Use of Auditory Stimuli to Maintain Lever-Pressing Behavior

This note presents a method of maintaining lever-pressing behavior in the rat by the use of a noxious auditory stimulus (*1*).

In experiments in which behavior is maintained by the escape or avoidance of a noxious stimulus, electric shock is usually employed as the stimulus (*2*). Electric shock, however, has a number of disadvantages. The current density the animal receives at each presentation of the shock is far from constant, the adjustment of the value of the current is often critical if consistent results are to be obtained, and the grid has to be designed with considerable care (*3*). Also, the animal is likely to become difficult to handle when its behavior is shock-maintained. Some of these difficulties may be overcome by the use of light as the noxious stimulus. A disadvantage of this method is that the animal can escape the light by a variety of behavior other than lever pressing. For example, the animal may close its eyes or crouch in a corner away from the light.

The noxious auditory stimulus consisted of a random signal reproduced over a University "tweeter" speaker having a frequency response range up to approximately 15,000 cy/sec. The noise had been previopsly recorded on an Ampex tape recorder, Model 600, which also has a frequency response up to 15,000 cy/sec. The "tweeter" was connected to the output of the amplifier by a 1-μf condenser. This attenuated frequencies of 1000 cy/sec about 10 times and frequencies of 10,000 cy/sec 2 times. This combination of components insured that the noise reaching the animal consisted principally of high audio frequencies. The noise was continually present unless the animal pressed the lever. Each lever press terminated the noise for a period of 16 sec. If the animal responded during the silent period, a further 16 sec was added to the period, commencing from the time of the second press.

An animal was run until it reached a steady rate of response. A cumulative response curve was recorded for this animal after the manner suggested by Skinner (*4*). This curve, after 30 hr of escape behavior, is shown in Fig. 1. Once an animal has reached a steady response rate, the functional relationship between the response rate and the intensity of the sound can be readily obtained by running the animal at decreasing

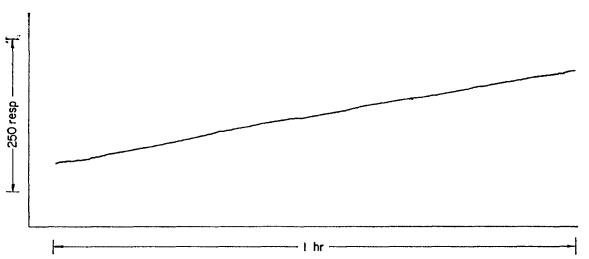

Fig. 1. Cumulative response curve of escape lever-pressing behavior after 30 hr of training.

intensities. The response rate is correlated with the intensity of the stimulus. This is demonstrated in Fig. 2 by the change in the slope of the curve at the points where the intensity of the sound has changed. The greatest intensity at which extinction occurs is a use-

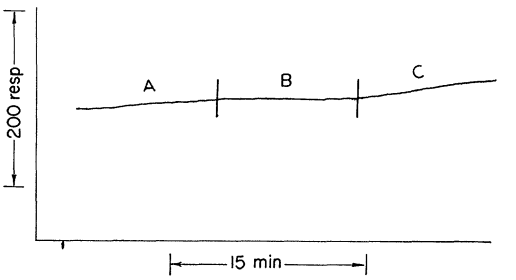

Fig. 2. Cumulative response curve of escape behavior at three different intensities of sound. The silent period was 16 sec throughout. Intensity $C >$ intensity $A >$ intensity B.

ful measure of the auditory threshold. At any given intensity of the stimulus, the rate of lever pressing is largely determined by the duration of the silent period following each response. Thus, different rates for any given intensity can be selected by choosing an appropriate silent period. The effect of varying this period while leaving the intensity constant is shown in Fig. 3. The effect of the alteration of the silent period is immediately apparent in the cumulative response curve. When one returns to the initial period, the initial rate is obtained.

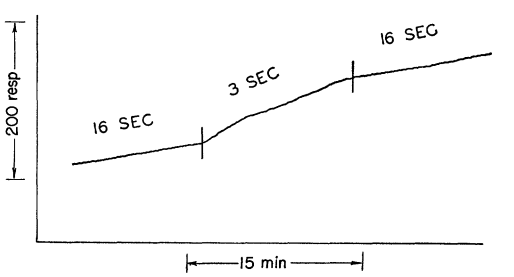

Fig. 3. Cumulative response curve of escape behavior at three different silent periods. Intensity the same as C of Fig. 2.

