TECHNICAL NOTE

AN APPARATUS FOR DELIVERY OF ELECTROCONVULSIVE SHOCK WITHOUT SITUATIONAL CHANGE

Research into the factors involved in consolidation of memory, and the disruption of the consolidation process, has been facilitated by the introduction by Jarvik and Essman (1960) of a reliable method for one-trial learning in mice. Disruptive electroconvulsive shock (ECS) can follow the learning by a definite time interval, since the learning occurs in only one trial. A concomitant advantage of the Jarvik-Essman method is that there is one clear response that indicates lack of learning (or memory disruption) and another, equally clear response that indicates learning. The first response is stepping off a small platform; the second is staying on the platform. This one-trial learning method requires that a separate group of mice represent each value of the independent variable. Subject losses due to deaths from the memory-disruptive treatment (electroconvulsive shock) have been a factor in delaying progress with this method. Post-ECS artificial respiration (Chevalier, 1965) has been suggested, but the present authors have found it less satisfactory than the alternative offered here.

The smaller times between the footshock (FS) and ECS indicated below represent a special concern of the present authors; usually, FS-ECS times may range up to 30 min or longer. In these longer FS-ECS intervals, the subject is usually removed from the FS apparatus and ECS electrodes are attached by hand. With the present apparatus, it is not necessary to remove the mice from the apparatus in order to deliver ECS.

This one-trial punishment apparatus for mice is of the hole-in-the-wall type (modified from Essman and Alpern, 1964; Jacobs and Sorensen, 1969). The apparatus is a 5 by 3.75 by 3.9 in. (12.7 by 8.9 by 9.2 cm) step-through avoidance box constructed of plywood, a view of which is shown in Fig. 1. The rear and side walls of the interior are covered with thin aluminum sheeting and the top and the remaining wall are painted black. The front wall is a 9 by 18 in. (30 by 45.7 cm) section of plywood with a 5-mm cut from center top to a 38-mm hole 196 mm on center from the base of the apparatus. A 3-mm brass tube is hinged into the space provided by the cut through the center of the front wall and the small wires that are passed through the brass tube are attached to two miniature, toothless alligator clips that serve as pinnal electrodes. There is no other attachment or harness to the animal. A cut was also made in the top of the box to provide for the angular travel of the brass tube as the animal made the step-through response. A 38 by 64 mm metal platform was attached to the front wall with a 40-w bulb 10 in. (25 cm) above it. The grid floor was con-

structed of 3-mm stainless steel rods placed 10-mm apart on centers. Grid shock was provided by a 900-v transformer in series with the mouse and two 620,000 Ω resistors. ECS was produced by a 900-v transformer in series with the mouse and a 40,000 Ω resistor. Additional resistance in the ECS circuit was provided by the electrode paste and individual subject resistance, which was minimal with regard to variance.

Before placing the mouse on the platform, the electrode paste and pinnal electrodes must be fixed to the subject's pinnae. The criterion for a punishable response is that all four feet must be inside the box. As soon as this occurs, the hole is covered by the experimenter with a piece of darkened plywood and footshock is delivered. The delivery of both FS and ECS is accomplished through a system of relays. Very small delays can be used between FS and ECS. A 0-sec delay is equivalent to the reaction time of the relays. See Fig. 2 for the control circuit.

Key to Components

T ₁	0-135-v Variac
T ₂	Transformer; output: 900 v
R ₁	620,000 Ω resistor
R ₂	620,000 Ω resistor
R ₃	40,000 Ω resistor
S ₁	SPST switch
D ₁	Potter & Brumfield time delay relay. Type CHB-38-70001; DPDT; coil, 120 v ac
RY ₁	Potter & Brumfield relay, 5KL A60, DPDT
RY ₂	Potter & Brumfield relay, GA 14-A, DPDT
A ₁	Agastat time delay relay. Type No. 2112-D-H1; DPDT; coil 28 v dc
A ₂	Agastat time delay relay. Type No. 2112-D-H1; DPDT; coil, 28 v dc
F ₁	1-amp fuse
F ₂	1-amp fuse

The onsets of FS and ECS were each controlled by a time delay relay, which was a "break before make" type. Leads to the FS and ECS circuits were interrupted by two DPDT relays that were dependent on the time delay relays. Another time delay relay (A₂) was in series with the double pole relay for the ECS circuit (RY₂) and served to control the duration of ECS.

Upon activation of time delay relay D₁, relay RY₁ for the FS circuit was closed and FS was delivered for 1-sec. Immediately after FS, the time delay relay D₁ switched on the ECS circuit, whereupon relay RY₂ and A₁ were closed and ECS was delivered at the expiration of the

Fig. 1. Cutaway view of apparatus.

delay set on relay A_1 . ECS was terminated by the relay A_2 , on which relay RY_2 for the ECS circuit was also dependent.

Immediately after receiving the ECS treatment, the subject must be turned ventral side up with the head elevated and with the long axis of the body approximating a 45° angle. Using this method, artificial respiration is not necessary, and fatalities resulting from the drowning of subjects on excess body fluids are prevented.

The following safeguards against the subject receiving shock through the head during FS (punishment) were employed:

- (1) The FS circuit and ECS circuit were completely isolated from one another.
- (2) During the FS phase, the insulated leads to the

Fig. 2. Control circuitry. Circuit as drawn permits a variable delay between FS and ECS, by adjusting A_1 to desired setting. Time between FS and ECS can be adjusted to zero by replacing A_1 with a DPDT momentary relay.

subject's head were dead; i.e., both leads were interrupted by a double-pole relay. This prevented any possible ground that might pass a current through the subject's head.

- (3) All electronic equipment and the step-through avoidance box were built on wood chassis and placed on a wooden table as a further precaution against a ground.

REFERENCES

- Chevalier, J. A. Permanence of amnesia after a single posttrial electroconvulsive seizure. *Journal of Comparative and Physiological Psychology*, 1965, 59, 125-127.
- Essman, W. B. and Alpern, H. Single trial conditioning: Methodology and results with mice. *Psychological Reports*, 1964, 14, 731-740.
- Jacobs, B. L. and Sorensen, C. A. Memory disruption in mice by brief posttrial immersion in hot or cold water. *Journal of Comparative and Physiological Psychology*, 1969, 68, 239-244.
- Jarvik, M. E. and Essman, W. B. A simple one-trial learning situation for mice. *Psychological Reports*, 1960, 6, 290.

GEORGE S. GROSSER
HECTOR E. PERCY
American International College