Generality of "drive-decay" as an explanatory concept^{1,2}

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Abstract

In a test of Deutsch's drive-decay theory of the extinction of intracranial self-stimulation, animals were trained gradually to wait for periods up to 20 min. between short bouts of self-stimulation. It is suggested that the gradual training and establishment of a discriminative stimulus may have resulted in this effect. The adequacy of drive-decay as a sole explanatory principle is questioned.

Problem

Deutsch (1961) and Deutsch & Howarth (1963) suggest that extinction of a bar-pressing response for rewarding electrical stimulation of the brain (ESB) is strictly a function of the time since the last brain shock. This theory states that electrical stimulation creates a drive and simultaneously reinforces behavior. According to this formulation, nonrewarded bar presses occur only as long as the drive elicited by ESB continues following the last reinforcement. This drive process is presumably tied to a neurological process which has a relatively short time course. The rapid cessation of bar pressing then, is due to the central phenomenon of "drive-decay." The course of this decay process would be prolonged as a function of such parameters as intensity of stimulation and number of reinforcements immediately preceding extinction. The primary determinant of extinction, however, is time since the last reinforcement.

The results of Pliskoff & Hawkins (1962) and of Herberg (1963) suggest that Deutsch's theory has limited predictive power since certain training procedures result in the failure of Deutsch's theory to predict extinction results.

The present study was designed to answer the following questions: (1) Is Deutsch's theory of "drive-decay" adequate in itself to explain the extinction data obtained in ESB, and (2) if so, how long does drive decay last? In order to maximize the temporal variable, moderate intensities and relatively few reinforcements were utilized.

Method

The Ss were three male albino rats of the Sprague-Dawley strain about 150 days old. Bi-polar stimulating electrodes were implanted in the septal region. All animals were pretrained to bar press for ESB in modified Skinner boxes at currents which maintained stable bar-pressing rates without producing convulsions (between 55-65 μ a for all animals). The training apparatus was a two-compartment shuttle box, each compartment measuring 5 in wide, 9-1/2 in long, and

14-1/2 in high, with a sliding plastic door between the compartments. In the back of each compartment was a bar, which when depressed produced a 60 cps alternating current shock to the brain lasting a maximum of 0.4 sec. If an animal kept the bar down for less than 0.4 sec. then he received a shock that lasted as long as the bar was depressed. Above each bar was a 24-v green light which signaled that the bar was active.

Animals were first trained to shuttle between the two compartments for a random number (between 1 and 10) of brain shocks (the green light was always on above the active bar). Following a given number of rewards at one bar, the green light was turned off and the bar de-energized. At the same time, the other bar was activated together with its green light. The green-light was thus established as a discriminative stimulus. This procedure was continued until the animals quickly and reliably left the deactivated bar (light off) and ran to the other compartment (bar activated, light on).

Animals were then trained to shuttle in this manner obtaining five shocks on each bar. On the test day, the animals began by shuttling five times for five brain shocks on each crossing. Following the fifth stimulation bout, the plastic barrier was inserted and the animal was required to wait a fixed number of seconds before the door was removed and the active bar made available. The green light remained on above the active bar.

The animal was delayed at each interval until he succeeded in pressing the activated bar with a latency of not more than 5 sec. after the removal of the barrier and until he succeeded in meeting this latency requirement for four out of five trials. The interval was then increased according to a prearranged schedule. The intervals used, in order, were: 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 46, 52, 58, 64, 70, 80, 90, 100, 110, 130, 150, 200, 340, and 600 sec. In addition, one animal was run four times with a 20-min. delay.

Following the test day, animals were sacrificed and perfused with 10% formalin. Brains were sectioned at 50 microns and electrode placements verified. The electrode tip of animal No. 0210 was found to be on the margin between the medial septal nucleus and the nucleus acumbens, and that of animal No. 24 was located in the diagonal band of Broca. Due to an accident, we were unable to confirm the placement of animal No. 10.

Results

All animals succeeded in meeting the criterion at every delay interval tested. There were no errors for any animal at any time during the testing days. In view of the fact that the behavior of all three animals was highly stereotyped, it may be interesting to look at some of the behavioral observations made.

During the early trials, when the delay was less than 10 sec., the animals became quite excited when their path was blocked. Attempts were made to push the door aside and occasional jumps were made in an attempt to hurdle the barrier. For intervals over 10 sec., however, the animals merely stopped at the barrier and waited. It is interesting to note that none of the animals turned back to the deactivated bar, even on the extremely long delay trials. The animals remained oriented toward the light at all times. The sound of the opening door resulted in an immediate alerting of the animals. Each S made his first press within 5 sec. on every trial. Animal No. 0210 seemed to sleep during the 20-min. wait. The sound of the opening door alerted him and his subsequent latency was less than 5 sec.

Discussion

The results indicate that Deutsch's notion of drive-decay is not sufficient in itself to account for the extinction of electrical self-stimulation behavior. Deutsch & Howarth (1963) state ".....when the electrical stimulus is switched off, extinction is extremely rapid, taking only a *few seconds* ." (Italics ours.) Our results indicate that this statement is, at best, of limited generality. It appears that the method of training (in this case gradual delay training with a discrimina-

tive stimulus) can greatly affect the course of extinction (of self-stimulation).

It is interesting to note the similarity of the behavior patterns exhibited by our animals on the early delay trials with the behavior reported by Deutsch & Howarth (1963). When first delayed, the animal struggled considerably. Training seemed, in our study, to eliminate this excitement from the animal's behavior patterns.

Work is now under way in our laboratory to test for the generality of our finding. We are about to investigate this phenomenon with larger increments between intervals of delay in order to determine if small steps are critical for the establishment of long delays. Finally, animals will be run to test the upper limit of this effect. It would be interesting to see how long an animal can be separated from ESB and still demonstrate motivated behavior.

References

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Notes

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