

CONTINGENCY LEARNING IN THE NONDEPRIVED PIGEON

by

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B. A., Wichita State University, 1974

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A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

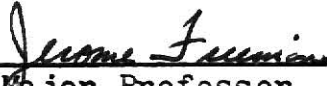
MASTER OF SCIENCE

Department of Psychology

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1977

Approved by:

  
Major Professor

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### Acknowledgements

This research was conducted during the author's tenure as a NIMH Predoctoral Trainee, Grant MH 08359. I would like to thank Drs. Jerome Frieman, Charles C. Perkins, Jr., and James Shanteau for their assistance. I am especially grateful to Dr. Jerome Frieman, my major advisor and friend, for his advice and encouragement during all phases of this study. Finally I would like to thank Pamla Hoadley both for drawing the figures and doing much of the typing of this manuscript, and more importantly for tolerating and encouraging the author on those days when his humor was less than adequate.

A number of investigators have demonstrated that some directed skeletal movements of animals are strongly influenced by whether or not certain stimuli are signals for appetitive objects, even though such movements are not necessary to insure the delivery of those appetitive objects. Hearst and Jenkins (1974), in reviewing some of these experiments, have postulated a general class of behaviors which they refer to as sign tracking.

Sign tracking refers to behavior that is directed toward or away from a stimulus as a result of the relation between that stimulus and the reinforcer, or between that stimulus and the absence of the reinforcer.---The word tracking is meant to be flexible in its application, it can refer to an organism's orientation, approach, or contact responses directed toward signs of particular reinforcers, as well as an organism's withdrawal responses directed away from signs that a reinforcer is not coming.

(Hearst & Jenkins, 1974)

They concluded that sign tracking is a very adaptive form of behavior for an organism. Those stimuli which, in the organism's natural environment, have come to be positively associated with biologically significant events (food, water, a mate) tend to occur in spatial proximity to these events. Hence, approaching these "signs" will generally bring the organism into contact with the appetitive object. Hearst (1975) feels that sign tracking is primarily dependent upon the organisms learning the contingent relationship between two environmental events.

Traditionally it was assumed that skeletal responses were sensitive primarily if not entirely to instrumental

contingencies, that is, when the delivery of the appetitive object is contingent upon a specified response being made by the subject (Kimble, 1961; Skinner, 1938). That this is not the case has been demonstrated a number of times. For example, Brown and Jenkins (1968) have shown that a Pavlovian procedure may lead to the conditioning of a skeletal response, key pecking in the pigeon. Pigeons who were exposed to an illuminated response key for 8 sec followed immediately by presentations of grain came to approach and peck the key. Brown and Jenkins called this phenomenon "autoshaping". In such a Pavlovian procedure the delivery of the appetitive object (US) is contingent only upon the presentation of another stimulus (CS) and is independent of the subject's behavior.

Gamzu and Williams (1971) showed that it is the contingency between the stimulus and the grain presentation, not just the pairing that is important in autoshaping. They exposed pigeons to two experimental conditions. Under their "differential" condition the US occurred not only at the end of the CS, but on a probabilistic schedule during the CS presentation. At intervals that averaged 30 sec in duration an 8.6 sec key light was presented. During each 1 sec of key illumination the probability of grain presentation was .03. That is, grain occurred on the average of once every 33 sec during the CS, and never occurred in the absence of the CS. Thus, the CS was not a signal of an inevitable US presentation, but indicated a period during

which US's occurred with some given momentary probability. In the "nondifferential" condition the probability of a US occurrence was made the same in the absence as in the presence of the CS. Key pecking did not affect CS or US presentations under either condition.

Four pigeons exposed to the "differential" condition eventually acquired the pecking response to the illuminated key. When these birds were switched to the "nondifferential" condition, key pecking dropped to a very low level during the CS and was also infrequent in the absence of the CS. Another group of five pigeons who were initially exposed to the "nondifferential" condition did not acquire a pecking response to the lighted key. However when they were switched to the "differential" condition, key pecking did develop in the presence of the CS, although at somewhat lower rates than in the other group of birds. Other experiments (Gamzu & Schwartz, 1973; Gamzu & Williams, 1973) have also demonstrated that a positive contingency between a key light and grain presentation is sufficient to elicit and maintain key pecking in pigeons.

The view presented here and elsewhere (Hearst, 1975; Hearst & Jenkins, 1974; Mackintosh, 1974; Moore, 1973; Schwartz & Gamzu, 1977) is that some skeletal movements (sign tracking in general and autoshaping in particular) can be conditioned via a Pavlovian procedure. A positive contingency between presentations of an illuminated key

and access to a grain hopper (that is, a stimulus-reinforcer relationship) is sufficient to produce directed pecking in the pigeon. Another view, however, is that autoshaped behavior is the result of an adventitious instrumental contingency. Since access to grain would accidentally follow a peck to the lighted key by only a short interval, this would increase the probability of further pecks to the key. Key pecking, presumably, would then be superstitiously maintained due to an accidental response-reinforcer relationship.

Two methods have typically been used to separate the effects of response-reinforcer and stimulus-reinforcer relations in autoshaping. One such method is the omission procedure under which the effects of the response-reinforcer relationship oppose the effects of the stimulus-reinforcer relationship. Williams and Williams (1969) applied this method to the basic autoshaping procedure. One group of birds was exposed to presentations of a 6 sec key light followed by grain presentation with an intertrial interval that averaged 30 sec, however pecks to the lighted key turned off the key and prevented delivery of the scheduled grain. Key pecking was both generated and maintained under this procedure although a negative response-reinforcer contingency was in effect. These results are consistent with the view that it is the stimulus-reinforcer relationship that is primarily responsible for autoshaped behavior.

The other method which has been used to separate the effects of stimulus-reinforcer and response-reinforcer relationships is to allow the subject to observe the stimulus-reinforcer relationship while somehow preventing approach toward or contact with the CS and/or US. Under this procedure the subjects would be allowed to only passively observe the stimulus sequence, and a response-reinforcer effect would presumably not occur since no approach or contact responses would be available to be strengthened. Typically this procedure is instituted by blocking the subject's access to the CS or the US with a barrier inserted between the subject and the response key and/or grain hopper.

A number of experiments in which subjects were physically prevented from contacting the CS or US have been performed. In one of these (Kirby, Muir, & Moore, cited in Moore, 1973, and Hearst & Jenkins, 1974) pigeons were exposed to a standard autoshaping procedure, but a hardware cloth screen prevented them from coming within several inches of the response key. The subjects were allowed to eat when the grain was presented. During a series of unreinforced test trials with the barrier removed, all birds approached and pecked the lighted key on the first or second trial it was available. Two other birds had observed both 60 trials with a CS+ and 60 trials with a CS- while the barrier was in place. In the unreinforced test

phase they made an average of 214 pecks to the CS+ and no pecks to the CS-. It is important to note, however, that during the training phase of the experiment the birds pointed their beaks and made biting movements in the direction of the inaccessible CS+.

In a similar experiment, Browne and Karpicke (cited in Hearst & Jenkins, 1974, and in Hearst, 1975) first magazine trained their pigeons, then inserted a plexiglass shield in front of the stimulus panel which blocked access to both the CS and US. Different groups of birds observed a positive, negative, or zero contingency between 6 sec key lights and presentations of the inaccessible grain hopper for 2-3 sessions. These birds did not tend to make any consistent movements toward the CS or US after the first few trials of the observation phase. Next, the birds received a standard session of autoshaping with the plexiglass shield removed. During this test session the positive, zero, and negative contingency groups averaged 263, 104, and 55 responses to the key respectively. The behavior of the birds revealed that they had learned the predictive relationship between the key light and food presentations.

Parisi and Matthews (1975) have also obtained results indicating that pigeons can learn a predictive relationship between a CS and US. Subjects were first given four days of magazine training. Next three groups of birds, a posi-

tive contingency group, a random control group, and a group which received neither presentations of the CS or of the US, were exposed to one session (35 trials) of observation training during which access to both the response key and the grain hopper was prevented by an acrylic barrier. With the barrier removed, three sessions of standard autoshaping and one session of omission training followed. A significant difference was reported between the positive contingency group and the random control group for cumulated response trials during the first three test sessions. The rate of acquisition of pecking was found to be greatest for the positive group, and least for the random group.

Browne (1976) performed two experiments in which he attempted to evaluate the role of overt movements and primary reinforcement in autoshaped behavior. In the first experiment, pigeons were given five sessions of magazine training. The next three sessions comprised the observation phase, during which a transparent shield was placed in front of the grain hopper. Thus, the grain was visible but inaccessible during the US presentations. Throughout the observation phase the response key was accessible and pecks to it were recorded. Different groups of birds observed positive, zero, and negative contingencies between the key light and the inaccessible grain. Another group received presentations of the inaccessible grain, but no presentations of the key light. The shield over the grain

hopper was then removed and the subjects given three "free" food presentations. For the next five sessions, the auto-shaping transfer phase, a standard autoshaping procedure was employed. During this phase the birds in the positive contingency group tended to peck sooner, on a greater proportion of trials, and at higher rates than birds from the other groups. For subjects in all groups pecks to the key were infrequent during the observation phase.

Browne's second experiment was performed to determine whether the positive contingency birds had learned to approach the response key or the negative contingency birds had learned to withdraw from the response key during the observation phase. A "long-box" was used with the grain hopper in the center of the front wall and the response key at one end. The subject's position in the box could be recorded via hinges and microswitches in the floor of the box. The procedure was similar to that of the first experiment: magazine training, followed by an observation phase, then followed by an autoshaping transfer phase. During the observation phase, Browne found that there was no tendency for the positive group to stand near the response key, or for the negative group to withdraw from it. However, when the grain hopper shield was removed and a standard auto-shaping procedure instituted, the positive contingency birds approached the response key significantly more than the negative birds on the first day of the test phase.

Browne concluded from these two experiments that what was learned during the observation phase was the relationship between two stimuli, rather than any overt movements. He considered his findings to be consistent with the general cognitive notion that subjects in animal experiments may learn about relationships between environmental events rather than simple associations between stimuli and responses. This investigation and others cited above indicate that animals can learn about contingencies among stimulus events, although no primary reinforcement is delivered, and although no consistent changes in overt behavior can be observed. The results of these types of experiments led Hearst (1975) to propose that the perception of stimulus-reinforcer contingencies tends to precede and direct behavior toward the most reliable predictor of a US.

This type of learning in animals would appear to be quite adaptive from an ethological point of view. Valid arguments have been made that the ecological niche of a species should be considered in attempts to explain behavior (Breland & Breland, 1966). In their natural environments those animals which approach stimuli that predict food tend to come into contact with food, and those animals which approach stimuli that predict a mate tend to come into contact with a mate (much research has been performed by ethologists on stimuli which are releasers for mating behavior, Eibl-Eibesfeldt, 1975).

There are, however, a number of problems in generalizing from laboratory experiments to the behavior of animals in their natural environments. One such problem is that in experimental studies animals are usually severely food deprived. Moran (1975) has discussed some of the problems regarding the exclusive use of severely food deprived subjects to formulate general laws of behavior. He concludes that severe food deprivation is an acute and abnormal condition for subjects, and that the behavior of a severely deprived subject may not be representative of the normal behavior of the species.

Although animals in their natural habitats are rarely subjected to conditions of severe food deprivation, it is quite possible that they can learn about relationships between environmental events. The two experiments presented here are an attempt to determine if pigeons can in fact learn about stimulus-reinforcer relationships while in a nondeprived state. It is important to point out that a distinction is being made here between learning and performance. This distinction implies that learning may occur in the absence of any overt behavioral change and that some assessment of performance will be necessary after the learning has occurred in order for this learning to be detected. In this respect these experiments (as were the observation experiments cited above) are similar to some of the classic latent learning studies (see Thistletwaite, 1951 for a review).

The present experiments are different from the classic investigations of latent learning in that Pavlovian procedures were employed and some primary reinforcement (magazine training) was delivered before presentations of the CS and US began.

The general plan of these experiments was to expose different groups of nondeprived pigeons to different contingencies between key light and grain presentations. Although differential behavior between the groups of birds was not expected to occur during this nondeprived conditioning phase, learning was expected to occur. That is, the prediction being made was that pigeons are capable of learning about relationships between events in the environment while in a nondeprived state. In order to assess if any learning had indeed occurred the birds in all of the groups were deprived and exposed to a standard autoshaping procedure. Differential facilitation of autoshaped behavior would indicate that some learning has occurred during the nondeprived training phase.

### Experiment I

This experiment was an attempt to determine if pigeons can learn about simple contingencies between environmental events while nondeprived. Different groups of birds were exposed to positive, negative, or zero relationships between presentations of a key light and grain while in a nondeprived state. In addition two control groups were run, a CS-only group which received only presentation of the key light, and the Hold group which received no preexposure to the CS or the grain. The birds in all groups were then deprived and exposed to a standard autoshaping procedure to determine if any learning had occurred during the nondeprived stage.

### Method

Subjects The subjects were 40 experimentally naive barn pigeons maintained at their free feeding weights during the nondeprived contingency phase of the experiment, and at approximately 75% of their free feeding weights during the magazine training phase and the deprived autoshaping phase. The birds were maintained with a grain mixture (50% wheat, 50% milo) presented both in their home cages and as the US in the experimental chamber via a grain hopper.

Apparatus All experimentation was conducted in two 3/4 inch plywood pigeon chambers with standard relay programming equipment located in an adjacent room. These chambers had internal dimensions of 32 cm X 26 cm X 43.5 cm. A Grason Stadler response key was mounted in the center of one wall 17.5 cm above a wire mesh floor of each chamber. Directly below each key, 5 cm from the floor was an opening 5.2 cm X 6.4 cm allowing access to a grain hopper. The response key was transilluminated by a chromatic stimulus of peak wavelength 555 nm projected from an Industrial Electronics display cell equipped with No. 44 miniature lamps. Noise from a ventilation fan was continuously present in the chamber to mask extraneous sounds. A 7 watt, 110 volt houselight mounted in the upper corner opposite the key provided constant diffuse illumination in the chamber except during US presentations when a magazine light

operated. The grain magazine was equipped with a photo-cell to measure eating behavior during all phases of the experiment.

Procedure This experiment had three consecutive phases: magazine training and free grain delivery (subjects deprived), a contingency phase (subjects nondeprived), and an autoshaping test phase (subjects deprived).

Phase 1: Magazine training and free grain delivery. All birds were reduced to and maintained at approximately 75% of their free feeding weights for this phase of the experiment. During the first session the pigeons were trained to approach and promptly eat from the grain hopper when it was presented. For the following two sessions the subjects received presentations of free unsignalled grain according to a variable interval time schedule with a mean of 60 sec (VT-60 sec) and a range of 15 to 120 sec. During these sessions grain presentations lasted for 3.5 sec, and each session ended after about 30 presentations of the grain.

Phase 2: Contingency phase. Before this phase was begun all birds were allowed to return to their free feeding weights and divided randomly into five groups of eight each. Throughout the course of this phase the subjects were allowed to feed ad lib in their home cages.

The contingency phase consisted of five sessions. Three groups of pigeons were exposed to presentations of

the CS (6 sec illumination of the response key with a light of 555 nm) in some temporal relation to the US (presentation of the grain hopper 3.5 sec). For the Signal group the CS was presented according to a VT-60 sec schedule, and simultaneously with the CS offset the grain was presented. For the Truly Random group the CS and the grain were presented according to independently operating VT-60 sec schedules. For the Unpaired group, CS presentations and grain presentations were programmed by separate, independently operating, VT-60 sec schedules. Onset of the CS initiated a 26 sec negative period (6 sec while the key was illuminated and the immediately succeeding 20 sec) during which neither schedule was in operation, that is no grain presentations or CS presentations were made during this time. A fourth group, the CS-only group was exposed to an equal number of CS presentations as the three preceeding groups, but was not exposed to any grain presentations during this phase. Finally a fifth group, the Hold group received no training during this phase of the experiment. Each session of the contingency phase ended after about 50 presentations of the CS and pecks to the key were recorded for birds in all of the groups.

Phase 3: Autoshaping test phase. All of the subjects were again reduced to and maintained at approximately 75% of their free feeding weights. At the start of the next session after the bird was placed in the chamber, the grain

hopper was presented and held until the pigeon had eaten from it for about 3 sec. Two more presentations of grain were offered. This magazine training was to insure that all birds would eat readily from the grain hopper during the test series which followed.

The autoshaping test phase followed immediately afterward. Each session consisted of 40 presentations of the CS and US. For subjects in all groups trials consisting of the 6 sec CS followed by immediate presentations of the grain hopper occurred according to a VT-60 sec schedule. All birds were exposed to five sessions in this phase. Key pecks were recorded.

