

*VISUAL EXPLORATION AS REINFORCEMENT OF CONDITIONED
BAR-PRESSING RESPONSES OF MONKEYS*

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A number of problems arise when conventional reinforcers such as food and water are used in operant-conditioning research with monkeys. The animals usually must be deprived for some time before testing; and the rigorous maintenance of various deprivation schedules in large monkey colonies is often very troublesome, particularly if all the animals in an experimental group must be given test sessions consecutively (for example, at 1-hour intervals) rather than simultaneously. Moreover, mechanical reinforcement dispensers, especially those for food pellets, are notoriously subject to breakdown. The amount of reinforcement to be given is also difficult to vary with such equipment.

Satiation during the test session is another problem which arises when food and water are used as reinforcers; changes in motivation often interact with the effects of experimental treatments, so that these effects are more difficult to evaluate. Researchers studying the effects of drugs on behavior must, in addition, check the side effects of many compounds on hunger and thirst when they use food and water reinforcers.

Because of these problems, I looked for another positive reinforcer to use with operant-conditioning schedules. Others have shown (Butler, 1953; Butler & Alexander, 1955; Butler & Harlow, 1954) that rapid learning, sustained responding without satiation (for up to 20 hours), and remarkably stable day-to-day performances can be obtained from monkeys by using visual-exploration reinforcement; i.e., rewarding the animal for an appropriate response by allowing it to visually survey the environment outside a completely enclosed test cage. These effects, which could be obtained without deprivation of previous visual experience, suggested that visual exploration might be a convenient and effective reinforcer for the maintenance of response rates on various operant-conditioning schedules. Therefore, I made the observations reported in this paper.

METHOD

Subjects

Thirteen rhesus monkeys, approximately 1.5 to 3 years old, were the subjects in these experiments. They were divided into two groups: six animals were in Group 1 and seven in Group 2. The animals in Group 1 had had previous bar-pressing experience for a liquid reinforcement on an FI schedule before they were used here; but the Group 2 Ss had had no operant-conditioning training before this research.

Apparatus

All testing was conducted in a completely enclosed cubiform cage 2 feet in length, width, and height. This cage was located in a sound-shielded room into which 80-decibel white noise was introduced during testing. The inside of the cage was well-illuminated and ventilated. An entrance door was located on one side of the cage; and on the other side, a lever approximately 2.5 inches long projected from the wall adjacent to a 5-inch-square glass window. This window was covered on the outside by an opaque metal door which was opened and closed by a motor. The window faced a portion of the test room which was empty except for a small cage containing a monkey.

Reinforcement schedules were programmed automatically by means of steppers, timers, relays, etc., all located outside the test room. All responses and reinforcements were recorded on counters and a cumulative-response recorder.

Experimental Design

Group 1. The animals in this group were first given 19 sessions of training on an FR 10 reinforcement schedule. They were then shifted to a VI 60-second schedule for 16 sessions. After their performances had reached stable levels, they were given 12 sessions of training on a program of DRL 30 seconds LH 9 seconds. All test sessions were 1 hour; not more than one session was given to an animal each day; and a 10-second visual-exploration reward was used throughout these studies. Thus, if the monkey pressed the bar appropriate to the schedule, the metal door opened and the animal could visually explore the area outside the test cage for 10 seconds. The number of responses of each animal and the number of reinforcements received were recorded for every session.

Group 2. These monkeys were given ten 2.5-hour daily sessions, in which they could freely vary both the frequency and duration of visual-exploration reinforcement. The door opened whenever the bar was pressed, and it remained open until the bar was released. The monkey often continued responding while the door was opening, so that the number of responses exceeded the number of reinforcements each session. During each session, total responses, total reinforcements, and total duration of all reinforcements were recorded.

RESULTS AND DISCUSSION

Table 1 gives the performances of the monkeys in Group 1 on the 4th through the 19th sessions of FR 10 training, on the 16 sessions of VI 60 seconds, and on the first 12 sessions of DRL 30 seconds LH 9 seconds. (The data from the first three sessions have been omitted because various response-reinforcement ratios ranging from FR 1 to FR 10 were used, depending upon the performance of individual animals.) On both the FR and VI schedules the response rates were stable after the first few test sessions, and both response and reinforcement rates were large enough to be usable in practical research. For example, on the FR schedule the animals responded a mean of 899.9 times per session during the last ten sessions, and they received a mean of 72.4 reinforcements. During the last ten sessions of VI 60 seconds, the monkeys responded a mean of 802.5 times per session and received a mean of 50.9 reinforcements, so that they earned 84.8 per cent of the total possible reinforcements available in a 1-hour period. The subsequent reduction in the response rates of these animals as a consequence of the DRL schedule is apparent, as well as the gradual improvement in the ability of the animals to obtain reinforcement on this schedule. Table 2 shows the ranges and standard deviations of the total sessional responses of the monkeys on the three schedules at three stages of training.

