The Effects of Chlorpromazine Hydrochloride upon Temporally Spaced Responding

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THE EFFECTS OF CHLORPROMAZINE HYDROCHLORIDE UPON TEMPORALLY SPACED RESPONDING

by
Stephen M. Bean

A Thesis submitted to the Faculty of the School of Graduate Studies in partial fulfillment of the Degree of Master of Arts

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Stephen M. Bean
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INTRODUCTION

The present study examines the effects of chlorpromazine hydrochloride (Thorazine) upon temporally spaced responding of pigeons maintained by a differential reinforcement of low rate schedule (DRL). DRL is a technique whereby animals may be trained to space their responses by selectively reinforcing inter-response times (IRT) longer than a specified value (Wilson and Keller, 1953).

Sidman (1956) has described two characteristics of the distribution of inter-response times on DRL schedules: (1) the form of the distribution, often with a peak at the shortest recorded IRT interval due to "bursts" of very short inter-response times, and usually with a second peak at or just before the minimum reinforced IRT; (2) the dependence of bursts (when they occur) upon the length of the preceding IRT--the probability of bursting is highest following inter-response times near the mode of the distribution. These properties have been widely confirmed by later works (Conrad, Sidman, and Herrnstein, 1958; Kellerher, Fry, and Cook, 1959).

It has been reported (Staddon, 1965) that pigeons exposed to a schedule which reinforces inter-response times longer than a given value (DRL schedule) eventually reach a stable pattern of responding which may be shown to be a function both of the DRL value and of previous experience with other DRL values. Staddon also concluded on the basis of his research that very few pigeons exposed to a DRL schedule of 30 seconds will adjust to it in a way comparable to their adjustment to
shorter values. This failure of adjustment to long values appears to be a species characteristic of pigeons.

A previous study of the effects of punishment upon temporally spaced responding of pigeons (Holz, Azrin, and Ulrich, 1963) has found that overall responses were reduced and temporally spaced response patterns stabilized, as a direct function of the intensity of the punishment. It was also reported that the response stabilization phenomenon was only temporary, in that it dissipated as the intensity of punishment was reduced. In fact, when the punishment contingency was removed, the IRT distribution returned to the pre-punishment pattern. These data were interpreted to indicate that punishment does not facilitate learning this form of behavior.

Pigeons were selected as the experimental subjects because of their normally elevated metabolic rate and overt bodily activity. Another contributing factor towards their selection was their reported inability to deal successfully with a DRL schedule of 30 seconds. Also, much is known regarding the behavior of the organism maintained by commonly employed reinforcement schedules such as fixed ratio, variable ratio, fixed interval, and variable interval (Ferster and Skinner, 1957). However, investigations utilizing DRL schedules are relatively few in number.

It was hypothesized that total response output would diminish and that stable temporal response patterns based on a success criterion of 30 seconds would increase as a function of the size of drug dosage.

Inasmuch as Holz, Azrin, and Ulrich reported no permanent or lasting effects of punishment upon response patterns, the purpose of this study is to
determine whether pigeons may be trained to respond in a more adaptive manner to a DRL schedule of 30 seconds by a reduction in the rate of emission of behavior through the administration of chlorpromazine hydrochloride.

Various experimenters (Kellerher, Riddle, and Cook, 1962; Dews, 1956; Gupta and Dhawan, 1960; and Burkman, 1962) have found that the administration of chlorpromazine hydrochloride to pigeons significantly modified behavioral patterns. Conditioned reflex activity was depressed and motoric activity and total response output were reduced. These behavioral effects were all reported as the result of studies of discrimination, conditioned reflexes, observing responses, and matching behavior.

A search of the literature has failed to yield evidence of investigations of the effects of chlorpromazine hydrochloride upon temporally spaced responding of pigeons maintained by a differential reinforcement of low rate schedule.
METHOD

Subjects

Three white Carneaux barren hen cul pigeons maintained within 15 grams of 80% of free feeding body weight were utilized. All had no previous experimental history and were of approximately the same age. All weighed approximately 400 grams. Maple peas were given when necessary to maintain the deprivation rhythm, and water was made available at all times. A fourth bird maintained at approximately 80% of free feeding body weight was used as a control for the effects of drug dosage but was not used in the actual experimentation procedures.