## Results

Contingency phase (subjects nondeprived). There was no consistent pecking at the illuminated response key for birds in any of the groups during this phase of the experiment. Pigeons in the Signal group did peck slightly more---on an average of 2.75% of trials. The larger number of trials with pecks for the Signal group was primarily due to one bird (#29) on one day (session 3), who accounted for 91% of all the trials with pecks for the Signal groups during this phase. Analysis of variance tests indicated that differences between the groups were not significant for two measures, number of trials with pecks or number of pecks per trial. To further indicate the similarity of these groups during the nondeprived phase, the median number of trials with at least one peck over all five sessions was 0 for all of the groups except the Unpaired group for which the median was .5.

The birds also showed no consistent eating behavior during this phase. The average per cent of trials on which eating occurred ranged from 1.13% for the Truly Random group to 1.75% for the Unpaired group.

Nonsystematic visual observation of the birds in all of the groups during this phase revealed no tendency for any of the pigeons to approach or withdraw from the key light. Rather, the birds tended to crouch in a corner and watch the key light and grain presentations.

Autoshaping test phase (subjects deprived). When the pigeons were again deprived and given standard autoshaping training, birds in the Signal group pecked sooner than birds in the other groups. The trial of the first peck for pigeons in each group is presented in Table 1. A Kruskal-Wallis one way analysis of variance by ranks yielded a significant treatment effect ( $H=19.4$ ,  $df=4$ ,  $p<.001$ ). Mann-Whitney  $U$  tests showed that birds in the Signal group and Hold group pecked significantly sooner than birds in any of the other groups ( $U_s \leq 11$ ,  $ps < .03$ ). No other between group comparisons yielded statistically significant differences for the trial of the first peck.

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Insert Table 1 about here

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Since some birds in all of the groups tended to peck on an early trial and not to peck again for a number of trials another measure, the first trial of three consecutive trials with at least one peck, was analyzed. The data for this measure also appear in Table 1. An nonparametric one way analysis of variance disclosed a significant treatment effect ( $H=11.84$ ,  $df=4$ ,  $p<.02$ ). Rank tests indicated that birds in the Signal and the Hold groups were significantly different from birds in the Unpaired and CS-only group ( $U_s \leq 12$ ,  $ps < .04$ ). No other between group

Table Caption

Table 1: Trial of the First Response and First Trial of  
Three Consecutive Trials with a Response for each Subject  
in each Group.

Table 1

Trial of the First Response and  
First Trial of Three Consecutive Trials with a Response

| Group           | Subject | Trial of the<br>1st Response | 1st Trial of<br>3 Consecutive Trials<br>with a Response |
|-----------------|---------|------------------------------|---------------------------------------------------------|
| Signal          | 3       | 1                            | 1                                                       |
|                 | 406     | 1                            | 19                                                      |
|                 | 29      | 5                            | 8                                                       |
|                 | 24      | 5                            | 36                                                      |
|                 | 5       | 7                            | 22                                                      |
|                 | 19      | 7                            | 12                                                      |
|                 | 419     | 13                           | 13                                                      |
|                 | 8       | 16                           | 86                                                      |
|                 |         | Median = 6                   | Median = 16                                             |
| Hold            | 20      | 2                            | 20                                                      |
|                 | 22      | 3                            | 10                                                      |
|                 | 403     | 6                            | 6                                                       |
|                 | 27      | 14                           | 45                                                      |
|                 | 413     | 22                           | 31                                                      |
|                 | 17      | 26                           | 31                                                      |
|                 | 23      | 29                           | 29                                                      |
|                 | 11      | 42                           | 45                                                      |
|                 |         | Median = 18                  | Median = 30                                             |
| Truly<br>Random | 26      | 17                           | 17                                                      |
|                 | 28      | 17                           | 33                                                      |
|                 | 18      | 28                           | 28                                                      |
|                 | 2       | 31                           | 31                                                      |
|                 | 15      | 31                           | 42                                                      |
|                 | 404     | 42                           | 56                                                      |
|                 | 7       | 46                           | 46                                                      |
|                 | 420     | 50                           | 63                                                      |
|                 |         | Median = 31                  | Median = 37.5                                           |
| Unpaired        | 417     | 1                            | 20                                                      |
|                 | 6       | 29                           | 41                                                      |
|                 | 12      | 35                           | 48                                                      |
|                 | 25      | 36                           | 38                                                      |
|                 | 30      | 45                           | 51                                                      |
|                 | 13      | 55                           | 55                                                      |
|                 | 9       | 56                           | 56                                                      |
|                 | 412     | 59                           | 59                                                      |
|                 |         | Median = 40.5                | Median = 49.5                                           |
| CS-only         | 21      | 16                           | 35                                                      |
|                 | 402     | 28                           | 31                                                      |
|                 | 1       | 29                           | 35                                                      |
|                 | 409     | 30                           | 30                                                      |
|                 | 14      | 43                           | 50                                                      |
|                 | 16      | 61                           | 66                                                      |
|                 | 10      | 67                           | 67                                                      |
|                 | 4       | 91                           | 114                                                     |
|                 |         | Median = 36.5                | Median = 42.5                                           |

comparisons revealed any significant differences with regard to this measure.

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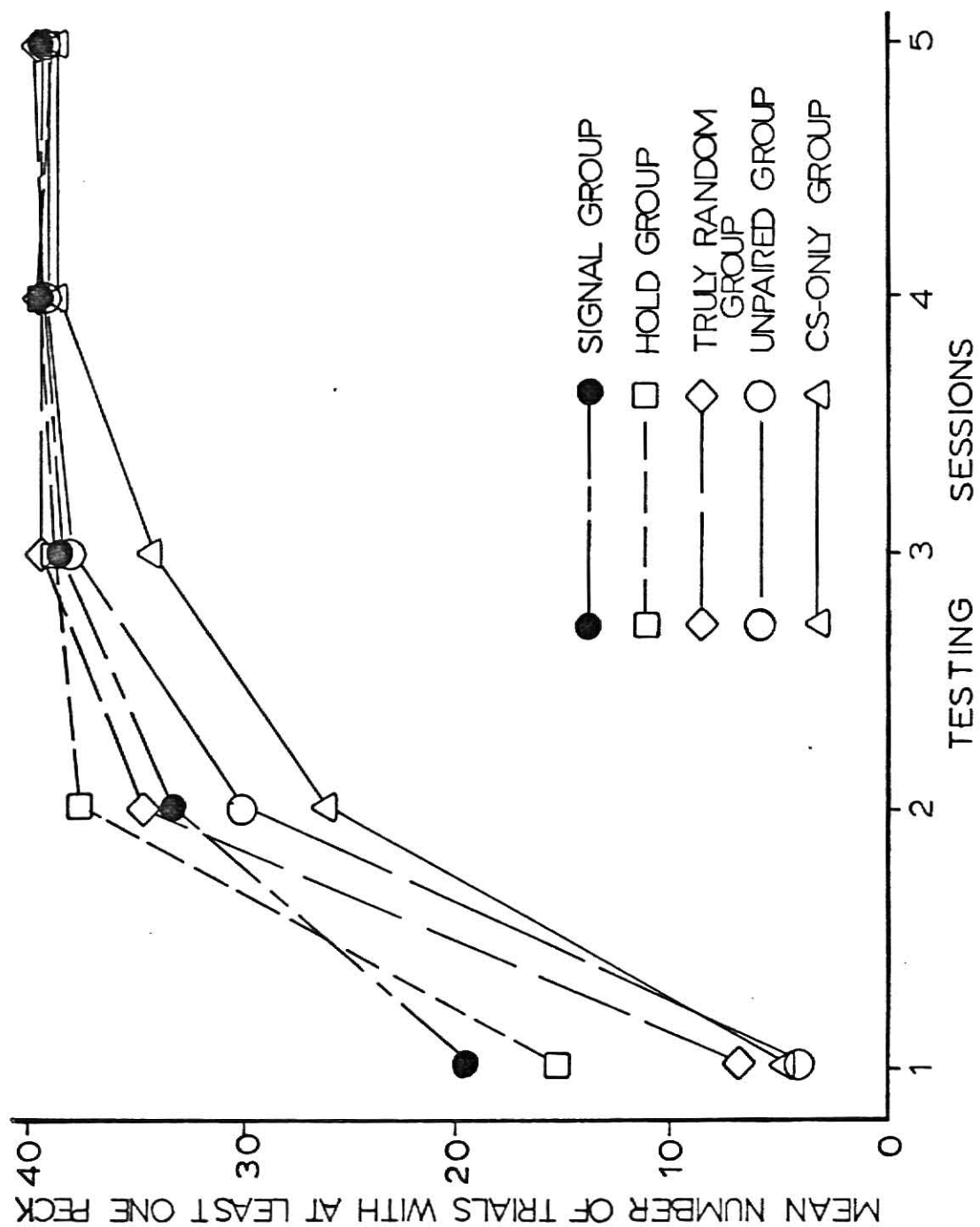
Insert Figure 1 about here

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Mean number of trials with at least one peck during each of the five autoshaping test sessions are given in Figure 1. A two way analysis of variance for repeated measures revealed significant differences between Groups,  $F(4,35)=3.17$ ,  $p<.03$ , and over Days,  $F(4,140)=170.8$   $p<.01$ . An independent comparison (Newman-Keuls), indicated that the Signal and Hold group were significantly different from the CS-only group. In addition there was a significant Groups by Days interaction,  $F(16,140)=2.29$ ,  $p<.01$ . This interaction was analyzed with independent comparisons (Newman-Keuls) of group means at different sessions of the testing phase. During session 1 the Signal group was not found to differ significantly from the Hold group, neither were the Truly Random, CS-only, or Unpaired groups found to be significantly different from one another. However, both the Signal and the Hold group differed significantly from the Truly Random, CS-only, and Unpaired groups. During session 2 the only difference that was significant was between the Hold and CS-only groups. No significant differences were found between the groups for the next

Figure Caption

Figure 1: Mean Number of Trials with at Least one Peck during the Autoshaping Test Sessions.



three sessions.

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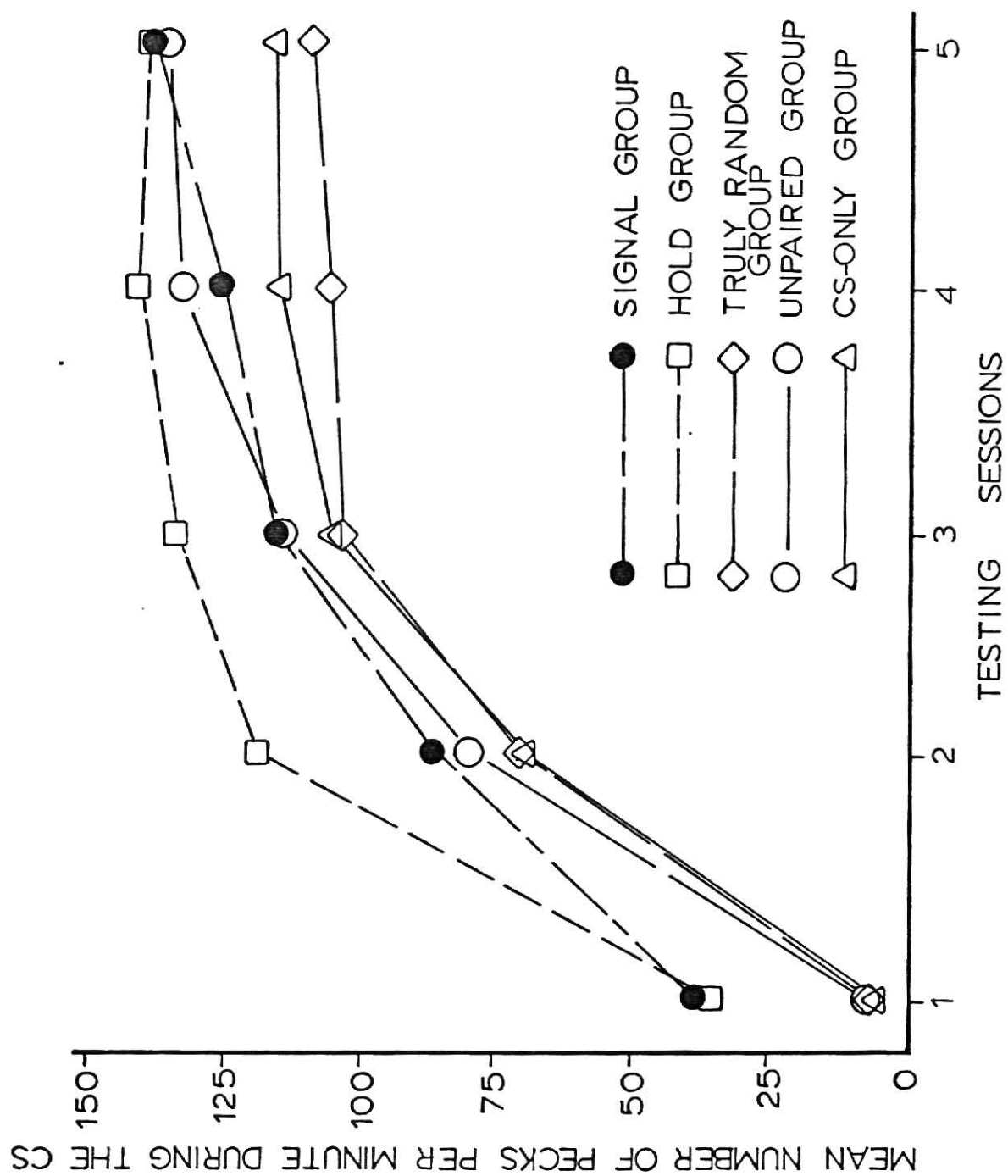
Insert Figure 2 about here

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Mean rate of pecking during the CS was also calculated for each group during the testing sessions. As Figure 2 shows, this measure did not differ as clearly between the groups. Although a two way repeated measures analysis of variance yielded a significant Groups effect,  $F(4,35)=3.06$ ,  $p<.03$ ; and a significant Days effect,  $F(4,140)=138.8$ ,  $p<.01$ . Independent comparisons (Newman-Keuls) indicated that the only significant differences were between the Hold group and the CS-only group; and between the Hold and the Truly Random group.

Figure Caption

Figure 2: Mean Number of Pecks During the CS Within Each Test Session.



### Discussion

That the birds in the Signal group acquired the pecking response more rapidly than birds in the Truly Random, Unpaired, and CS-only groups indicates that pigeons can learn about relationships between environmental events while in a nondeprived state. The absence of a difference between the Signal and Hold groups on all of the measures might be attributed to a "ceiling effect". That is, with the parameters used in the test phase of this experiment the key pecking response is acquired quite rapidly and maintained at a high rate unless the subjects have been exposed to conditions that retard subsequent acquisition of autoshaping.

The birds in the Truly Random, Unpaired, and CS-only groups were exposed to precisely such conditions. While nondeprived, subjects in the Truly Random group may have learned that the CS and US were unrelated and this would have interfered with acquisition of the positive relationship between these events. The pigeons in this group also exhibited a lower asymptote for rate of pecking than did birds in the Hold group. These findings are consistent with those of other investigators (Gamzu & Williams, 1971, 1973; Mackintosh, 1973) who have found that prior exposure to random presentations of a key light and food interfered with subsequent autoshaping behavior, specifically resulting in lower asymptotic rates of pecking. Likewise the

birds in the Unpaired group acquired information about the negative relationship between the key light and grain presentations which retarded subsequent acquisition of the positive stimulus-reinforcer relationship. It is unclear as to why the pigeons in the Unpaired group eventually acquired a rate of pecking equal to that of the birds in the Signal and Hold groups.

The behavior of the CS-only group could be interpreted in terms of latent inhibition. Nonreinforced preexposure of a stimulus has been found on numerous occasions to interfere with subsequent conditioning to that stimulus (e.g. Lubow, 1973; Siegal, 1972). Indeed the birds in this group seem to suffer from a greater retardation effect with respect to the number of trials with pecks than do birds in the other groups. This finding is not consistent with that of Mackintosh (1973) who obtained results indicating that deprived pigeons given prior exposure to random key light and grain presentations were retarded more than deprived pigeons given prior exposure to key light presentations only. The results of Mackintosh were only marginally significant and the measure he used was rate of pecking, however for that same measure used in this experiment no significant differences were found between the Truly Random and the CS-only groups. The difference between the results reported here and those of Mackintosh could be due to differences in procedural details or to the fact that the

pigeons were nondeprived during the preexposure in this experiment. It is clear however, that in this experiment the birds in the Truly Random, CS-only, and Unpaired groups were retarded in the acquisition of autoshaped behavior relative to the birds in the Signal and Hold groups.

