THE EFFECT OF SECOBARBITAL ON A MULTIPLE SCHEDULE IN THE MONKEY

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It has recently been reported that the effect of sodium pentobarbital on the operant behavior of pigeons depends on the schedule of reinforcement used to maintain responding (Dews, 1955b). Behavior under a fixed-interval (FI) schedule of reinforcement showed greater sensitivity to this compound than behavior reinforced under a fixed-ratio (FR) schedule (Ferster & Skinner, 1957).

Using a tandem fixed-interval, fixed-ratio schedule (tand FI FR; Ferster & Skinner, 1957), Herrnstein and Morse (1956) subsequently showed that sodium pentobarbital at the proper dose will fractionate a tand FI 10 min. FR 12 performance in pigeons. The behavior resulting from such a tandem schedule is to a large extent similar to the response pattern under fixed-interval reinforcement. The organism shows both the positively accelerated rate changes (scallop) typical of FI as well as the rapid responding characteristic of FR. Herrnstein and Morse were able to obtain selective interference of the drug with the FI and FR components of the tandem performance.

They demonstrated both the occurrence of a depression in over-all rate and the loss of positive curvature characteristic of the effect of pentobarbital on a simple FI performance as well as the relative insensitivity to this drug of the rapid responding (FR) component of the tandem performance. Under tand FI 10 FR 12, rapid responding normally occurs towards the end of each reinforcement cycle. After administration of sodium pentobarbital, the entire 10-minute pre-reinforcement periods were filled with response bursts at high rates alternating with periods of no response.

Herrnstein and Morse's finding confirmed Dews' (1955b) observations concerning the selective effect of pentobarbital on FI and FR behavior. It also provided confirming evidence for the occurrence of FI and FR components within a tandem-schedule performance. As such, it was one of the first reports demonstrating the use of a pharmacological agent as an aid in the experimental analysis of behavior.

This note presents a further confirmation of some of the Herrnstein, Morse, and Dews findings described above.

SUBJECTS

The subjects of the experiment were two adult male Rhesus monkeys. The animals had been maintained for several weeks on a 44-hour (± 30 minutes), water-deprivation schedule. Food was always available in the individual living cages.

APPARATUS AND PROCEDURE

Two modified telegraph keys were center-mounted, one above and the other below, in one side wall of a 24-inch-cube aluminum cage. The lower key was mounted 2 inches from the grid floor of the cage with 10 inches between it and the top key. A force of approximately 25 grams was necessary to close the contacts of either key.

Pressing the top key was reinforced under a multiple fixed-interval, fixed-ratio schedule (mult FI FR) (Ferster & Skinner, 1957). Like tandard FI FR, this schedule combines features of both FI and FR schedules. The FI and FR contingencies are programmed independently, however, and each schedule component is correlated with an exteroceptive stimulus.

In the present experiment, FI 2 alternated with FR 40. A red and green light mounted 2 inches above the top key served as the schedule-correlated stimuli. Red was the FI stimulus, green was the FR stimulus.

The monkeys were run every other day at approximately the same time during the afternoon for a total of 70 reinforcements per session. Each reinforcement consisted of 0.5 cubic centimeter of water.

Each session was started with FI 2 and the red light. The termination of a session after 70 reinforcements was indicated by: 1) switching off the green light above the top key after completion of the 35th FR run; and 2) switching on a 60-watt, 110-volt A.C. light mounted into the ceiling of the experimental cage behind milk glass.

One hour after termination of each session the animals were allowed free access to water for one hour.

Experimental sessions were programmed automatically. Data were recorded on a cumulative recorder.

The second key, mounted below the top one, was nonfunctional. Responses on this key were recorded on the base-line pen of the cumulative recorder.

RESULTS AND DISCUSSION

Only the data obtained during the 43rd session with one monkey will be presented here. The cumulative record showing the effect of 30 milligrams per kilogram of sodium secobarbital presented in Fig. 1 is typical of the data obtained with both animals. In the session shown, drug was administered at the arrow almost immediately after the completion of an FR run. The cumulative-recorder pen was reset at this time; and after injection, the animal was returned to the experimental cage with the houselight turned on (TO). The first vertical mark after the reset indicates the restarting of the experimental session with an FI period. This first post-drug FI run (at *A*) was already disrupted: the record shows a rapid response rate which shifts abruptly to a low rate just before reinforcement. The following FR run was still normal, however. The next four FIFR cycles (8 reinforcements) showed an over-all depression of responding. The absence of a pause and the high rate during almost the entire first FI run after secobarbital administration are characteristic of the initial phase of the effect of the drug under the conditions of this experiment. They may be comparable to the short period of excitability observed in many species before a barbiturate-induced depression sets in. A similar "stimulant" effect recurred after the animal came out of the depressant phase (at *E*). This time, the response frequency on the second nonfunctional lever had also increased.

During the depressant phase, responding during the FI periods was almost entirely depressed. The first three FR runs (at *B*, *C*, and *D*) during the depressant phase showed groups of responses at high rates alternating with periods of no response. During the depressant phase, then, the effects of secobarbital on a mult

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M.S.: F.I. 2'; F.R. 40. ALTERNATING

Figure 1. The effect of 30 milligrams per kilogram of secobarbital on FI 2 FR 40 in a Rhesus monkey.

FIFR in the monkey were similar to the pigeon data reported previously by Herrnstein and Morse (1956).

The fourth FR run (before the FI period labelled *E*) might still be interpreted as belonging to the depressant phase: it showed an abnormally long pause. The next FR run (at *F*) was almost entirely back to normal. At this time, the FI runs at *E*, *G*, and *H* were still disrupted, showing almost complete absence of pausing after each reinforcement and a rough grain. The performance in the FI stimulus during this phase of the experiment can also be described as showing "groups of responses at high rates alternating with periods of no response." Because of this feature of the FI performance during the post-depression phase, the conclusion of Herrnstein and Morse should be accepted with caution. Their data may not have shown such a clear-cut fractionation of the FI and FR components of the tandem FI FR performance. On the other hand, considering the fact that several authors (Blough, 1957; Dews, 1955a) have obtained considerable deteriorative effects with pentobarbital in discrimination situations, the present performance in the FI stimulus may represent a failure of discrimination. It will take further research to resolve the issues at hand.

The general conclusion that FI behavior is more easily affected by a barbiturate than FR behavior was, however, clearly born out by the present data. All FR runs after the one at *F* were back to normal. Fixed-interval pauses of a length comparable to the pre-drug performance do not return until *J*. The fixed-interval behavior

was still disrupted for the most of the FI periods making up the remainder of the session: sharp knees, for example, occur at *K*, *M*, and *N* before the animal shifted to the terminal rate. Short pauses during the terminal rate (as at *L*) also occurred for the remainder of the session.

The effects of large doses were very similar. The performance went through the same phases. The extent and the duration of the depressant phase increased, however.

SUMMARY AND CONCLUSIONS

The effect of secobarbital on the lever-pressing behavior of monkeys under mult FI 2 FR 40 was investigated. The effect of the drug on the behavior can be described in terms of three phases: 1) a brief stimulant phase; 2) a period of over-all depression; and 3) a post-depression excitatory phase.

The general conclusion of previous investigations that FI behavior is more sensitive to the effects of a barbiturate than FR behavior was confirmed. Because of certain features of the behavior during the FI periods during the post-depression excitatory phase, the conclusion of Herrnstein and Morse that the pentobarbital can be used to demonstrate the presence of FI and FR components within a tandem FI FR performance should be validated with other species, schedules, and barbiturates.

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