Recovery experiences and the source of aversive effects of electroconvulsive shock

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The hypothesis tested was that aversive effects associated with multiple administrations of electroconvulsive shock (ECS) are a function of the post-ECS recovery experience. One group of Ss was allowed to recover in the same compartment in which ECS was given, while a second group was allowed to recover in a dissimilar compartment. Avoidance of the shock compartment developed differentially in the two groups. The results supported the conclusion that part of the aversive effect developed as a function of the recovery experience.

Although a single presentation of ECS usually results in amnesia for both the shock itself and events just preceding its occurrence, several studies, using repeated ECS presentation, have demonstrated increased fear of the ECS experience (Chorover & Schiller, 1965; Hudspeth, McGaugh, & Thomson, 1964; McGaugh & Madsen, 1964). In general, the source of this aversive effect has not been adequately determined. Dawson & Prior (1965) tested the possibility that the noxious effects which occur with multiple presentations of ECS are a function of the post-ECS recovery period and, thus, not of the shock itself. Their findings indicated no difference in avoidance of the shock compartment between Ss recovering in this compartment or Ss recovering in a different compartment. It is possible, however, that their methodology, which was different from most earlier studies, was not sensitive enough to detect a difference between the two groups. The present study used the experimental procedure of Hudspeth, McGaugh, & Thomson (1964) to provide a more decisive test of the possibility that aversive effects of ECS are associated with the recovery period.

SUBJECTS

Forty female albino Sprague-Dawley rats, 30 of which were 63 days old and 10 of which were 199-214 days old, served as Ss. The younger rats were housed in pairs and the older rats singly in standard wire-mesh rodent cages. Throughout the experiment, all Ss were provided with ad lib access to food (Purina Laboratory Chow) and water.

APPARATUS

A 30-in. circular container with a white peripheral wall, 10 in. high, served as one of two compartments used. This compartment (Compartment A) had a floor of ¼-in.

plywood covered with clear vinyl plastic. Located in its center was a 4¼ x 5 in. stepdown platform, 3 in. high, painted black and also covered with vinyl. The second compartment (Compartment B) was constructed to contrast sharply with Compartment A. This consisted of a 12½ x 18 x 13 in. cardboard box, painted black inside. Located in the center of its floor was a stepdown platform identical to that in Compartment A.

ECS was administered via miniature clip electrodes attached to Ss' pinnae prior to the beginning of each trial. The electrical apparatus was designed to deliver 35-50 mA ac for a brief duration sufficient to produce full tonic seizure.

PROCEDURE

The Ss were assigned randomly to two experimental groups and two control groups with the restriction that three of the older animals be included in each experimental group and two in each of the control groups.

The experiment began with a 3-day habituation phase consisting of one trial per day. On these trials, all Ss were placed, with electrodes attached, in the center of the step-down platform in Compartment A. Stepdown latencies (SDLs), in which the time taken for S to step off the platform (place both forepaws on the floor of the compartment), were recorded as a measure of avoidance behavior. On these trials, any S remaining on the platform a maximum of 45 sec was gently pushed off.

Differential shock treatment (DST) was begun immediately following the stepdown responses on the third trial of habituation. This phase of the study continued for seven trials. These trials were identical to those during habituation except that immediately upon completing the stepdown response, S received ECS (experimental groups), subconvulsive shock (2 mA) (first control group, N = 7), or no shock (second control group, N = 7). Following ECS administration, Ss in the ECS-same

group (N = 12) were allowed to recover in the shock compartment (A). Ss in the ECS-different group (N = 14), however, were removed immediately following ECS to the nonshock compartment (B) for recovery. Each animal was returned to its home cage following a trial.

On the day following the last trial of DST, each S was given a posttest in Compartment B. On this day, Ss were given one trial in which they were placed, without electrodes, in the center of the stepdown platform in Compartment B. Again, SDLs were recorded.

RESULTS

Mean SDLs per trial for each group are given in Fig. 1. SDLs were essentially equivalent for the four groups ($F < .01$) during habituation.

For the DST, significant effects were found due to treatments ($F = 50.96$, $df = 3/36$, $p < .01$), trials ($F = 6.72$, $df = 6/216$, $p < .01$), and the Treatments by Trials interaction ($F = 1/82$, $df = 18/216$, $p < .05$). Simple effects analysis for each trial of DST yielded significant treatment effects on each of the seven trials (all $F_s = 10.5$, $df = 3/36$, $p < .01$). Newman-Keuls comparisons between all possible pairs of treatment means for each trial of DST indicated that SDLs for Group ECS were significantly greater ($p < .01$) than those for the other groups. The mean SDLs for the ECS-same and ECS-different groups did not differ significantly until the fourth trial of DST, whereafter they remained clearly different ($p < .01$), with the ECS-different group having shorter SDLs. The Newman-Keuls analysis further showed that, with the exception of the second trial of DST, the latencies for the ECS-different group did not differ significantly from the SDLs for the no-shock group until the fifth trial. In contrast, the ECS-same group showed consistently longer SDLs than the no-shock group from the second trial of DST to the seventh.

