requires only half the length of a single one and additional conductors wound on a common axis reduce the total length of wire in each proportionately. Three or four electrodes may be wound in this fashion with a modification of the jig to an "X" shape to hold four bobbins.

When the desired length of electrode is wound, the wires are clipped and the mandrel may be withdrawn; if a protective coating is required the electrode is left on. It may be coated with a silastic rubber paste (Dow Corning Medical Adhesive, Type A) put on with an artist's brush to the rotating mandrel. Greater protection is afforded by inserting the electrode in a tightly fitting silicone rubber tube. This may be done by selecting a section of silicone tubing that is .005 to .010 in. smaller in bore than the outside diameter of the electrode. The tube is then soaked in xylene or ether, which causes it to expand. The electrode on the mandrel is then inserted into the tubing and when the solvent evaporates, the latter will shrink to its original size.

The electrodes thus produced are extremely flexible, resist breakage through flexion almost indefinitely because the bending stress is distributed over an appreciable length of wire. A bifilar pair electrode, close-wound as described, contains 46 in. of wire per inch of electrode length and presents a dc resistance of only 125 ohms. Both the Teflon coating of the wire and the silicone rubber coating is nearly impervious to most biological agents as is the stainless steel of the conductors.

A number of variations on this electrode are possible. A flexible cannula may be inserted in the hollow core of the electrode for the application of chemical agents to the site being electrically monitored. If a pair of electrodes is allowed to remain on the mandrel after winding and the process repeated, the result is a coaxial electrode in which all four conductors may be active or the outer pair may be grounded and thus form a shield for the inner conductors. If a thin-wall silicone tubing is used it is possible to build up two or three layers of alternate electrodes, insulator, electrodes, etc. Each variation retains the advantages of flexibility and resistance to breakage and to chemical deterioration from body fluids.

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NOTES

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2. The wire may be purchased from Havg, Inc., Super Temp Wire Division, West Canal Street, Winooski, Vermont.

ECS disruption of avoidance produced by an air blast and tone

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Rats were taught to bar press for food in a Skinner box. The amount of time needed to make 10 bar presses increased significantly after a bar press was accompanied by an air blast and loud tone. This increase did not occur if the air blast and tone were followed 8 sec later by an ECS. The technique is simple and effective, and preserves the previously established effects of ECS on recent memory. Hopefully it will prove useful in situations where the investigator wishes to establish a one-trial passive avoidance without the use of painful shock.

Electroconvulsive shock (ECS) has been widely used in experiments attempting to disrupt retention. Most ECS studies have used a one-trial learning paradigm, which allows precise control of the training-ECS interval, and also minimizes adverse reactions that might build up to the ECS itself after repeated administrations (Hayes, 1948).

Although it is possible to devise a one-trial appetitive learning task (Tenen, 1965), most investigators have used the passive-avoidance paradigm. In these studies the S always has been trained to avoid a particular behavior by pairing that behavior with a painful electric shock. The effects of an ECS immediately after training typically have been to negate the effects of the painful shock so that the behavior continues at the prepunishment level.

The use of painful shock for establishing a one-trial passive avoidance is widely accepted, and generally appears entirely

adequate for this purpose. There are several reasons, however, that an alternative means for producing a one-trial passive avoidance would be of value. First, it would be useful to know the effects of ECS upon retention of an avoidance response established without using painful shock. In addition, some ECS investigations might require that the same S be trained on two completely different tasks, or that he be trained to make an avoidance without receiving painful shock. In the present study, a method is described for producing a one-trial passive avoidance using an air blast coupled with a loud tone. The effects of ECS upon this training also are described.

METHOD

Subjects

The Ss were 28 male albino rats (Holtzman), individually housed and maintained at 80% body weight throughout the experiment.

Apparatus

The test chamber was a Skinner box equipped with a lever and a pellet feeder, and enclosed in a sound-insulated cubicle. The ECS was delivered through modified alligator clips fastened to the rat's ears. Leads from the clips to a shocker (Lafayette No. A-615B) emerged through a small hole in the top of the cubicle, and allowed free movement without entangling the animal.

A length of latex rubber tubing (Aloe R780; o.d. 1/4 in., i.d. 1/16 in.) was mounted on the grid floor so that an air blast could be directed at the underside of a rat that was bar pressing. Compressed air was forced into the rubber tube until an air

bubble approximately 6 in. in length "popped out" in the tube. This air bubble was sealed in the tube with clamps, the manual release of which caused an air blast to be discharged into the test cage.

In an attempt to make certain that an avoidance response would develop after only one presentation of the noxious stimulus, a 2.8 kc tone of approximately 80 dB always accompanied the air blast. This tone was delivered through a fixed-tone generator (Lehigh Valley Electronics No. 1664) mounted inside the test cubicle.