Thus differential behavior between the groups during the test phase revealed that some learning had occurred during the nondeprived training phase, although no consistent pecking was evidenced in this phase. Since intermittent visual observation also failed to reveal any differential approach behavior between groups, these findings are incompatible with an analysis of autoshaping that is based on the accidental reinforcement of pecking. Rather these results are consistent with the view that subjects in animal experiments are capable of learning about relationships between environmental events, and this learning can occur while the subjects are nondeprived.

## Experiment II

The results of Experiment I indicated that nondeprived pigeons can acquire knowledge about simple relationships between key light and grain presentations. This experiment attempted to determine if pigeons could also learn about more than one stimulus-reinforcer relationship. Specifically this investigation attempted to determine if these birds could learn to discriminate between two colors of key lights while nondeprived. Different groups of birds were exposed to presentations of two colors of key lights each related in some way to grain presentations. The pigeons were then all deprived and exposed to a Pavlovian discrimination training procedure to determine if learning had occurred during the nondeprived stage.

## Method

Subjects The subjects were 36 experimentally naive White Carneaux pigeons obtained from the Palmetto Pigeon Factory maintained at their free feeding weights during the non-deprived training phase of the experiment, and at approximately 75% of their free feeding weights during the magazine training phase and the discrimination testing phase.

Apparatus The apparatus was the same as that used in Experiment I.

Procedure This experiment had three consecutive phases: magazine training and free grain delivery (subjects deprived), a differential training phase (subjects nondeprived), and a discrimination testing phase (subjects nondeprived).

Phase 1: Magazine training and free grain delivery. All birds were reduced to and maintained at 75% of their free feeding weights for this phase of the experiment. This phase was identical to the magazine training phase in the first experiment.

Phase 2: Differential training phase. All birds were allowed to return to their free feeding weights before this phase was begun. Throughout this phase subjects were allowed to feed ad lib in their home cages. Thirty-two of the subjects were divided randomly into four groups of eight birds each.

Three groups of birds were exposed to presentations

of the CS+, the CS-, and the US (3.5 sec presentation of the grain hopper). The stimuli used for the CS+ and the CS- were 6 sec illuminations of the response key with lights of 555 nm or 538 nm. These two colors of key light were counterbalanced such that for half of the birds in each group 555 nm was the CS+ and 538 nm was the CS-, for the other birds the reverse was the case. For the True Discrimination (TD) group trials occurred according to a VT-60 sec schedule. Whether a CS+ or a CS- was presented on any particular trial was determined according to a quasi-random sequence with the restrictions that there were an equal number of CS+ and CS- presentations and that no more than three CS+ or three CS- trials could occur consecutively. Simultaneously with the offset of the CS+ the grain hopper was presented. The CS- had no programmed consequences. For the Psuedo Discrimination (PD) group presentations of the CS+ and CS- occurred according to a VT-60 sec schedule. Whether a CS+ or CS- was presented on any particular trial was determined according to a quasi-random sequence. Grain was presented immediately after the offset of a random half of each type of CS. The Reversal group (RV) was exposed to the same sequence of events as was the TD group except that the color corresponding to the CS+ during training would be the CS- during testing and the color corresponding to the CS- during training would be the CS+ during testing. In addition a con-

trol group, the Hold group, was included. This group received no training during this phase.

The nondeprived training phase lasted for six sessions. Each session consisted of 80 trials. Pecks to the key were recorded. If birds in any of the groups pecked on more than a total of twenty trials and ate on more than a total of 20 trials during this phase they were dropped from the study. This criterion resulted in the loss of 1 bird from the TD group and 2 birds each from the PD and RV groups. In reaction to this some birds were added to each of these groups. Since the number of birds added to each group was based on data collected on the first day of the training phase unequal group sizes resulted. These additional birds resulted in group sizes of 9 for the TD group, 7 for the PD group, and 7 for the RV group. The size of the Hold group remained at 8.

Phase 3: Discrimination testing phase. All of the subjects were again reduced to and maintained at 75% of their free feeding weights for this phase of the experiment. At the start of the next session the grain hopper was presented and held until the pigeon had eaten from it for about 3 sec. Two more presentations of grain were offered. This magazine training was to insure that all birds would eat readily from the hopper during the test sessions which followed.

The discrimination test phase followed immediately.

For subjects in all groups, trials consisting of either CS+ or CS- occurred according to a VT-60 sec schedule. Whether a CS+ or a CS- occurred was determined according to a quasi-random sequence with the restrictions that there were an equal number of CS+ and CS- trials and that no more than two consecutive trials of either type could occur. Grain presentation was simultaneous with the CS+ offset and the CS- had no programmed consequences. This procedure continued for seven sessions. Each session ended after 20 US presentations and key pecks were recorded.

## Results

### Differential training phase (subjects nondeprived).

With the exception of those 4 birds excluded for exceeding the pecking and eating criterion, no consistent pecking or eating behavior was evidenced during this phase. No significant differences were found between the groups for the number of CS+ trials during which a peck occurred, the number of CS- trials with a peck, or the number of trials on which eating occurred. The average per cent of CS+ trials pecked on, CS- trials pecked on, and of trials on which eating occurred was less than 1% for all of the groups.

As in Experiment I intermittent visual observation of the birds indicated that they did not approach or withdraw from the key lights. The subjects in all groups again tended to crouch in a corner and observe the key light and grain presentation.

### Discrimination testing phase (subjects deprived).

Based on the results of Experiment I it was assumed that birds in all of the groups would acquire the pecking response quite rapidly. Unfortunately this was not found to be the case. Some birds did not begin pecking until the fourth or fifth testing session. Since it was difficult to interpret the results obtained from such birds it was decided that unless a subject had pecked on at least 10 trials during session 3 of the test phase, the bird would

be dropped from the group before any statistical analyses were performed. This criterion resulted in the loss of 1 bird from the TD group, 2 birds from the PD group, 2 birds from the Hold group, and no birds from the RV group. The group's sizes were then 8, 5, 6, and 7 respectively.

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Insert Figures 3 and 4 about here

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The mean percentage of trials on which pecks occurred that were CS+ trials and the mean percentage of pecks during trials that were to the CS+ were computed and are presented in Figures 3 and 4. Statistical analyses on these measures failed to reveal either a significant Groups effect or a significant Groups by Days interaction. The mean number of CS+ trials with pecks and CS- trials with pecks are presented in Figure 5. Figure 6 shows the mean rate of pecking during the CS+ and CS-. All of these measures failed to yield any significant effects.

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Insert Figures 5 and 6 about here

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The median percentage of trials on which pecks occurred that were CS+ trials are presented in Figure 7. A Kruskal-Wallis nonparametric analysis of variance fail-

Figure Caption

Figure 3: Mean Per Cent of Trials with Pecks During CS+ Trials Within Each Test Session.

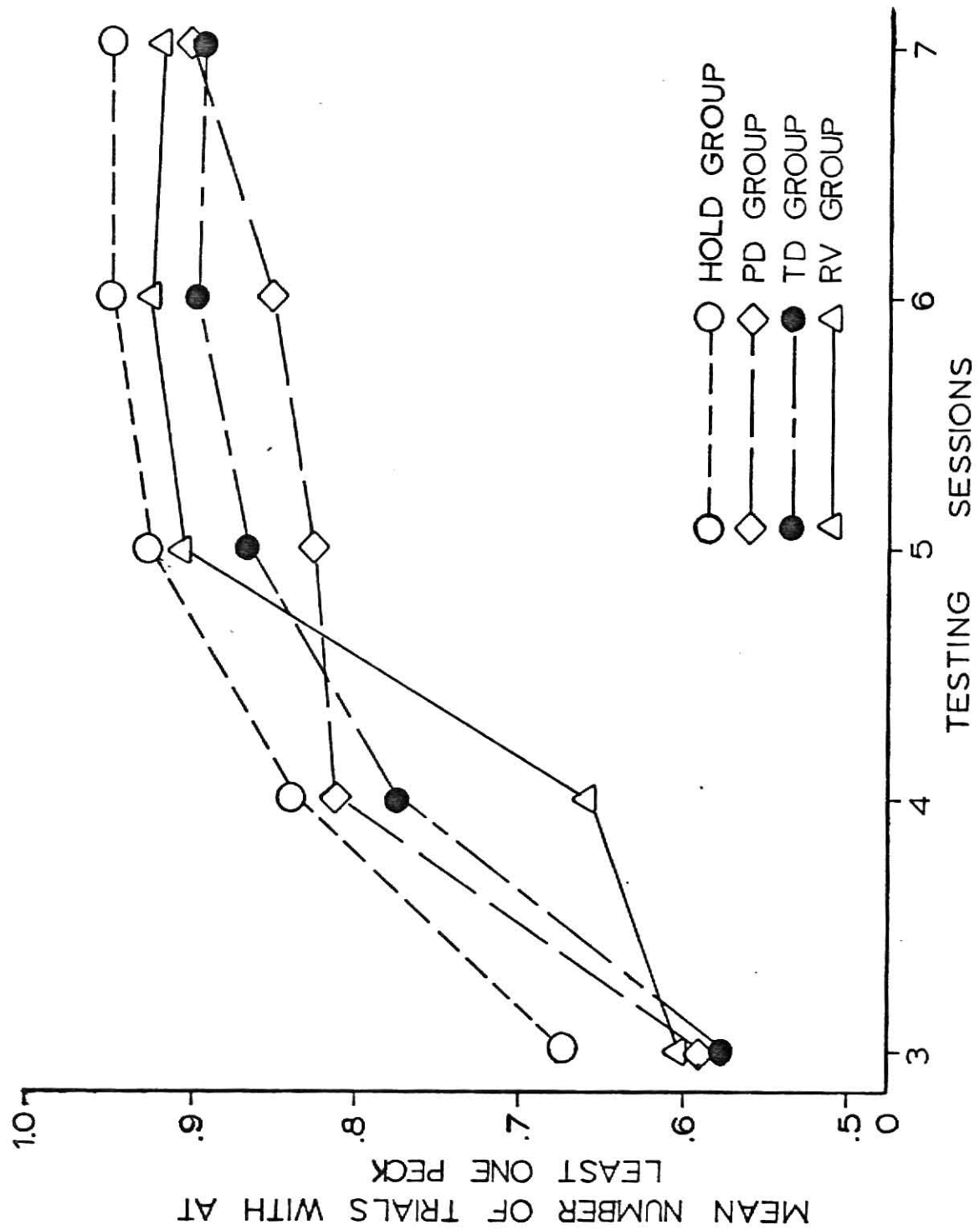


Figure Caption

Figure 4: Mean Percentage of Pecks During Trials to the CS+ Within Each Test Session.

