

water. No other interpretation appears possible.

This interpretation explains not only all of our results but also some results of the earlier workers which heretofore have not been adequately explained. To cite just one example, the observation that the differentiation of cysts in 16 drops of active blood was greatly enhanced above the value obtained for the same number of cysts in two drops can be interpreted as simply a consequence of the larger amount of water available (5).

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Punishment in the Squirrel Monkey *Saimiri sciurea*

Abstract. Punishment has been found not only to suppress the rate of a food-maintained operant response in the squirrel monkey under conditions of high deprivation but to inhibit the emission of that response for 50 days (400 hours) after the punishment has been withdrawn.

Since the publication of Estes's "An Experimental Study of Punishment" (1), the effects of presenting a severely aversive stimulus, such as a strong electric shock, contingent upon the emission of a response have been generally regarded as temporary. When shocks were of such an intensity as to completely suppress the rate of bar-pressing in the rat, Estes found that recovery occurred when the punishing stimulus was withdrawn. Recently, Azrin (2) found that during prolonged exposure to punishment the rate of a pigeon's key-pecking in the presence of shock returned to a level comparable to that observed before the introduction of punishment. In pigeons subjected to very severe current intensities, however, Azrin (3) reported recovery only about 12 days after the shock had been removed.

Little is known about the effects of

punishment on the behavior of higher organisms, such as the monkey, although a considerable amount of research on a related phenomenon, conditioned suppression, has been reported, most recently by Brady (4) and Sidman (5). In this experiment I used a technique similar to that of Azrin, with squirrel monkeys as subjects, in an attempt to extend the earlier findings to a wider variety of species (6).

Two experimentally naive, adult, short-haired squirrel monkeys (*Saimiri sciurea*) were starved to 80 percent of the body weights they had had on a free-feeding regimen and were then conditioned to press a lever for food rewards. During the initial stages of training every response was reinforced; later, responding was reinforced intermittently, with mean intervals of first 1, then 3, and finally, 6 minutes between rewards (VI-1, VI-3, and VI-6). After the rate of response had been stabilized on the VI-6 schedule, the experiment was begun. Table 1 summarizes the procedures and results.

Each daily session lasted for 8 hours, so that, although the number of animals available was small, a considerable amount of data were gathered (560 hours for each monkey). On days 1 to 7 the subjects were run on the VI-6 schedule; no punishments were given. During this period an average of 2846 responses were made each day by monkey No. 19 and 2246 by monkey No. 20.

On day 8 the punishment procedure was instituted. After each response, an electric shock of 1-ma intensity and 500-msec duration was given through a grid floor, through the walls of the box in which the monkeys were run, and through the lever. The number of responses in 8 hours was 65 for monkey No. 19 and 29 for monkey No. 20. During the next 11 days the same procedure was in effect, and the number of responses fell to an average of nearly one per day for both animals. This means that the monkeys obtained virtually no food for 8 hours; their weights therefore declined rapidly (as mentioned above, the monkeys were at 80 percent of their normal weights before the experiment began). The weights were allowed to fall an additional 100 g (to 60 percent of normal) before the animals were given food in their home cages, to prevent death and in order to continue the experiment. Punishment was withdrawn on the 20th day, and during succeeding sessions the mean interval between reinforcements was decreased. There was no recovery in the rate of response during the next 50 days (400 hours); then the experiment was terminated.

The monkeys, after punishment was instituted, and thereafter, showed an

Table 1. Summary of procedures and results. CRF, every response reinforced.

Schedule of reinforcement	Punishment condition	Mean No. of responses per session	
		Monkey No. 19	Monkey No. 20
VI-6	Days 1-7 Off	2846	2246
VI-6	Day 8 On	65	29
VI-6	Days 9-19 On	1.4	0.9
VI-6	Day 20 Off	0	0
VI-1	Days 21-34 Off	1.3	0
VI-1/2	Days 35-55 Off	0.8	0.6
CRF	Days 56-70 Off	1	0.9

unwillingness to enter the experimental chamber and what could probably be described as "fearful" behavior when they were finally placed in the box. They would crouch in the corner farthest from the lever and would remain there during the entire session. This behavior persisted throughout the 50 days from the termination of punishment until the end of the experiment.

It would appear that the squirrel monkey does not recover from the effects of punishment as do the pigeon and the rat. However, this is not certain, since there were differences other than that of species between the conditions of the study reported here and conditions of the studies of Estes and Azrin—for example, differences in shock intensity and duration, method of presentation of shock, and frequency of food reinforcement. It does, however, seem reasonable to suppose that the monkey may be more sensitive than the pigeon and may therefore be more like man. If this is correct (and further research is needed before any definite conclusions are drawn), severe punishment may have the effect not only of eliminating any desired response but also of permanently inhibiting adaptive behavior in higher organisms.

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