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SELF-IMPOSED TIMEOUTS DURING A SUCCESSIVE
DISCRIMINATION: ESCAPE OR STIMULUS CHANGE?

THE UNIVERSITY OF NORTH CAROLINA AT
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SELF-IMPOSED TIMEOUTS DURING A SUCCESSIVE DISCRIMINATION:

ESCAPE OR STIMULUS CHANGE?

by

Patricia A. Santoro

A Dissertation Submitted to
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Approved by

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APPROVAL PAGE

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SANTORO, PATRICIA A. Self-imposed Timeouts During a Successive Discrimination: Escape or Stimulus Change? (1978) Directed by: Dr. Donald Wildemann. Pp. 72

The purpose of the present investigation was to examine the two major theoretical explanations for subject-initiated timeout responding during a successive discrimination. Stimulus change theorists suggest that the perceptible changes in the stimulus configuration as a consequence of timeout responding serve to reinforce that responding. Escape theorists maintain that timeout responses are emitted in order to eliminate specific stimuli that have acquired aversive characteristics.

Different consequences for a timeout response, varying in the amount of visual and auditory stimulus change, were arranged for six groups comprised of three pigeons each. Two tones of differing frequencies were used as stimuli in the separate components of the multiple discrimination schedule. In the S+ component, pecks on a key were required in order to obtain reinforcement; in the S- component, responses on a foot treadle were required for reinforcement. The timeout key was introduced once the auditory discrimination was well established. Timeout responses were first recorded during a baseline phase. Experimental manipulations included an extinction phase which involved eliminating reinforcement for treadle responding. This procedure was used in an attempt to increase the aversiveness of the S-. A second procedure to enhance the aversiveness of the S- was the application of shock contingent upon treadle pressing during S-. The final procedure sought to extinguish timeout responding by the elimination of its consequences. Timeout responses during baseline, treadle extinction, shock, and timeout extinction were compared. Key-peck response rates were also examined.

The present study demonstrated the establishment of auditory stimulus control of treadle pressing and key pecking in a multiple schedule. The study also showed that the two responses were not independent, since positive behavioral contrast occurred. Finally, the S- component of the multiple schedule did result in properties that produced more subject-initiated timeout responses during the S- component than during the S+ component.

The results were discussed in terms of behavioral contrast effects and an interactional interpretation of the effect stimulus change on escape performance. This interpretation was preferred over a simple stimulus change or escape hypothesis. The overlap between the two hypotheses does not allow for support of either one or the other.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

Recent experimental animal literature has reported a surprising finding, namely that during a schedule of positive reinforcement subjects will sometimes self-impose a period of signaled extinction or timeout. The self-imposed timeout usually involves the removal of reinforcement in conjunction with a change in stimulation. Self-imposed timeouts are especially surprising since other research has demonstrated the aversive properties of timeouts. For example, studies have shown that animal and human subjects will respond to escape or avoid a timeout from reinforcement (e.g., Ferster, 1957, 1958; D'Andrea, 1971). Research has also demonstrated that when a timeout from reinforcement is made contingent upon a specific response, the rate of that response will decrease (Holz, Azrin, & Ayllon, 1963; Zimmerman & Ferster, 1964). However, experiments that have reported the apparent reinforcing effects of timeout from reinforcement have limited the generalization that such a timeout manipulation functions as an aversive event (Dardano, 1973). These paradoxical findings have generated wide speculation.

Several theoretical positions have been developed in an attempt to explain the timeouts that have been shown to occur during either a simple reinforcement schedule or in a multiple discrimination schedule. Rilling, Askew, Ahlskog, and Kramer (1969), Rillig, Kramer, and Richards (1973) and Terrace (1971) have all demonstrated that pigeons would learn a new response, pecking a timeout key, in order to remove the stimulus associated with extinction in a multiple discrimination schedule. These investigators hypothesized that the timeout response was emitted to escape from an aversive stimulus, the S- (i.e., the stimulus signaling extinction). Other investigators (e.g., Azrin, 1961; Dardano, 1973) have posited that a self-imposed timeout can serve as an escape from the aversive aspects of a low density schedule of reinforcement.

A second theory of self-imposed timeouts is that the organism responds for a change in stimulation. Coughlin (1973) and von Strumer, Beale, and Davison (1975) have argued that the aversiveness of the stimulus associated with extinction could not be the crucial factor producing timeout responding. Rather, they posited that the reinforcing properties of stimulus change was the major cause of timeout responding. An important confound in this theoretical position is that a change in stimulation provides a form of escape and the extent of the escape may be a function of the amount and type of stimulus change.

The majority of research investigating timeout from a schedule of reinforcement or timeout from a successive discrimination has supported either the stimulus change hypothesis or the escape hypothesis. However, two additional theories have been suggested. Leitenberg (1965) postulated that research into timeout from positive reinforcement could be explained by a reinforcement maximizing hypothesis. For example, when a positive reinforcer, like food, was eliminated, behavior could be maintained by a weaker reinforcer such as stimulus change.

Falk (1971) has postulated yet another theory to explain timeout responding, relating such responding to other adjunctive behaviors. Falk refers to adjunctive behavior as extra, concurrent behavior maintained by the reinforcing properties of the schedule parameters governing another class of behaviors. In an investigation of polydipsia, Falk (1966) reinforced a pecking response on a fixed-interval schedule that was increased from 2 seconds through 300 seconds. The consumption of water, an adjunctive behavior since it was not reinforced by the food schedule, increased linearly up to a maximum point and then fell off at the higher requirements. Falk (1971) suggested that timeout responding induced by a fixed-ratio, fixed-interval, or multiple reinforcement schedule was simply an adjunct to the response under schedule control. Although schedule-induced escape has many of the characteristics of an adjunctive behavior, Falk was not aware of any schedule-induced escape research where the characteristic bitonic function was obtained (i.e., an increase in adjunctive responding as a function of schedule parameters followed by a decrease in responding). In a recent study, however, Brown and Flory (1972) did obtain a bitonic function for schedule induced escape. They reported that as a logarithmic increase in the fixed-interval schedule was imposed, the frequency, rate, and duration of escape, as well as the percentage of session time spent in escape, increased to a maximum and then decreased. The authors implied that escape behavior was a function of three factors: stimulus change, increasing schedule aversiveness and a decrease in the rate of transitions from reinforcement to non-reinforcement. They suggested a correlation between escape responding as an adjunctive behavior and schedule-induced polydipsia and schedule-induced attack. The behaviors have in common that each is induced by intermittent schedules of reinforcement, is correlated with a stimulus that has reinforcing properties, each is related to reinforcement frequency by a bitonic function, and finally, each behavior occurs mainly in the post-reinforcement period. Labeling escape behavior as an adjunctive response that cannot be explained in traditional conditioning terms, however, does not explain the antecedent events leading to a response-produced timeout. A more valuable approach would be a detailed functional analysis of the parameters related to schedule aversiveness and the reinforcing properties of stimulus change influencing the production of timeouts.