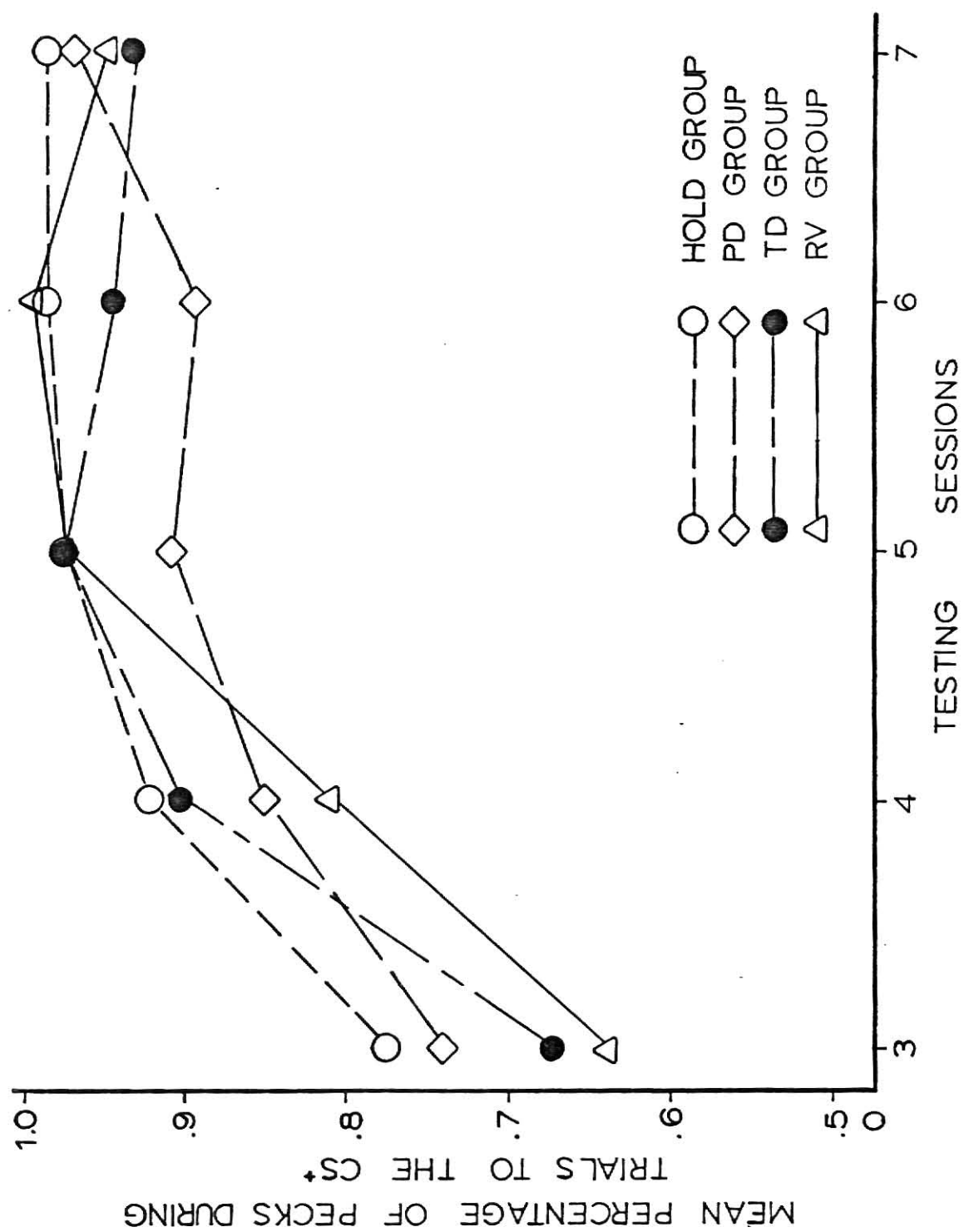


Figure Caption

Figure 5: Mean Trials with Pecks within each Test Session

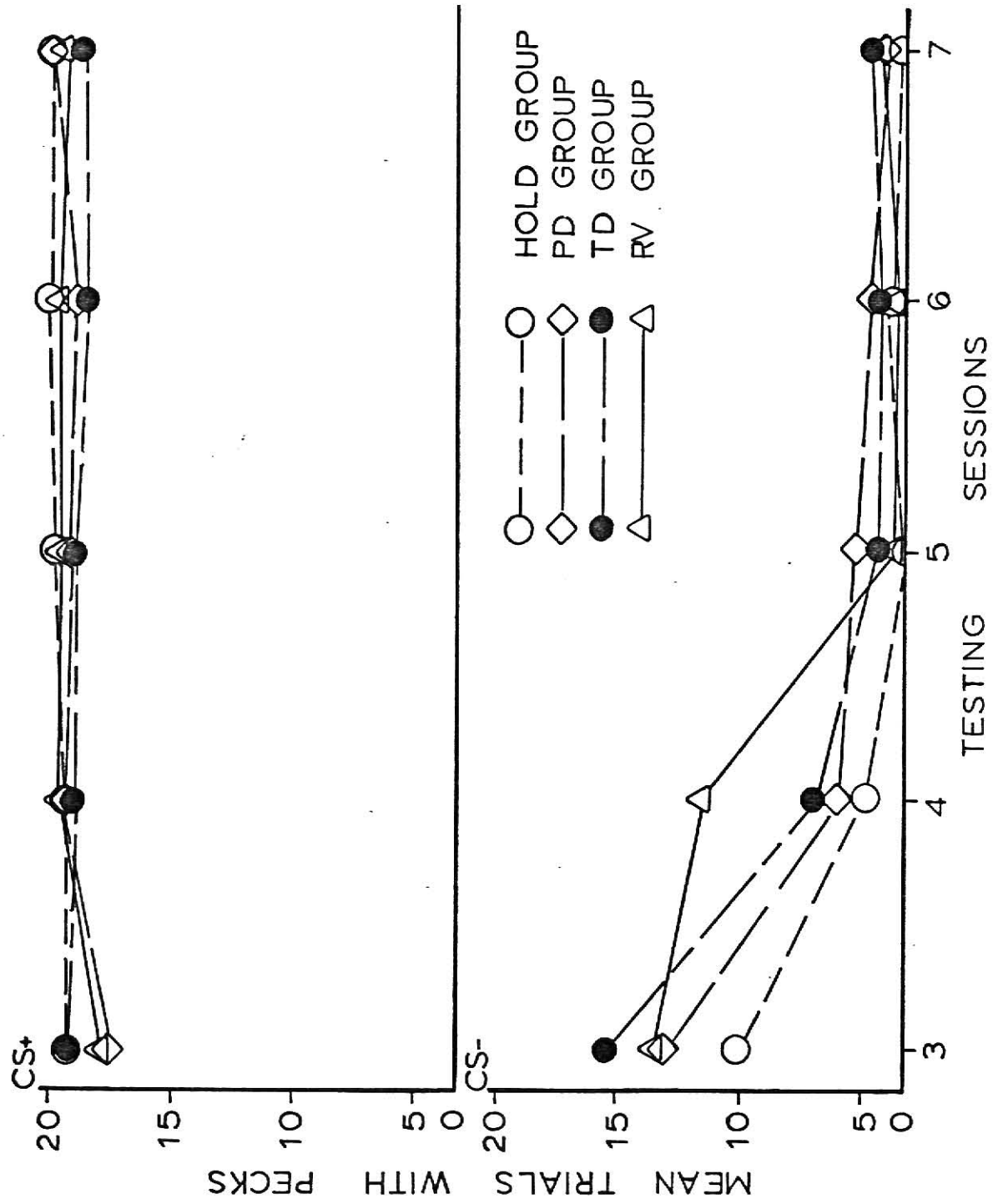
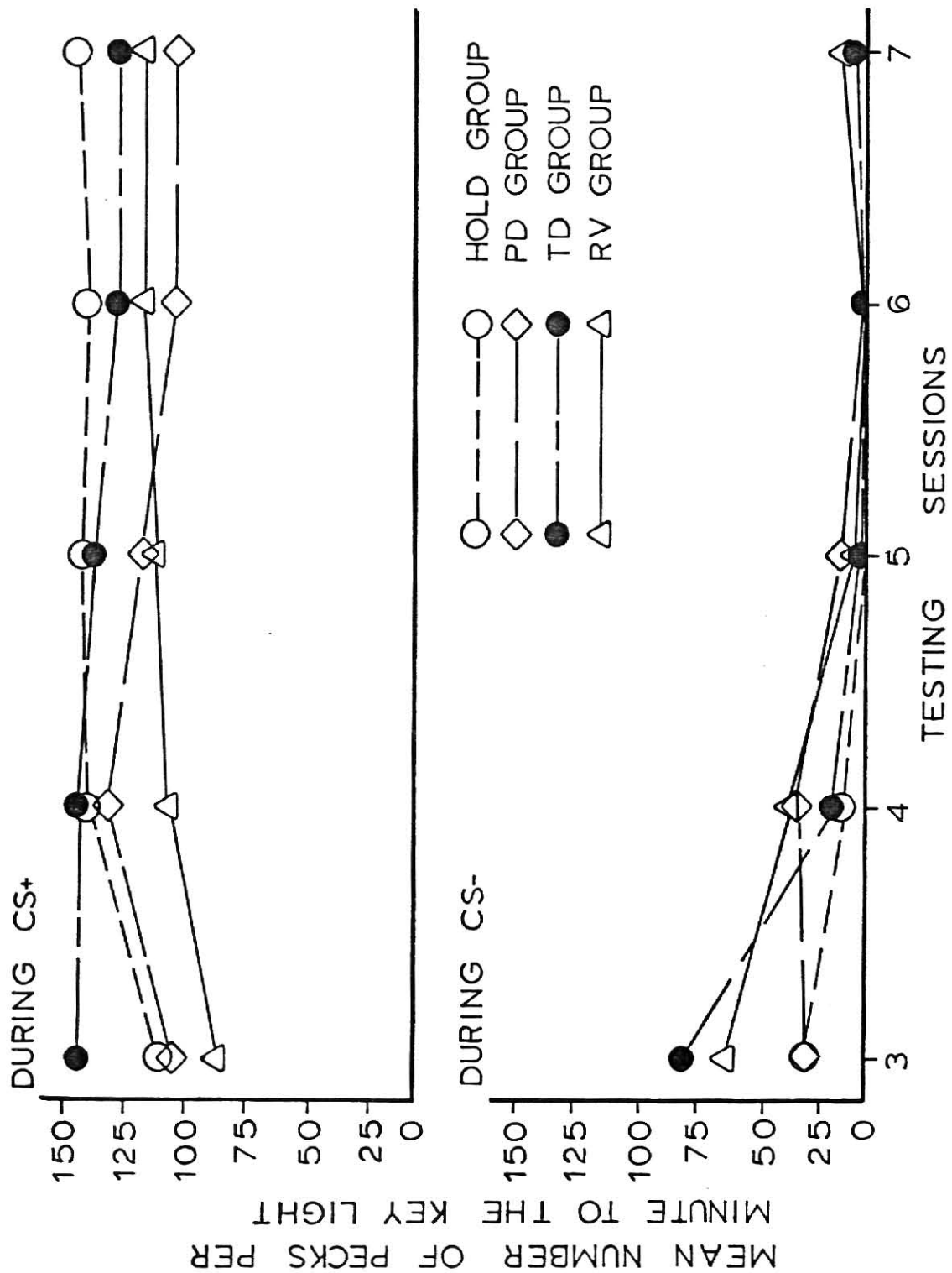


Figure Caption

Figure 6: Rate of Pecking to the CS+ and the CS- During each Session of the Testing Phase.



ed to yield significant differences between the groups for any of the sessions.

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Insert Figure 7 about here

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The median percent of pecks during trials to the CS+ are presented in Figure 8. No significant differences were found for this measure. The median rate of pecking to the CS+ and CS- were also computed and appear in Figure 9. The TD group appears visually quite different from the RV group on the median rate of pecking to the CS+. However the only significant difference found between these two groups was for session 3 (Mann-Whitney U test).

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Insert Figures 8 and 9 about here

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Since significant differences were difficult to obtain on the measures mentioned above the median trial of the first CS+ peck and the first CS- peck were analyzed in the hope that these would be more sensitive measure. These data are presented in Table 2. No group was found to peck significantly sooner on one type of CS than on the other, and no significant differences were found between groups for either the median trial of the first CS+ peck

Figure Caption

Figure 7: Median Per Cent of Trials with Pecks that were CS+ Trials During each Session of the Testing Phase.

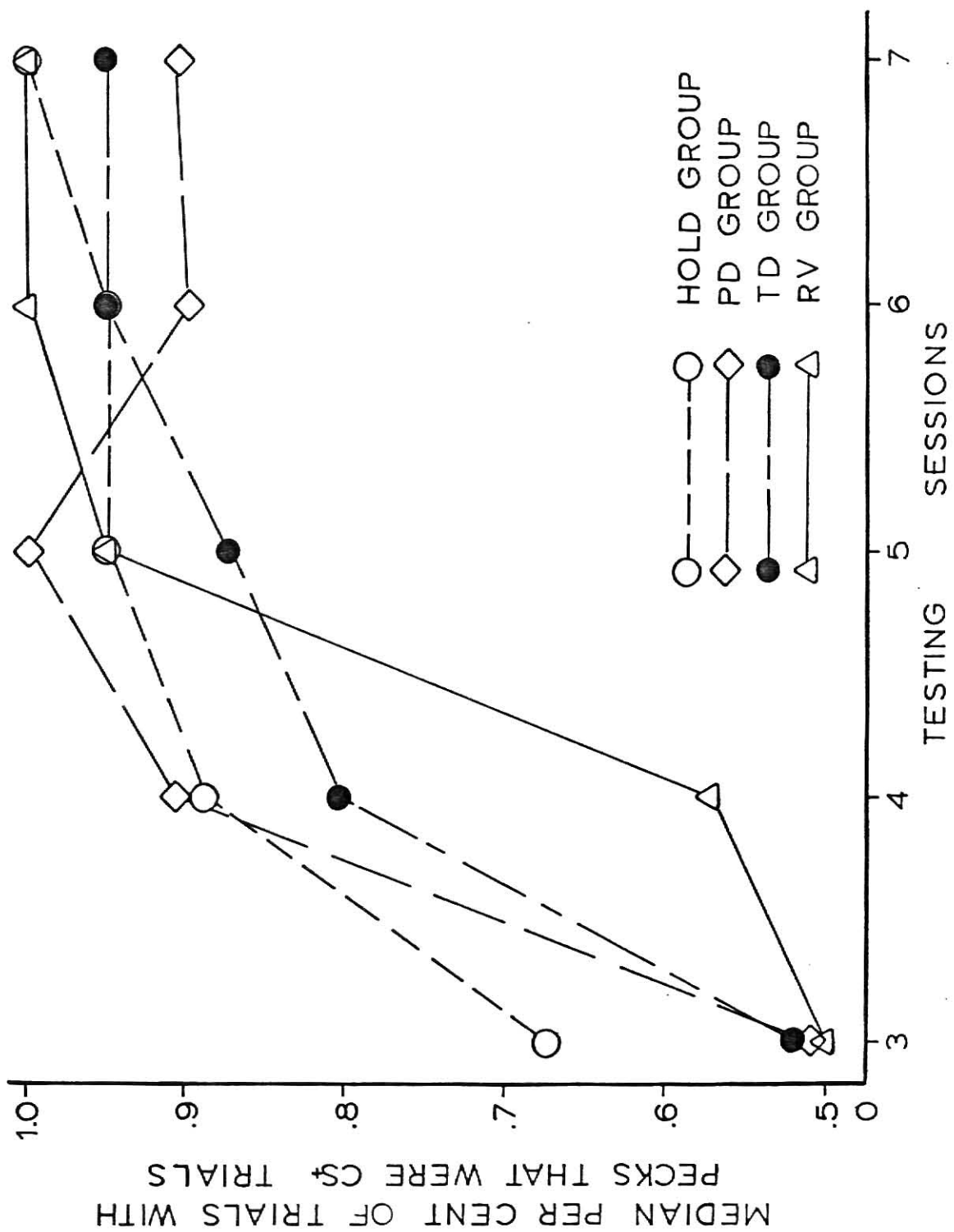


Figure Caption

Figure 8: Median Per Cent of Pecks During Trials to the CS+ during each Session of the Testing Phase.

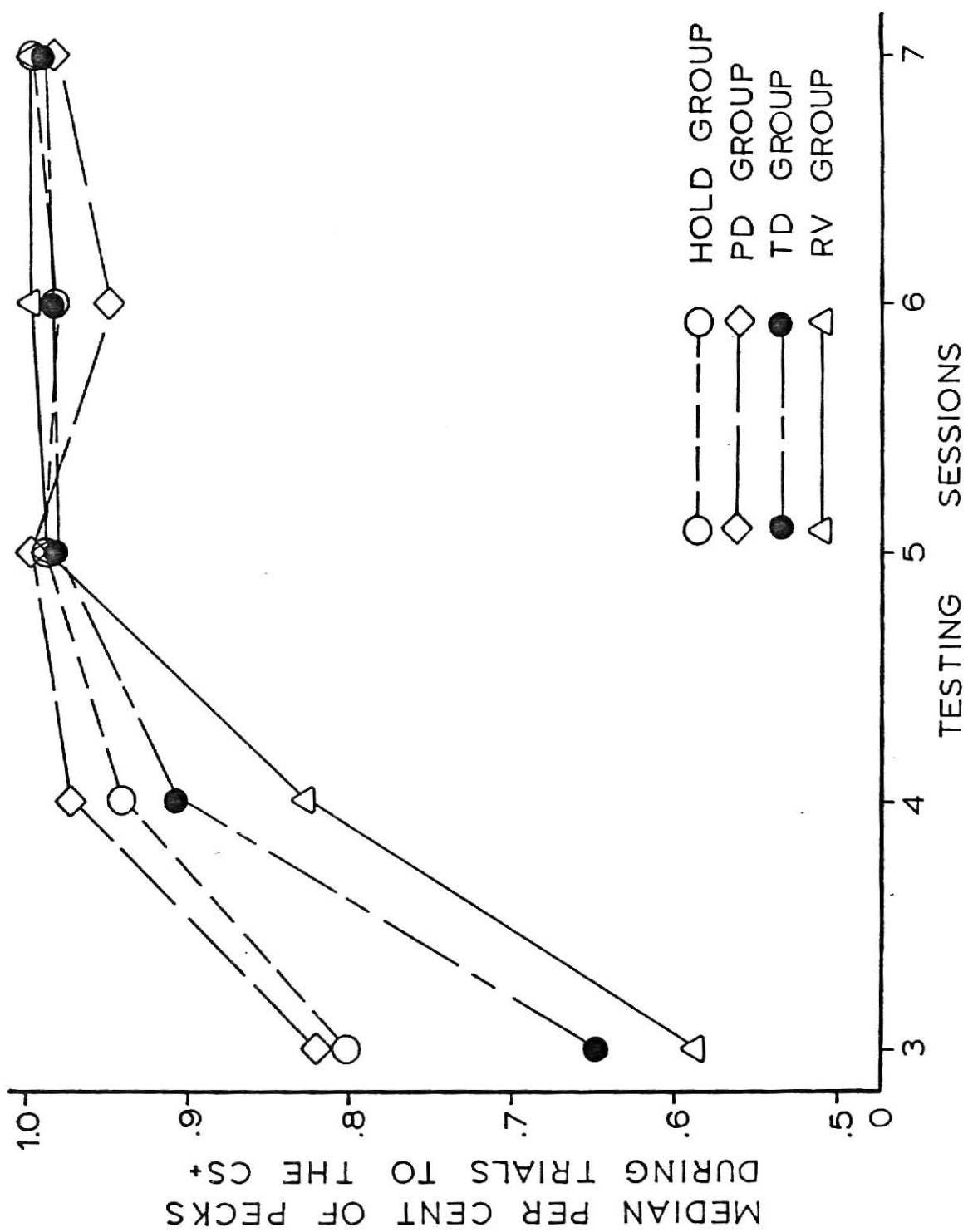
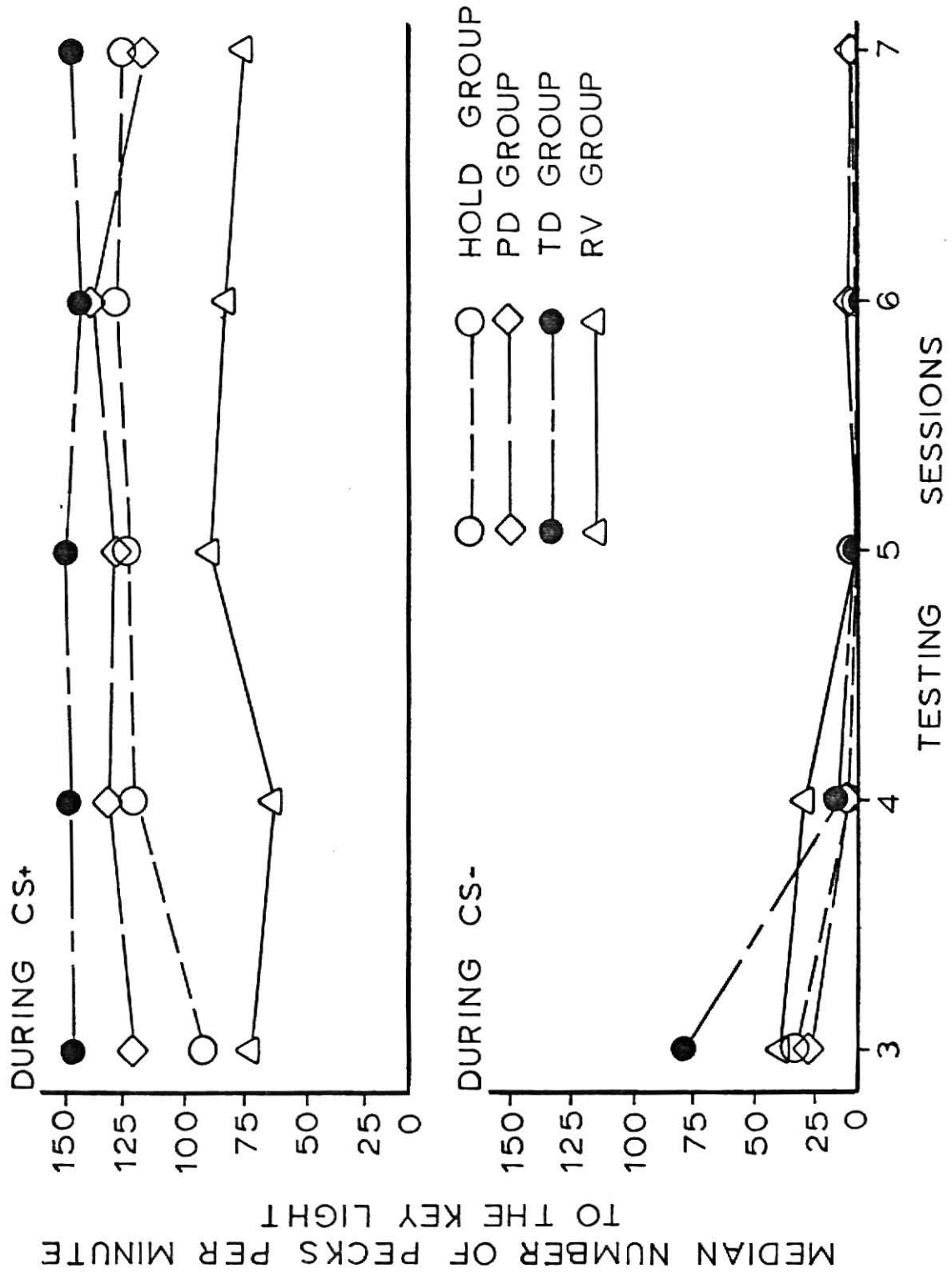


Figure Caption

Figure 9: Median Number of Pecks Per Minute to the Key  
Light during each Session of the Testing Phase.



or the median trial of the first CS- peck. In fact, the TD group birds pecked to the CS- on an earlier trial than to the CS+. If the pigeons had mastered the discrimination during the training phase, the differences for this group should have been in the opposite direction.