Apparatus

A 15.5 by 13 by 11 inch response chamber was utilized. The chamber was fitted with a 15 cfm exhaust fan to provide proper ventilation. The response key was a .75 inch back lighted translucent disk mounted 8 inches above the chamber floor. It required approximately 6 grams of force to operate. Located 4.5 inches below the key was a 2 by 2 inch opening through which a grain hopper, containing 50% Kaffir, 40% Vetch, and 10% Hempseed could be made available. Every response which met the DRL criterion was reinforced by a 4 second presentation of grain. All responses and reinforcements were recorded from an Esterline Angus event recorder. Reinforcements were also recorded from an electromagnetic recorder. Inter-response times were obtained by measurement of Esterline Angus records.
The inside illumination was provided by two 5 watt lamps mounted behind one inch circular milk glass lenses. These lamps were mounted 4 inches from either side of the key, and 1.5 inches below the chamber ceiling. During reinforcements, these house lights were extinguished, and a small white light above the reinforcement hopper came on. The entire procedure was programmed by appropriate electromechanical timers and relay circuitry.

Chlorpromazine hydrochloride was injected intramuscularly by means of a 2 cc capacity syringe. The powdered form of the drug was mixed proportionately with equal amounts of sterile water to insure an equal volume for each dosage.

Procedure

Training Procedure

After being trained to respond appropriately to the food magazine, the three experimental birds were trained to peck the response key on a continuous reinforcement schedule. The birds were then transferred directly to the 30 second DRL schedule which was in effect throughout the experiment for all subjects. With this schedule, a response was reinforced only if 30 or more seconds elapsed between successive responses. Inappropriate responses, i.e. those which did not meet the 30 second criterion, automatically reset the timer to the 30 second starting position. The sessions were one hour in duration and were arranged over a period of approximately one month.

The subjects were given 20 experimental one hour DRL (30 seconds) sessions prior to the administration of the drug in an attempt to stabilize the inter-response times (Staddon, 1965).
Drug Procedure

The drug was introduced on a chronic dosage basis. The intramuscular route of administration was utilized and the injections were made directly into the pectoral muscle. (Berryman, Jarvik, and Nevin, 1961; Gupta and Dhawan, 1960; and Dews, 1956).

Various experimenters (Kellerher, Riddle, and Cook, 1962; Dews, 1956; Gupta and Dhawan, 1960; and Burkman, 1962) have reported wide variances in the behavioral and physiological effects of the administration of chlorpromazine hydrochloride to pigeons in various dosages ranging from .7mg/kg of body weight to 30mg/kg of body weight. In an attempt to sample a broader range of drug effects, five experimental dosages were employed over a period of five successive days. Dosages ranged from 10mg/kg of body weight to 50mg/kg of body weight. The dosage was increased for each bird by 10mg/kg of body weight each day of running. All birds received the same drug dosage each day. Each bird was injected two hours prior to being placed into the experimental chamber to insure that the drug was fully absorbed and its effects were maximal (Berryman, Jarvik, and Nevin, 1961). All responses and reinforcements were recorded for each bird under the influence of each of the five drug dosages.

Having completed the recording of performances under all drug dosages, the birds were not run for a period of four days in an effort to allow
the residual effects of the drug to fully dissipate. At the end of this period, the birds were placed into the experimental chamber for a one hour duration and their individual performances recorded in order to determine if the removal of the drug effected a reversal to the pre-drug established temporal response pattern. This procedure was analogous to that followed by Holz, Azrin, and Ulrich (1963).
RESULTS

All data were analyzed in terms of a distribution of inter-response times. These data are presented in Fig. 1 in the form of a histogram depicting the performances of each bird under each drug and pre-drug condition. The graph was constructed by calculating the percentages of the total responses which followed a previous response by a specific number of seconds. The inter-response times were recorded within class intervals of 5 seconds. Because a 30 second DRL schedule was in effect for all birds throughout the experiment, all percentages shown for inter-response times of 30 seconds or greater, constitute the percent of reinforced responses for that session.

Pre-Drug Performances

Inter-Response Time Distribution

Analysis of the distribution of inter-response times indicated that the majority of the responses (98% on the average) were within inter-response times of 25 seconds or less. More specifically, on the average, approximately 50% of the total response output was localized within the class interval of 0-5 seconds. This phenomenon occurred as the result of bursts of 4-6 responses occurring in an equal number of seconds. Various investigators (Sidman, 1956; and Wilson and Keller, 1953) have reported that these bursts are common on a DRL schedule.
Session to session inter-response time variability per bird was relatively low. In 95% of the cases, scores for a given day did not vary from the average by more than five percentage points.

**Response Output**

Prior to the introduction of chlorpromazine hydrochloride, the total response output of all subjects greatly exceeded the ideal rate of one response every 30 seconds which would have led to optimum reinforcement occurrence. Session to session variability was small for each subject. The data as presented in Fig. 1 indicate that the rate of response per session did not vary more than approximately ± 20% of the average rates over sessions.

