Psychopharmacologia 3, 60–65 (1962). LSD 980

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Effects of Pentobarbital, Lysergic Acid Diethylamide and Chlorpromazine on Matching Behavior in the Pigeon*

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With 2 Figures in the Text

(Received August 14, 1961)

Matching-to-sample procedures are of interest in behavioral pharmacology since they provide techniques for assessing the effects of drugs on complex visual discriminations. In such procedures, correct performance is possible only if a response is made to some common property of the standard and comparison stimuli. Since the matching situation involves a "conditional" discrimination, it contrasts with procedures in which correct responding can be based upon the properties of a single stimulus.

Through procedural variations, the matching technique may be employed in several important problem areas: (a) If the subjects are required to learn a large number of such discriminations in succession, "learning sets" may be studied; (b) the use of sets of comparison stimuli with some common property permits the study of concept formation; (c) delayed responding may be studied by interposing a delay interval between the offset of the standard stimulus and the onset of the comparison stimuli.

In a previous experiment (Cumming and Berryman, 1961), the acquisition and maintenance of matching behavior were studied within a situation which required the subject to match from a small set of stimuli (three hues) with standard and comparison stimuli simultaneously present. The study reported here was designed to investigate the effects of pharmacological variables on this performance.

Method

Subjects. The subjects were four white Carneaux barren hen pigeons, supplied by the Palmetto Pigeon Plant. Throughout the course of the experiment they were maintained at 80% of their free-feeding weights. Subjects were exposed to the experimental procedure daily for five days a week, except when their weights exceeded the 80% *ad libitum* value by 15 gm. All birds weighed approximately 400 gm.

* This research was carried out at Columbia University, under support from Grant MY-3673 from the Institute of Mental Health, U.S. Public Health Service.

Apparatus. The response chamber was in the form of an isosceles right triangle, 24″ by 24″ by 35″. There were three response keys which could be individually illuminated with red, green, or blue light. A grain magazine provided reinforcements consisting of a mixture of Kaffir corn, vetch and hemp seed.

Procedure. The procedure is represented schematically in Fig. 1. During the 25 second intertrial interval all keys are dark. A trial is started by illuminating the center key with one of the three hues. As soon as the bird pecks the center key, both side keys are illuminated, one with a hue matching that on the center key, the other with one of the two non-matching hues. All three keys remain illuminated until the bird pecks either of the side keys. When the side key response is made, all the key lights are turned off. If this response was to the side key of matching hue, the grain magazine is made available for three seconds; if it was to the non-matching side key, the chamber lights are turned off, and the bird left in total darkness for three seconds. The intertrial interval follows either the reinforcement or the blackout, and the next trial is presented 25 seconds later. This sequence continues until each of the 12 stimulus conditions has been presented 13 times, for a total of 156 trials. The first 12 trials are regarded as practice trials, and excluded from the data analysis. Since the birds carry out the required sequence of center and side key pecks with very short latencies, the entire session, exclusive of the practice trials, takes about 72 minutes. The appearance of a given hue on the center, left, or right keys is randomly permuted to control for position and alternation preferences. Further details of this procedure are given in CUMMING and BERRYMAN (1961).

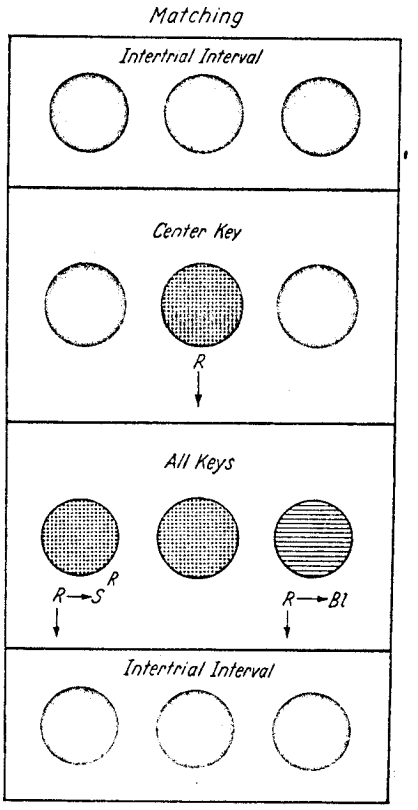

Fig. 1. Matching-to-sample procedure. See text for explanation

Preliminary training: All subjects had been previously exposed to the procedure just described during an extended study of matching

behavior. Since eight months had elapsed since this experiment, the birds were given 15 daily sessions of 144 trials each in order to stabilize their behavior prior to the introduction of drug variables.