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Insert Tables 2 and 3 about here

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One final measure was analyzed. The data for the median number of CS+ trials with pecks out of the first 20 trials with pecks appear in Table 3. No significant differences were found between groups for this measure.

Table Caption

Table 2: Median Trial of the First Peck to the CS+ and the CS- for each Group.

Table 2

## Median Trial of First Peck

| <u>Group</u> | <u>CS+</u> | <u>CS-</u> |
|--------------|------------|------------|
| TD           | 27         | 24.5       |
| RV           | 24         | 21         |
| PD           | 12         | 22         |
| Hold         | 20.5       | 21.5       |

Table Caption

Table 3: Median Number of CS+ Trials with Pecks out of the  
First 20 Trials with Pecks for each Group.

Table 3

Median Number of CS+ Trials with Pecks  
Out of the First 20 Trials with Pecks

| <u>Group</u> | <u>Median Number of<br/>CS+ Trials with Pecks</u> |
|--------------|---------------------------------------------------|
| TD           | 11.5                                              |
| RV           | 11.86                                             |
| PD           | 11.6                                              |
| Hold         | 14                                                |

### Discussion

This experiment unfortunately failed to yield any evidence that would indicate that the birds had learned about the relationships between the different key light colors and grain presentations during the nondeprived phase. Some differential behavior between the groups should have occurred during the testing phase if the pigeons had learned while nondeprived. Although the RV group seemed to peck at a lower rate to the CS+ than did the TD or Hold groups these differences were only marginally significant and short lived at best. At any rate, the size of the effects obtained in this experiment did not approach the magnitude of those in Experiment I. Either the birds did not learn during the nondeprived phase, the large amount of variability in the data masked any differences that would have appeared, or the birds learned a general stimulus-reinforcer relationship but did not learn to differentiate between the two key light colors.

The results of the first experiment indicated that when this type of procedure is used, the differences between the treatment groups occur only during the early sessions of the test phase. Unfortunately the data points for these early sessions in this experiment were so unreliable, due to the number of birds that were not pecking at all, that they precluded the application of statistical analyses. Even if the differences did persist into the later sessions

of the test phase, the small and unequal number of subjects in each group would have provided little statistical power to detect them. For these reasons it is possible that pigeons can learn a discrimination while nondeprived, although this procedure may not be suitable to determine if this is in fact the case.

One possible way to have controlled for the small and unequal sample sizes would have been to expose all of the birds to a standard autoshaping procedure, using a white key light as the CS, until pecking was well established. The pigeons would then have been allowed to regain their free feeding weights before exposing them to the Pavlovian discrimination procedure. This would probably have insured that all of the birds would peck during the early trials of the testing phase; however, pilot data had indicated that if the birds had previously learned to peck the key, they would continue to do so even if nondeprived. The number of pigeons that pecked during the training phase of this experiment was a problem as it was, so this experimental manipulation was not performed.

Thus since there was no differential behavior between the groups during testing, this experiment failed to demonstrate that the pigeons had learned to discriminate between the two key light colors while nondeprived.

### General Discussion

These two experiments seem to lend themselves to different conclusions. Experiment I clearly indicated that the pigeons had learned about the relationships between key light and grain presentations while nondeprived. Experiment II, however, failed to demonstrate that the nondeprived birds learned to discriminate between the two key light colors. There were other differences between the behavior of the birds in these two experiments as well. During the nondeprived training phase of Experiment I only one bird displayed any tendency to peck the key; however, this bird did not eat from the grain hopper while nondeprived and pecked only during one session. In Experiment II, on the other hand, four birds exceeded a pecking and eating criterion and had to be dropped from the study.

There were some procedural differences between Experiment I and Experiment II that might be invoked to account for the differences in the birds' behavior. The pigeons in Experiment I were mixed breed barn pigeons while the birds in the second experiment were Palmetto while car-neauxs. The length of the nondeprived training session was greater in Experiment II (approximately 80 minutes) than in Experiment I (approximately 50 minutes) as well. Either of these differences might account for the different results that were obtained.

The discrepancy between the results of the test phases

of these two experiments can be dealt with by an analysis that does not appeal to differences in procedural details however. The results of Experiment I showed that pigeons could learn about a predictive relationship between a key light and the presentation of food while nondeprived. The results of Experiment II are not necessarily inconsistent with these findings, that is, the pigeons may have learned a general stimulus-reinforcer relationship but may not have discriminated between two colors of key lights while nondeprived. It is quite possible that since there was little if any differential reward to the pigeons for discriminating between the two key light colors, and since the two key colors that were used were highly similar (555 nm vs 538 nm) there was probably a large amount of generalization between the two key light colors during the nondeprived training phase.

For example, the TD birds might have learned that key light color 1 predicted food, and that key light color 2 predicted no food. Since, however, the positive relationship between key light color 1 and food might have generalized almost completely to key light color 2; and the negative relationship between key light color 2 and food might have generalized almost completely to key light color 1, the "knowledge" that the pigeons acquired from the training phase might have been only that key light illuminations are followed approximately 50% of the time by grain presen-

tations. If this were the case, then the birds in all of the groups would have learned functionally the same 50% predictive relationship between key light illuminations and grain presentations. Unfortunately no group was run that was exposed to only one key light color followed by food 50% of the time to compare these birds to.

When the birds were again deprived and exposed to a Pavlovian discrimination procedure, discriminating between the two key light colors was differentially reinforced. (Beavers, 1975, for example has presented evidence suggesting that deprived pigeons prefer to peck in the presence of a key light color that predicts subsequent grain presentations and not to peck in the presence of a key light color that predicts the absence of grain. Therefore the birds would be reinforced in the testing phase for discriminating between the two key colors.) Since the birds in all of the groups that were given nondeprived training had learned approximately the same predictive relationship during this training due to the large amount of generalization between the key light colors, they behaved quite similarly while in the testing phase. The results of Experiment I also suggest that pigeons in the experimental groups would behave differently from birds in the Hold group only if they had been exposed to conditions that retard subsequent acquisition of autoshaping. Perkins, Beavers, Hancock, Hemmendinger, Hemmendinger, and Ricci (1975) have demonstrated that if as few as 5% of key

light trials are followed by food, substantial pecking occurs in deprived pigeons. Therefore it is unlikely that prior exposure to presentations of a key followed by grain 50% of the time would retard subsequent acquisition of autoshaping and there is no reason to expect the birds in the TD, RV, and PD groups to behave differently than the birds in the Hold group of Experiment II.

One possible way to access the accuracy of the account offered here to explain the differences between the two experiments might be to run the second experiment again, but to use more dissimilar key light colors. This would decrease the amount of generalization between the two colors during the nondeprived training. This experiment was not run, however, because it was felt that two more dissimilar stimuli, although decreasing the generalization during training, would be so easily discriminated during testing as to allow no room for any differences in learning between the groups to appear. That is the discrimination would be mastered so quickly by birds in all of the groups that any differences would probably be masked.

The primary aim of this investigation was to show that nondeprived pigeons could learn about relationships between events in the environment. Experiment I clearly indicated that this was the case, nondeprived pigeons could acquire knowledge about stimulus-reinforcer relationships. The second experiment produced results that, although not in-

consistent with the results of the first experiment, did not demonstrate that nondeprived birds could master a discrimination between two key light colors. An analysis based on generalization between the two key light colors during nondeprived training has been advanced to encompass the results of both of these experiments. It is unfortunate but not surprising that the magnitude of the effects obtained in these experiments is not overwhelming. Any differences between the groups of birds when they enter the deprived testing phase disappears rapidly since autoshaping behavior is highly "prepared". The inference to be drawn from this investigation (particularly from Experiment I) is that deprivation is not a necessary condition for the acquisition of knowledge about relationships between events in the environment.

Assuming that the analysis offered here is correct, these findings are consistent with the view that learning about stimulus-reinforcer relationships is an adaptive form of learning. These results, particularly those of the first experiment, tend to confirm the findings of other investigators (Browne, 1976; Parisi & Matthew, 1975) that pigeons can learn about the relationships among events in the environment although no primary reinforcement is delivered and no consistent responding occurs during training. The findings of Experiment I also tend to support Hearst's (1975) view that the acquisition of stimulus-

reinforcer relationships precede and direct behavior toward the most reliable predictor of a US.

These findings are also important in view of the criticisms such as Moran's (1975) that the behavioral laws derived from the use of severely food deprived subjects may not generalize to the behavior of nondeprived subjects. Although it was necessary to deprive the pigeons to obtain behavioral evidence that learning had occurred during the training phase, this does not detract from the fact that the birds did learn while nondeprived. Results such as these indicate that what is studied in laboratory experiments may be relevant to behavioral processes occurring in the natural environments of the animals used as subjects because Experiment I clearly demonstrated that food deprivation is not a necessary condition for the acquisition of knowledge about the relationships between environmental events such as a key light and grain presentation. It would thus appear that as Hearst and Jenkins (1974) have proposed, sign tracking is a very general class of behavior occurring in a wide range of behavioral situations.

Moreover the results of this investigation add pigeons to the group of animals such as rats (Thistletwaite, 1951) and chimpanzees (Yerkes, 1948) that have been shown to be capable of learning by observing while nondeprived. Experiment I clearly indicated that the birds had acquired some information about the relationship between the key

light and grain presentations during the nondeprived training phase. These results are further evidence to be added to that presented elsewhere (Hearst, 1975; 1977) which indicate that learning can occur in the absence of primary reinforcement and observable behavioral change. The procedure used here and that of Browne (1976) will prove quite useful in assessing this type of learning.

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Appendix A  
Data for the Signal Group Birds in Experiment I

| Subject |                    | Training Session |    |    |    |   | Testing Session |     |     |     |     |
|---------|--------------------|------------------|----|----|----|---|-----------------|-----|-----|-----|-----|
|         |                    | 1                | 2  | 3  | 4  | 5 | 1               | 2   | 3   | 4   | 5   |
| 3       | CS pecks           | 0                | 10 | 75 | 28 | 9 | 188             | 173 | 432 | 479 | 467 |
|         | non CS pecks       | 0                | 3  | 22 | 10 | 4 | 398             | 53  | 34  | 36  | 47  |
|         | trials with pecks  | 1                | 0  | 0  | 0  | 0 | 736             | 45  | 58  | 76  | 94  |
|         | trials with eating | 2                | 0  | 0  | 0  | 0 | 40              | 36  | 39  | 40  | 40  |
| 29      | CS pecks           | 0                | 0  | 0  | 0  | 0 | 32              | 36  | 40  | 40  | 40  |
|         | non CS pecks       | 0                | 10 | 75 | 28 | 9 | 188             | 173 | 432 | 479 | 467 |
|         | trials with pecks  | 0                | 3  | 22 | 10 | 4 | 398             | 53  | 34  | 36  | 47  |
|         | trials with eating | 0                | 4  | 24 | 8  | 4 | 31              | 38  | 40  | 40  | 39  |
| 5       | CS pecks           | 0                | 1  | 0  | 1  | 0 | 40              | 35  | 40  | 36  | 36  |
|         | non CS pecks       | 0                | 0  | 0  | 0  | 0 | 66              | 371 | 562 | 579 | 632 |
|         | trials with pecks  | 0                | 0  | 0  | 0  | 0 | 106             | 153 | 28  | 26  | 28  |
|         | trials with eating | 0                | 0  | 0  | 0  | 0 | 17              | 32  | 40  | 38  | 40  |
| 24      | CS pecks           | 0                | 1  | 1  | 0  | 0 | 39              | 40  | 40  | 40  | 40  |
|         | non CS pecks       | 0                | 0  | 4  | 1  | 0 | 48              | 447 | 436 | 449 | 504 |
|         | trials with pecks  | 5                | 0  | 2  | 3  | 0 | 74              | 551 | 35  | 71  | 22  |
|         | trials with eating | 0                | 0  | 1  | 1  | 0 | 15              | 40  | 39  | 40  | 40  |
| 8       | CS pecks           | 4                | 0  | 4  | 2  | 0 | 33              | 37  | 40  | 40  | 40  |
|         | non CS pecks       | 0                | 0  | 0  | 0  | 0 | 1               | 0   | 402 | 398 | 410 |
|         | trials with pecks  | 0                | 2  | 0  | 0  | 0 | 28              | 20  | 393 | 100 | 74  |
|         | trials with eating | 0                | 0  | 0  | 0  | 0 | 1               | 0   | 37  | 40  | 40  |
| 19      | CS pecks           | 0                | 0  | 0  | 0  | 0 | 40              | 40  | 40  | 40  | 40  |
|         | non CS pecks       | 0                | 0  | 0  | 0  | 0 | 368             | 663 | 690 | 705 | 700 |
|         | trials with pecks  | 0                | 0  | 0  | 0  | 0 | 342             | 91  | 83  | 78  | 59  |
|         | trials with eating | 0                | 0  | 0  | 0  | 0 | 27              | 38  | 40  | 40  | 39  |

Appendix A - cont.

Data for the Signal Group Birds in Experiment I

| Subject |                    | Training Session |   |   |   |   | Testing Session |     |     |     |     |
|---------|--------------------|------------------|---|---|---|---|-----------------|-----|-----|-----|-----|
|         |                    | 1                | 2 | 3 | 4 | 5 | 1               | 2   | 3   | 4   | 5   |
| 406     | CS pecks           | 0                | 0 | 0 | 0 | 0 | 256             | 335 | 451 | 308 | 493 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 0 | 404             | 106 | 77  | 53  | 53  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 0 | 23              | 40  | 40  | 40  | 29  |
|         | trials with eating | 6                | 0 | 0 | 1 | 1 | 38              | 40  | 40  | 40  | 40  |
| 419     | CS pecks           | 0                | 0 | 0 | 0 | 0 | 4               | 358 | 387 | 494 | 579 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 0 | 4               | 202 | 25  | 61  | 23  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 0 | 4               | 33  | 38  | 39  | 40  |

# Appendix B

## Data for the CS-only Group Birds in Experiment I

| Subject |                    | Training Sessions |    |   |    | 1  | Testing Sessions |     |     |     | 5 |
|---------|--------------------|-------------------|----|---|----|----|------------------|-----|-----|-----|---|
|         |                    | 1                 | 2  | 3 | 4  |    | 2                | 3   | 4   |     |   |
| 14      | CS pecks           | 0                 | 0  | 1 | 9  | 0  | 438              | 569 | 539 | 466 |   |
|         | non CS pecks       | 0                 | 6  | 1 | 18 | 0  | 487              | 71  | 40  | 16  |   |
|         | trials with pecks  | 0                 | 0  | 1 | 3  | 0  | 34               | 40  | 40  | 40  |   |
|         | trials with eating | 0                 | 0  | 0 | 0  | 39 | 39               | 40  | 40  | 40  |   |
| 4       | CS pecks           | 0                 | 0  | 0 | 0  | 0  | 0                | 16  | 326 | 392 |   |
|         | non CS pecks       | 0                 | 0  | 0 | 0  | 0  | 0                | 7   | 327 | 47  |   |
|         | trials with pecks  | 0                 | 0  | 0 | 0  | 0  | 0                | 7   | 37  | 38  |   |
|         | trials with eating | 0                 | 0  | 0 | 0  | 40 | 39               | 40  | 40  | 40  |   |
| 10      | CS pecks           | 4                 | 27 | 2 | 0  | 0  | 74               | 463 | 464 | 549 |   |
|         | non CS pecks       | 0                 | 11 | 4 | 3  | 0  | 24               | 62  | 30  | 20  |   |
|         | trials with pecks  | 4                 | 4  | 1 | 0  | 0  | 13               | 40  | 40  | 40  |   |
|         | trials with eating | 0                 | 0  | 0 | 0  | 37 | 40               | 40  | 40  | 40  |   |
| 16      | CS pecks           | 0                 | 0  | 0 | 0  | 0  | 167              | 567 | 575 | 623 |   |
|         | non CS pecks       | 0                 | 0  | 0 | 0  | 0  | 120              | 157 | 54  | 45  |   |
|         | trials with pecks  | 0                 | 0  | 0 | 0  | 0  | 18               | 39  | 39  | 40  |   |
|         | trials with eating | 0                 | 0  | 0 | 0  | 33 | 28               | 40  | 37  | 39  |   |
| 1       | CS pecks           | 0                 | 0  | 0 | 0  | 39 | 411              | 514 | 596 | 631 |   |
|         | non CS pecks       | 0                 | 0  | 0 | 0  | 3  | 38               | 28  | 29  | 26  |   |
|         | trials with pecks  | 0                 | 0  | 0 | 0  | 8  | 40               | 40  | 40  | 40  |   |
|         | trials with eating | 0                 | 0  | 0 | 0  | 40 | 40               | 40  | 40  | 40  |   |
| 21      | CS pecks           | 0                 | 0  | 0 | 0  | 22 | 375              | 422 | 342 | 243 |   |
|         | non CS pecks       | 0                 | 0  | 0 | 0  | 35 | 143              | 44  | 42  | 20  |   |
|         | trials with pecks  | 0                 | 0  | 0 | 0  | 7  | 29               | 33  | 34  | 33  |   |
|         | trials with eating | 0                 | 0  | 0 | 0  | 39 | 33               | 40  | 40  | 39  |   |

Appendix B - cont.