Table 3 shows the number of responses of the Group 2 monkeys, and the amount of time they spent in visual exploration. Butler and Alexander (1955) had previously conducted a similar experiment. They reported that the monkeys spent approximately 40 per cent of their time exploring the environment (a monkey colony), and that this duration remained highly stable from session to session despite variation in response rate and in the number of reinforcements received. My results support Butler's and Alexander's findings, although my monkeys spent more of their time in exploration. This difference may be due to the relative absence of auditory stimuli in the test situation. I have observed that loud

Table 1
Performances of Group 1 Monkeys on Various Reinforcement Schedules

Session	FR 10		VI 60 Seconds		DRL 30 Seconds LH 9 Seconds	
	R	\bar{r}	R	\bar{r}	R	\bar{r}
1	—	—	3469.3	47.3	864.5	12.3
2	—	—	1933.3	45.7	856.8	14.2
3	—	—	1131.8	51.7	616.5	10.5
4	1371.0	104.0	1044.3	51.5	524.0	13.2
5	1388.0	100.7	908.2	51.3	475.3	14.0
6	1059.0	81.7	631.0	51.7	310.2	18.2
7	860.8	68.5	766.5	49.0	352.8	17.2
8	789.3	67.7	707.3	49.2	338.5	17.3
9	940.0	78.7	922.2	50.3	267.8	21.3
10	992.8	78.5	483.3	49.5	253.0	18.7
11	830.0	67.5	571.2	50.8	361.7	19.2
12	902.7	74.3	623.0	51.5	372.3	17.2
13	924.3	71.2	1005.7	51.8	—	—
14	833.8	70.3	1054.2	52.5	—	—
15	851.2	70.2	845.2	50.2	—	—
16	900.3	71.8	1158.5	54.2	—	—
17	875.0	69.0	—	—	—	—
18	933.5	72.8	—	—	—	—
19	955.2	78.2	—	—	—	—

R = mean number of responses

\bar{r} = mean number of reinforcements

Table 2
Standard Deviations and Ranges of the Total Responses Made by the Monkeys on Schedules FR 10, VI 60 Seconds, and DRL 30 Seconds LH 9 Seconds as a Function of Stage of Training.

Stage of Training	FR 10			VI 60 Seconds			DRL 30 Seconds LH 9 Seconds		
	Session	S.D.	Range	Session	S.D.	Range	Session	S.D.	Range
Beginning	4	446.6	841-1934	1	1766.0	1249-6179	1	396.4	392-1243
	5	762.2	659-2736	2	1197.5	607-3888	2	464.5	542-1417
Middle	11	494.2	316-1560	8	394.3	282-1214	6	147.0	116-500
	12	634.5	264-1702	9	1225.4	199-3394	7	185.1	164-609
End	18	601.7	614-2042	15	687.7	182-1868	11	200.6	85-591
	19	447.1	596-1797	16	935.5	241-2973	12	205.6	105-613

Table 3
Performances of Monkeys in Group 2

Session	Responses			Reinforce- ments	% of Session Spent in Exploration	
	Mean	S.D.	Range	Mean	Mean	Range
1	254.7	115.2	136-412	139.5	23.2	5.6-57.4
2	259.9	153.0	102-542	149.0	45.2	10.7-82.5
3	217.4	—	—	126.0	43.2	16.3-85.3
4	287.4	—	—	152.6	44.9	17.6-80.3
5	256.3	216.7	138-743	127.6	58.2	20.6-91.0
6	311.3	256.6	121-846	157.1	60.9	30.7-93.7
7	293.1	—	—	157.6	60.0	20.1-87.3
8	492.3	—	—	233.1	63.6	30.5-92.8
9	502.1	365.7	147-1113	238.3	57.0	26.8-92.4
10	716.7	589.5	163-1841	285.9	52.2	26.1-93.8

sounds, and particularly vocalizations of other monkeys, tend to reduce the monkey's visual exploratory behavior.

After these experiences with the use of visual exploration as a positive reinforcer, I believe that it has certain advantages over the conventional reinforcers of food and water. First, no deprivation is required to yield satisfactory response rates. Second, little or no satiation occurs within long test sessions or over extended periods of time in which many sessions are given. Third, there are fewer mechanical problems in presenting the reward to the subject. Also, the amount of reinforcement given to the animal is easily varied by changing the duration of the exploratory period with a timer. Finally, an important advantage relevant to psychopharmacological research may be the elimination of possible side effects of a drug on hunger and thirst which tend to obscure more important drug actions. More speculatively, investigatory motivations appear to be of especial significance in primate behavior. When such motives are used in the study of psychotropic drug effects, they may be much more relevant to human behavior than the so-called biological drives.

SUMMARY

The effect of using visual-exploration reinforcement in various operant-conditioning schedules was studied with monkeys. It was found that: The animals maintained satisfactory response rates on schedules FR 10, VI 60 seconds, and DRL 30 seconds.

When monkeys themselves were allowed to determine how much time they spent in exploration, they spent from 50 to 60 per cent of the test session looking out of the test cage. No evidence of satiation was found, either within or between sessions.

Visual-exploration reinforcement appears to have many advantages over the conventional reinforcers of food and water in operant-conditioning research with monkeys.

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