Self-imposed timeouts have been investigated in discrimination learning, where responding to one stimulus (S+) is reinforced while responding to another stimulus (S-) is extinguished. Results of research in discrimination learning have led investigators to assume that the stimulus correlated with extinction is an aversive stimulus (e.g., Amsel, 1962; Terrace, 1966). Terrace has provided indirect evidence for the aversiveness of S- from his research with errorless discrimination learning. Terrace has developed a procedure to train a successive discrimination without S- responding (i.e., without extinguishing responding to the S-). Errorless learning experiments typically employ superimposition and fading procedures to ensure that the S- is presented early and gradually into the discrimination sequence, thereby sharpening stimulus control and decreasing the likelihood of responding in the presence of the nonreinforced stimulus. Terrace has reported that emotional responses to the S- and peak shift do not occur after this errorless training but do occur after traditional discrimination training with extinction of S-responding.

Direct support for the aversiveness of S- has been provided by Rilling, Askew, Ahlskog, and Kramer (1969). They used an escape paradigm where pigeons could temporarily remove a stimulus correlated with extinction by pecking a second key. Pigeons were randomly assigned to the experimental and control groups and given training on a multiple schedule of reinforcement in which periods of variable-interval reinforcement alternated with periods of extinction. One peck on a second key resulted in a 30-second timeout, during which pecks on the first key had no effect and all lights in the chamber were turned off. Pecks on the second key had no effect for the control group. The experimental group demonstrated a higher rate of timeout responding during all but the first phase of training. The results were interpreted as support for Terrace's (1966) hypothesis that a traditionally trained S- becomes a conditioned aversive stimulus. Since timeout responses were rarely emitted in the presence of the S+ and consistently emitted during S-, timeout responding was interpreted to be an escape response from a conditioned aversive stimulus. The results of the control group allowed for the dismissal of explanations involving the effects of increased variability or extinction produced aggression against an inanimate object.

Rilling et al.'s study did not, however, rule out the possibility that the stimulus change produced by a timeout response was reinforcing.

Thus, stimulus change could have accounted for the increased timeout responding during S-. In an attempt to control for this confounding variable, Terrace (1971) repeated the paradigm used by Rillig et al. (1969) with the addition of "stimulus change" and "displacement" control groups. The aversiveness of the S- was manipulated by extinguishing S- responding in one group of pigeons while a second group was trained on the same discrimination with an errorless procedure. Therefore, the conditioned aversiveness of S- was theoretically high for one group and not the other. Subjects trained with each procedure were further subdivided into three groups. For one group a timeout response turned off the S- for 5 seconds during which time the house light and key light remained on. For a second group, a timeout response turned the timeout key light off for 5 seconds but had no effect on the S- light and the house light. For a third group timeout responding had no effect. The results showed that "errorful" pigeons would learn a few response that was contingent upon the removal of the S-. Subjects trained with the errorless method, however, did not emit such timeout responses. The responding on the timeout key could not be attributed to increased activity due to frustration since virtually no responding occurred on the displacement key (i.e., the key with no consequence). The reinforcing properties of stimulus change were also eliminated as a major factor resulting in timeout responding since minimal timeout responding took place when the consequence was merely a change in the timeout key light. Terrace concluded that after discrimination training with errors, the S- becomes an aversive stimulus that can serve as a secondary negative reinforcer.

Rillig, Kramer, and Richards (1973) extended Terrace's results. Rilling et al. suggested that the aversiveness of the S- was not proportional to the number of non-reinforced responses to the S-; instead, it was a function of the procedure for introducing S- in the discrimination training. Four groups of pigeons differed in the way S- was introduced during training. The groups varied according to whether or not the S- was presented early or late in training and whether or not it was presented progressively or in a constant form. When presented progressively, the intensity and duration of S- was gradually increased over five sessions. The constant procedure groups were given the S- at its maximum intensity upon first presentation. A peck on the timeout key during S- resulted in the darkening of the chamber and the keys for 10 seconds. Rilling et al. found that the number of S- responses emitted was not correlated with the number of timeouts produced. According to the authors, since the correlation between timeouts and errors was near zero, the aversiveness of the S- could not be estimated from the number of S- responses. They suggested that an S- which is presented for the first time after periods of non-differential reinforcement is more aversive than an S- which is immediately introduced after shaping.

Unfortunately, Rilling et al. assumed that the S- was a conditioned aversive stimulus at the beginning of their investigation and thus made no attempt to control for the reinforcing properties of stimulus change. They justified their procedure by citing Terrace's (1971) finding that control subjects who had a stimulus change emitted few pecks on the timeout key which suggested that the timeout behavior was not maintained by a small stimulus change. Unfortunately, this justification seems inadequate since other results supporting the theory that timeout responding is maintained by the reinforcing effects of stimulus change have been reported. These results will be reviewed later in this paper.

The aversiveness of certain schedules of reinforcement and stimuli associated with these schedules also has been investigated with the timeout paradigm. Azrin (1961) trained pigeons to peck a key for a fixed ratio schedule of reinforcement. Concurrently, a second timeout key was made available continuously. One peck on the timeout key changed the color and intensity of the ambient illumination of the chamber and response keys, as well as rendering responses on the food key ineffective. A second response on the timeout key returned conditions to their original state. Hence the procedure was essentially control of extinction by the organism. The requirement for reinforcement in the fixed ratio schedule was increased from 65 to 200 in each 1 hour daily session.

At low response requirements the pigeons spent very little time in timeout. As the requirements were increased, the pigeons spent more time in timeout. For example, when the response requirement was 200, the subjects would spend as much as 50% of their time in timeout. Azrin posited that the pigeons imposed a period of extinction on themselves because certain stages of a schedule of reinforcement may acquire aversive properties despite the absence of an explicit aversive stimulus. The results of this study are interesting since the pigeons were, in effect, self-imposing a signaled extinction (the S- stimuli consisted of the change in color and illumination of the house and key lights). Although they could respond on the food key during the timeout, responses were not reinforced. Therefore, even though non-reinforced responding occurred in the presence of the self-imposed S-, this responding did not acquire aversive properties. Alternatively, the reinforcing properties of stimulus change could have been stronger than the schedule of food reinforcement. Azrin argued against the possible reinforcing effects of stimulus change "since the pigeon imposed extinction periods regardless of whether an increase or decrease in illumination was associated with timeout" (p. 383). Both increased and decreased illumination represent changes in stimulation. However, the rewarding effects of a change in stimulation are not necessarily restricted by a certain direction. Thus, Azrin's study failed to determine whether timeout responding was due to the reinforcing properties of stimulus change or due to the conditioned aversive properties of the reinforcement schedule.

