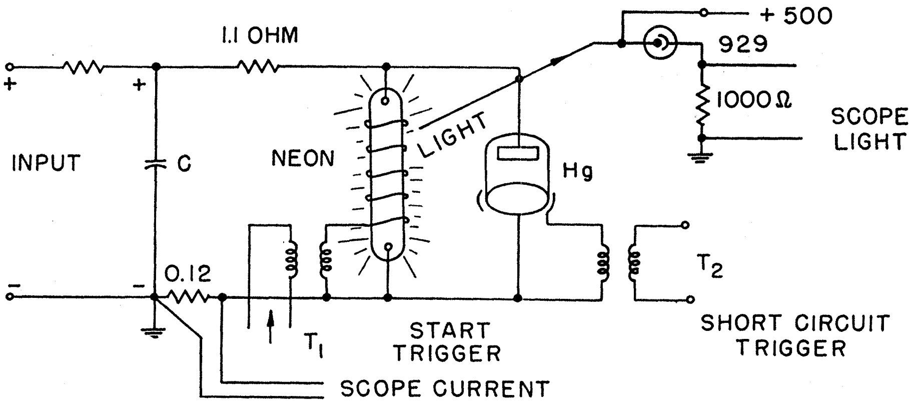

Fig. 1. Circuit used to study afterglow effects in gas discharges.

ing of the density of the gas in the cylindrical glass bulb.

Figure 1 shows a circuit used for studying the afterglow effects in gas discharges whereby the electrical excitation is suddenly extinguished at any desired condition of a capacitor discharge. With argon, krypton, and xenon gas, the light decreases suddenly to a low value and then decreases at a much slower rate to zero. However, with neon gas the light *rises* when the discharge is short-circuited under conditions described.

The neon tubes used in the experiment were cylindrical, about 33 cm long, and slightly less than 1.2 cm in inside diameter. They were filled with neon at various pressures from 5 to 20 mm-Hg, according to neon sign-tube pumping practice. The lamps were flashed by discharging a charged capacitor into them. In mid-flash they were shorted by the triggered breakdown of a low-impedance mercury arc tube (1 inch in diameter and 5 inches long) in parallel with the flash tube. The short circuit was arranged at any desired time after the start of the flash by a variable delay circuit which triggered the mercury tube into conduction after the elapsed delay time. In this manner the short circuit could be made to occur at any time between 10 and 1000 μsec after the start of the flash.

The light was studied by means of a phototube (type 929, with a type S-4 surface) with 500 volts on the plate and a 1000-ohm load resistor to insure a linear light-voltage relationship.

In every case of a shorted neon flash the light intensity increased momentarily at the instant the circuit was shorted. This was true whether the short circuit occurred at the beginning of the flash or at the end. The light from the mercury tube was shielded from the phototube.

Figure 2 shows light from a normal neon flash lamp when flashed from 50 μf charged to 900 volts (broken curve). Superimposed are a number of other light curves which were each obtained when the neon lamp was short-circuited at a different time. The solid lines show what happened to the light intensity subsequent to the instant of the short circuit. For each shorted flash, the light intensity followed the broken curve up to the instant of the short and then followed the solid curve.

