Electroconvulsive shock and the response: ECS interval¹

HENRY E. ADAMS AND L. J. PEACOCK

UNIVERSITY OF GEORGIA

Abstract

It was attempted to determine whether the decrement in retention produced by ECS was a function of the response-ECS interval or the location of the interpolated ECS in the trial-test interval. It was hypothesized that when ECS is in close temporal relationship to a response, whether it is original learning or a test trial, a decrement in performance occurs; while ECS which is more remote in time from a trial does not create such a decrement. Four groups of rats, on a 24 hr. training interval, were given ECS 15 min., 1 hr., 23 hr., or 23 hr. 45 min. after the first trials. The greatest decrement in retention was found in the 15 min., 23 hr., and 23 hr. 45 min. groups, which supports the hypothesis.

When learning is followed shortly by electroconvulsive shock (ECS) there is a decrement in retention. Duncan (1949) has explained this retrograde amnesia (RA) in terms of consolidation theory, which postulates that each learning trial contributes to the formation of an engram. Learning does not become permanent until this engram consolidates. If ECS is given shortly after learning it causes a "physiological storm" which interferes with consolidation and creates a decrement in retention. Duncan has indicated that the shorter the time interval between the learning trial and the ECS, the greater is the disruption of the consolidation process which results in a greater decrement in performance. Duncan found little RA effect for ECS which was given 1 hr. after the learning trial. Duncan's results have been supported by numerous experimenters.

It should be noted that Duncan used groups in which the elapsed time between response and ECS ranged from 20 sec. to 14 hr. Since his animals received one trial per day, the shortest interval between ECS and the test trial was at least 8 hr. On a 24 hr. interval from trial to trial it is possible that the crucial factor may be the placement of the ECS in the interval rather than the elapsed time between a learning trial and ECS. For example, if this interval were 24 hr. then ECS administered 15 min. before the test trial should have a similar effect to ECS administered 15 min. following the original learning. The present experiment was designed to test this hypothesis.

Method

Subjects

The Ss were 40 male albino rats of the Dublin Sprague-Dawley strain. They were approximately 90 days old at the beginning of the experiment and weighed between

200 and 250 gm. They were on an ad lib schedule for food and water.

Apparatus

The apparatus was a modified Miller-Mowrer hurdle box. The two compartments of the box were separated by a 2-1/2 in high hurdle and a guillotine door. Each compartment was 10-1/2 in long, 6-1/2 in wide, and 5 in high. The shock box was painted black and the safe compartment was white. When the guillotine door was raised, a 7-1/2 watt bulb (CS) located in the end wall of the shock compartment was activated intermittently. Ten sec. after the onset of the flickering light, an electric current of 0.8 ma regulated by a Grason-Stadler shock scrambler charged the grids of the shock compartment. The CS terminated with the onset of shock. Jumping responses were timed automatically from the onset of the CS to the lowering of the guillotine door, which occurred immediately after the S jumped over the hurdle and entered the safe compartment.

The ECS apparatus was similar to the one described by Hayes (1948). A current of approximately 35 ma was administered through alligator clips attached to the animal's ears. The duration of the ECS current was 0.3 sec. ECS was delivered in the black compartment, in the presence of the flickering light.

Procedure

All Ss were given six learning trials a day for four days. Ten Ss were randomly assigned to each of the four groups. These four groups were treated identically except that there were different time intervals between response and ECS. The first group received ECS 15 min. after the sixth trial, the second group received ECS 1 hr. following the sixth trial, and the third group received ECS 23 hr. after the sixth trial, and the fourth group received ECS 23 hr. and 45 min. after the sixth trial. The interval between the sixth and seventh trial for all groups was 24 hr. The ECS was administered in the avoidance compartment of the hurdle box. Each S received only one ECS.

Results and Discussion

A mixed model analysis of variance of the number of avoidance responses indicated that the difference between response-ECS intervals was not significant ($F = .30$, $df = 3/36$). The trial blocks were significant at the .01 level of confidence ($F = 38.21$, $df = 2/72$). These results indicate that the number of avoidance responses increased in all groups over trial blocks. The interaction between response-ECS intervals and trial blocks

was significant at the .01 level of confidence ($F=3.14$, $df=6/72$). This interaction indicates that the groups were significantly different on the second trial block, but reached the same level of performance in the fourth trial block. In the second trial block the mean number of avoidance responses for the group receiving ECS 15 min. after the sixth trial was 2.0, the mean of avoidance responses for the group receiving ECS 1 hr. after the sixth trial was 3.0, the mean number of avoidance responses for the group receiving ECS 23 hr. after the sixth trial was 1.4, and the mean number of avoidance responses for the group receiving ECS 23 hr. and 45 min. after the sixth trial was 1.4. The differences between the group which received ECS 1 hr. after the sixth trial and the rest of the groups were significant at the .05 level of confidence as determined by t tests. The mean differences between the other three groups were not significant. None of the differences between the various groups on the fourth trial block were significant.

An analysis of the response latency data yielded results similar to those obtained from the analysis of the number of avoidance responses.

These results indicate that the time between the last response and ECS is not the only variable determining the decrement in behavior. In fact, the present results would indicate that an important factor seems to be the absolute time between ECS and a response regardless of whether the ECS precedes or follows a response. These results would indicate that giving ECS 15 min. before a test trial block, which is sufficient time to allow the animal to recover from the gross effects of ECS,

produces a decrement similar to the one produced by ECS given 15 min. after original learning. The principal factor seems to be contiguity of ECS and learning regardless of order. This finding supports a study by Adams & Lewis (1962a) which indicates that ECS has a prograde as well as a retrograde effect. The present study does not support a consolidation hypothesis of the RA effect of ECS since the group receiving ECS 23 hr. and 45 min. after a learning trial showed as great a decrement in performance as the group which received ECS 15 min. after the consolidation of the engram had been initiated. These results do seem to be compatible with an interference hypothesis of ECS as proposed by Coons & Miller (1960), Adams & Lewis (1962a, 1962b) and Lewis & Adams (1963).

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Note

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