of their cages, the Ss began vigorously biting the wire mesh between them and the food, climbing up the front side of the cage, and extending their forepaws toward the food. This stage lasted for about 5 min, after which random patterns of behavior, such as vigorous running in circles, became interspersed with the attempts to obtain the food. This was followed by a steady decrease in the vigor and frequency of attempts to reach the food and a general decrease in the vigor of other behaviors. Finally, within a period of 25-30 min after the initial introduction of the unobtainable food, all Ss were observed sitting quietly at the back of the cage, usually orienting towards the back of the cage (i.e., away from the suspended food).

Subsequent observation of the CF animals indicated that they did make intermittent attempts to reach the food, but such behavior decreased over time and had dropped out completely by the time the treatment was terminated.

Initial Acquisition-Extinction
Separate speed (reciprocal time) measures were obtained for each of the three runway segments. Since analysis of variance on running speeds over these segments showed essentially the same effects, speed data averaged over the three segments of the alley are presented in Fig. 1.

Acquisition analysis of variance showed that both groups of Ss learned the running response over days $[F(9,144) = 215.58, p < .01]$. No effects were obtained involving the group variable.

Analysis of variance of the first extinction yielded significant effects of groups $[F(1,16) = 4.86, p < .05]$ and days $[F(4,64) = 71.34, p < .01]$, indicating that the running response was extinguished in all Ss, with Group CF Ss running more slowly overall. Retrace data are also shown in Fig. 1. A retrace is defined as a 180-deg turn in the runway. The first extinction retrace data show that retraces increased over days for both groups $[F(4,64) = 7.19, p < .01]$. The number of retraces over days, however, increased faster for the CF than for the NF group $[F(4,64) = 2.92, p < .05]$, and Group CF made significantly more retraces overall $[F(1,16) = 9.82, p < .01]$.

The pattern of results we describe suggests that the continuous frustration treatment did not interfere with the acquisition of an instrumental approach to food but did affect the subsequent extinction of that response. Presumably extinction reactivates the previously learned avoidance tendencies in the CF Ss, resulting in increased retracing and decreased approach responding relative to the NF Ss.

Second Acquisition-Extinction
Speed data for the second acquisition and speed and retrace data for the second extinction are shown in
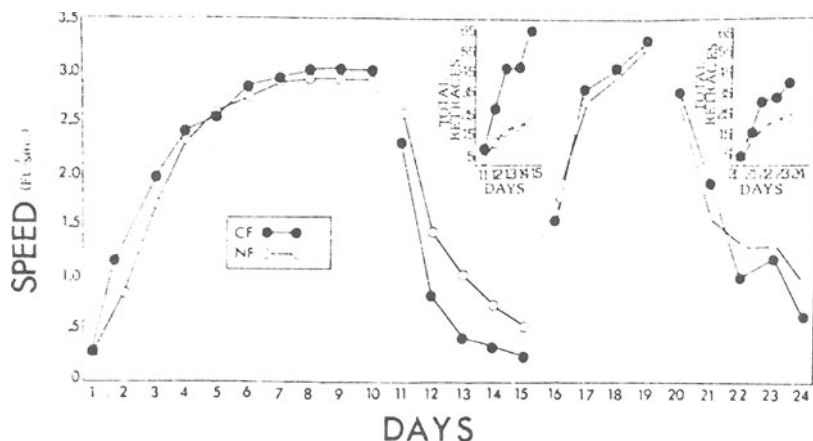
Fig. 1. Running speeds for the four runway phases of the experiment and retrace data for the two extinction phases.

Fig. 1. Analysis of variance showed that both groups relearned the running response nondifferentially over days [$F(3,48) = 161.74$, $p < .01$]. In the second extinction phase, running speeds declined over days [$F(4,64) = 60.04$, $p < .01$], and retraces increased over days [$F(4,64) = 10.62$, $p < .01$]. The main effect and interactions involving the groups variable were nonsignificant for both speed and retrace measures.

Since, during the second extinction test, Ss were put back into an unattainable food situation, it was expected that the group differences observed during the first extinction test would, if anything, be magnified in the second extinction test. The results are clearly contrary to expectation. If it is assumed that in the first phase of the study avoidance responding is facilitated in CF Ss by building up internal stimuli associated with frustration (s_F), the extinction data can be explained. Increasing the magnitude of s_F in Phase 1 does not affect the subsequent development of reward anticipation in the runway, since the Ss do not experience frustration during the first runway acquisition phase. In the first extinction phase, s_F starts out at a higher level for CF Ss and thus elicits competing avoidance responses more effectively, producing slower overall instrumental approach responding. Conditioned frustration feedback stimuli build up in the runway for both groups during the first extinction, but remain stronger in the CF group throughout the phase. During reacquisition, then, stronger levels of residual s_F are counterconditioned to the approach response for CF Ss, resulting in nondifferential responding in the two groups during the second extinction. Such an analysis is, of course, highly speculative, particularly in light of the fact that the two extinction tests differed procedurally.

Our analysis of the present experiment is that responses strengthened during the initial home cage treatment compete with a subsequently learned goal approach response during the extinction of the latter. When viewed in this context, a variety of experiments are available that are in line with the present data. Kurtz & Walters (1962), for example, found that when uncontrollable shocks were admimistered to a group of

rats prior to food-reinforced runway acquisition, these Ss stopped running faster than nonshocked control Ss when shocks were later, during a test phase, introduced into the runway goalbox along with food reinforcement for both groups. In a similar situation, Anderson & Paden (1966) found that rats that were "tumbled" stopped running sooner than "nontumbled" rats when shocks were added to the food reinforcement in the runway goalbox. Pearl, Walters, & Anderson (1964) found the same results, using shocks and loud noise in a barpress situation.

These experiments differ from the present one insofar as the aversive stimulation was uncontrollable, while in the present study Ss were able to avoid the source of aversive stimulation. The same mechanism, however (i.e., strengthening of competing responses), may be operative in both the present study and those cited above.

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