

NONCONSUMPTION OF THE REINFORCER UNDER DRUG ACTION

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Cats were trained to respond on a multiple discriminative schedule, with milk as reinforcement. Two subjects did not immediately consume the reinforcer when they were injected with 6 mg of methylphenidate before the experiment. This observation could be repeated in one of the subjects under various conditions of reinforcement and various doses of the drug. Control experiments showed that under normal conditions the same cats never ignored the reinforcer. The modification induced by the drug in the relationship between behavior and the reinforcement is discussed in its bearing on the notion of reinforcer.

In a paper on the effects of drugs on positively reinforced behavior, Dews (1956) mentioned that a pigeon injected with 3 mg of methamphetamine did not consume a food reinforcer during the FR component of a multiple FI 15 FR 60 schedule. Although Dews had observed this fact on only one occasion, it was worth mentioning because of its bearing on the relationship between the reinforcer and behavior. A similar effect was observed in a more dramatic way in cats undergoing a series of experiments on the modification of behavior by an excitant drug (Faidherbe, Schlag, & Richelle, 1961).

METHOD

From a group of five cats, two (one female and one male, No. 4 and No. 6) did not immediately consume the reinforcer. The data for these cats will be considered here. Cat 4's normal body weight is 2.500 kg, and Cat 6's normal body weight is 2.900 kg. During the experiment, the cats were maintained at about 90% of their normal weight. Their diet consisted of the milk they received as reinforcement during the experimental session; however, on weekends, they were given an equivalent amount of milk, plus 75 g of boiled meat.

The operant-conditioning equipment provided for a positive reinforcer (2 ml of milk) delivered through an electromagnetic tap into a milk tray, where it remained permanently available to the subject. The selected response

was introducing the forepaw into a cubic hole cut in the wall of the cage. This response opened a circuit by interrupting a ray of light projecting on a photocell. The experimental cage was in an isolated room, and the cats were observed through a one-way window. Responses and reinforcements were recorded on a cumulative recorder.

After preliminary shaping and reinforcement on CRF and a small FR schedule, the five cats were put on a multiple discriminative schedule in which an auditory stimulus (S^D = weak buzzer) signaled the end of a 75-sec interval (or S^A) and remained on until the response was given. Thus, responses in S^A were ineffective; the reinforcement was delivered, and S^D terminated after one response in S^D . The maximum number of reinforcements was obtained for a minimum number of responses when no responses were emitted in S^A and the latencies of responses in S^D were negligible.

During the first month, a series of three or four daily sessions (2 hr each) without drug alternated with a similar series of sessions in which the cats were given a subcutaneous injection of 2 mg of methylphenidate immediately before the experimental session.² After an interruption of 4 weeks, the subjects underwent a series of 15-18 1-hr daily sessions. On the day following this last series, two cats were injected with 6 mg of methylphenidate. However, they did not consume the reinforcer. We then attempted to reproduce and to analyze some aspects of the phenomenon in a series of

¹Methylphenidate was kindly supplied by CIBA as "Rilatine" (European trade name).

²(methyl α -phenyl-2-piperidineacetate)

about 30 sessions, including a few test sessions with various doses of the drug, controls under experimental extinction and satiation, and change from the multiple schedule described to an FI 75 sec schedule.

RESULTS

Table 1 is a summary of the experimental program and results. For each session with drug, it shows the number of responses (R), the number of reinforcements (Rf), and the number of these reinforcements which were not immediately consumed (Rf not im. cons.). Figures are given for the first hour and also for the whole session, since test sessions were sometimes prolonged beyond the usual 1 hr. The number of responses and reinforcements in the last session of a series before the test session with drug are given for comparison.

Experimental Series 1

In a report of the first part of this experiment, individual differences in behavioral reactions to the drug were emphasized (Faidherbe, Schlag, & Richelle, 1961). The two cats considered here showed a highly stable behavior. The effect of the drug (at the 2-mg dose) was slight, and interfered very little with the regular responding at the onset of S^D. The number of responses in the interval remained low, although in other animals the drug induced an increase of responding in S^A and a

change in the regular pattern of responding in S^D.

When injected for the first time with the large dose of 6 mg, Cat 4 responded as regularly as before at the onset of S^D, but ignored most of the reinforcements (50 out of 85). Cat 6 ignored 24 of the 50 received in a 1-hr session, and showed a marked increase in the number of responses in S^A.

This particular effect of the drug could not be reproduced in Cat 4 in any of the subsequent series of experiments (FI 75 sec and mult). During all test sessions, this cat showed a generalized agitation which totally excluded the conditioned response.

Experimental Series 2

Cat 6 did not consume the reinforcer in each test session of a similar program. In Condition 2, the typical FI pattern broke down when 6 mg of the drug was injected. This cat sustained a high rate of responding throughout the session, and ignored two reinforcements.