Data for the CS-only Group Birds in Experiment I

| Subject |                    | Training Session |   |   |   |   | Testing Session |     |     |     |     |
|---------|--------------------|------------------|---|---|---|---|-----------------|-----|-----|-----|-----|
|         |                    | 1                | 2 | 3 | 4 | 5 | 1               | 2   | 3   | 4   | 5   |
| 402     | CS pecks           | 0                | 0 | 0 | 0 | 0 | 81              | 428 | 426 | 406 | 410 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 0 | 122             | 53  | 22  | 22  | 27  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 0 | 12              | 37  | 38  | 40  | 40  |
|         | trials with eating | 0                | 0 | 0 | 0 | 0 | 36              | 38  | 38  | 40  | 40  |
| 409     | CS pecks           | 0                | 2 | 0 | 0 | 0 | 49              | 362 | 384 | 456 | 408 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 0 | 19              | 67  | 39  | 38  | 39  |
|         | trials with pecks  | 0                | 1 | 0 | 0 | 0 | 11              | 39  | 39  | 40  | 39  |
|         | trials with eating | 0                | 0 | 0 | 0 | 0 | 35              | 39  | 37  | 36  | 36  |

# Appendix C

## Data for the Unpaired Group Birds in Experiment I

| Subject |                    | Training Session |   |   |   | 1  | Testing Session |     |     |     | 5   |
|---------|--------------------|------------------|---|---|---|----|-----------------|-----|-----|-----|-----|
|         |                    | 1                | 2 | 3 | 4 |    | 1               | 2   | 3   | 4   |     |
| 30      | CS pecks           | 3                | 0 | 0 | 0 | 0  | 0               | 311 | 480 | 547 | 515 |
|         | non CS pecks       | 1                | 0 | 0 | 0 | 0  | 0               | 90  | 23  | 22  | 18  |
|         | trials with pecks  | 1                | 0 | 0 | 0 | 0  | 0               | 32  | 40  | 40  | 40  |
|         | trials with eating | 1                | 0 | 0 | 0 | 40 | 40              | 40  | 40  | 40  | 40  |
| 12      | CS pecks           | 0                | 0 | 0 | 0 | 1  | 1               | 231 | 313 | 296 | 302 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 0  | 0               | 46  | 20  | 10  | 12  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 1  | 1               | 33  | 40  | 40  | 40  |
|         | trials with eating | 0                | 0 | 0 | 0 | 40 | 40              | 39  | 39  | 40  | 40  |
| 13      | CS pecks           | 0                | 0 | 0 | 0 | 0  | 0               | 333 | 496 | 628 | 624 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 0  | 0               | 136 | 38  | 23  | 25  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 0  | 0               | 26  | 32  | 40  | 40  |
|         | trials with eating | 4                | 0 | 0 | 1 | 37 | 37              | 27  | 32  | 40  | 40  |
| 25      | CS pecks           | 0                | 0 | 0 | 0 | 28 | 28              | 393 | 451 | 535 | 538 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 1  | 1               | 834 | 51  | 38  | 31  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 4  | 4               | 35  | 40  | 40  | 40  |
|         | trials with eating | 0                | 1 | 0 | 0 | 38 | 38              | 37  | 40  | 40  | 40  |
| 6       | CS pecks           | 5                | 0 | 0 | 0 | 27 | 27              | 508 | 470 | 589 | 621 |
|         | non CS pecks       | 1                | 0 | 0 | 0 | 23 | 23              | 247 | 27  | 27  | 33  |
|         | trials with pecks  | 2                | 0 | 0 | 0 | 6  | 6               | 40  | 39  | 40  | 40  |
|         | trials with eating | 4                | 0 | 0 | 0 | 39 | 39              | 40  | 40  | 40  | 40  |
| 9       | CS pecks           | 4                | 2 | 0 | 0 | 0  | 0               | 200 | 399 | 455 | 415 |
|         | non CS pecks       | 7                | 7 | 3 | 0 | 0  | 0               | 198 | 33  | 29  | 28  |
|         | trials with pecks  | 2                | 2 | 0 | 0 | 0  | 0               | 29  | 39  | 40  | 40  |
|         | trials with eats   | 4                | 1 | 0 | 0 | 38 | 38              | 38  | 39  | 40  | 40  |

Appendix C - cont.

Data for the Unpaired Group Birds in Experiment I

| Subjects |                    | Training Session |   |   |   |   | Testing Session |     |     |     |     |
|----------|--------------------|------------------|---|---|---|---|-----------------|-----|-----|-----|-----|
|          |                    | 1                | 2 | 3 | 4 | 5 | 1               | 2   | 3   | 4   | 5   |
| 412      | CS pecks           | 0                | 1 | 1 | 0 | 0 | 0               | 154 | 601 | 677 | 783 |
|          | non CS pecks       | 0                | 3 | 1 | 0 | 0 | 0               | 108 | 167 | 51  | 40  |
|          | trials with pecks  | 0                | 1 | 1 | 0 | 0 | 0               | 18  | 40  | 40  | 40  |
|          | trials with eating | 5                | 3 | 1 | 1 | 0 | 40              | 40  | 40  | 40  | 40  |
| 417      | CS pecks           | 0                | 0 | 0 | 0 | 0 | 207             | 438 | 480 | 529 | 584 |
|          | non CS pecks       | 0                | 0 | 0 | 0 | 0 | 563             | 125 | 27  | 24  | 24  |
|          | trials with pecks  | 0                | 0 | 0 | 0 | 0 | 22              | 32  | 35  | 36  | 36  |
|          | trials with eating | 0                | 0 | 0 | 0 | 0 | 38              | 30  | 34  | 33  | 33  |

Appendix D

Data for the Truly-Random Group Birds in Experiment I

| Subject |                    | Training Session |   |   |   | Testing Session |     |     |     |
|---------|--------------------|------------------|---|---|---|-----------------|-----|-----|-----|
|         |                    | 1                | 2 | 3 | 4 | 1               | 2   | 3   | 4   |
| 26      | CS pecks           | 0                | 0 | 0 | 0 | 110             | 273 | 281 | 299 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 206             | 48  | 27  | 16  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 18              | 38  | 40  | 40  |
|         | trials with eating | 0                | 0 | 0 | 0 | 37              | 39  | 40  | 40  |
| 15      | CS pecks           | 0                | 0 | 0 | 0 | 9               | 348 | 402 | 411 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 2               | 156 | 26  | 15  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 4               | 38  | 39  | 40  |
|         | trials with eating | 0                | 0 | 2 | 0 | 40              | 38  | 40  | 40  |
| 2       | CS pecks           | 0                | 0 | 0 | 0 | 40              | 337 | 267 | 337 |
|         | non CS pecks       | 0                | 2 | 0 | 1 | 39              | 152 | 59  | 11  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 10              | 39  | 40  | 40  |
|         | trials with eating | 0                | 0 | 0 | 0 | 40              | 40  | 40  | 40  |
| 28      | CS pecks           | 0                | 0 | 0 | 0 | 38              | 320 | 315 | 460 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 13              | 295 | 18  | 20  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 11              | 38  | 39  | 40  |
|         | trials with eating | 0                | 0 | 1 | 0 | 40              | 35  | 40  | 40  |
| 7       | CS pecks           | 0                | 0 | 0 | 0 | 0               | 426 | 517 | 533 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 0               | 239 | 24  | 30  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 0               | 35  | 40  | 39  |
|         | trials with eating | 0                | 0 | 0 | 0 | 40              | 40  | 40  | 39  |
| 18      | CS pecks           | 0                | 0 | 0 | 0 | 34              | 137 | 279 | 272 |
|         | non CS pecks       | 0                | 0 | 0 | 0 | 12              | 14  | 8   | 12  |
|         | trials with pecks  | 0                | 0 | 0 | 0 | 13              | 33  | 39  | 39  |
|         | trials with eating | 2                | 1 | 0 | 0 | 32              | 37  | 40  | 40  |

Appendix D - cont.

Data for the Truly-Random Group Birds in Experiment I

| Subject |                    | Training Session |    |   |   |   | Testing Session |     |     |     |     |
|---------|--------------------|------------------|----|---|---|---|-----------------|-----|-----|-----|-----|
|         |                    | 1                | 2  | 3 | 4 | 5 | 1               | 2   | 3   | 4   | 5   |
| 404     | CS pecks           | 6                | 5  | 0 | 0 | 0 | 0               | 320 | 615 | 633 | 668 |
|         | non CS pecks       | 0                | 14 | 0 | 0 | 0 | 0               | 692 | 190 | 49  | 31  |
|         | trials with pecks  | 2                | 1  | 0 | 0 | 0 | 0               | 27  | 40  | 40  | 40  |
|         | trials with eating | 10               | 0  | 0 | 0 | 1 | 37              | 40  | 40  | 40  | 40  |
| 420     | CS pecks           | 0                | 0  | 0 | 0 | 0 | 0               | 125 | 339 | 460 | 478 |
|         | non CS pecks       | 0                | 0  | 0 | 0 | 0 | 1               | 201 | 53  | 13  | 16  |
|         | trials with pecks  | 0                | 0  | 0 | 0 | 0 | 0               | 20  | 40  | 40  | 40  |
|         | trials with eating | 0                | 0  | 0 | 0 | 0 | 39              | 40  | 40  | 40  | 40  |

# Appendix E

## Data for the Hold Group Birds in Experiment I

| Subject |                                                                     | Training Session |   |   |   |   | Testing Session        |                        |                       |                       |                       |
|---------|---------------------------------------------------------------------|------------------|---|---|---|---|------------------------|------------------------|-----------------------|-----------------------|-----------------------|
|         |                                                                     | 1                | 2 | 3 | 4 | 5 | 1                      | 2                      | 3                     | 4                     | 5                     |
| 20      | CS pecks<br>non CS pecks<br>trials with pecks<br>trials with eating |                  |   |   |   |   | 214<br>289<br>21<br>39 | 532<br>164<br>38<br>40 | 549<br>68<br>40<br>40 | 531<br>55<br>40<br>40 | 474<br>50<br>40<br>40 |
| 17      | CS pecks<br>non CS pecks<br>trials with pecks<br>trials with eating |                  |   |   |   |   | 14<br>8<br>8<br>40     | 433<br>173<br>39<br>38 | 541<br>34<br>38<br>40 | 582<br>33<br>40<br>34 | 591<br>39<br>40<br>40 |
| 22      | CS pecks<br>non CS pecks<br>trials with pecks<br>trials with eating |                  |   |   |   |   | 352<br>188<br>31<br>40 | 349<br>105<br>34<br>35 | 391<br>23<br>38<br>39 | 458<br>19<br>39<br>39 | 485<br>24<br>40<br>40 |
| 23      | CS pecks<br>non CS pecks<br>trials with pecks<br>trials with eating |                  |   |   |   |   | 52<br>51<br>11<br>36   | 507<br>34<br>39<br>40  | 522<br>27<br>40<br>40 | 501<br>24<br>40<br>40 | 487<br>22<br>40<br>40 |
| 11      | CS pecks<br>non CS pecks<br>trials with pecks<br>trials with eating |                  |   |   |   |   | 0<br>0<br>0<br>39      | 478<br>37<br>37<br>40  | 587<br>33<br>39<br>40 | 638<br>31<br>39<br>39 | 606<br>31<br>36<br>40 |
| 27      | CS pecks<br>non CS pecks<br>trials with pecks<br>trials with eating |                  |   |   |   |   | 9<br>5<br>4<br>22      | 378<br>630<br>36<br>34 | 406<br>42<br>39<br>40 | 448<br>21<br>39<br>40 | 423<br>17<br>40<br>40 |

Appendix E - cont.

Data for the Hold Group Birds in Experiment I

| Subject | 1                  | Training Session |   |   | 5 | Testing Session |     |     | 5   |
|---------|--------------------|------------------|---|---|---|-----------------|-----|-----|-----|
|         |                    | 2                | 3 | 4 |   | 2               | 3   | 4   |     |
| 403     | CS pecks           |                  |   |   |   |                 |     |     |     |
|         | non CS pecks       |                  |   |   |   | 553             | 588 | 599 | 587 |
|         | trials with pecks  |                  |   |   |   | 25              | 33  | 32  | 45  |
|         | trials with eating |                  |   |   |   | 40              | 40  | 40  | 40  |
| 413     | CS pecks           |                  |   |   |   |                 |     |     |     |
|         | non CS pecks       |                  |   |   |   | 562             | 701 | 786 | 778 |
|         | trials with pecks  |                  |   |   |   | 82              | 34  | 53  | 43  |
|         | trials with eating |                  |   |   |   | 36              | 35  | 39  | 39  |

# Appendix F

## Data for the TD Group Birds in Experiment II

### Subject

|       | Training Session    |    |   |   |    | 6  | 1  | 2   | Testing Session |     |     |     | 6   | 7   |
|-------|---------------------|----|---|---|----|----|----|-----|-----------------|-----|-----|-----|-----|-----|
|       | 1                   | 2  | 3 | 4 | 5  |    |    |     | 3               | 4   | 5   |     |     |     |
| 801*  | CS+ pecks           | 1  | 0 | 0 | 10 | 15 | 22 | 0   | 257             | 429 | 480 | 487 | 476 | 472 |
|       | CS- pecks           | 0  | 0 | 0 | 0  | 28 | 14 | 0   | 219             | 408 | 126 | 5   | 0   | 6   |
|       | non CS pecks        | 0  | 0 | 2 | 2  | 32 | 5  | 0   | 53              | 51  | 23  | 15  | 16  | 55  |
|       | + trials with pecks | 1  | 0 | 0 | 0  | 4  | 3  | 0   | 14              | 20  | 20  | 20  | 20  | 20  |
|       | - trials with pecks | 0  | 0 | 0 | 0  | 4  | 3  | 0   | 14              | 20  | 16  | 3   | 0   | 0   |
|       | trials with eating  | 6  | 0 | 1 | 7  | 2  | 2  | 20  | 20              | 20  | 20  | 20  | 20  | 20  |
| 826   | CS+ pecks           | 0  | 0 | 0 | 0  | 0  | 0  | 0   | 1               | 234 | 343 | 335 | 336 | 347 |
|       | CS- pecks           | 1  | 0 | 0 | 0  | 0  | 0  | 0   | 0               | 69  | 7   | 1   | 0   | 0   |
|       | non CS pecks        | 0  | 0 | 0 | 2  | 0  | 5  | 0   | 0               | 58  | 24  | 12  | 13  | 17  |
|       | + trials with pecks | 0  | 0 | 0 | 0  | 0  | 0  | 0   | 1               | 20  | 20  | 20  | 20  | 20  |
|       | - trials with pecks | 1  | 0 | 0 | 0  | 0  | 0  | 0   | 0               | 16  | 3   | 1   | 0   | 0   |
|       | trials with eating  | 0  | 0 | 0 | 1  | 1  | 3  | 20  | 20              | 20  | 20  | 20  | 20  | 20  |
| 828   | CS+ pecks           | 0  | 0 | 0 | 0  | 0  | 0  | 30  | 303             | 329 | 278 | 347 | 237 | 212 |
|       | CS- pecks           | 0  | 0 | 0 | 0  | 0  | 0  | 8   | 184             | 225 | 27  | 16  | 5   | 0   |
|       | non CS pecks        | 0  | 0 | 0 | 0  | 0  | 0  | 3   | 206             | 66  | 16  | 12  | 4   | 11  |
|       | + trials with pecks | 0  | 0 | 0 | 0  | 0  | 0  | 9   | 19              | 19  | 20  | 20  | 20  | 20  |
|       | - trials with pecks | 0  | 0 | 0 | 0  | 0  | 0  | 4   | 19              | 19  | 4   | 3   | 1   | 0   |
|       | trials with eating  | 0  | 0 | 0 | 0  | 0  | 0  | 20  | 20              | 20  | 20  | 20  | 20  | 20  |
| 809** | CS+ pecks           | 0  | 0 | 0 | 0  | 0  | 0  | 0   | 0               | 6   | 91  | 149 | 168 | 217 |
|       | CS- pecks           | 0  | 0 | 0 | 0  | 0  | 0  | 10  | 1               | 9   | 28  | 1   | 0   | 1   |
|       | non CS pecks        | 0  | 0 | 0 | 0  | 0  | 0  | 0   | 1               | 2   | 49  | 12  | 16  | 6   |
|       | + trials with pecks | 0  | 0 | 0 | 0  | 0  | 0  | 0   | 0               | 3   | 16  | 20  | 20  | 19  |
|       | - trials with pecks | 0  | 0 | 0 | 0  | 0  | 0  | 1   | 1               | 6   | 15  | 1   | 0   | 1   |
| 816*  | CS+ pecks           | 6  | 1 | 0 | 30 | 55 | 0  | 237 | 424             | 424 | 388 | 394 | 331 | 324 |
|       | CS- pecks           | 12 | 0 | 0 | 5  | 51 | 0  | 218 | 95              | 0   | 26  | 13  | 1   | 0   |
|       | non CS pecks        | 13 | 1 | 0 | 16 | 36 | 0  | 44  | 28              | 19  | 22  | 17  | 18  | 12  |
|       | + trials with pecks | 2  | 1 | 0 | 3  | 4  | 0  | 17  | 20              | 20  | 20  | 20  | 18  | 20  |
|       | - trials with pecks | 5  | 0 | 0 | 1  | 4  | 0  | 15  | 9               | 0   | 3   | 4   | 1   | 0   |
|       | trials with eating  | 10 | 6 | 3 | 7  | 6  | 28 | 20  | 20              | 20  | 20  | 20  | 20  | 20  |