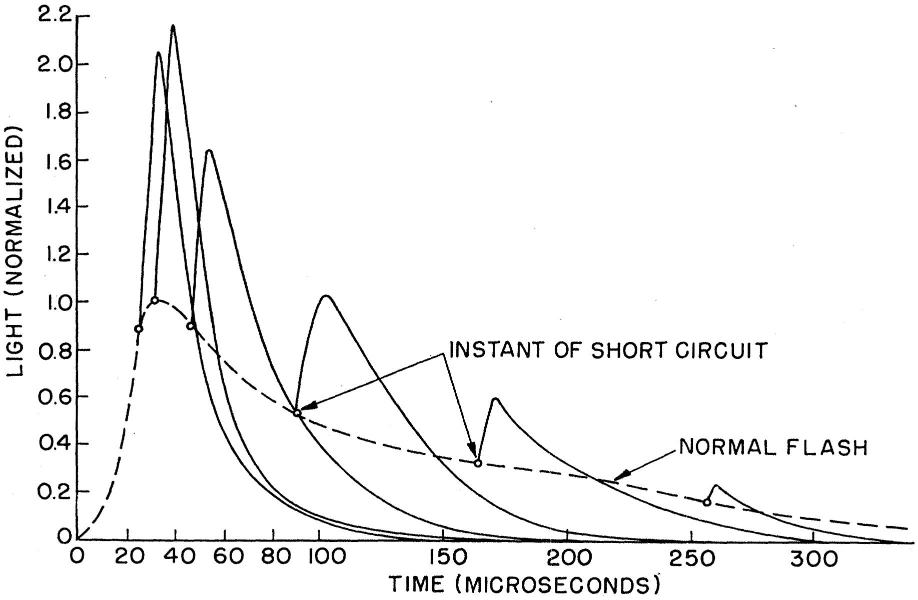

Fig. 2. Effect of short-circuiting on the intensity of light from a neon flash lamp. Broken curve, light intensity before the short; solid curves, light intensity subsequent to the short.

It can be seen from the figure that a short circuit occurring near the time of a normal intensity peak resulted in a light pulse of about twice the normal intensity and one-third the normal duration.

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Drive Decay: The Cause of Fast "Extinction" of Habits Learned for Brain Stimulation

Abstract. According to Deutsch's theory of intracranial self-stimulation, cessation of responding after the withdrawal of the stimulus should be a simple function of time without stimulation. To test this prediction, the lever was withdrawn from a Skinner box for varying times, then replaced and normal extinction completed. The number of extinction trials was a simple function of the time the lever was out of the box, thus confirming Deutsch's hypothesis that cessation of responding in this instance is due to a decay of a motivational excitation produced by the electrical stimulation, and not a function of the number of unreinforced trials as in normal extinction.

Lever-pressing habits learned for electrical stimulation of the brain differ from the more familiar forms of lever pressing in three ways (*1*). First, the rates of lever pressing are extremely high; secondly, the habits show almost no satiation; and thirdly, they apparently extinguish extremely quickly when the electrical current is switched off. To explain the second and third, Deutsch's theory (*2*) predicts that the electrical stimulus must act on both the drive and

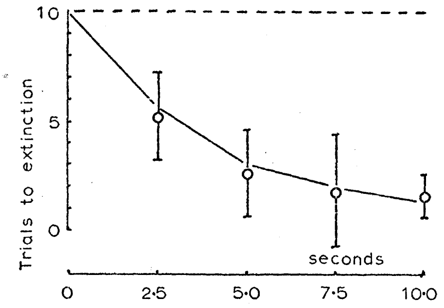

Fig. 1. The average effect of lever withdrawal on five animals. The solid line shows the prediction from Deutsch's hypothesis. The dotted line shows the prediction from the hypothesis that extinction is a function of the number of unreinforced trials. The circles are the experimentally observed effects of lever withdrawal.

reinforcement pathways. Hence the electrical stimulus will reinforce a present lever press and simultaneously motivate future ones. On this hypothesis the habits are resistant to satiation because each stimulus increases rather than decreases the drive state of the animal, while the fast extinction is due to the decay of the drive state when the electrical stimulus is switched off.

It seemed that the simplest way to test Deutsch's hypothesis lay in its prediction that extinction should be a simple function of time since the last electrical stimulus and would be independent of the number of unreinforced lever presses occurring in that time. This prediction is in marked contrast to extinction of the more usual kinds of lever-pressing habits which are very little affected by a time interval between training and extinction (*3*) and which extinguish more quickly with massed rather than spaced trials (*4*).

Our first experiment was simply to remove the rats from the lever by hand. At first they struggled to return to the lever, but after about 20 to 30 seconds they ceased to struggle and when released showed no inclination to return to the lever.

