Drug Effects on Lever Positioning Behavior

Abstract. A technique is described for generating a continuous lever positioning response in the rhesus monkey. The effects of several drugs on this behavior were studied.

As part of a research program concerned with the development of an automated motor assessment test battery for use with primate subjects, we have devised a technique for generating a lever positioning response in the rhesus monkey. Our aim was to obtain a quantitative index of muscle steadiness and fatigue that would perhaps be sensitive to the effects of drugs, ionizing radiations, and other biologically effective variables. Also, we felt that some of the properties of lever positioning were of interest in their own right, since the continuous nature of this behavior distinguishes it from such discrete responses as lever pressing and key pecking, and such discrete response measures as rate, latency, and duration.

The subjects for the initial phase of this experiment were three rhesus monkeys maintained in restraining chairs. Crackers and water were continually available to them. Each chair was fitted with a lever positioning device placed at waist level within easy reach of the animal's outstretched arm. The lever was an aluminum rod, ¾ inch in diameter and 4½ inches long. It could be moved through an arc of 72° along the animal's midline. The lever housing (a 3- by 5-inch aluminum chassis) was continually electrified to prevent the subject from resting or bracing its arm or paw during test sessions.

In the experiments to be described, each subject was tested for 1 hour each day. A red flashing light was on during test sessions and off at all other times. By means of a 0.25-megohm potentiometer connected to the lever, and a Varian recorder, a continuous record of the lever position through time was obtained.

During the first 10 days of training, each monkey was continually shocked as long as the lever was located within 24° of the resting position. (The lever was closest to the animal when in its resting position.) If the subject moved the lever to any point more than 24° away from the resting position, that is, between 24° and 72°, the shock was turned off and remained off as long as the lever was held within this region. By means of a cable, pulley, and weight (0.9 kg) system, the lever, when released, would return to its resting position. Thus, the subject could avoid shock only as long as it held the lever within the 24° to 72° region. Each subject learned to correctly position and hold the lever within the first 30 to 60 minutes of training and each remained virtually shock-free throughout the next 10 sessions. The contingencies for shock avoidance were then changed. During the next 3 months of training, the subjects could avoid shock only by positioning the lever more than 24° but less than 48° from the resting position; that is, between 24° and 48°. Movement of the lever into either the 0° to 24° or the 24° to 72° regions now produced shock. The subjects again learned to correctly position and hold the lever within the first two to three training sessions and each remained virtually shock-free thereafter. A typical record from this base-line determination period is shown in Fig. 1. Fluctuations in the base-line curves were generally negligible, and each subject usually held the lever within 2° to 3° of the center position throughout the hour-long session. (A point 32° from the resting position was taken as the center or "zero" position. The subject was thus shocked whenever the curve exceeded ± 12°.)

The following data were obtained from a single subject. By increasing the weight load on the lever to 4 kg, the "heavily weighted lever" curve of Fig. 1 was obtained. A recurrent pattern of slow release of the lever to the point where shock was received, followed by a rapid recovery to a "safe" position can be seen. Similar effects were obtained after intramuscular (IM) injections of either Nembutal or lysergic acid diethylamide (LSD). These curves differ mainly in the rate of recurrence of the release and recovery pattern, although it is possible that such differences are due mainly to the particular dosage values used. An IM administration of Benzedrine produced a series of spindly curves toward the end of the session, which are interpreted as an increase in muscular tremor. The slow