The behavior of seven more rats has been investigated in this apparatus. The results are essentially the same as those reported for the first. It has also been found that it is possible to alternate the aversive sound with a positive food reinforcement in a dual schedule. With such a program the animal's response rate shifts in accordance with the schedule. Intersession response variability to the aversive sound appears to be roughly commensurate with that found for positive reinforcement schedules. In spite of this variability, day by day intensity-rate functions are clearly discriminable with little or no overlapping, once the appropriate intensities have been empirically ascertained.

This method of maintaining lever pressing is at present being used in conjunction with the investiga-

tion of the behavior changes produced by bilateral lesions of the hippocampal system. It should be useful, also, when combined with food-maintained behavior in investigations of any variables that are considered to be related to the affectivity of the animals (*5*).

J. M. HARRISON
W. H. TRACY

Psychological Laboratory, Boston University, Boston, Massachusetts

References and Notes

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Inexpensive Stain for Paper Electrophoresis

Bromphenol blue is an expensive dye, as one soon learns when doing large numbers of paper-strip electrophoresis determinations. Since light green SF can be used satisfactorily at less than 10 percent of the cost of bromphenol blue and, in addition, does not require washing with alcohol or preparation with mercuric chloride, its use may be attractive to others. In our hands the strips have proved to be the equal in all respects of those stained with bromphenol blue (*1*). Griffith (*2*) suggested that there were several stains of possible value in staining these strips; our best results were with the light green, although fast green may be used interchangeably (it is slightly more expensive).

A modification of the Grassmann technique (*3*) for paper-strip electrophoresis was followed using Whatman No. 3 filter paper strips ¾ in. in width. Serum was streaked across the base line using a hemoglobin pipette (20 mm^3). Barbiturate buffer, *p*H 8.6, was employed, and the strips were run overnight (approximately 15 hr) at 3.5 ma. After oven-drying for ½ hr at approximately 105°C, the strips were ready for staining.

A shallow glass dish large enough to allow the strips to lie flat (Pyrex baking dish) was used. Strips were first immersed 5 to 8 min in 1-percent acetic acid solution. The acetic acid enhances the adsorption of the proteins on the filter paper and minimizes their loss on developing (*4*). This original wash was saved. The strips were then immersed for 5 to 8 min in 1-percent light green SF dissolved in a 1-percent solution of acetic acid in distilled water. They were then washed with the original 1-percent acetic acid using gentle agitation for about 1 min. This was repeated three times, using fresh 1-percent acetic acid, a total of four washes. The final wash was allowed to remain on the strips 5 to 8 min with occasional agitation. Further handling of the strips depends on individual needs. Our strips were air-dried, cleared with mineral oil, mounted in 1-in. Scotch tape, and scanned with a Photovolt Densitometer Model 425

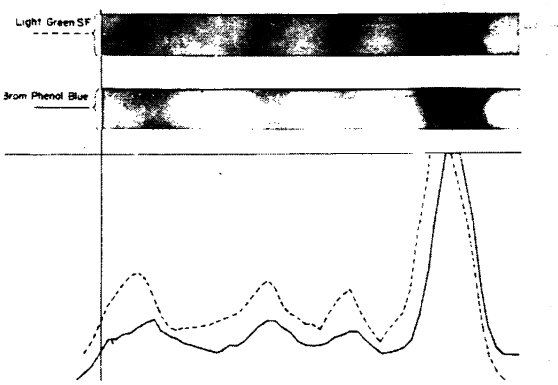

Fig. 1. Paper electrophoresis strips run simultaneously and stained by standard bromphenol blue technique (solid line) and light green SF (dashed line). Curves drawn from Photovolt Densitometer Model 425.

LENORE A. RIDEOUT
ROBERT W. PRICHARD

Department of Pathology, Bowman Gray School of Medicine, Winston-Salem, North Carolina

References and Notes

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Our delight in any particular study, art or science rises in proportion to the application which we bestow upon it. Thus, what was at first an exercise becomes at length an entertainment.—JOSEPH ADDISON.