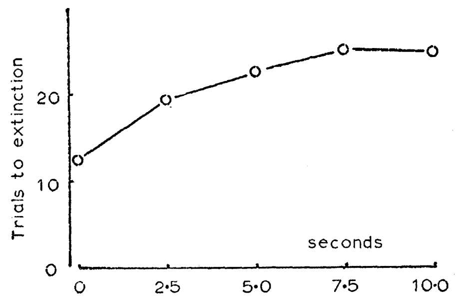

Fig. 2. The number of lever presses to extinction increases as a function of the duration of an increment in stimulus intensity.

In a second experiment, we attempted to measure the speed of extinction a little more precisely. We used six male Sprague-Dawley animals which had been used in a previous experiment (*5*). After further training we compared their extinction under two conditions, one of normal extinction and one in which the lever was removed from the box for 7 seconds before the extinction trials started. Our prediction was that the number of lever presses to extinction under this condition would be the same as the number of lever presses occurring after 7 seconds of normal extinction, and that the animals would stop responding at the same time in both cases. The average figures for ten trials in each condition on six animals were 1.92 and 1.87 lever presses and 11.4 and 10.1 seconds.

In our third experiment we took five experimentally naive male albino rats of the Sprague-Dawley strain, three with tegmental electrodes and two with hypothalamic electrodes. They were trained to press the lever for a minimal electrical stimulus. We then compared their performance under normal extinction with extinction after the lever had been removed from the cage for 2.5, 5.0, 7.5, and 10.0 seconds immediately before the extinction trials. The conditions were given in a balanced order. For each animal we measured the number of lever presses during normal extinction which occurred more than 2.5, 5.0, 7.5, and 10.0 seconds after the electrical stimulus was switched off. These figures we treated as predictions of the number of lever presses to extinction after 2.5, 5.0, 7.5, and 10.0 seconds of lever withdrawal. The results are shown in Fig. 1. Again the data fit very well the hypothesis that extinction under these conditions is a simple function of time since the last electrical stimulus to the brain, and flatly contradict the alternative hypothesis that extinction is a function of the unreinforced lever presses.

Since the extinction curves plotted as in Fig. 1 can be considered to reflect the decay of some drive process, we attempted to get a comparable measure of the growth of the same process. To do this, we investigated in a single animal the effect of the duration of an increase in the stimulus intensity on the number of lever presses to extinction. Instead of removing the lever from the cage prior to the extinction trials, we now increased the intensity of the stimulus by 50 percent for intervals of 2.5, 5.0, 7.5, and 10.0 seconds, before starting the extinction trials. The results are shown in Fig. 2. The number of lever presses to extinction increases with the duration of the higher intensity of stimulation in a way which resembles the form of the decrease shown in Fig. 1.

A speedy cessation of a habit maintained by electrical stimulation of the lateral hypothalamus has been found by Wyrwicka *et al.* (*6*). In their experiment the habit was learned for a food reward and its subsequent evocation by stimulation of the lateral hypothalamus can only be attributed to a motivational effect of the stimulation. Also, in this case the food reward was still available so that the cessation of the habit can only be explained by a swift reduction of the hunger drive when the stimulation stops (*7*).

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7. This study was wholly supported by U.S. Public Health Service grant M-4563 and National Science Foundation grant G 21376, while one of us (C.I.H.) was a special fellow of the NIH. We are greatly indebted to Dr. D. A. Hamburg for help and encouragement.

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Transportation of Oyster Drills by Horseshoe "Crabs"

Abstract. Horseshoe "crabs" (*Limulus polyphemus*) collected in New Haven Harbor, Long Island Sound, had large numbers of oyster drills attached to them. Since these animals migrate long distances, they may be important distributors of oyster drills.

Attempts to protect shellfish beds from predaceous gastropods, *Eupleura caudata* and *Urosalpinx cinerea*, by removing the predators by mechanical (*1*) or chemical (*2*) methods may be only partially effective because these gastropods can reinvade the beds. For example, benthic arthropods may carry these gastropods back into cleared areas. The first record of phoresy of oyster drills on benthic arthropods was