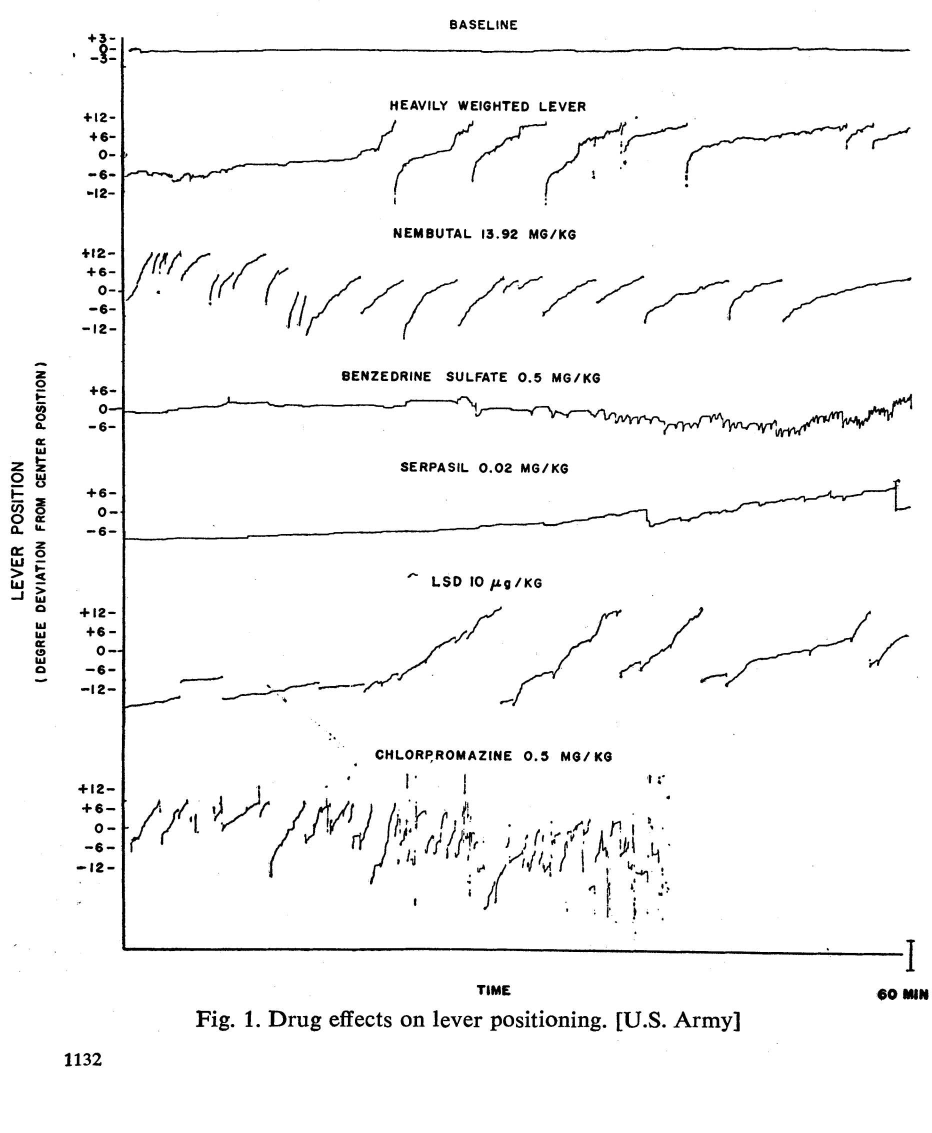

Fig. 1. Drug effects on lever positioning. [U.S. Army]

drift in the Serpasil (IM) curve may indicate a fatigue effect or perhaps a partial extinction of the avoidance response due to the tranquilizing properties of this drug. The chlorpromazine (IM) run, which was characterized by an extremely rapid rate of release and recovery, was stopped after approximately 45 minutes because of the large number of shocks the animal was receiving. Each curve was obtained approximately 15 minutes after drug administration, and at least 2 weeks intervened between drug administrations. The curves shown here represent the second or third determination for each drug. Good reproducibility of each drug effect was obtained in all cases.

It is clear, then, from the data for three subjects, that the lever positioning response is easily conditioned and quite stable. The data from one subject indicates that this measure is at least partially sensitive to factors known to produce fatigue and tremor, and appears to differentiate among several classes of drugs. In addition to exploring the effects of other drugs on lever positioning, future research will focus on dose-response relations and drug interactions with such behavioral variables as the orientation and physical characteristics of the lever, the width of the "safe" region, and the probability of being shocked for incorrect positioning.

ROBERT CLARK
JAMES A. JACKSON
JOSEPH V. BRADY
Department of Experimental Psychology, Walter Reed Army Institute of Research, Washington, D.C.