Drug administration: Next, a series of drug tests was carried out in the following sequence: sodium pentobarbital, 5 and 10 mg/kg; lysergic acid diethylamide, 0.05 mg/kg; and chlorpromazine, 10 and 20 mg/kg. Drugs were injected into the pectoral muscle 10 minutes before the daily run. In the case of chlorpromazine, a single test at 20 mg/kg was made three hours after injection. Dose levels for pentobarbital and chlorpromazine were established from those reported in the literature. A 0.05 mg/kg dose of lysergic acid diethylamide was selected after preliminary testing with 0.025, 0.05, 0.10, and 0.30 mg/kg. In all cases, several control days intervened between successive drug tests to allow for recovery of normal performance.

Results

During preliminary training, accuracy was initially well above chance and reached a stable asymptote after ten days for all four birds. The final accuracy level attained was slightly lower than that reached in previous experimentation (CUMMING and BERRYMAN, 1961), and there was somewhat greater quotidian variability. The stable means and ranges are shown in the Table.

Table. *Per cent correct matches for four subjects in control and drug conditions*

Subject	Range of normal accuracy	Sodium Pentobarbital		Lysergic acid diethylamide: 0.05 mg/kg		Chlorpromazine		
		5 mg/kg	10 mg/kg	Day 1	Day 2	10 mg/kg	20 mg/kg	3 hours 20 mg/kg
44	92— 99	94	85	94	97	85	93	81
72	78— 97	88	67	88	82	91	93	97
73	90—100	93	83	90	92	87	85	85
74	92— 99	92	77	92	97	96	92	75

Pentobarbital: Injection of 5 mg/kg produced little, if any, effect on the performance. In all birds, accuracy was slightly below the mean, but within the normal range of variability. After two control days, the dose level was raised to 10 mg/kg. The data of the Table indicate that all birds then showed a conspicuous decrease in accuracy, falling well below any normal performance. An analysis of this effect for successive quarters of the experimental session is shown in Fig. 2.

Accuracy was only slightly above the chance level during the first quarter, increased during the next two quarters, and by the end of the session fell within the normal range. (Data for Bird 74 are lacking for

the fourth quarter, due to an apparatus failure.) Despite this initial decrease in accuracy, the working pace of the birds was unaffected, and the sessions were completed in the usual 72 minutes.

Lysergic acid diethylamide: In initial testing the smallest dose (0.025 mg/kg) had no apparent effect, while at levels of 0.05, 0.10, and

