Conditioned suppression and self-stimulation¹

ROGER W. MCINTIRE

UNIVERSITY OF MARYLAND

Using medial forebrain bundle stimulation as reward, seven rats were trained to bar-press on a fixed ratio (FR) of 15. Performance on the same schedule was established using food reward. A foot shock paired with the off-set of a 60 sec. tone (CS) was used in acquisition of conditioned suppression under both reinforcement conditions. When the schedule was lowered to FR 3, conditioned suppression failed to appear when intracranial stimulation (ICS) was used as the reinforcer but remained under food. A second experiment using only ICS reward demonstrated that the rat's position in a chained schedule at the on-set of the CS could predict suppression performance. These performances varied consistently with the local reinforcement density and the electrical parameters of the ICS. The author concludes that the absence of interrupting behaviors associated with food-rewarded behavior, such as travel to a food cup and consummatory behaviors, leads to the demonstrated resistance to conditioned suppression in ICS-supported behavior.

Using intracranial stimulation (ICS) as reward, Brady & Conrad (1960) demonstrated resistance to conditioned suppression in rats, cats and monkeys. The investigators speculated that there are "anxiety-reducing" properties accompanying stimulation of some limbic system structures.

Individual performances of conditioned suppression are predicted in the present report. However, the assumption is that because Ss working for ICS need not interrupt their bar-pressing behavior to receive reward, they are greatly resistant to distraction. Also, the immediacy of ICS reward provides an extremely rapid behavior with a stereotyped topology which may reduce distractibility allowing S to "work through" the suppression interval. Therefore, the predictions depend upon the extent to which a particular reinforcement schedule allows self-stimulation to be uninterrupted and of a stereotyped topography.

Method

Subjects. Seven male albino rats of the Sprague-Dawley strain were implanted with bi-polar electrodes in the area of the medial forebrain bundle just lateral to the lateral nucleus of the hypothalamus. The surgical procedure was similar to the technique described by Valenstein, Hodos, & Stein (1961). Three weeks after surgery, Ss were brought to 80% of body weight and maintained there throughout the experiment.

Apparatus. A Plexiglas chamber with a 1-sq. ft. floor area was used and is described in detail by McIntire & Wright (1965). A platform 2 in. long and 1 in. deep operated a microswitch when pressed with 25 gm pressure by S.

Training in Phase 1. One-hour daily training sessions were given until S was bar-pressing steadily on a fixed ratio of 15 for seven days. One half-hour used ICS (.3 sec. at 500 μ a) and 1/2 hr. used food as a reinforcer. Each day the order of the use of the two reinforcers was

reversed. In each 1/2 hr. period a 1000 cps tone (CS) was presented for a 60 sec. interval at a time randomly selected between the 5th and 25th min.

For the next 10 days a 1.6 ma shock was delivered through the grid floor for the 2 sec. following each tone presentation. Two Ss were continued for another six days with the schedule reduced to FR 5 for four days and then to FR 3.

Results of Phase 1. Figure 1 represents both normal response rate and the rate during the CS presentation. The right hand graphs show the performances of the two Ss continued with more frequent reinforcement. While complete suppression is demonstrated at FR 15, suppression of bar-pressing for food and for ICS differ at the reduced schedules. ICS supported behavior shows absence of suppression at FR 3.

Training in Phase 2. Differences in suppression performance were demonstrated in Phase 1 under densities of ICS reinforcements from FR 3 to 15. Therefore, if a schedule is used where densities vary to these extents, suppression performance might be predictable from knowledge of the local density of ICS. In this phase four rats of Phase 1 were continued in daily training sessions on a chain schedule in which there are periods of bar-pressing continuously reinforced by ICS interrupted by periods in which S must work without ICS reinforcement. The first component required 20 responses on the permanently mounted lever and this lead to the insertion of a retractable lever. This lever was available for 20 responses rewarded by ICS. At the end of the second component the lever was withdrawn and the cycle initiated again.

Daily sessions 1 hr. in length were conducted for 10 days employing ICS of the same parameters as in Phase

Fig. 1. Suppression performance of behavior supported by food and ICS reward.

1 and a conditioned suppression trial was presented in each session.

During days 11 through 42, four conditioned suppression trials were programmed for each S each day. These trials were response contingent and occurred 5, 10, 15, or 20 responses into each component of the schedule. The sets of ICS parameters consisted of one of four intensities (200, 400, 600 and 800 μ a) and one of four durations (.1, .2, .3, and .5 sec.). The 16 possible combinations were presented in a different random order for each S over the 32 test days, each combination given for two days. Therefore, in each two days of the test, S was given a single set of ICS parameters and on each of these two days received four conditioned suppression trials representing each of the eight schedule positions.

Results of Phase 2. Figure 2 represents the performance for ICS reward during the CS interval under the various test conditions. The predicted performances (represented by the bar graphs) assume that during the CS interval S would finish the ICS component, if it were available, and then not respond again until the end of the suppression interval. Therefore, no responses are pre-

dicted when the CS begins in the work component, 20 is predicted when the ICS bar is just coming into the box, and 15, 10, 5 and zero for the various positions of onset of the CS in the ICS component.

Under conditions of low-magnitude ICS, when the CS was presented in the ICS component, suppression occurred before S finished the component and, therefore, he did not make the predicted number of responses. Unpredictable suppression performance occurred where the CS interval was initiated just as the ICS component became available. Of the 64 tests made of this condition (all Ss at all ICS parameters), 23 showed 20 responses for ICS as predicted and 31 showed zero responses. It seems that if S managed to make the first response for ICS before being "distracted" by the CS the 20 responses were completed; if not, no responses were made.

Predicted values and the data coincide (1) when the CS began in the work-component, and (2) when the CS began in the ICS component and a high magnitude ICS was used. Under these conditions, S showed an over-all resistance to suppression.

Performance during the suppression interval on the work component was suppressed in all conditions with 90.4% of the 512 individual tests giving total response scores of less than 2.

Discussion

It seems that the data did not support the view that the resistance to suppression under ICS is due to a reduction in anxiety unless it is further hypothesized that the anxiety reduction is related to both magnitude and frequency of ICS and that the rate of decay of this effect is rapid enough to account for suppression when S is only temporarily interrupted as in Phase 2. A more parsimonious position seems to be that the attenuation of suppression is limited to conditions using frequent, high magnitude ICS. These conditions allow little vulnerability to distraction and have the unique characteristic of making no demand that S be distracted from his task to receive reinforcement.

References

- Brady, J., & Conrad, D. Some effects of limbic system self-stimulation upon conditioned emotional behavior. *J. comp. physiol. Psychol.*, 1960, 53, 128-137.
- McIntire, R., & Wright, J. Parameters related to response rate for septal and medial forebrain bundle stimulation. *J. comp. physiol. Psychol.*, 1965, 59, 131-134.
- Valenstein, E., Hodos, W., & Stein, L. A simplified electrode assembly for implanting chronic electrodes in the brains of small animals. *Amer. J. Psychol.*, 1961, 74, 125-128.

Note

1. This research was performed under contract No. DA-49-193-MD-2810 between the Office of the Surgeon General, United States Army, and the University of Maryland.

Fig. 2. Predicted and obtained ICS-member performance during the suppression interval. Bar graphs represent predicted while line graphs represent the mean value obtained. Small figures associated with each bar give no. of Ss performing exactly as predicted (N=4).