Experimental Series 3

After returning to the discriminative procedure, Cat 6, injected with 8 mg, made most responses in the presence of S^D and obtained 41 reinforcements within the 1-hr session. However, this cat consumed only 5 reinforcements during the interval preceding the next S^D. Before the cat finally drank the major part of the milk, 26 reinforcements had accumu-

TABLE 1
Summary of the Experimental Program

Exp. Series	Schedule	Cat. No.	Number of Sessions	Last Session Before Test with Drug		Test Session with Methylphenidate						
				R	RF	Dose (mg)	Duration	First hour		Whole Session		Rf not im. cons.
								R	Rf	R	Rf	
1	Mult	4	35*	40	36	6	1 hr 50 min	57	47	95	85	50
		6	38*	41	36	6	1 hr	237	50	237	50	24
2	FI 75 sec	4	13	70	21	6	1 hr	0	0	0	0	0
		6	14	130	41	6	1 hr	505	45	505	45	2
3	Mult	4	6	40	32	8	1 hr	0	0	0	0	0
		6	7	84	43	8	1 hr	88	41	88	41	36
4	Mult	4	12	68	40	4	2 hr 40 min	0	0	0	0	0
		6	7	136	48	6	4 hr 45 min	165	8	410	75	25
5	FR 5	6	5	280	56	5	2 hr 30 min	146	29	290	58	5

* Including 10 sessions with a 2-mg injection of methylphenidate.

lated. At the end of the experiment, about 30 ml was left. Intervals between responses were filled with agitated movements, contrasting with the quiet sitting usually observed in this animal under normal conditions on the same schedule.

Experimental Series 4

A small red light used as the S^D instead of the buzzer was inefficient in eliciting more than a few conditioned responses in Cat 6 injected with 6 mg, although this type of S^D had controlled the behavior perfectly well under normal conditions in several preceding sessions. In the same session, which was prolonged for 4 hr and 45 min, the cat resumed responding regularly when the buzzer was reintroduced. Regular responding was maintained for more than 1 hr and 20 min after the reinforcer was removed. The reinforcer was then reintroduced, and 50 reinforcements were received during the next hour. This makes the total number of reinforcements obtained during the session equal to 75, out of which 25 were not immediately consumed. The cat let a maximum of 8 reinforcements accumulate before drinking them, usually at the end of an interval.

Experimental Series 5

Finally, Cat 6 was injected with 5 mg before the last series of 5 sessions on FR 5. Out of 58 reinforcements, this animal did not consume 5 within the interval following the reinforced response.

Control experiments were run to show that removing the reinforcer under normal conditions leads to rapid extinction of the conditioned response, and that behavior cannot be maintained when the animal is satiated. Also, during sessions without drug, animals always consumed the reinforcement immediately.

CONCLUSIONS

The maintenance of conditioned behavior irrespective of the reinforcer cannot be explained by an effect of methylphenidate on hunger drive, because the effect was not similar when the cat was satiated. Moreover, part of the accumulated milk was generally consumed after it had been ignored during 2 to 26 intervals. Though under normal conditions the milk was always consumed immediately after responding, and removing the rein-

forcer led to rapid extinction, reinforcement was not essential to responding under drug. Therefore, the phenomenon observed here could not possibly be compared to a variety of hoarding behavior such as the one described by R. Myers (1960) in rats. At any rate, such hoarding behavior could not be related to any species characteristic of cats, although it is part of the species repertoire of the rat.

The discriminative stimulus might be said to acquire a secondary-reinforcer value. But why the drug should increase this value would remain unclear. In any case, this would leave unexplained occurrences of nonimmediate consumption of reinforcement on FR and FI schedules.

A simpler hypothesis can be made when not only recorded responses are considered but the whole activity of the subject continuously observed in the experimental cage. The drug generates a state of generalized excitation, in which a bit of behavior—whether it is a highly automatized conditioned response or anything else from the animal's natural repertoire, such as licking its paw, or moving its head forward rhythmically—tends to recur and repeat itself for a long time. When a discriminative stimulus is still perceptible to the animal in this state of excitation, and when a stable behavior has been previously established in response to that stimulus, the conditioned response is likely to occur in what might be called *perseverative behavior*, irrespective of the events usually controlling this response, such as presentation and removal of positive reinforcer. A highly automatized response must be required in order to obtain the effect described here since it could not be reproduced in Cat 4, although it was best observed in this animal after several weeks' working on the same schedule. Subsequent experiments involved changes of programming to which the cat adjusted slowly, probably never reaching within a few sessions of the same degree of automatization it had reached when the first high-dose injection was given. Cat 6 was a more "plastic" subject in the sense that its behavior changed appropriately from one program to another within 1 or 2 hr.

What maintains behavior in these circumstances remains to be solved. What is the reinforcing agent, if the experimentally arranged reinforcer is no longer acting as such? The question arises whether the name reinforcer is

still appropriate when dealing with a kind of behavior that appears as a discharge of the organism rather than as a response to the environment.

REFERENCES

Dews, P. B. Modification by drugs of performance on simple schedules of positive reinforcement. *Ann. N.Y. Acad. Sc.*, 1956, **63**, 268-281

Faidherbe, J., Schlag, J., and Richelle, M. Action différentielle d'un excitant nerveux central mise en évidence par une technique de conditionnement operant chez le chat. *Archives Internationales de Physiologie et de Biochimie*, 1961, **69**, 52-68.

Myers, R. Spontaneous hoarding during operant conditioning. *J. exp. Anal. Behav.*, 1960, **3**, 154.

Received June 13, 1961