Zimmerman and Ferster (1964) have suggested still another possible cause of timeout responding. They posited that timeout responding could represent a temporary loss of control by the reinforcement schedule. In their study they varied the size of the fixed ratio and did not find a monotonic function between the number of timeouts produced and the size of the ratio. Their data indicated that "when the food schedule should be most aversive there was little disposition on the part of the subject to switch" (p. 19). Perhaps what was maintaining the timeout responding was an interaction of the weakened control of the reinforcement schedule, the increased reinforcing value of a change in stimulation, and the aversive aspects of stimuli that signal a low rate of reinforcement. Dardano

(1973) arrived at similar conclusions in his investigation of self-imposed timeouts during a progressive ratio schedule of reinforcement.

Several studies have been reported that favor a stimulus change interpretation. Appel (1963) conducted a study where two response keys were concurrently available to pigeons. Several different fixed-ratio schedules of reinforcement were alternated on one key while one response on a second key provided one of the following conditions: (a) a change in visual stimulation and the removal of the food reinforcement contingency; or (b) a change in visual stimulation and no effect on the reinforcement contingency; or (c) no changes. A second response on this key restored the original conditions, except for the "no change" condition. Subjects in the no change group emitted few responses. However, when responses on the timeout key resulted in a stimulus change, such responses were a function of the ratio size on the reinforcement key. Whether or not reinforcement was available during the period of the stimulus change had a minimal effect upon the frequency of timeout responding. Thus Appel found that the stimuli associated with a stimulus change as well as the aversiveness of the schedule of reinforcement functioned together to increase or decrease the relative reinforcing value of stimulus change. Responding on the second key was under control of the increased reinforcing value of stimulus change since the responding only occurred when the consequent event was a change in stimulation regardless of the presence of reinforcement. This change in stimulation derived its reinforcing value from the escape it provided when the original stimulating conditions became aversive. Here again the confound between stimulus change and escape from an aversive situation is obvious.

Coughlin (1970) attempted to replicate the finding of Rilling et al. (1969) that the stimulus associated with extinction served as a conditioned aversive stimulus which the pigeons escaped by pecking a timeout key. Coughlin found that when the consequence of a timeout response was the removal of the key lights, timeout responding ceased for most birds. However, if a blackout of the chamber followed the timeout response, responding occurred at a higher level. He suggested that the appropriate explanation of timeout responding was in terms of the reinforcing value of stimulus change. This conclusion contradicts the findings of Terrace (1971).

Coughlin (1972) reported that response contingent electric shock during S- resulted in more response suppression than extinction. He, therefore, concluded that the conditioned aversive properties of the S- were greater for the shocked groups. Coughlin (1973) attempted to test both the stimulus change hypothesis and the escape hypothesis offered by Terrace. His study involved two major manipulations, the amount of stimulus change and the aversiveness of the S-. Coughlin argued that if timeout responding was an escape from an aversive stimulus then, if the stimulus were made more aversive, timeout responding should increase. One way to increase the aversiveness of the S- was to shock responses in the presence of the S-. Subjects were divided into four groups according to the stimuli presented during timeout: blackout-shock; blackout-no shock; no blackout-shock; and no blackout-no shock. The pigeons were trained to discriminate between a green and red key light on a multiple variable-interval extinction schedule. Pecks on a second key produced either a timeout from the schedule in effect or a total blackout of the chamber. During the second phase, half the birds were shocked for responding during S-. The hypothesis that greater aversiveness produced by shock would maintain higher rates of timeout responding was only supported in the first session of the shock procedure. After the first session, the timeout rates decreased for the shock groups while the rate increased for the no-shock groups. As a possible explanation for these results, Coughlin suggested that the aversive properties of the punishment generalized from the S- key to the timeout key. Thus, any conclusions that the subjects escaped from S- as a result of its aversive properties could not be justified due to the contaminating effects of generalization.

Coughlin also reported greater timeout responding when a timeout response eliminated all illumination in the box than when the timeout peck eliminated the S-. Thus, greater stimulus change produced by timeout responding resulted in more timeout responses, suggesting stimulus change was a reinforcer. Goas (1972), using rats as subjects, has reported a similar result. He compared one group of rats who could produce a blackout and leave the S- on, to a second group who could turn the S- off and leave the house lights on. A higher timeout rate was found for the group producing the blackout, supporting the stimulus change hypothesis.

Unfortunately, Coughlin's procedure did not differentiate between the reinforcing properties of stimulus change and the conditioned aversive properties of the S-. Coughlin posited that "different degrees of stimulus change merely allowed for more escape; that is, a greater change in aversiveness" (p. 303). Coughlin's procedure may have been confounded by his choice of stimuli. Terrace (1966) remarked that a typical behavior for pigeons during S- was to turn away from the S- key. Coughlin reported that this behavior occurred in his study. Thus, some pigeons may have learned that turning away from the S- was the most efficient method of escaping the S-. Since such responses were not measured, the possibility exists that birds in the shock groups could have been making more and longer escape responses by turning away from the key. Thus, the possibility of unauthorized escape responses confounds an interpretation of Coughlin's results.

Von Sturmer, Beale, and Davison (1975), in the second part of their study, also investigated aversive control by S-. The authors suggested that, if timeout responding was maintained by the aversive control of the S-, then nonpresentation of the S- should eliminate timeout responding. Following discrimination training, each pigeon received 30 sessions in which the stimulus correlated with extinction (green key) was not presented. During the extinction component, only the timeout key was lit and operating while the main key was dark. The next phase in the study employed a variable time (VT) schedule, that is, the stimulus associated with the variable-interval component was eliminated and the food schedule became response independent. During this phase, a peck on the timeout key stopped the VT tape and turned off the key light for 30 seconds. In the follow-phases, the VT schedule was eliminated (extinction) for 20 sessions and then the timeout response was extinguished. Therefore, in the final phase of the experiment, pecking on all keys had no effect.

Timeout responding was maintained during the 20 sessions in which the stimulus correlated with extinction was absent. The pigeons were, however, presented with a visible key on which no stimulus appeared. According to Terrace (1971), this blank key is technically a second S-, although it rarely occasions responding. Since it is not clear whether or not the aversiveness of the S- is due to non-reinforced responding, the implications for the presence of the blank key are not definitive. An important conclusion offered by the authors was that a self-imposed blackout during the extinction component of a successive discrimination "was not a measure of the aversiveness of the arranged key stimulus associated with the extinction component" (p. 135).

Timeout responding was also maintained when the stimulus associated with the VT component was eliminated, although there was a decrease in rate. In this phase the pigeons were confronted with a blank key during both the S+ and S- components (response independent reinforcement was available during the S+). The decrease in frequency of timeout responding could be explained by the decreased aversiveness of the "new" S- due to the presence of food associated with a blank key. In the next phase, the VT component underwent extinction and timeout responding increased. Theoretically, the S+ could have acquired aversive properties in this phase due to the nonreinforced responding. And finally, when the blackout contingency on the timeout key was eliminated, responding on that key disappeared for all birds. This result illustrated that the timeout response was under the control of its immediate consequence, a total blackout of the chamber.