Procedure

All Ss were trained to bar press for food on a continuous reinforcement (CRF) schedule to a criterion of 50 bar presses in less than 300 sec. After reaching criterion, Ss were given two sessions of habituation to the ear clips. These sessions were given on two successive days, and continued each day until Ss completed 50 CRF responses while wearing the ear clips.

Six hours after the last habituation trial, Ss were placed in the Skinner box with ear clips in place, and the amount of time needed to complete 10 CRF bar presses was recorded. This time served as a baseline against which later performances were compared.

The Ss then were divided randomly into four groups representing all possible air blast and ECS combinations. One group (Group AT-ECS) received a blast of air to their undersides immediately following the 10th baseline trial. At the same time, the 80-dB tone was activated for 3 sec. Five seconds after tone offset, these Ss received a 50-mA ECS lasting 0.3 sec. These ECS parameters were sufficient to produce in all Ss the extension and clonus associated with a full seizure pattern. During the convulsion, each S was removed to its home cage.

Group ECS did not receive the air blast and tone, but was given an ECS 8 sec after the 10th baseline bar press. Group AT received the air blast and tone immediately after the 10th baseline bar press. Five seconds after the tone stopped, these Ss were removed from the test chamber and returned to their home cages. Finally, Group NT (no treatment) received neither an air blast and tone, nor an ECS. These animals were returned to their home cages 8 sec after the 10th baseline bar press.

Twenty-four hours after the baseline data were recorded, all Ss were retested in the test chamber with the ear clips attached. Again a record was made of the number of seconds to make 10 bar presses. The dependent variable was a difference score, obtained by calculating for each S how many more seconds it took to complete 10 bar presses on the retest day than it had on baseline day.

RESULTS AND DISCUSSION

Results are presented in Fig. 1. Individual group comparisons (Newman-Keuls procedure) indicated that the group receiving only an air blast and tone (Group AT) took longer than any other group to make 10 bar presses on the retest day ($p < .01$ for all comparisons). None of the other group differences approached statistical significance.

Similarly, Group AT was the only group whose performance during the retest differed from baseline performance ($p < .02$, two-tailed; Wilcoxon matched-pairs signed-ranks test). All seven rats in this group took longer to make 10 bar presses after receiving the air blast and tone, while S performances in the remaining three groups varied about the baseline.

Several conclusions may be drawn from these data. First, it is clear that an air blast and tone produced a one-trial passive avoidance for bar pressing in the Skinner box. All seven rats in Group AT had increased latencies to make 10 bar presses on the retest day, with an average increase in latency of about 40 sec. Control rats that received no treatment (Group NT) showed a statistically nonsignificant decrease of about 3 sec in the time

Fig. 1. Mean increase in amount of time to make 10 bar presses after treatment administration. An air blast and tone significantly increased the time required, but an ECS 8 sec later eliminated this increase. ECS alone had no effect. Average time to make 10 bar presses on baseline day was 23, 27, 30, and 37 sec for Groups ECS, NT, AT, and AT-ECS, respectively. These differences were nonsignificant ($p > .05$; Newman-Keuls test), and remained nonsignificant on retest day except for Group AT, which took longer than the other three groups to make 10 bar presses ($p < .01$ for all comparisons).

needed to make 10 bar presses on the retest day.

It is also clear that an ECS negated the effects of the air blast and tone. Group AT-ECS averaged about 5 sec longer to make 10 bar presses on retest day than it had on baseline day, but this increase in time was not statistically significant. There were no statistically significant differences in the amount of time to make 10 bar presses between Group AT-ECS and Group NT. ECS alone apparently had no effects on bar pressing in the Skinner box. Rats in Group ECS took almost identical amounts of time to make 10 bar presses on the baseline and retest days.

In the past, a commonly used method of producing one-trial passive avoidance has been to train rats to stay on a platform by administering foot shock when they stepped off. Ordinarily, an ECS had to be administered within a few seconds after training in order to produce amnesia for the foot shock. However, Schneider and Sherman (1968) found that they could produce amnesia up to 6 h after training if a second (noncontingent) foot shock was given immediately prior to the ECS. These data have raised several questions, among them whether ECS must closely follow peripheral shock in order to produce amnesia in the passive-avoidance situation. The findings in this paper add to the evidence suggesting that amnesic effects of ECS can occur in the absence of a preceding peripheral shock.

The present study demonstrates that an air blast and tone combination provides an adequate alternative to painful electric shock in establishing a one-trial passive avoidance for bar pressing in the Skinner box. This technique also preserves the previously established effects of ECS on recent memory. The application of ECS 8 sec after the onset of the air blast and tone abolished the passive-avoidance response. The availability of a one-trial passive-avoidance paradigm not established through painful shock could prove useful in a variety of future ECS investigations.

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