Appendix F - cont.

Data for the TD Group Birds in Experiment II

| Subject |                     | Training Session |   |   |   |   | 6 | 1  | 2   | Testing Session |     |     | 6   | 7   |
|---------|---------------------|------------------|---|---|---|---|---|----|-----|-----------------|-----|-----|-----|-----|
|         |                     | 1                | 2 | 3 | 4 | 5 |   |    |     | 3               | 4   | 5   |     |     |
| 307     | CS+ pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 17  | 307             | 253 | 279 | 265 | 298 |
|         | CS- pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 14  | 212             | 4   | 2   | 2   | 0   |
|         | non CS pecks        | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 22  | 594             | 40  | 30  | 18  | 11  |
|         | + trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 4   | 20              | 18  | 20  | 20  | 20  |
|         | - trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 2   | 20              | 1   | 2   | 1   | 0   |
|         | trials with eating  | 0                | 0 | 0 | 0 | 0 | 0 | 11 | 19  | 20              | 18  | 20  | 20  | 20  |
| 827     | CS+ pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 3   | 46              | 24  | 23  | 30  | 17  |
|         | CS- pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 6   | 3               | 0   | 0   | 0   | 0   |
|         | non CS pecks        | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 13  | 1               | 1   | 1   | 1   | 0   |
|         | + trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 3   | 18              | 15  | 13  | 10  | 10  |
|         | - trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 3   | 1               | 0   | 0   | 0   | 0   |
|         | trials with eating  | 0                | 0 | 0 | 0 | 0 | 0 | 20 | 20  | 20              | 20  | 20  | 20  | 20  |
| 814     | CS+ pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 111 | 283             | 322 | 278 | 286 | 290 |
|         | CS- pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 36  | 120             | 48  | 5   | 25  | 4   |
|         | non CS pecks        | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 35  | 32              | 22  | 9   | 33  | 9   |
|         | + trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 12  | 20              | 20  | 20  | 19  | 20  |
|         | - trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 10  | 17              | 6   | 4   | 5   | 1   |
|         | trials with eating  | 0                | 0 | 0 | 0 | 0 | 0 | 19 | 20  | 20              | 20  | 20  | 20  | 20  |
| 810     | CS+ pecks           | 0                | 0 | 0 | 0 | 0 | 1 | 1  | 7   | 256             | 245 | 128 | 83  | 96  |
|         | CS- pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 17 | 37  | 196             | 72  | 27  | 53  | 91  |
|         | non CS pecks        | 0                | 4 | 0 | 0 | 1 | 0 | 1  | 4   | 391             | 178 | 119 | 139 | 53  |
|         | + trials with pecks | 0                | 0 | 0 | 0 | 0 | 1 | 1  | 5   | 19              | 19  | 20  | 20  | 20  |
|         | - trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 6  | 8   | 20              | 17  | 12  | 16  | 19  |
|         | trials with eating  | 4                | 1 | 8 | 0 | 0 | 1 | 19 | 20  | 20              | 20  | 20  | 20  | 20  |
| 302     | CS+ pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 219 | 293             | 318 | 326 | 327 | 303 |
|         | CS- pecks           | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 177 | 111             | 336 | 222 | 288 | 74  |
|         | non CS pecks        | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 133 | 58              | 157 | 20  | 20  | 20  |
|         | + trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 19  | 20              | 20  | 20  | 20  | 20  |
|         | - trials with pecks | 0                | 0 | 0 | 0 | 0 | 0 | 0  | 19  | 16              | 8   | 3   | 1   | 2   |
|         | trials with eating  | 0                | 0 | 0 | 0 | 0 | 0 | 20 | 20  | 20              | 20  | 20  | 20  | 20  |

\* denotes that a bird has been dropped from the study due to exceeding the pecking and eating criterion during the nondeprived training phase (see page 33)

\*\* denotes that a bird has been dropped from the study for not meeting the response criterion during the testing phase (see page 35-36)

# Appendix G

## Data for the RV Group Birds in Experiment II

| Subject |                     | Training Session |    |     |     |     | 1   | 2   | Testing Session |     |     |     |     | 6 | 7 |
|---------|---------------------|------------------|----|-----|-----|-----|-----|-----|-----------------|-----|-----|-----|-----|---|---|
|         |                     | 1                | 2  | 3   | 4   | 5   |     |     | 3               | 4   | 5   |     |     |   |   |
| 304*    | CS+ pecks           | 1                | 5  | 55  | 45  | 9   | 1   | 0   | 3               | 27  | 35  | 21  | 18  |   |   |
|         | CS- pecks           | 1                | 2  | 18  | 22  | 26  | 31  | 54  | 13              | 11  | 16  | 2   | 0   |   |   |
|         | non CS pecks        | 0                | 0  | 19  | 13  | 5   | 3   | 4   | 1               | 3   | 1   | 2   | 0   |   |   |
|         | + trials with pecks | 1                | 2  | 13  | 14  | 8   | 0   | 1   | 2               | 18  | 17  | 11  | 13  |   |   |
|         | - trials with pecks | 1                | 1  | 9   | 12  | 15  | 9   | 9   | 5               | 5   | 5   | 2   | 0   |   |   |
|         | trials with eating  | 5                | 19 | 26  | 27  | 29  | 20  | 20  | 20              | 20  | 20  | 20  | 20  |   |   |
| 805     | CS+ pecks           | 0                | 0  | 0   | 0   | 0   | 1   | 1   | 26              | 118 | 180 | 213 | 268 |   |   |
|         | CS- pecks           | 0                | 0  | 0   | 0   | 0   | 0   | 2   | 30              | 12  | 0   | 0   | 0   |   |   |
|         | non CS pecks        | 0                | 0  | 1   | 0   | 0   | 1   | 0   | 13              | 31  | 13  | 9   | 13  |   |   |
|         | + trials with pecks | 0                | 0  | 0   | 0   | 0   | 1   | 1   | 14              | 20  | 18  | 20  | 20  |   |   |
|         | - trials with pecks | 0                | 0  | 0   | 0   | 0   | 1   | 2   | 14              | 9   | 0   | 0   | 0   |   |   |
|         | trials with eating  | 0                | 1  | 0   | 0   | 0   | 6   | 20  | 20              | 20  | 20  | 20  | 20  |   |   |
| 812     | CS+ pecks           | 3                | 0  | 1   | 0   | 0   | 0   | 0   | 189             | 133 | 121 | 133 | 137 |   |   |
|         | CS- pecks           | 0                | 0  | 0   | 0   | 0   | 0   | 17  | 134             | 66  | 1   | 0   | 0   |   |   |
|         | non CS pecks        | 0                | 0  | 0   | 0   | 0   | 0   | 12  | 651             | 111 | 59  | 36  | 18  |   |   |
|         | + trials with pecks | 1                | 0  | 1   | 0   | 0   | 0   | 9   | 19              | 19  | 20  | 19  | 20  |   |   |
|         | - trials with pecks | 0                | 0  | 0   | 0   | 0   | 0   | 6   | 19              | 17  | 1   | 0   | 0   |   |   |
|         | trials with eating  | 0                | 3  | 0   | 0   | 0   | 19  | 20  | 19              | 20  | 20  | 20  | 20  |   |   |
| 804*    | CS+ pecks           | 3                | 29 | 167 | 68  | 6   | 3   | 0   | 55              | 144 | 125 | 184 | 168 |   |   |
|         | CS- pecks           | 1                | 7  | 184 | 164 | 194 | 201 | 60  | 119             | 99  | 33  | 1   | 9   |   |   |
|         | non CS pecks        | 0                | 32 | 185 | 20  | 11  | 18  | 5   | 16              | 12  | 21  | 38  | 12  |   |   |
|         | + trials with pecks | 1                | 5  | 28  | 22  | 1   | 1   | 0   | 14              | 20  | 19  | 20  | 20  |   |   |
|         | - trials with pecks | 1                | 4  | 31  | 29  | 29  | 26  | 9   | 18              | 19  | 4   | 1   | 1   |   |   |
|         | trials with eating  | 34               | 27 | 37  | 33  | 37  | 36  | 19  | 20              | 20  | 20  | 20  | 20  |   |   |
| 308     | CS+ pecks           | 0                | 0  | 0   | 0   | 0   | 0   | 0   | 103             | 62  | 87  | 103 | 74  |   |   |
|         | CS- pecks           | 0                | 0  | 0   | 0   | 0   | 0   | 196 | 1               | 0   | 0   | 0   | 1   |   |   |
|         | non CS pecks        | 0                | 0  | 0   | 0   | 0   | 0   | 115 | 23              | 9   | 7   | 2   | 1   |   |   |
|         | + trials with pecks | 0                | 0  | 0   | 0   | 0   | 0   | 109 | 19              | 20  | 20  | 20  | 19  |   |   |
|         | - trials with pecks | 0                | 0  | 0   | 0   | 0   | 0   | 16  | 1               | 0   | 0   | 0   | 1   |   |   |
|         | trials with eating  | 0                | 0  | 0   | 0   | 0   | 0   | 13  | 1               | 0   | 0   | 0   | 1   |   |   |
|         |                     | 0                | 0  | 0   | 0   | 0   | 20  | 20  | 20              | 20  | 20  | 20  | 20  |   |   |

Appendix G - cont.

Data for the RV Group Birds in Experiment II

| Subject            | Training Session    |   |   |    |   | Testing Session |    |    |     |     |     |     |     |     |
|--------------------|---------------------|---|---|----|---|-----------------|----|----|-----|-----|-----|-----|-----|-----|
|                    | 1                   | 2 | 3 | 4  | 5 | 6               | 1  | 2  | 3   | 4   | 5   | 6   | 7   |     |
| 813                | CS+ pecks           | 3 | 0 | 0  | 0 | 0               | 0  | 0  | 32  | 240 | 220 | 169 | 152 |     |
|                    | CS- pecks           | 1 | 0 | 0  | 0 | 0               | 0  | 0  | 16  | 126 | 8   | 6   | 0   |     |
|                    | non CS pecks        | 4 | 0 | 0  | 0 | 0               | 0  | 0  | 5   | 381 | 196 | 144 | 42  |     |
|                    | + trials with pecks | 1 | 0 | 0  | 0 | 0               | 0  | 0  | 11  | 19  | 19  | 20  | 20  |     |
|                    | - trials with pecks | 1 | 0 | 0  | 0 | 0               | 0  | 0  | 6   | 19  | 6   | 2   | 0   |     |
| trials with eating | 1                   | 6 | 0 | 2  | 2 | 0               | 16 | 20 | 20  | 19  | 20  | 20  | 20  |     |
| 803                | CS+ pecks           | 0 | 0 | 0  | 0 | 0               | 0  | 11 | 279 | 459 | 410 | 396 | 434 | 436 |
|                    | CS- pecks           | 0 | 0 | 0  | 0 | 0               | 0  | 3  | 237 | 420 | 240 | 33  | 28  | 133 |
|                    | non CS pecks        | 0 | 0 | 0  | 0 | 0               | 0  | 1  | 291 | 60  | 70  | 36  | 28  | 26  |
|                    | + trials with pecks | 0 | 0 | 0  | 0 | 0               | 0  | 5  | 18  | 20  | 20  | 20  | 20  | 20  |
|                    | - trials with pecks | 0 | 0 | 0  | 0 | 0               | 0  | 2  | 17  | 20  | 19  | 5   | 9   | 12  |
| trials with eating | 1                   | 0 | 2 | 0  | 0 | 0               | 20 | 20 | 20  | 20  | 20  | 20  | 20  |     |
| 817                | CS+ pecks           | 0 | 0 | 0  | 0 | 0               | 0  | 0  | 110 | 146 | 104 | 86  | 75  | 68  |
|                    | CS- pecks           | 0 | 0 | 0  | 0 | 0               | 0  | 4  | 84  | 80  | 9   | 0   | 0   | 0   |
|                    | non CS pecks        | 0 | 0 | 0  | 0 | 0               | 0  | 20 | 178 | 186 | 124 | 58  | 12  | 3   |
|                    | + trials with pecks | 0 | 0 | 0  | 0 | 0               | 0  | 0  | 18  | 20  | 20  | 20  | 20  | 19  |
|                    | - trials with pecks | 0 | 0 | 0  | 0 | 0               | 0  | 1  | 15  | 13  | 4   | 0   | 0   | 0   |
| trials with eating | 0                   | 0 | 0 | 0  | 0 | 0               | 20 | 20 | 20  | 20  | 20  | 20  | 20  |     |
| 824                | CS+ pecks           | 7 | 0 | 6  | 2 | 0               | 0  | 3  | 100 | 236 | 443 | 478 | 541 | 515 |
|                    | CS- pecks           | 3 | 0 | 11 | 3 | 0               | 0  | 1  | 64  | 173 | 88  | 18  | 6   | 57  |
|                    | non CS pecks        | 5 | 5 | 4  | 3 | 2               | 0  | 0  | 54  | 42  | 36  | 23  | 57  | 53  |
|                    | + trials with pecks | 2 | 0 | 1  | 1 | 0               | 0  | 1  | 17  | 20  | 20  | 20  | 20  | 20  |
|                    | - trials with pecks | 2 | 0 | 1  | 2 | 0               | 0  | 1  | 12  | 20  | 15  | 2   | 2   | 3   |
| trials with eating | 1                   | 0 | 0 | 0  | 0 | 0               | 18 | 20 | 20  | 20  | 20  | 20  | 20  |     |

\* denotes that a bird has been dropped from the study due to exceeding the pecking and eating criterion during the nondeprived training phase (see page 33)

\*\* denotes that a bird has been dropped from the study for not meeting the response criterion during the testing phase (see page 35-36)