The authors suggested that the explanations dealing with escape from an aversive stimulus offered by Rilling et al. (1969), Rilling et al. (1973) and Terrace (1971) were inadequate to explain the subjects' switching into blackout. Rilling and his associates concluded that the aversiveness of the stimulus signaling extinction was derived from the low reinforcement rate, yet the reinforcement rate was just as low in the 30-second blackout. According to Rilling's analysis, the blackout itself should have become aversive. Terrace attributes the aversiveness of S- and the resulting escape behavior to the subject's non-reinforced responding in the presence of S-. While his analysis would explain why the blackout did not become aversive, Rilling et al. (1973) did not obtain a relationship between timeout responding and non-reinforced S- responding. The final conclusion reached by von Sturmer et al. was that perhaps the consequence of a large stimulus change was controlling the timeout responding. This conclusion, as mentioned earlier, was also supported by Appel (1963) and Coughlin (1973). It seems that when a low baseline schedule of reinforcement with weak control over responding is paired with the opportunity to produce a stimulus change, the result will be increased timeout responding. Terrace's control procedure of having a timeout peck turn off the key light may not have been an easily discriminable stimulus change for maintaining the behavior. Coughlin (1973) and Goas (1972) found that there was a greater tendency for the animals to respond on a timeout key when the result was a blackout (large stimulus change) than when the consequence of a peck was merely eliminating the key lights.

As this review shows, previous investigations have used inadequate control procedures in their attempt to delineate the important variables affecting timeout responding during a reinforcement schedule. Problems such as unrecorded escape responses, generalization of the aversive properties of shock to the timeout response, and inadequate controls for stimulus change conditions have led to a confounding between the S- escape theory and the stimulus change theory of timeout responding. The present study attempted to eliminate these confounding variables. To prevent unrecorded escapes from a localized stimulus (e.g., turning away from an S- on a key), two tones of differing frequencies were used as the S+ and S-. Two degrees of S- aversiveness were also employed. Following reinforcement for responding in the presence of the S-, these responses were extinguished. An additional increase in the aversiveness of the S- was obtained by shocking responses during the presentation of the S-, To prevent generalization between the punished S- response and the timeout response, the S- response was treadle pressing while S+ and timeout responding were key pecks. Both Hemmes (1973) and Scull and Westbrook (1973) have reported no positive contrast effects when one stimulus is correlated with a treadle response. These results led the investigators to conclude that there was no generalization between the two responses.

The amount of stimulus change associated with the timeout response, as well as the degree of escape from the S-, were manipulated by using six groups of pigeons, each with a different consequence for a response on the timeout key. The six timeout consequences represented a rank ordering of the amount of stimulus change contingent upon a response. By representing a continuum of change in stimulation as consequences for timeout responding, the present study tested discrepant hypotheses based on the two major theoretical explanations of self-imposed timeout responding. Table 1 shows the predicted results of timeout responding for the six groups based on the three theoretical formulations. The stimulus change theory would predict that those groups providing the largest stimulus change would emit the greatest number of timeout responses. The escape theory would predict that those groups which experienced the removal of the S- stimulus would emit the largest number of timeout responses. The dichotomy between these two theories may prove to be nonfunctional if the results demonstrate that the various forms of stimulus change provide different levels of escape. These results would be predicted by an interactionist position.

Table 1

Predicted Results According to Escape, Stimulus Change and Interactional Theories

	Rank Orderings of Highest to Lowest Timeout Responders		
Groups	Escape Theory	Stimulus Change Theory	Interactional Theory
Total Escape	1.5	1.0	1.0
Blackout	4.0	2.0	2.5
Increase Intensity	6.0	4.5	5.0
Decrease Intensity	3.0	4.5	4.0
Tone Off	1.5	3.0	2.5
No Change	5.0	6.0	6.0

CHAPTER II

METHOD

Subjects

Eighteen naive White Carneaux pigeons, maintained at 80% of their free-feeding weights, were assigned to six experimental groups on the basis of their discrimination indices.

Apparatus

The two experimental chambers were gray plywood boxes having subject areas of 40 cm x 36 cm x 39.5 cm and 38 cm x 34 cm x 37 cm. In each box the two-key and one-treadle intelligence panel was located on one wall. All keys were 2.5 cm in diameter and 27.4 cm above the floor. One key, illuminated by an amber light (timeout key) was 9.5 cm to the left of the center of the panel while a second key, illuminated by a purple light (reinforcement key) was 9.5 cm to the right of center. All keys required between 15 and 20 g to be operated. A grain hopper was located in the middle of the panel. The treadle was located 11 cm to the left of the hopper and 4 cm from the floor. A force of 55 g was required to operate each treadle. The treadle was made of 1 cm thick plastic with an area approximately 7 cm x 2 cm. The ends of both treadles curved slightly toward the subjects to allow easy access with the foot.

The subjects stood on a shock grid floor composed of approximately 600 1½ in. galvanized roofing nails, 1.5 cm apart. The nails were wired together alternately in order to create an electric circuit. The floor was designed in such a way that the pigeons could not short-circuit the shocks with either foot position or urine or feces.

The two auditory stimuli (S- and S+) were presented via two sonalerts positioned behind the intelligence panel in each box. The two tones (100 Hz and 2500 Hz) were programmed for presentation at three different decibel levels, 52 db, 62 db and 72 db for the different timeout conditions.

A diffuse, 15-watt house light was located in the center of each chamber's ceiling. A speaker on the back wall of each box was used to present white noise. Extraneous noise was masked by white noise and by the ventilation fan. Reinforcement was a 3.5 sec period of access to mixed grain.

Stimulus presentations, shocks and the recording of responses were controlled by solid state logic components.

Procedure

Preliminary training. All subjects were trained to key peck using standard autoshaping procedures. Once a stable response rate for key pecking was observed for each bird, foot treadle responding was established. During this procedure the key was covered to prevent any incompatible responses. The general strategy used in treadle-press training was to first reinforce the birds for standing near the treadle. It was observed generally that once the birds would stand near the treadle, accidental responses would occur. These responses would be reinforced immediately. When stable treadle response rates were established for all subjects, they were presented with both manipulanda simultaneously. When it was observed that each bird would emit both responses in one session, discrimination training began. All but two subjects exhibited stable response rates for the two manipulanda.

