Effects of d-amphetamine on multiple schedule performance in the pigeon

DAVID A. GIBSON

UNIVERSITY OF ALABAMA

This study provided a systematic replication of the finding that the effects of d-amphetamine upon the operant behavior of pigeons trained to respond on a multiple schedule of positive reinforcement are largely determined by the control rate of responding.

The current literature reflects a changing emphasis in which the predominance of schedule contingencies is stressed over other controlling variables, such as motivation, in determining the modification of behavior by drugs. For example, there is now abundant evidence suggesting that the amphetamines have at least two general effects on behavior: if the control response rate is low, these drugs will increase the rate (Kelleher, Fry, Deegan, & Cook, 1961; Zimmerman & Schuster, 1962; Smith, 1964); by contrast, if behavior under control conditions occurs relatively frequently (Dews, 1958a; Kelleher et al, 1961; Smith, 1964), the amphetamines will decrease the overall rate of responding. Most of these studies have employed rats, monkeys and human Ss. What data there are available relative to the effects of the amphetamines on schedule performance in pigeons are congruent with data for other species (Smith, 1964).

The purpose of the present investigation was to provide a systematic replication (Sidman, 1960) of the differential effects of d-amphetamine on multiple schedule performance in the pigeon. The intention was to compare schedule components characterized normally by very slow and very rapid baseline rates of responding. An effort was made to cover the entire dose-effect range.

Subjects

Two adult Silver King pigeons (P-1 and P-2) of undetermined age and sex served as Ss. Both birds were experimentally naive at the beginning of the study and were maintained throughout at 80% of their free-feeding body weights.

Apparatus

The experimental chamber was a pigeon box of the type described in detail elsewhere (Ferster & Skinner, 1957).

Procedure

In three sessions of preliminary training, both Ss were successively adapted to the experimental chamber, magazine trained, shaped to peck an unlighted response key and given 20 reinforcements on a continuous reinforcement schedule. The reinforcing stimulus was a 3.5-sec. access to mixed grain. The schedule was then shifted to a multiple fixed ratio (FR)—dif-

ferential reinforcement of low rates (DRL). In the FR component, the 50th peck after the beginning of the component was followed by the reinforcing stimulus. In the DRL component, reinforcement was made available every 15 sec. but only if the S had not responded for 15 sec., i.e., whenever the bird waited for 15 sec. without responding, the next response produced reinforcement. Responses that occurred in the DRL component before the end of the 15 sec. reset a timer and reinstated the 15-sec. waiting period. The response key was transilluminated by a red light during the FR 50 component and by a green light during the DRL 15-sec. component.

The sequence of multiple schedule components was kept constant throughout the experiment; the sequence was (R equals fixed-ratio, D equals DRL) DRRD. Each daily session lasted until 40 reinforcements were presented or until the end of 3 hr. When inspection of the data indicated a stable day-to-day performance had developed, the dose-effect regimen was initiated. Dextro-amphetamine sulfate was dissolved in 0.9 percent sodium chloride solution and injected intramuscularly. The injections were made 5 min. prior to the experimental session. Each day on which the drug was given was paired with the preceding day on which the S was given a saline injection. The results on the latter days have been used for analysis of the "control" performance. Eight observations were made for each bird at each dose. Between successive drug injections, sufficient time elapsed for baseline patterns and rates of responding to be restored; a minimum period of three days was allowed to elapse. All doses are given

Fig. 1. Effects of d-amphetamine upon overall responses per minute during fixed-ratio and differential reinforcement of low rate components of a multiple FR 50 DRL 15-sec. schedule of food reinforcement. Rate changes are expressed as the ratio of the rate during the drug session to the rate during the preceding control session (output ratio). Each data point is an average of 8 experimental sessions.

Fig. 2. Effects of d-amphetamine on the averaged frequency distribution of inter-response-times for the two subjects in the differential reinforcement of low rates component of a multiple FR 50 DRL 15-sec. schedule of food reinforcement.

in terms of mg/kg (the weights of these birds were 410 and 417 gm for P-1 and P-2, respectively).

Results and Discussion

The stable performance was in accord with the description given by Ferster & Skinner (1957). Both Ss responded at a very low rate when the component was DRL 15-sec. and at a much higher relative rate when the component was FR 50. For bird P-1, the stable FR rate was 92 responses per minute and the DRL rate was 8 responses per minute. For bird P-2, the stable FR and DRL rates were 141 and 12 responses per minute, respectively. The saline injection was found to be entirely without discernible effect. Figure 1 shows the effects of d-amphetamine expressed as an "output ratio" or ratio of the overall rate after drug administration to the overall rate during the preceding control (saline) session. Doses of 0.3 mg/kg had no recognizable effect on the behavior. Following 1.0 and 3.0 mg/kg doses, there was a clear suppression of the high FR rate and an increase in the DRL responding. This

differential effect was particularly intensified by the 3.0 mg/kg dose which produced a 75% decrease in the FR response rate of bird P-1 and a 62% decrease in the FR response rate of bird P-2. Responding in the DRL component increased 34% for bird P-1 and 28% for bird P-2 at the 3.0 mg/kg dose. The 10.0 mg/kg dose completely abolished all responding in both components of the multiple schedule. It is apparent from Fig. 1 that the same range of doses produced comparable behavioral changes in both Ss.

A more detailed analysis of the effects of d-amphetamine on responding in the DRL component is presented in Fig. 2, which shows inter-response-time distributions averaged for the two Ss at three parameter values. The form of the distribution of inter-response times (i.e., the population of intervals between consecutive responses) is increasingly skewed to the right as a function of dose, with 3.0 mg/kg producing a peak in the first class interval.

In general, the present experiment replicates (for certain doses) the initial observation with regard to the effects of d-amphetamine on schedule performance in the pigeon and strengthens the broader generalization (Dews, 1958b) that the behavioral effects of this drug are dependent upon the initial control rate of responding.

References

- Dews, P. B. Analysis of effects of psychopharmacological agents in behavioral terms. *Fed. Proc.*, 1958a, 17, 1024-1030.
- Dews, P. B. Studies on behavior: IV. Stimulant actions of methamphetamine. *J. Pharmacol. exp. Therap.*, 1958b, 122, 137-147.
- Ferster, C. B., & Skinner, B. F. *Schedules of reinforcement*. New York: Appleton-Century-Crofts, 1957.
- Kelleher, R. T., Fry, W., Deegan, J., & Cook, L. Effects of meprobamate on operant behavior in rats. *J. Pharmacol. exp. Therap.*, 1961, 331, 271-280.
- Sidman, M. *Tactics of scientific research*. New York: Basic Books, Inc., 1960.
- Smith, C. B. Effects of d-amphetamine upon operant behavior of pigeons: enhancement of reserpine. *J. Pharmacol. exp. Therap.*, 1964, 146, 167-174.
- Zimmerman, J., & Schuster, C. R. Spaced responding in multiple DRL schedules. *J. exp. Anal. Behav.*, 1962, 5, 497-504.