**Percent Of Reinforced Responses**

Because the rate of response significantly surpassed the optimum level, relatively few reinforcements resulted for each bird. The percentage of reinforced responses (inter-response times equal to or greater than 30 seconds) for each bird under pre-drug conditions, is presented in Fig. 1. Approximately 0% of total responses were reinforced for bird # 204, 1% for bird # 201, and 2% for bird # 205.
Performance Under Drug Treatments

Inter-Response Time Distribution

As presented in Fig. 1, the analysis of the distribution of inter-response times under all drug conditions, failed to indicate any pattern of significant changes as a function of the amount of the drug dosage. However, the inter-response time distribution for bird # 201 at a dosage of 40mg/kg of body weight, showed a high relative frequency of responses greater than 30 seconds. This may in part be accounted for by an extremely low total response output for that particular session. In comparison with pre-drug performances, no change occurred in the percentage of responses occurring within inter-response times of 25 seconds or less.

Response Output

As presented in Fig. 1, total response output under drug treatments did not vary significantly as a function of the level of the drug dosage for any bird. In comparison with pre-drug performances, bird # 205 manifested an increase in total response output under all drug conditions, while birds # 204 and # 201 demonstrated no appreciable changes.

Percent Of Reinforced Responses

The percentage of reinforced responses did not significantly increase as a function of drug dosage in any bird. As Fig. 1 indicates, in comparison with pre-drug performances, no appreciable changes were noted.
DISCUSSION

The results clearly indicate no appreciable changes in the inter-response times distribution or percentage of reinforced responses as the drug dosage was increased.

Various experimenters (Blough, 1957; Kellerher, Riddle, and Cook, 1962; and Dews, 1956) have reported that injections of chlorpromazine hydrochloride in dosages ranging from 1.7mg/kg of body weight to 30mg/kg of body weight have caused a prolongation and development of pauses and decreased total response output. Similarly, Ivanova (1960) indicated that doses of chlorpromazine hydrochloride ranging from .3mg/kg of body weight to 10mg/kg of body weight produced complete immobility in the birds. The results of the present study are not at all congruent with these findings.

Ordinarily, the differential reinforcement of low rate schedule is extremely sensitive to the effects of drugs (Dews, 1962). It is therefore, reasonable to assume that the drug dosages utilized in this study either were not large enough to produce any significant behavioral modifications, or that injections of the same dosage of a drug can produce variable effects in the same species of animal.

Possibly, the effects of chlorpromazine hydrochloride are determined in large measure by the individual features of the experimental animal, or perhaps, individual differences in drug sensitivities exist within a given species of an animal.
SUMMARY

The responses of 3 pigeons were maintained by a differential reinforcement of low rate schedule. With this schedule, responses were reinforced only when a fixed period of time (30 or more seconds) elapsed without an intervening response. The subjects were unable to satisfactorily adjust to this schedule of reinforcement.

The introduction of chlorpromazine hydrochloride in five dosages ranging from 10mg/kg of body weight to 50mg/kg of body weight did not produce significant changes in the distribution of inter-response times or effect total response output. The data were interpreted in terms of specific differences and variability of drug action.
<table>
<thead>
<tr>
<th>Post Drug</th>
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<tr>
<td>50mg</td>
<td>676 tot. responses</td>
<td>362 tot. responses</td>
<td>494 tot. responses</td>
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<tr>
<td>40mg</td>
<td>622 tot. responses</td>
<td>13 tot. responses</td>
<td>432 tot. responses</td>
</tr>
<tr>
<td>30mg</td>
<td>666 tot. responses</td>
<td>481 tot. responses</td>
<td>525 tot. responses</td>
</tr>
<tr>
<td>20mg</td>
<td>616 tot. responses</td>
<td>606 tot. responses</td>
<td>643 tot. responses</td>
</tr>
<tr>
<td>10mg</td>
<td>569 tot. responses</td>
<td>830 tot. responses</td>
<td>942 tot. responses</td>
</tr>
<tr>
<td>Pre-Drug</td>
<td>( \bar{X} = 400 ) responses</td>
<td>( \bar{X} = 500 ) responses</td>
<td>( \bar{X} = 763 ) responses</td>
</tr>
</tbody>
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Fig. 1
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Blough, D.D., Effects of drugs on visually controlled behavior in pigeons. In Garattini and Ghetti (Eds.), *Psychotropic Drugs*, 1957, 110-118.


