A Study of the Acquisition of Learning-Set Behavior in Pigeons

E. Jill Moir
Western Michigan University

Follow this and additional works at: https://scholarworks.wmich.edu/masters_theses
Part of the Experimental Analysis of Behavior Commons

Recommended Citation
https://scholarworks.wmich.edu/masters_theses/2676
A STUDY OF THE ACQUISITION OF LEARNING-SET BEHAVIOR IN PIGEONS

by

E. Jill Moir

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
August 1973
ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to Dr. R. Malott for his continual encouragement and valuable advice throughout this research project. The constructive criticisms and evaluations of Dr. W. Hitzing and Dr. J. Michael have also been invaluable.

I am also very indebted to Miss Diane Hatfield for the tremendous help she gave me in conducting this experiment. I very gratefully acknowledge the time and effort which she devoted to this project.

The entire faculty in the Department of Psychology has been extremely helpful and stimulating throughout my graduate studies. I am particularly grateful to Dr. N. Kent for the opportunity to work as one of his graduate teaching assistants.

I would also like to express my gratitude towards the Canadian Association for the Mentally Retarded whose financial assistance made it possible for me to complete this graduate course.

Elizabeth Jill Moir
MASTERS THESIS

MOIR, Elizabeth Jill
A STUDY OF THE ACQUISITION OF LEARNING-SET
BEHAVIOR IN PIGEONS.

Western Michigan University, M.A., 1973
Psychology, experimental

University Microfilms, A XEROX Company, Ann Arbor, Michigan
TABLE OF CONTENTS

INDEX OF FIGURES ........................................... ii
INDEX OF TABLES ........................................... iii
INTRODUCTION .................................................. 1
METHOD .......................................................... 4
Subjects ......................................................... 4
Apparatus ......................................................... 4
Procedure ......................................................... 8
RESULTS AND DISCUSSION ................................. 12
REFERENCES ..................................................... 22
# INDEX OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>5</td>
</tr>
<tr>
<td>Figure 2</td>
<td>13</td>
</tr>
<tr>
<td>Figure 3</td>
<td>14</td>
</tr>
<tr>
<td>Figure 4</td>
<td>15</td>
</tr>
<tr>
<td>Figure 5</td>
<td>17</td>
</tr>
<tr>
<td>Figure 6</td>
<td>18</td>
</tr>
<tr>
<td>Figure 7</td>
<td>20</td>
</tr>
</tbody>
</table>
INDEX OF TABLES

Table 1 ............................................. 10
Learning-set (L-set) behavior refers to the observed ability of a subject to solve any one of a class of discriminations with increased efficiency. Kamil and Hunter (1970) studied the acquisition of L-set behavior in myna birds using junk stimuli (stimuli that vary across several dimensions such as color, shape, size). In an attempt to control interproblem stimulus generalization which might result from the use of junk stimuli, the present experiment uses only four colors in a series of discrimination reversal problems with pigeons.

A discrimination problem is the repeated simultaneous presentation of two stimuli such that a response to one is reinforced while a response to the other is not reinforced. Only one response may be emitted at each presentation of a problem. A criterion is set to determine when a problem is considered to be "solved".

The stimuli in the present experiment are arranged in a specific sequence which attempts to equate the difficulty of each of the problems when it is first presented. (See Method for further explanation).

In the study of Kamil and Hunter, an adjustable mastery criterion was used. The present experiment uses a fixed mastery criterion of five successive correct responses. An adjustable criterion would produce a change in experimental conditions between problems, the effects of which have not been assessed. A minimal criterion, unlike a fixed number of trials per problem, provides observable evidence that some learning occurs on each problem, and it also minimizes the amount of overlearning per problem. A minimal criterion such as this not only provides evidence of learning on each problem but, at the same time, it allows a maximum number of problems to be
presented in one session.

Data from a pilot study by the author revealed a high rate of "shift" errors when a correction procedure was used. The correction procedure meant that, when a bird responded incorrectly to a stimulus pair, that pair was presented again until the bird responded correctly. The shift errors involved the bird shifting its response to the opposite side of the apparatus to which it had previously responded regardless of the position of the colors. In order to avoid this procedural artifact, a noncorrection procedure was adopted for the present study.

