Escape and avoidance learning for discontinuous ICS as a function of intertrial interval¹

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Five rats were given discontinuous ICS on one side of a tilt box following a 5-sec CS. No avoidances were made, and escape time was a direct linear function of the intertrial interval (5, 15, 30, or 60 sec).

Intracranial self-stimulation (ICS) is commonly regarded as some kind of "rewarding" phenomenon, particularly when electrode tips are located in the medial forebrain bundle (Olds & Olds, 1963). An alternative hypothesis is that ICS is painful and behavior is maintained only because subsequent stimulation reduces or inhibits the aversive aftereffects (Olds & Milner, 1954; Ball & Adams, 1965; Ball, 1967). In the Ball and Adams experiment, rats approached the arm of a T-maze where they received ICS when trials were massed, but avoided it when trials were spaced. These results could be accounted for if the hypothesized aversive aftereffects of ICS decayed with time. Such an assumption would be similar to the drive decay hypothesis suggested by Deutsch & Howarth (1963). The present experiment is designed to allow rats either to escape or avoid discontinuous ICS presented at different intertrial intervals. If ICS is fundamentally aversive, it might be expected that animals would display an increasing tendency to avoid ICS after longer intertrial intervals.

SUBJECTS AND ELECTRODE IMPLANTATION

The Ss were five male Charles River strain albino rats, four being about 100 days old and one 300 days old. All Ss had a previous history of bar pressing for ICS and all were maintained on an ad lib diet of Purina Lab Chow. Stainless steel bipolar electrodes, .014 in. in diam (Plastic Products Co.), were aimed at the lateral hypothalamus and median forebrain bundle. Following the experiment, histology (cresyl violet stain) confirmed these placements.

APPARATUS

A tilt box (26 x 7 x 9 in.) was painted black on one side and white on the other with a 1-in. hurdle between sides. White pilot lights were mounted at each end and a Plexiglas top was slit down the middle to allow the overhead passage of the electrode cable attached to a mercury swivel. A Davis D-501 time-interval generator produced a triggering pulse every 0.50 sec and was operating continuously so that it would not be a discriminative stimulus for the onset of the ICS. Event markers recorded the onset and offset of the warning lights, the ICS, and all crossings in the tilt box. Sine wave stimulation was delivered from a variac and current was monitored on a CRO.

PROCEDURE

In pretraining, each S was shaped to bar press for ICS and a relatively high current intensity was selected to maximize bar pressing rate. Ss were then given about 100 pretraining trials in the tilt box with varying intertrial intervals to make sure they had learned to jump over the hurdle to escape or avoid the ICS. The intertrial intervals were 5.0, 15.0, 30.0, and 60.0 sec, and were followed by the onset of the two warning lights. Crossing to the other side during the intertrial interval did not restart the trial, and Ss could get ICS on either side. After the warning lights were on for 5.0 sec, ICS was delivered (unless S made an avoidance to the other side during these 5 sec, in which case the next trial began). Animals could escape the ICS by crossing to the other side which would turn it off and begin the next trial. The ICS was delivered discontinuously 0.5 sec

on, 0.5 sec off. The pilot lights went off whenever an escape or avoidance was made.

In training, Ss were given a number of long sessions in which blocks of 25-50 trials were run under each intertrial interval with the order of presentation randomized and changed on each experimental day. Combining all sessions, each S received about 200 trials (not including pretraining) under each intertrial interval.

RESULTS AND DISCUSSION

Perhaps the main finding is that virtually no avoidances were made under any of the conditions. An occasional response occurred during the 5-sec warning period, but such behavior was considered a random crossing since a few random crossings also took place during the intertrial interval. Most animals never made any crossings of the tilt box except to turn off the ICS.

In the calculation of escape times, latencies longer than 3.0 min were not counted since occasional, very long escape times appeared to be due to motoric side effects. For example, some Ss circled slowly in the direction contralateral to the side stimulated (previously noted by Roberts, 1958) for long periods of time. Generally these effects were observed only under the longer intertrial interval conditions.

Mean escape times for each animal are shown in Fig. 1. It can be seen that the longer the time since the last ICS, the longer Ss chose to receive stimulation. This main effect is highly significant ($F = 62.86$, $df = 3/12$, $p < .001$).

The results of this experiment might not be viewed as critical since the longest intertrial interval (1 min) does not equal the spaced training conditions (5-30 min) used by Ball & Adams (1965). However, significant performance decrements have been demonstrated with 60 sec after stimulation

Fig. 1. Mean escape time for individual rats as a function of intertrial interval.

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Fig. 1. Mean time for each of the three performance measures under the R (reinforced) trials and N (nonreinforced) trials of the FR 2 schedule and under all trials of the continuous reinforcement (Crf) schedule.

only one exception (starting time measures for S5). These results replicate the findings of Capaldi (1958) among others. Since the present results were obtained under conditions which could not have permitted S to be influenced by subtle E-provided cues, they lend no support to the alternative hypotheses suggested by Surridge & Amsel (1965a, b).

Figure 1 also shows that N times were also consistently longer than trial times obtained under subsequent exposure to the continuous reinforcement schedule, again with only one exception (running time measures for S6). In contrast, no

consistent differences were noted between R times generated under the FR-2 and CRF schedules. These results suggest that differences obtained between R and N trials under the FR 2 schedule cannot simply be accounted for on the basis of satiation effects of the just-obtained reinforcement.

Finally, a further analysis of the data (not shown) indicated that alternation behavior generated with the automated runway was extremely reliable across sessions and Ss. Comparisons of the three daily N-trial medians with the corresponding R-trial medians for each of the four Ss under each of the last three sessions of exposure to the FR 2 schedule showed that N-trial times were longer than R-trial times in all but two of the 36 cases.

The consistency of our data in combination with the fact that our results are in agreement with results obtained by workers using conventional runways, point up the advantages of using an automated apparatus. Information about runway performance can be obtained without the possible introduction of E bias and without the tedium of manually operating a runway. Indeed, while our rats dine in the runway, we dine at the snack bar.

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(Gallistel, 1966, 1967) and even after 10-15 sec (Johnson, 1968; Johnson, Lobdell, & Levy, in preparation). One is forced to ask why hypothesized aversive aftereffects show no sign of decay after 60 sec. In addition, the longer the intertrial interval, the more the animals seem to prefer ICS. While the present results cannot be considered conclusive, they offer no comfort to the aversive ICS hypothesis.

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NOTE

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