# Appendix H

## Data for the PD Group Birds in Experiment II

Subject

|       | 1                   | 2  | Training Session |   |    | 6   | 1   | 2   | Testing Session |     |     | 6   | 7   |
|-------|---------------------|----|------------------|---|----|-----|-----|-----|-----------------|-----|-----|-----|-----|
|       |                     |    | 3                | 4 | 5  |     |     |     | 3               | 4   | 5   |     |     |
| 829   | CS+ pecks           | 0  | 0                | 0 | 0  | 0   | 0   | 51  | 78              | 116 | 90  | 84  | 61  |
|       | CS- pecks           | 0  | 0                | 0 | 0  | 0   | 0   | 7   | 66              | 48  | 27  | 6   | 0   |
|       | non CS pecks        | 0  | 0                | 0 | 0  | 0   | 0   | 36  | 17              | 12  | 19  | 2   | 3   |
|       | + trials with pecks | 0  | 0                | 0 | 0  | 0   | 0   | 13  | 13              | 19  | 19  | 19  | 20  |
|       | - trials with pecks | 0  | 0                | 0 | 0  | 0   | 0   | 4   | 15              | 9   | 12  | 2   | 0   |
|       | trials with eating  | 0  | 0                | 0 | 0  | 0   | 17  | 17  | 17              | 19  | 18  | 20  | 19  |
| 807** | CS+ pecks           | 0  | 0                | 0 | 0  | 0   | 0   | 0   | 0               | 0   | 0   | 0   | 0   |
|       | CS- pecks           | 0  | 0                | 0 | 0  | 0   | 0   | 0   | 0               | 0   | 0   | 0   | 0   |
|       | non CS pecks        | 0  | 0                | 0 | 0  | 0   | 0   | 0   | 0               | 0   | 0   | 0   | 0   |
|       | + trials with pecks | 0  | 0                | 0 | 0  | 0   | 0   | 0   | 0               | 0   | 0   | 0   | 0   |
|       | - trials with pecks | 0  | 0                | 0 | 0  | 0   | 0   | 0   | 0               | 0   | 0   | 0   | 0   |
|       | trials with eating  | 0  | 0                | 0 | 0  | 0   | 20  | 19  | 19              | 19  | 20  | 20  | 20  |
| 811   | CS+ pecks           | 0  | 0                | 0 | 0  | 0   | 32  | 146 | 103             | 215 | 140 | 57  | 134 |
|       | CS- pecks           | 0  | 0                | 0 | 0  | 0   | 55  | 66  | 22              | 0   | 0   | 48  | 11  |
|       | non CS pecks        | 1  | 0                | 0 | 0  | 0   | 103 | 36  | 14              | 9   | 2   | 13  | 4   |
|       | + trials with pecks | 0  | 0                | 0 | 0  | 0   | 8   | 20  | 17              | 20  | 19  | 18  | 20  |
|       | - trials with pecks | 0  | 0                | 0 | 0  | 0   | 10  | 16  | 20              | 0   | 0   | 8   | 3   |
|       | trials with eating  | 0  | 0                | 0 | 0  | 0   | 20  | 20  | 20              | 20  | 20  | 20  | 20  |
| 301   | CS+ pecks           | 0  | 0                | 0 | 0  | 0   | 13  | 214 | 358             | 260 | 278 | 282 | 271 |
|       | CS- pecks           | 0  | 0                | 0 | 0  | 0   | 0   | 157 | 61              | 7   | 0   | 0   | 3   |
|       | non CS pecks        | 0  | 0                | 0 | 0  | 0   | 8   | 343 | 86              | 11  | 8   | 11  | 11  |
|       | + trials with pecks | 0  | 0                | 0 | 0  | 0   | 4   | 19  | 20              | 20  | 20  | 20  | 20  |
|       | - trials with pecks | 0  | 0                | 0 | 0  | 0   | 0   | 14  | 7               | 2   | 0   | 0   | 2   |
|       | trials with eating  | 0  | 0                | 0 | 0  | 0   | 20  | 20  | 20              | 20  | 20  | 20  | 20  |
| 821*  | CS+ pecks           | 5  | 3                | 0 | 10 | 61  | 55  | 11  | 260             | 321 | 301 | 204 | 248 |
|       | CS- pecks           | 27 | 20               | 2 | 20 | 114 | 71  | 97  | 295             | 18  | 35  | 0   | 2   |
|       | non CS pecks        | 43 | 3                | 5 | 7  | 59  | 16  | 36  | 213             | 40  | 153 | 41  | 24  |
|       | + trials with pecks | 4  | 1                | 0 | 2  | 8   | 5   | 1   | 18              | 20  | 20  | 19  | 20  |
|       | - trials with pecks | 6  | 4                | 1 | 5  | 14  | 7   | 11  | 6               | 6   | 7   | 0   | 2   |
|       | trials with eating  | 6  | 16               | 5 | 8  | 17  | 20  | 19  | 20              | 20  | 20  | 20  | 20  |

Appendix H - cont.

Data for the PD Group Birds in Experiment II

Subject

|                    | Training Session    |    |    |   |   | Testing Session |    |     |     |     |     |     |     |     |
|--------------------|---------------------|----|----|---|---|-----------------|----|-----|-----|-----|-----|-----|-----|-----|
|                    | 1                   | 2  | 3  | 4 | 5 | 6               | 1  | 2   | 3   | 4   | 5   | 6   | 7   |     |
| 806                | CS+ pecks           | 0  | 0  | 0 | 0 | 0               | 3  | 227 | 243 | 440 | 396 | 425 | 411 |     |
|                    | CS- pecks           | 0  | 0  | 0 | 0 | 0               | 3  | 204 | 189 | 318 | 104 | 24  | 31  |     |
|                    | non CS pecks        | 0  | 0  | 0 | 0 | 0               | 4  | 351 | 71  | 239 | 126 | 154 | 181 |     |
|                    | + trials with pecks | 0  | 0  | 0 | 0 | 0               | 1  | 16  | 19  | 20  | 20  | 20  | 20  |     |
|                    | - trials with pecks | 0  | 0  | 0 | 0 | 0               | 3  | 16  | 18  | 20  | 15  | 8   | 7   |     |
| trials with eating | 7                   | 0  | 0  | 0 | 0 | 0               | 20 | 20  | 20  | 20  | 20  | 20  | 20  |     |
| 303**              | CS+ pecks           | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 0   | 245 | 366 | 336 | 300 |     |
|                    | CS- pecks           | 0  | 0  | 0 | 0 | 0               | 1  | 0   | 8   | 240 | 347 | 142 | 13  |     |
|                    | non CS pecks        | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 1   | 471 | 385 | 234 | 73  |     |
|                    | + trials with pecks | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 0   | 19  | 20  | 20  | 20  |     |
|                    | - trials with pecks | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 4   | 17  | 20  | 18  | 7   |     |
| trials with eating | 0                   | 0  | 0  | 0 | 0 | 0               | 20 | 20  | 20  | 20  | 20  | 20  | 20  |     |
| 815*               | CS+ pecks           | 8  | 0  | 1 | 0 | 0               | 12 | 184 | 237 | 217 | 246 | 163 | 123 | 49  |
|                    | CS- pecks           | 16 | 4  | 0 | 1 | 5               | 50 | 175 | 13  | 0   | 0   | 15  | 0   | 0   |
|                    | non CS pecks        | 13 | 11 | 1 | 0 | 0               | 17 | 172 | 53  | 54  | 93  | 9   | 14  | 36  |
|                    | + trials with pecks | 1  | 0  | 1 | 0 | 0               | 4  | 19  | 20  | 20  | 20  | 20  | 20  | 17  |
|                    | - trials with pecks | 5  | 1  | 0 | 1 | 1               | 14 | 20  | 5   | 0   | 0   | 0   | 2   | 0   |
| trials with eating | 7                   | 5  | 7  | 4 | 3 | 14              | 20 | 20  | 20  | 20  | 20  | 20  | 20  | 20  |
| 808                | CS+ pecks           | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 52  | 295 | 307 | 259 | 264 | 238 |
|                    | CS- pecks           | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 31  | 21  | 0   | 0   | 0   | 0   |
|                    | non CS pecks        | 0  | 1  | 0 | 0 | 0               | 0  | 0   | 19  | 200 | 17  | 11  | 12  | 7   |
|                    | + trials with pecks | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 8   | 18  | 19  | 19  | 20  | 20  |
|                    | - trials with pecks | 0  | 0  | 0 | 0 | 0               | 0  | 0   | 7   | 5   | 0   | 0   | 0   | 0   |
| trials with eating | 0                   | 0  | 0  | 0 | 0 | 0               | 20 | 20  | 20  | 20  | 20  | 20  | 20  | 20  |

\* denotes that a bird has been dropped from the study due to exceeding the pecking and eating criterion during the nondeprived training phase (see page 33)

\*\* denotes that a bird has been dropped from the study for not meeting the response criterion during the testing phase (see page 35-36)

# Appendix I

## Data for the Hold Group Birds in Experiment II

| Subject | Training Session    |    |     | Testing Session |     |     |     |     |
|---------|---------------------|----|-----|-----------------|-----|-----|-----|-----|
|         | 1                   | 2  | 3   | 4               | 5   | 6   | 7   |     |
| 823     | CS+ pecks           | 0  | 0   | 0               | 126 | 238 | 233 | 251 |
|         | CS- pecks           | 0  | 0   | 0               | 112 | 80  | 3   | 0   |
|         | non CS pecks        | 0  | 0   | 0               | 35  | 19  | 16  | 14  |
|         | + trials with pecks | 0  | 0   | 0               | 18  | 19  | 19  | 20  |
| 822     | - trials with pecks | 0  | 0   | 0               | 18  | 13  | 1   | 0   |
|         | trials with eating  | 14 | 16  | 19              | 19  | 20  | 20  | 20  |
|         | CS+ pecks           | 3  | 143 | 139             | 154 | 171 | 146 | 112 |
|         | CS- pecks           | 3  | 49  | 8               | 0   | 7   | 0   | 0   |
| 818     | non CS pecks        | 0  | 155 | 46              | 5   | 8   | 23  | 20  |
|         | + trials with pecks | 2  | 19  | 20              | 19  | 20  | 20  | 20  |
|         | - trials with pecks | 2  | 11  | 2               | 0   | 1   | 0   | 0   |
|         | trials with eating  | 19 | 20  | 20              | 20  | 20  | 20  | 20  |
| 825**   | CS+ pecks           | 1  | 97  | 225             | 238 | 228 | 257 | 240 |
|         | CS- pecks           | 0  | 33  | 51              | 30  | 20  | 3   | 4   |
|         | non CS pecks        | 0  | 44  | 35              | 18  | 46  | 14  | 12  |
|         | + trials with pecks | 1  | 16  | 20              | 20  | 20  | 20  | 20  |
| 820     | - trials with pecks | 0  | 8   | 10              | 3   | 5   | 2   | 2   |
|         | trials with eating  | 20 | 18  | 20              | 20  | 20  | 20  | 20  |
|         | CS+ pecks           | 0  | 0   | 0               | 177 | 251 | 195 | 209 |
|         | CS- pecks           | 0  | 0   | 0               | 58  | 4   | 0   | 0   |
| 820     | non CS pecks        | 0  | 0   | 0               | 57  | 32  | 20  | 12  |
|         | + trials with pecks | 0  | 0   | 0               | 20  | 19  | 20  | 20  |
|         | - trials with pecks | 0  | 0   | 0               | 17  | 4   | 0   | 0   |
|         | trials with eating  | 18 | 17  | 20              | 20  | 19  | 20  | 20  |
| 820     | CS+ pecks           | 5  | 141 | 338             | 407 | 430 | 436 | 457 |
|         | CS- pecks           | 2  | 25  | 90              | 43  | 1   | 5   | 0   |
|         | non CS pecks        | 0  | 28  | 23              | 26  | 18  | 13  | 23  |
|         | + trials with pecks | 1  | 20  | 20              | 20  | 20  | 20  | 20  |
| 820     | - trials with pecks | 1  | 9   | 8               | 6   | 1   | 1   | 0   |
|         | trials with eating  | 20 | 20  | 20              | 20  | 20  | 20  | 20  |

Appendix I - cont.

Data for the Hold Group Birds in Experiment II

| Subject             | 1 | 2 | Training Session |   |   | 6 | 1  | 2   | 3   | Testing Session |     |     | 6   | 7 |
|---------------------|---|---|------------------|---|---|---|----|-----|-----|-----------------|-----|-----|-----|---|
|                     |   |   | 3                | 4 | 5 |   |    |     |     | 4               | 5   | 6   |     |   |
| CS+ pecks           |   |   |                  |   |   |   | 0  | 0   | 0   | 0               | 28  | 98  | 173 |   |
| CS- pecks           |   |   |                  |   |   |   | 0  | 0   | 0   | 1               | 22  | 99  | 30  |   |
| 802** non CS pecks  |   |   |                  |   |   |   | 0  | 0   | 0   | 0               | 13  | 181 | 10  |   |
| + trials with pecks |   |   |                  |   |   |   | 0  | 0   | 0   | 0               | 8   | 11  | 20  |   |
| - trials with pecks |   |   |                  |   |   |   | 0  | 0   | 0   | 1               | 7   | 10  | 9   |   |
| trials with eating  |   |   |                  |   |   |   | 4  | 0   | 0   | 18              | 20  | 4   | 20  |   |
| CS+ pecks           |   |   |                  |   |   |   | 0  | 0   | 149 | 226             | 266 | 184 | 205 |   |
| CS- pecks           |   |   |                  |   |   |   | 0  | 0   | 31  | 6               | 0   | 1   | 0   |   |
| 305 non CS pecks    |   |   |                  |   |   |   | 1  | 0   | 36  | 14              | 16  | 14  | 9   |   |
| + trials with pecks |   |   |                  |   |   |   | 0  | 0   | 19  | 20              | 20  | 20  | 20  |   |
| - trials with pecks |   |   |                  |   |   |   | 0  | 0   | 9   | 2               | 0   | 1   | 0   |   |
| trials with eating  |   |   |                  |   |   |   | 20 | 20  | 20  | 20              | 20  | 20  | 20  |   |
| CS+ pecks           |   |   |                  |   |   |   | 0  | 221 | 357 | 403             | 375 | 407 | 437 |   |
| CS- pecks           |   |   |                  |   |   |   | 2  | 159 | 126 | 6               | 3   | 2   | 29  |   |
| 306 non CS pecks    |   |   |                  |   |   |   | 1  | 130 | 85  | 24              | 32  | 24  | 35  |   |
| + trials with pecks |   |   |                  |   |   |   | 0  | 16  | 20  | 20              | 20  | 20  | 20  |   |
| - trials with pecks |   |   |                  |   |   |   | 1  | 17  | 14  | 2               | 1   | 2   | 5   |   |
| trials with eating  |   |   |                  |   |   |   | 20 | 20  | 20  | 20              | 20  | 20  | 20  |   |

\* denotes that a bird has been dropped from the study due to exceeding the pecking and eating criterion during the nondeprived training phase (see page 33)

\*\* denotes that a bird has been dropped from the study for not meeting the response criterion during the testing phase (see page 35-36)

CONTINGENCY LEARNING IN THE NONDEPRIVED PIGEON

by

WILLIAM CHARLES DEEDS

B. A., Wichita State University, 1974

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AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1977

Two experiments were conducted in order to determine if pigeons can learn about relationships between environmental events while nondeprived. The first experiment attempted to determine if nondeprived pigeons can learn about simple contingencies between key light and grain presentations. Different groups of birds were exposed to positive, zero, or negative correlations between presentations of a key light and grain. Two control groups were also included, a CS-only group which received only presentations of the key light, and a Hold group which received no preexposure to the key light or grain while nondeprived. No consistent pecking or eating behavior was observed during the nondeprived training phase in any of the groups. When deprived and exposed to standard autoshaping procedures, birds in the Positive and Hold groups pecked sooner and on a greater number of trials than birds in the other groups. These results indicated that nondeprived pigeons do learn about simple relationships between key light and grain presentations.

The second experiment attempted to determine if pigeons could learn to discriminate between two colors of key lights while nondeprived. Different groups of birds were exposed to presentations of two key light colors, each related in some way to grain presentations. For the TD group the key light colors were related to grain presentations in the same relationships during both this training phase and in

the subsequent testing phase. That is one key light color was always followed by grain and the other key light color was never followed by grain. For the RV group the relationships were reversed. The key light color that was never followed by grain during the training phase was always followed by grain during the testing phase, and the key light color that was always followed by grain during the training phase was never followed by grain during the testing phase. The PD group received grain presentations following a random half of the presentations of each key light color. In addition a Hold group, which received no preexposure to the two key light colors, was included. Following this training phase birds in all of the groups were deprived and exposed to a Pavlovian discrimination training procedure during the testing phase. The behavior of the four groups of birds was not found to be significantly different during the testing phase.

The first experiment clearly indicated that the pigeons had learned about the relationships between key light and grain presentations while nondeprived. The second experiment produced results that, although not inconsistent with the results of the first experiment, failed to demonstrate that nondeprived pigeons could master a discrimination between two key light colors. An analysis based on generalization was advanced to encompass the results of both of these experiments. The conclusion inferred from these experiments was that deprivation is not a necessary condi-

tion for the acquisition of knowledge about relationships between events in the environment. That is pigeons do learn about stimulus-reinforcer contingencies while in a nondeprived state.