Levine (1959a; 1959b), and Cumming and Berryman (1965) have each developed methods of analyzing response tendencies on discrimination tasks. Both of their procedures deal with correct and incorrect responses. Harlow's error factor analysis (1959) deals only with those errors which are relevant to his four error factors. In an attempt to present a clearer analysis of response tendencies, this study considers all errors emitted by each subject in the experiment. By analyzing response tendencies in terms of incorrect responses, only those responses where the animal's behavior is definitely not under the control of the appropriate stimuli are analyzed. This analysis also includes consideration of sequential errors, and an analysis of the types of errors that occur when a discrimination is close to perfect.

This study presents its data in terms of the performances of the individual subjects. Traditional L-set experiments present data in terms of the average performance of a group of subjects. As
Sidman (1960) pointed out, group averages are contaminated by both intra- and intersubject variability. Studies of individual performances allow an accurate analysis of the latter type of variability. Given an example of group data from an L-set experiment, it is not possible to determine if it presents a representative picture of the individual behavioral processes. The amount of individual variability adversely affects the validity of the behavioral process described by group data.

This study, therefore, presents an analysis of the development of L-set behavior in pigeons under specially controlled experimental conditions where particular attention has been paid to procedural variables that have not been directly controlled in previous studies. The stimuli have been designed to reduce the possibility of stimulus generalization across problems, and a fixed minimal mastery criterion was chosen to provide evidence of learning on each problem. Also, an error analysis was used which provides information about response tendencies on responses which were definitely not controlled by the appropriate stimulus.
METHOD

Subjects

The subjects were three experimentally naive barren hen White King pigeons. During the experiment all animals were maintained at 70 percent of their free feeding weight. Sessions were conducted only if an animal's weight was within twelve grams of its 70 percent weight. Dry grit and water were freely available in the home cage at all times.

Apparatus

Sessions were conducted in a quiet well-lighted classroom. The experimenter sat at a small booth containing a modified Wisconsin General Test Apparatus (Figure 1). The apparatus consisted of a box made of 3/4 inch plywood, measuring 8\(\frac{1}{2}\) inches by 12 inches, by 18 inches. The floor of the box was made of wire mesh and covered with newspaper that was changed prior to each session.

On one end of the apparatus was a hinged door so that the animal could be easily placed in the box. On the other end was an intelligence panel identical to that described by Millar and Malott (1968). The intelligence panel contained a plexiglass window with three holes, each 1-5/8 inches in diameter, and 2-5/8 inches apart, center to center. This observation window could be manually covered using a piece of masonite as a guillotine door. Stimuli were placed on a sliding tray which was perpendicular to, and just below the obser-
Figure 1. A diagram of the modified Wisconsin General Test Apparatus used in this study.
vation window. The tray contained three one-inch holes or "foodwells", each directly below a corresponding hole in the plexiglass window. The foodwells were covered by the stimuli at which the pigeon pecked. A peck would produce sufficient force to move the stimulus and uncover the foodwell.

For the purposes of this experiment, the center hole of the observation window was covered with plexiglass, and the center foodwell was left uncovered and empty. Thus, it was possible for the animal to view the stimuli through the plexiglass, and peck a stimulus after sticking its head through the corresponding hole on either the right or left side of the intelligence panel.

The stimuli for this experiment were two-inch cubes made of balsa wood, and painted on four sides, each side a different color. Each cube had five coats of paint, and three coats of lacquer to reduce the amount of chipping caused by the birds' pecking responses. The paint used was Testors Hot Fuel Proof Dope: 1408 Yellow; 1404 Insignia Red; 1402 Medium Green; 1411 True Blue; 1422 Clear.