Discrimination training. Birds were reinforced according to a multiple variable-interval (VI) 1-minute peck, VI 1-minute press schedule of reinforcement. The reinforcing component for treadle pressing was signaled by a steady, low frequency tone (1000 Hz) provided by a sonalert. Reinforcement consisted of a 2.5 sec access to a tray of mixed grain. During reinforcement all stimuli in the chamber except the house light and the feeder light were turned off. The house light remained illuminated in order to eliminate any possible confounding due to a blackout being associated with reinforcement. During the reinforcement component for treadle pressing, key pecks were not reinforced. Another sonalert provided a 2500 Hz modulated tone signaling the reinforcing component for key pecking. Reinforcement for treadle pressing was not available during this component. Sessions consisted of a random presentation of 12 2-minute key reinforcement components (S+) and 12 2-minute treadle reinforcement components (referred to as S- since it will later be the extinction component). These trials were separated by a 5-sec intertrial interval during which time the key was dark, tones were off and the house light remained on. This intertrial interval ensured that a response to S- was never followed by the presentation of S+. This procedure is essential in a later phase of the discrimination training where S- is paired with extinction of the treadle response.

A change-over-delay (COD) of 5 sec, in addition to the intertrial interval of 5 sec, was required between a response on one manipulanda and an immediate response on the other, leading to reinforcement. This requirement was imposed when it was observed that chaining had developed and was interfering with the discrimination learning procedure. The COD successfully broke the chain of responses alternating between manipulanda.

Each subject's ability to discriminate was assessed by calculating a discrimination index. Correct responses (key responses emitted during S+ or treadle responses emitted during S-) were divided by the sum of correct and incorrect responses. Discrimination indices of .75 or greater demonstrated an acceptable discrimination between the two tones. After 3 months of discrimination training, the first experimental session was initiated. Since all of the birds had not met the criterion for discrimination of .75, three birds were assigned to each of the six groups on the basis of a matching procedure. Each group consisted of birds with high, medium and low discrimination indices. Appendix A shows the mean discrimination index for each bird in each group prior to the first experimental phase.

The groups differed according to the amount of stimulus change contingent upon a timeout response. These contingencies are shown in Table 2. Responses on the timeout key had no effect for those subjects in the no-change control group. Two stimulus change control groups were used. For one group, a response on the timeout key resulted in an increase in the intensity of the tone signaling S+ or S- (from 62 db to 72 db). For the other group, a response on the timeout key decreased the intensity of the

Table 2

Consequences of a Timeout Response for Each Group

	Change in Stimulation	
Groups	Tone (S+ or S-)	Houselight
No Change	ON	ON
Blackout	ON	OFF
Decreased Intensity	DECREASE	ON
Increased Intensity	INCREASE	ON
Tone Off	OFF	ON
Total Escape	OFF	OFF

tone from 62 db to 52 db. Subjects in the blackout group experienced a blackout (house light off) with the tone remaining on as a result of the timeout peck. Responses on the timeout key turned off the tone (either S+ or S-) for the subjects in the tone-off escape group. Subjects in the total escape group experienced both the removal of the tone and the house light as the timeout consequence. During all timeout periods reinforcement was not available.

Experimental conditions. The first experimental phase provided a baseline measure of timeout responding. An amber timeout key was made available during both the S+ and S- components of the multiple schedule. One peck on the timeout key resulted in a 20-sec duration of the consequences previously described for each group. At the end of the timeout, the prior conditions were reinstated. The VI tapes scheduling reinforcement did not run during the timeout periods. The timers controlling the duration of the S+ and S- components continued to run during the timeout. If a timeout was produced when there was less than 20 sec remaining for the component, the timeout ended when the interval time elapsed and the 5-sec intertrial interval started. Baseline timeout recordings were taken for 15 sessions.

In the next phase of the experiment treadle responses during S- were extinguished while key pecking during S+ remained on a VI 1-minute schedule of reinforcement. The timeout key remained available during S+ and S- components as in the previous phase. Responses during this phase of the study were recorded for 20 days.

The shock phase of the experiment resembled the previous phase except that, in order to increase the aversiveness of the S-, each treadle response in the presence of the S- received contingent shock. The shock consisted of 60 to 100 volts for .2 sec delivered through the shock grid floor. The voltage varied for each bird due to differences in resistance. A shock level was chosen for each bird based on the elicitation of a strong startle response (wing flapping, jumping). To ensure that a minimum amount of shock was received, two random shocks were delivered if no treadle responses were emitted during the first half of the session. The shocks were always during the S- and were never delivered contingent upon a key peck.

As a final procedure for evaluating the effect of the consequences of the timeout responses, the contingencies were eliminated. That is, a response on the timeout key had no effect. This manipulation was to ensure that the timeout response was a function of its consequences. Shock was eliminated during this phase while reinforcement continued on a VI 1-minute schedule for pecking during the S+ component.

Dependent measures. The number of timeout responses were recorded for each bird during S+ and S- throughout the four phases of the experiment. Treadle response rates and key peck response rates were also calculated for each bird during the S+ and S- components throughout the four experimental phases.

The indices used in the present experiment to denote an adequate criteria of discrimination learning were low compared to other research in the area of discrimination learning. However, researchers investigating timeout responding during multiple schedules (Coughlin, 1973; Terrace, 1971) have not set stringent response requirements for the learned discrimination. Coughlin did not report any measure of discrimination for his subjects, while Terrace reported the range of the number of errors made by each bird. Since the purpose of the investigations was to examine timeout responding during a signaled period of extinction, S-, within a multiple schedule, a stringent discrimination requirement did not seem necessary. Another important point to be considered is the difficulty in establishing and maintaining an auditory discrimination in pigeons. Low discrimination indices were obtained for some subjects and these were maintained over an extended period of time suggesting that the maximum level of learning had been reached.

CHAPTER III

RESULTS

Response Rates

The daily response rates for all birds on both the treadle and the key during S+ and S- components for the first two phases of the study can be found in Appendix B. Table 3 shows the averages for the first five and the last five sessions during these two phases for each subject. The response rates are shown only for the baseline and extinction phases of the experiment since these were the important phases for illustrating the effects of extinguishing the treadle response. Fairly stable rates for both responses were observed during baseline with the exception of Bird 18 who would not treadle press consistently and Bird 11 who would not key peck. A rapid reduction in treadle pressing occurred for all subjects in the first experimental phase which eliminated reinforcement for treadle pressing.