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Punishment Inhibits an Instrumental Response in Hooded Rats

Abstract. Punishment led to the cessation of a food-rewarded bar-pressing response in hooded rats deprived of food for 23 hours. The response remained inhibited for 2 weeks, and only one of four rats resumed responding when food deprivation was increased to 47 and 71 hours.

Recently Appel (*1*) reported an experiment in which punishment of squirrel monkeys led to the lasting cessation of a previously well-learned bar-pressing response. Appel concluded that punishment has a stronger and more lasting effect on monkeys than on rats or pigeons, contrasting his findings with those of a study by Estes (*2*). In Estes's study the most severe condition consisted of administering shocks to the rats for every bar press during the first hour of extinction; responding was diminished but did not cease. Estes's study has led to the widespread impression that punishment only temporarily reduces the tendency to make a response, especially when the response is necessary to fill a strong need (*3*). Using pigeons, Azrin (*4*) found that punishment contingent upon each response tended to reduce responding maintained by food reward. However, with continued punishment, response rate recovered to an extent dependent upon intensity of shock. Only when very severe shock was employed did responding cease. In view of Azrin's findings and those of Appel, we feel that Estes's failure to obtain cessation of responding may have been due to an insufficient number of punishment trials or insufficiently severe punishment to produce an aversive habit strong enough to predominate over the bar pressing which had been rewarded by food. To test whether bar pressing for a food reward can be eliminated in rats by punishment of the response, an approximate replication of Appel's experiment was performed with hooded rats.

Table 1. Summary of results of experiment in which hooded rats learned a response to obtain food, the response was inhibited by punishment, and the inhibition persisted when the punishment was removed and the rats were retested after being deprived of food for varying periods of time.

Rat No.	Responses during practice		Responses during punishment (total)	Reinforcements during punishment	Responses during retest after food deprivation of			Reinforcements during retest (total)
	Mean	On 4th day			23 hr	47 hr	71 hr	
1	425	420	6	4	1	425	345	23
2	626	594	10	9	0	0	2	2
3	285	141	13	3	32	0	4	7
4	547	429	2	2	0	1	0	1

After 22 hours of food deprivation, four hooded rats were trained in a Skinner box to associate the click of the food magazine with reinforcements of 0.05-g spherical pellets. The rats then learned to press a bar to obtain pellets, and they were maintained on continuous reinforcement for the remainder of the 1-hour session in which this took place. This was followed by 4 days of gradually lengthening fixed-interval schedules until the rats responded regularly on a 4-minute fixed-interval schedule. The rats were fed for an hour in their cages after each day's session, and water was continually available in the cages. After four 1-hour daily sessions on the 4-minute fixed-interval schedule, punishment was introduced on the fifth day with the same reinforcement schedule effective. The punishment was contingent upon each bar-pressing response. It consisted of 1-ma electric shocks delivered through the grid floor; the duration of shock was 100 msec for three of the rats and 500 msec for the fourth. Punishment was continued until no bar pressing occurred during a full 1-hour daily session. This criterion was reached in a maximum of 4 days and a maximum of 13 punishments. The rats were not run again for 14 days, during which the 1-hour-per-day feeding schedule was continued. Then, after 23 hours of food deprivation, the rats were placed in the box for 1 hour with the 4-minute fixed-interval schedule in effect. There was no punishment for responding. The rats were tested again the next day after 47 hours of deprivation, and after 71 hours of deprivation the following day.

As seen in Table 1, while the rats had pressed the bar on the average of 470 times an hour on the 4-minute fixed-interval reinforcement schedule, they required very few punishments to cease responding altogether—only two for rat No. 4 which had received 500-msec shocks. After 2 weeks of rest, they produced virtually no responses after 23 hours of deprivation even though the first response was rewarded by food. (The 32 responses by rat No. 3 consisted of bursts produced by leaning on the bar four times—the only responses during the hour.) The difference between the mean number of responses per hour before punishment and the mean number in the first hour 14 days after punishment is highly significant ($t = 5.7$; $p < .001$). In the absence of punishment, it is highly unlikely that responding would have virtually ceased in 14 days. Skinner (*5*) found that a learned operant endured for 4 years without intervening practice.

Even under conditions of severe food deprivation, three of the rats did not commence to press the bar for food