The stimuli were placed so that a peck causing the cube to turn would reveal an unpainted side of the cube. Also, the stimulus pairs were arranged so that, as the positive stimulus color (S+) and the negative stimulus color (S-) faced the observation window, the tops of the cubes each had the same color exposed (eg. S+ - red and S- - green, and yellow on the top of both cubes). These two procedures assured that only the colors of the S+ and the S- were the relevant stimuli.
Under the direct supervision of the author, a second experimenter conducted all sessions with subject S19. The author conducted all sessions with S14 and S16.

A stopwatch was used to measure all time intervals required by the experimental procedure.
Procedure

Sessions were conducted daily for a period of 50 minutes or until the subject had received 50 reinforcements, whichever occurred first. These limitations were arbitrarily set so that the experimenters could regulate their experimental times, and to assure that the birds were maintained at 70 percent of their free-feeding weight.

Standard operant conditioning procedures were used to shape the initial cube-pecking response in all of the subjects. Throughout the experiment, reinforcement consisted of one or two large pieces of grain placed in the foodwell under a stimulus cube.

Each trial began when the guillotine door was raised, and ended when the door was lowered after a subject has pecked a cube to uncover the foodwell and when available, had consumed the food. There was a 15-second interval between every trial. During this time, the food was always removed, and placed in the foodwell assigned for the next presentation. This procedure reduced the possibility that the subject's responses were controlled by auditory stimuli.

Initially, with only one cube presented, all subjects were required to emit, on each side of the apparatus, five consecutive responses, each with a latency of less than five seconds. Next, all subjects were required to emit ten consecutive responses with latencies of less than five seconds when the side of the stimulus presentation was varied according to a random sequence. Throughout
shaping and preliminary training, the animals were exposed to a random order of presentations for the four colors, with the color changing on every trial.

When the behavioral criterion for the preliminary training had been met, the first discrimination problem was presented. For every trial, the side on which the positive stimulus was placed was varied according to a semi-random 10-trial sequence (i.e., for every ten trials, S+ occurred five times on the right side of the apparatus, and five times on the left side). The S+ was presented on the same side of the apparatus for a maximum of four consecutive trials. Each semi-random sequence consisted of 100 trials, and a different sequence was used for each day of the week.

Displacement of S+ was reinforced with food on a continuous schedule of reinforcement. Displacement of the negative stimulus (S-) was not reinforced. No other consequence was presented contingent upon incorrect responses.

A series of eight problems (four color discriminations and the reversals of those discriminations) were presented in the order shown in Table 1. The order of colors is specifically arranged so that after the first four problems were initially presented, subsequent problems involved an S+ and S- both of which were either S+'s or S-′s on the immediately preceding presentation of each color. For example, with the pair yellow (S+) and red (S-), yellow had previously been S+ in the pair yellow - blue, and red had previously been S+ in the pair red - green. This stimulus order was designed to reduce the amount of response bias on trial one of each problem.
<table>
<thead>
<tr>
<th>$S^+$</th>
<th>$S^-$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Yellow</td>
</tr>
<tr>
<td>Green</td>
<td>Blue</td>
</tr>
<tr>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td>Yellow</td>
<td>Blue</td>
</tr>
<tr>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Blue</td>
<td>Green</td>
</tr>
<tr>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>Blue</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

Table 1. The order for presentation of problems used throughout the study.
The criterion for each problem was defined as five consecutive correct trials. This criterion was chosen because the probability that five consecutive correct responses would be emitted is \((\frac{1}{2})^5\) or 1/32, which is less than .05, the level of statistical significance usually referred to in psychological research. However, for this experiment, this calculation of probability is confounded by successive presentations of a problem. Once this criterion was met for each of the eight problems, the entire sequence of problems was repeated.

Due to the specification of session length in terms of time or reinforcements, a problem was not always solved within one session. When a problem did not reach criterion within one session, training on that problem was continued at the beginning of the succeeding session. However, the criterion of five consecutive correct responses had to be met within one session before the next problem was presented.
RESULTS AND DISCUSSION

Figures 2, 3 and 4 show the rates of errors for the three subjects. All subjects' error rates decreased by the end of the experiment. Subject 14 had a mean of 13.4 errors per problem in the first 10 problems of the study and this dropped to a mean of 2.1 errors per problem for the last 10 problems. The error rate for S16 dropped from a mean of 25.6 to 4.1 errors per problem, and for S19, the mean dropped from 21.1 to 4.3 errors per problem.