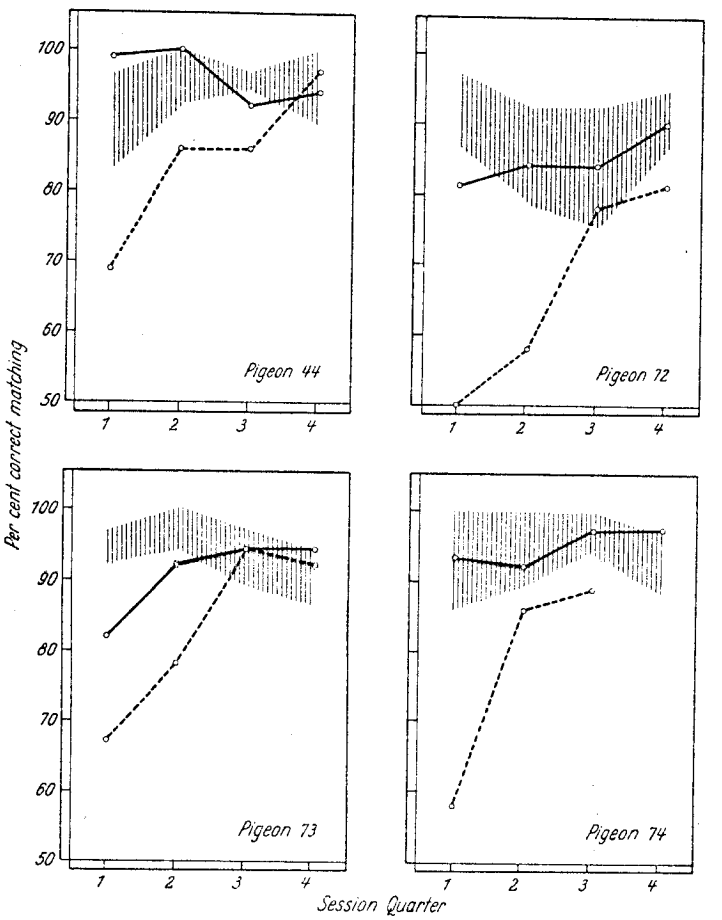

Fig. 2. Per cent correct matches for the first, second, third, and fourth quarters of the 144-trial session, with 10 mg/kg of sodium pentobarbital and 0.05 mg/kg of lysergic acid diethylamide. The shaded area indicates the range of normal accuracy. Dotted lines show performance with 10 mg/kg pentobarbital; solid lines show performance with 0.05 mg/kg lysergic acid diethylamide

0.30 mg/kg, the birds did not peck the keys for periods ranging from 20 minutes to three hours. Observation indicated that the birds spent this time sitting in the experimental chamber. If the chamber was opened during this period, the birds turned to face the experimenter and were capable of normal locomotion. When they did start to work,

the accuracy of their matching performance was near normal, but the latencies of responses to both the center and side keys were occasionally exceedingly long. All birds were then given two sessions at a dose level of 0.05 mg/kg.

The Table shows that overall accuracy was within the normal range. The analysis by quarters given in Fig. 2 indicates that, with the exception of Bird 73, accuracy is close to, or within, the normal ranges. Bird 73 exhibited an initial decrease, followed by normal accuracy after the first quarter. Thus, lysergic acid diethylamide produced an initial period of inactivity, but only slightly affected the birds' accuracy after responding started.

Chlorpromazine: As the Table indicates, a dose level of 10 mg/kg left the performances of Birds 72 and 74 unchanged, but produced decrements in accuracy in Birds 44 and 73. At 20 mg/kg, Bird 73 showed decreased accuracy, but the other birds were unaffected. On the basis of the report (DEWS, 1958) that the effects of chlorpromazine on a multiple schedule of reinforcement can be observed after six hours, the 20 mg/kg dose was repeated and the animals run three hours after injection. Under these conditions, Birds 44, 73 and 74 all exhibited deterioration of performance, while the error frequency of Bird 72 stayed within its normal range. Throughout the entire series of chlorpromazine tests, response latencies remained normal.

Under all conditions, the animals recovered their normal accuracy on the control days which followed each drug test.

Discussion

Our results will be compared with the findings reported by BLOUGH (1957) of the effects of sodium pentobarbital, lysergic acid diethylamide, and chlorpromazine on a conditional discrimination. Although he requires an essentially similar performance of his subjects, his procedure differs from ours in certain respects: (1) there is no intertrial interval between the presentation of successive sets of standard and comparison stimuli; (2) no "observing" response is required to the standard stimulus; (3) correct responses are reinforced intermittently, rather than regularly. The effects of these variables on conditional discrimination performances are still unclear. However, our results are in general agreement with his.

BLOUGH (1957) has reported that pentobarbital initially decreased accuracy and increased response rate, but that the control performance was recovered as the session progressed. Our results can be considered to substantiate this finding. Although a trial-by-trial procedure permits no reliable estimate of rate, it was observed that while pigeons receiving pentobarbital were hyperactive, ataxic, and incoordinated, their response latencies were normal.

Our finding of greatly increased latencies early in sessions of lysergic acid diethylamide administration confirms BLOUGH's (1957) observation that this drug lowers response rate. However, there is only slight support for his tentative suggestion that lysergic acid diethylamide may increase accuracy, with only one subject (Bird 44) showing any improvement.

In the same paper, BLOUGH has also noted that chlorpromazine lowered both accuracy and response rates. Our chlorpromazine data have too much inter- and intra-subject variability to permit comment on this point.

Summary

A report is given of the effects of three drugs on matching-to-sample behavior in pigeons. Pentobarbital produced considerable initial decrements in accuracy, with relatively fast recovery to normal levels. With lysergic acid diethylamide, an initial period of inactivity, during which the birds did not respond to the experimental task, was followed by essentially normal performance. Chlorpromazine effects showed considerable variability both within and across subjects.

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