A dramatic increase in key pecking rates was apparent for all birds (except 11) when extinction of the treadle response was initiated. The increased key pecking was observed in both the S- and S+ components. This finding of behavioral contrast is illustrated in Figure 1, a representative graph of key peck rates during the S+ and S- components for all phases of the experiment for Bird 3. This figure emphasized the generalization that occurred between treadle pressing and key pecking due to the change in experimental contingencies. Removal of reinforcement for treadle

Table 3

Average Treadle and Keypeck Response Rates for the First and Last Five Sessions in Both Components for the Baseline and Extinction Phases

Increase Intensity

Bird Number	3				18				19			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	.42	.28	.54	.11	.17	.12	.26	.16	.37	.17	.45	.17
Last 5	.37	.19	.56	.12	.18	.09	.39	.15	.30	.11	.53	.09
Extinction												
First 5	.02	.00	.89	.55	.01	.004	.80	.51	.024	.002	.66	.45
Last 5	.03	.00	1.03	.56	.00	.00	.95	.60	.004	.00	.78	.61

Decrease Intensity

Bird Number	1				9				17			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	.49	.10	1.09	.11	.30	.08	.52	.14	.18	.07	.29	.09
Last 5	.47	.12	1.03	.05	.30	.07	.75	.11	.20	.09	.50	.12
Extinction												
First 5	.05	.002	1.47	.97	.002	.00	1.12	.87	.01	.00	1.00	.58
Last 5	.004	.00	1.41	.61	.00	.00	.91	.67	.00	.00	1.29	.78

Table 3

(Continued)

No Change

Bird Number	7				11				13			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	.31	.19	.34	.08	.32	.21	.01	.00	.32	.20	.23	.08
Last 5	.23	.09	.32	.06	.29	.13	.00	.00	.32	.16	.21	.04
Extinction												
First 5	.04	.03	.43	.25	.03	.02	.00	.00	.02	.008	.46	.27
Last 5	.04	.01	.52	.17	.004	.00	.00	.00	.00	.00	.55	.29

Tone Off

Bird Number	6				15				20			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	.33	.27	.54	.16	.55	.27	.60	.14	.29	.19	.86	.21
Last 5	.27	.16	.50	.13	.53	.20	.90	.26	.32	.18	.98	.14
Extinction												
First 5	.09	.006	.51	.29	.09	.006	.93	.72	.02	.004	1.46	1.01
Last 5	.02	.00	.78	.50	.03	.00	1.30	1.08	.03	.00	.78	.48

Table 3

(Continued)

Black Out

Bird Number	8				12				10			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	.36	.10	.44	.06	.06	.12	.72	.28	.36	.25	.29	.11
Last 5	.31	.08	.34	.05	.26	.11	.63	.17	.41	.20	.42	.07
Extinction												
First 5	.03	.006	.40	.28	.06	.004	.93	.72	.09	.04	.64	.37
Last 5	.002	.00	1.17	.91	.09	.00	.76	.44	.02	.008	.65	.40

Total Escape

Bird Number	2				4				5			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	.24	.11	.73	.48	.38	.27	.23	.07	.44	.27	.60	.33
Last 5	.17	.05	.68	.42	.38	.21	.22	.07	.31	.26	.93	.35
Extinction												
First 5	.03	.002	.86	.63	.04	.03	.37	.29	.03	.00	1.16	.66
Last 5	.02	.00	1.04	.68	.006	.002	.57	.40	.002	.00	1.46	.91

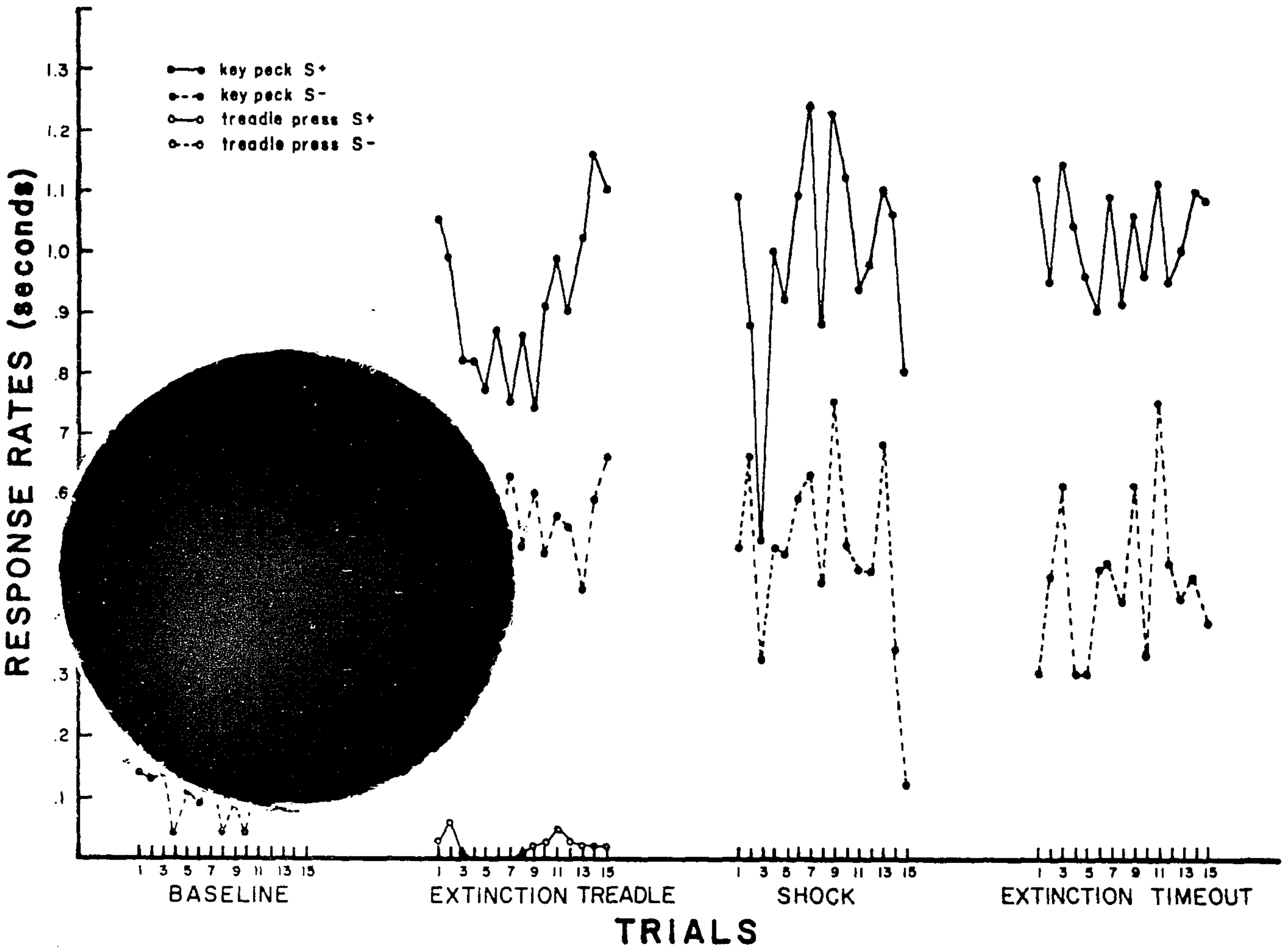

Figure 1. Response rates for key pecking and treadle pressing for Bird 3.