For all three birds, the mean error rates for the 10 problems preceding the last 10 problems was higher than the terminal means (S14 - 3.8; S16 - 5.7; S19 - 7.3). This indicates that with further training, it is probable that the birds' error rates would have decreased more.

Early in training it can be seen from figures 2, 3 and 4 that there was a great deal of fluctuation in the number of errors emitted on different problems. Towards the end of this experiment as errors decreased, those differences diminished.

On 83 percent of the occasions when the stimuli were reversed for the first time, the error rates were significantly higher than they had been for the initial problems. On the second reversals, only 58 percent of the problems had more errors than the first reversals. These data support previous observations (Skinner, 1938; Gonzalez, Behrend and Bitterman, 1967) that initial reversals disrupt discrimination behavior more than subsequent reversals.
Figure 3. The number of errors emitted per problem by S16.
Figure 4. The number of errors emitted per problem by S19.
Figures 5 and 6 illustrate position preferences and stay preferences respectively. Position preference refers to the rate that errors were emitted on one side of the apparatus. Stay preference refers to the rate that errors were emitted on the same side of the apparatus as the immediately preceding response. These data are presented in terms of blocks of 50 errors because the measure of preferences in terms of individual problems became less reliable as the birds' error rates decreased.

From figure 5 it can be seen that all subjects clearly displayed some position preference throughout the study. For S14, the majority of incorrect responses were emitted on the right side of the apparatus. Both S16 and S19 initially emitted most errors on the left side, but their preferences reversed later in the experiment. Although the error rates for all subjects decreased as the experiment progressed, the majority of errors that were emitted occurred on the preferred side of the apparatus.

In figure 6, the illustration of "stay" preferences includes when the previous response had been correct and reinforced, and when the previous response had been incorrect and not reinforced. All three birds clearly showed a stay preference, and this preference was maintained even as the number of errors per problem decreased. Previous attempts to illustrate win-stay, lose-shift behaviors indicated that the subjects most frequently emitted win-stay and lose-stay behaviors, and therefore, both these behavior were presented together.

The acquisition of L-set behavior can be measured in terms of
For every block of 50 errors, the percent of the errors which were emitted on the right side of the apparatus is shown for S14, S16 and S19.
Figure 6. For every block of 50 errors, the percent of errors where the incorrect response was emitted on the same side of the apparatus as the immediately preceding response is shown for S14, S16 and S19 (ie. stay preference).
correct responses on trial two of each problem. Figure 7 illustrates for each subject that the percent of problems in terms of blocks of 10 problems where trial two was correct was close to chance. A closer analysis of conditional probability of a correct response on trial two as a function of S+ position, response and reinforcement on trial one clearly indicated that the three birds emitted a high percentage of stay responses. Therefore, the birds did not develop one-trial learning. However, the decrease in errors per problem, and the related increase in problem solving efficiency demonstrated some acquisition of L-set behavior in all subjects.

It is possible that an apparatus might be designed which would eliminate the response preferences developed in this study. For example, requiring a subject to emit one response at one end of the box, and the next response at the opposite end of the box would probably decrease the rate of "stay" responses, and also help to eliminate the side preferences.

It is also possible that the correction procedure, which generated a high rate of "shift" errors early in training in the pilot study, might counterbalance the high rate of "stay" errors observed in this study if it were used throughout the study.

This study has demonstrated the acquisition of L-set behavior in pigeons through the gradual decrease in errors over numerous presentations of discrimination reversal problems. It also demonstrated that orderly single-organism data can be obtained in L-set experiments. Further, the data illustrate the worsening of performance due to initial reversal, and the eventual equation of problem difficulty.
Figure 7. For every block of 10 problems, the percent of problems where a correct response was emitted on trial two is shown for S14, S16 and S19.
Both "side" and "stay" preferences were developed by all subjects, and although "side" preferences drifted, the error biases were maintained even during the more efficient later performances.
REFERENCES