The posttest was designed to measure the degree to which aversive effects (especially for the ECS-different group) had become associated with cues in Compartment B. To test this effect, the data for the last trial of DST and that for the posttest were analyzed together as a 4 by 2 repeated measures design. Significant differences were found among treatment groups ($F = 10.55$, $df = 3/35$, $p < .01$), across trials ($F = 35.05$, $df = 1/35$, $p < .01$), and for the Treatments by Trial interaction ($F = 11.03$, $df = 3/35$, $p < .01$).¹ Analysis of simple effects and Newman-Keuls comparisons for the posttest trial indicated that only the differences between the mean SDL

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Fig. 1. Mean stepdown latency for each group on every trial.

for the subshock group and the means for both the no-shock and the ECS-same groups were significant ($p < .01$).

Two facts stand out. The first, that the posttest means for the ECS-different and the no-shock groups show no difference from the last trial of DST; and the second, that the sub-shock and ECS-same groups showed a marked decrease in SDLs on the posttest. These facts taken together indicate that the recovery compartment had a differential effect on the treatment group. The significance of this effect was tested by simple effects analysis for treatment groups. The analysis showed that the SDLs for the sub-shock and ECS-same groups decreased significantly ($F = 31.79$, $df = 1/35$, $p < .01$, and $F = 26.99$, $df = 1.35$, $p < .01$, respectively) in going from the last trial of DST to the posttest. The corresponding decreases in SDLs observed for the ECS-different and no-shock groups were not significant.

DISCUSSION

The finding of the present investigation, that avoidance developed differentially in the two ECS groups, suggests that some of this aversiveness is a function of the postshock recovery experience. Although SDLs increased in both ECS groups, they developed more slowly in the group recovering from ECS in the nonshock compartment. The fact that Ss in the ECS-different group showed little change in mean SDL in going from the final trial of the DST to the posttest, while the mean SDL for the ECS-same group was appreciably lowered, implied that components of

this aversiveness due to recovery became associated, through principles of conditioning, with cues in the recovery environment.

Although the present results argue that part of the noxious effects of ECS are due to aspects of the recovery period, the fact that SDLs were observed to increase during DST warrants further consideration. In this respect it is useful to consider the possible contributions of stimulus generalization. Although intentions were to make the two recovery compartments as dissimilar as possible, at least one component, the stepdown platform, was the same in both cases. It was necessary to include this platform in Compartment B to obtain

avoidance measures on the posttest. Other possibilities might include kinesthetic cues involved in placing the animal on the platform. Stimulus generalization is evident in the performance of the subshock group on the posttest, where it appears that some aspects of the total experience in Compartment B were similar enough to those in Compartment A to result in significant avoidance.

In a similar manner, the finding that the aversive effects of ECS recovery become conditioned to stimuli in the recovery compartment can be extended to include stimulus generalization of cues in Compartment B to cues in Compartment A. This might then account for some of the avoidance behavior observed in the ECS-different group during the shock phase. Perhaps by making the experiences in the two compartments even less similar, the difference in SDLs between the two ECS groups could have been enhanced.

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NOTE

1. Following the final trial of DST, one of the Ss in the ECS-different group expired, resulting in one less degree of freedom for all analysis which included the posttest.

Visual stimulus complexity and approach behavior in rats

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Three experiments examined the relationship between visual stimuli and approach behavior in rats. The results indicate that rats have an optimum preference level for stimulus complexity, which can be shifted by repeated stimulus presentation.

Dember & Earl (1957) suggest that Ss exposed to stimuli of varying complexity will demonstrate a preference for stimuli of "moderate complexity" and avoid stimuli which are either "extremely simple" or "extremely complex." This preference should result in an inverted U-shaped function, provided that the stimuli cover a sufficient range of complexity

and include both ends of the continuum.

Several studies show that rats express a preference for the more complex of two stimuli (e.g., Dember, Earl, & Paradise, 1957; Baker & Franken, 1967). Recently, Sales (1968) has extended the findings in this area by presenting Ss with a wide range of complex stimuli, obtaining the predicted inverted U function with