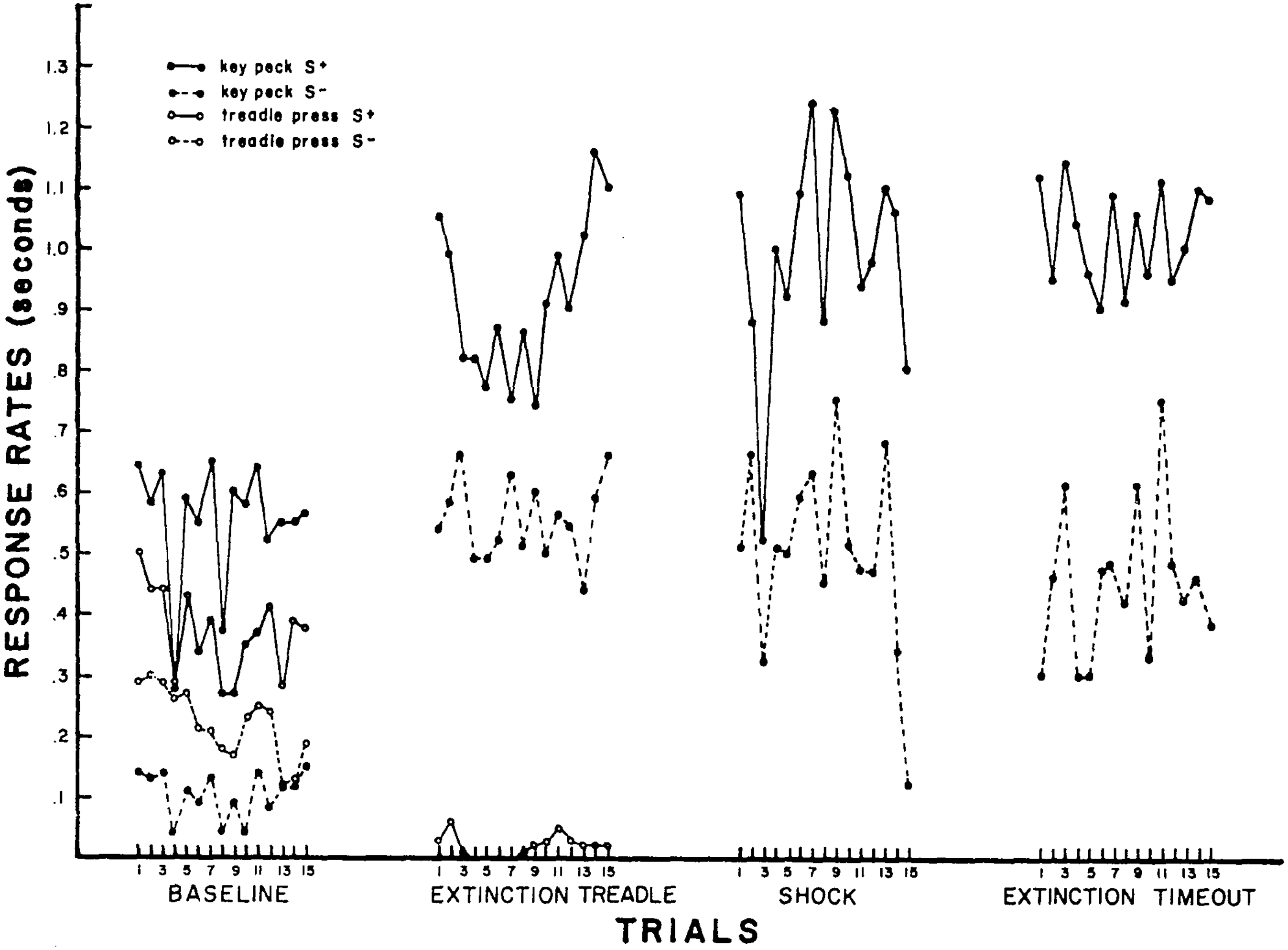

Figure 1. Response rates for key pecking and treadle pressing for Bird 3.

pressing resulted in an increased response rate for key pecking despite the fact that the key peck contingency remained unchanged. Unlike the previous studies employing different responses in each component of the multiple schedule (Premack, 1969; Westbrook, 1973), extinction of the treadle pressing resulted in positive contrast in key pecking. This result illustrates the presence of generalization across the two behavioral measures.

A three-way repeated measures analysis of variance was performed on the key peck response rates with groups as the between variable and phases and conditions as the within variables. The results of the analysis can be found in Table 4. The results revealed a significant difference ($p < .01$) between response rates during the baseline and extinction phases. The rate of key pecking during extinction was significantly higher than the response rate during the baseline phase.

A significant main effect for the conditions variable was obtained ($p < .01$) as expected, since key pecks were reinforced in the presence of S+ and not reinforced in the presence of S-.

Also significant in the analysis was the main effect variable for the groups ($p < .01$). The Newman-Keuls statistic was used to analyze the multiple comparisons between the six groups. Although there was a significant F-ratio, no significant pairs of means were obtained using the post hoc statistic. This apparent incongruity has been attributed to the high power of the F test compared to the low power of the post hoc tests (Soderquist & Gaebelein, 1977).

Table 4

ANOVA for the Keypeck Response Rates

Source	df	MS	F
Between	17		
Groups	5	5.90	12.826**
Subj. w. Groups	12	.46	
Within	54		
Phases	1	33.47	39.85**
Groups x Phases	5	.86	1.02
Phases x Subj. w. Groups	12		
Conditions	1	29.89	35.58**
Groups x Conditions	5	.71	.85
Conditions x Subj. w. Groups	12		
Phases x Conditions	1	.42	.50
Groups x Phases x Conditions	5	.16	.19
Phases x Conditions x Subj. w. Groups	12		
Pooled Error		.84	

The high rate of key peck responding attained during the extinction phase was maintained throughout the remainder of the experiment. This finding was consistent for most birds. However, during the shock phase, in which shock was contingent upon treadle responses a suppressive effect of shock on key pecking also occurred. This result illustrates the generalization between the two different responses. This decrease in key peck response rate for some birds was observed both in the S+ and S- components. This finding emphasized the generalization across responses in the two components of the multiple schedule.

Timeout Responding

The daily records of timeout responding during S+ and S- for all birds in each group throughout the experiment can be found in Appendix C. Minimal responding on the timeout key was observed for Birds 6, 8, 9, 10, 11, 12 and 13. The extreme variability, large individual differences, and frequent absences of timeout responding limit the usefulness and feasibility of statistical analysis. This result suggests that the phenomena may not be robust or predictable.

