The effect of spreading depression on a simple discrimination task

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The effect of spreading cortical depression on a simple discrimination situation in which the behavior was maintained by secondary cues previously paired with intracranial electrical stimulation was studied. It was concluded that bilateral spreading cortical depression blocked the ability of Ss to learn due to interference with association rather than with motor performance.

Depression of spontaneous electrical activity of the cortex has been shown to interfere with learning. Instrumental responses are degraded when bilateral spreading depression is chemically or mechanically induced (Olds & Travis, 1960; Rudiger & Fifkova, 1963). However, poor performance in a learning situation could not unequivocally be attributed to the S's inability to learn due to cognitive impairment since cortical depression prevents the expression of overt motor behavior. Bilaterally depressed animals were observed to crouch in a corner of the cage unless stimulated with a strong unconditioned stimulus. Conditioned stimuli elicited no responses (Olds & Travis, 1960). It was impossible, therefore, to assess a S's ability to learn under those conditions with instrumental behavior as a dependent variable.

The present study was designed to investigate the effects of spreading depression on learning in a situation where an instrumental response conditioned during spreading depression could be expressed in the absence of spreading depression.

Method

Six albino rats of the Purdue-Wistar strain were implanted with stainless steel bipolar electrodes according to the method of Valenstein, Hodos, & Stein (1961). The electrodes were placed into the median forebrain bundle as later sectioning and staining demonstrated. Two 5 mm openings were trephined to expose the parieto-occipital cortices without injuring the dura mater. These openings were maintained by securing polyethylene nuts over the openings with screws and dental cement. These were closed to the atmosphere by placing stainless steel bolts in the nuts.

After recovery from the surgery, Ss were trained to bar press for electrical stimulation until a stable rate for bar pressing was achieved. The bar press rate ranged from 25 to 55 per min., and each bar press resulted in a stimulus train of 0.5 sec. duration. Stimulus intensity ranged from 20 ma to 35 ma. Following training and stabilization, Ss were placed in a neutral gray start box from which they could enter a white or a black chamber. Each S was in this choice situation for a period of 5 min. and the time spent in each chamber was recorded. Ss were then removed and cotton pledgelets soaked in 2% KCl were placed in the cortical cannulae (Leao, 1944). Ss were then placed in the chamber which they least preferred in the previous choice situation and were then stimulated by the experimenter at the same rate they had previously bar pressed. The stimulation by E lasted for a period of 20 min. Ss were then removed and allowed to recover from the KCl induced spreading depression. Following recovery they were placed in the gray start box again and were allowed to enter either of the chambers. The time spent in the selected chamber was recorded.

Results

Figure 1 shows the total amount of time Ss spent in the least preferred chamber before and after electrical stimulation in that chamber. It can be seen that the control group increased the amount of time spent in the initially least preferred chamber ($F = 7.05$, $p < .05$) while the experimental group did not increase the amount of time spent in that chamber ($F = 0.00$).

Discussion

The results demonstrate that the control Ss were able to associate the chamber brightness cues (black or white) with the positively reinforcing electrical stimulation. This was shown by the significant increase

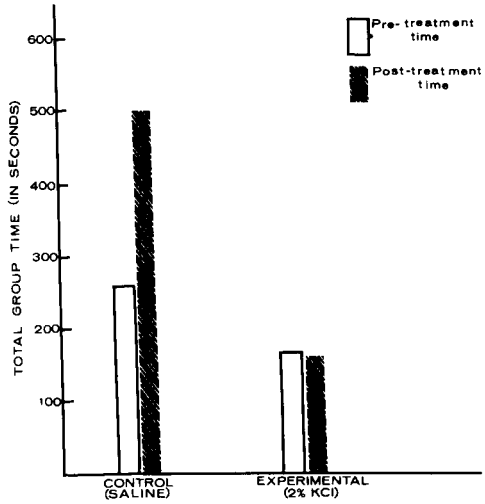

Fig. 1. Pre- and post-treatment time spent in least preferred chambers by KCl and saline treated groups.

in amount of time spent in the chamber in which they were stimulated when after the stimulation they were again allowed to make a choice between the two chambers. The experimental group did not show an increased preference for the chamber in which they were stimulated.

The results indicate that Ss in the experimental group were not able to learn or possibly remember the association between brightness and electrical stimulation. Since the measure of learning was not taken during the course of spreading depression, the conclusion that spreading depression interrupts learning at the "cognitive" level rather than at the "motor" level seems justified.

References

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Note

1. This report is based on a thesis submitted to the faculty of Purdue University in partial fulfillment of the requirements for the M. S. degree.