Table 5 shows the mean timeout responses and difference ratios (DR) for each subject during each experimental phase. The difference ratios were obtained by dividing the number of timeout responses during S- by the total number of timeout responses made during both the S- and S+ components. The mean number of timeout responses found in Table 5 does suggest some important differences. All groups except the no-change control group had at least one subject emitting a mean number of timeout responses greater than two per session. The total-escape group was the only group

Table 5

Mean Timeout Responses and Difference Ratios for Each Bird in Each Group

Increase Intensity

Bird Number		3			18			19	
	S+	S−	DR	S+	S−	DR	S+	S−	DR
Baseline	1.10	.40	.27	4.20	6.30	.60	7.20	7.40	.51
Extinction	.26	8.10	.97	.46	3.70	.89	.60	1.26	.68
Shock	0.00	2.00	1.00	.20	1.46	.88	.53	1.30	.71
No shock - Ext. T.O.	0.00	1.13	1.00	0.00	.60	1.00	.13	.40	.75

Decrease Intensity

Bird Number		1			9			12	
	S+	S−	DR	S+	S−	DR	S+	S−	DR
Baseline	.60	0.00	0.00	0.00	.06	1.00	.13	.06	.32
Extinction	.73	9.40	.93	0.00	0.00	0.00	.06	1.73	.97
Shock	.60	3.26	.84	0.00	0.00	0.00	0.00	.13	1.00
No shock - Ext. T.O.	1.80	9.80	.84	0.00	0.00	0.00	0.00	0.00	0.00

Table 5

(Continued)

No Change

Bird Number		7			11			13	
	S+	S-	DR	S+	S-	DR	S+	S-	DR
Baseline	1.46	.93	.39	1.50	.13	.08	.16	.06	.27
Extinction	0.00	1.86	1.00	.40	.53	.57	.06	0.00	0.00
Shock	0.00	0.00	0.00	.06	0.00	0.00	0.00	0.00	0.00
No shock - Ext. T.O.	0.00	.06	1.00	.13	.27	.68	0.00	0.00	0.00

Tone Off

Bird Number		6			15			20	
	S+	S-	DR	S+	S-	DR	S+	S-	DR
Baseline	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Extinction	.26	.86	.77	0.00	0.00	0.00	.60	2.50	.81
Shock	0.00	.26	1.00	.60	4.80	.89	0.00	.66	1.00
No shock -	0.00	.26	1.00	0.00	.46	1.00	0.00	.20	1.00

Table 5

(Continued)

Black Out

Bird Number	8			12			10		
	S+	S-	DR	S+	S-	DR	S+	S-	DR
Baseline	0.00	0.00	0.00	25.70	30.80	.55	0.00	0.00	0.00
Extinction	0.00	0.00	0.00	6.20	14.30	.70	0.00	.53	1.00
Shock	0.00	0.00	0.00	.60	3.66	.86	0.00	0.00	0.00
No shock - Ext. T.O.	0.00	0.00	0.00	0.00	1.26	1.00	0.00	0.00	0.00

Total Escape

Bird Number	2			4			5		
	S+	S-	DR	S+	S-	DR	S+	S-	DR
Baseline	2.20	5.30	.71	0.00	0.00	0.00	49.60	47.60	.49
Extinction	.80	3.80	.83	2.50	5.10	.67	1.26	10.86	.90
Shock	.13	1.06	.89	2.50	6.26	.71	.13	2.26	.95
No shock - Ext. T.O.	.13	.66	.84	1.46	4.50	.76	0.00	0.00	0.00

where all three subjects demonstrated a moderate to high number of timeout responses. In terms of individual timeout performances, Birds 1, 3, 4, and 20 demonstrated a low number of timeout responses during baseline, yet showed a noticeable increase in responding when the extinction phase was initiated. This increase in timeout responding was observed only during the S- component, i.e., during the component signaling extinction. Four other birds -- 2, 5, 12, and 18 -- started baseline with a moderately high number of timeout responses during S+ and S-. Their daily number of timeout responses gradually decreased. Indeed, for these subjects during the extinction phase, the number of timeout responses was less than in the baseline phase. Nevertheless, the extinction phase increased the difference in timeout responding during S+ and S-. For example, as Table 5 shows, in the baseline phase Bird 5 averaged 50 timeout responses during S+ and 48 during S-. In the extinction component, however, Bird 5 emitted an average of one timeout response during S+ and 11 during S-. As expected, of those birds who made timeout responses, the majority of the responses occurred during the S- component. Also observed for most responders was a marked drop in timeout responding when shock was initiated. This change could possibly be attributed to the suppressive effects of the shock stimuli. Two exceptions to this observation were Bird 4, whose timeout responding remained about the same, and Bird 15, who showed a dramatic increase in timeout responding. These findings illustrate the inconsistent effects of the shock procedure.

In the final phase of the experiment, where the contingencies associated with a timeout response were eliminated, the number of timeout responses dropped to zero for almost all subjects. As Table 5 shows, some temporary increase in timeout responding was observed for Birds 3 and 4 and might be expected as a frequently observed result of the extinction procedure. Only Birds 1 and 15 showed dramatic increases in timeout responding prior to their total extinction.

Table 6 shows the number of timeout responses emitted during the first and last five sessions of each phase for all 18 birds. These data further illustrate the change in pattern of timeout responding for some of the birds. For example, during baseline Birds 2, 3, 7, 11, 12, 18 and 19 all demonstrated a high number of timeout responses during the first five sessions and a markedly decreased number during the last five sessions. One exception to this observation was Bird 5 who maintained a high rate of responding throughout all the sessions. During the extinction phase most timeout responders increased their number of timeout responses during S- compared to the S+ component. However, as can be seen from the table, the number of responses is often less than that exhibited during baseline. Therefore, a meaningful additional measure of this relationship would be a difference ratio.

Table 5 includes the ratio of timeout responses during S- to the total number of timeout responses made during both components in all four phases. A ratio less than .50 indicates more timeout responding during S+, while a ratio greater than .50 indicates more responding during S-. When timeout responses were made only during the S- component the ratio score was 1; whereas, when timeout responses were made only during S+ the score was 0. A dash (-) indicates that no timeout responses

Table 6

Number of Timeout Responses Emitted During the First and Last Five Sessions for All Components

	Increase Intensity						Decrease Intensity					
Bird Number	3		18		19		1		9		17	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	15	6	46	61	76	100	1	0	0	0	2	1
Last 5	0	0	7	16	15	7	0	0	0	1	0	0
Extinction												
First 5	3	55	2	12	5	8	7	100	0	0	1	4
Last 5	0	12	5	36	1	5	0	13	0	0	0	0
Shock												
First 5	0	15	0	5	0	2	0	3	0	0	1	2
Last 5	0	9	3	16	7	16	7	37	0	0	0	0
Extinction-Timeout												
First 5	0	12	0	6	2	1	0	18	0	0	0	0
Last 5	0	4	0	0	0	2	0	6	0	0	0	0

Table 6

(Continued)

	No Change						Tone Off					
Bird Number	7		11		13		6		15		20	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	22	13	11	0	0	1	1	0	1	0	1	0
Last 5	0	0	5	2	3	0	0	0	0	0	0	0
Extinction												
First 5	0	0	5	8	1	0	0	0	0	0	0	0
Last 5	0	1	0	0	0	0	2	5	0	1	9	37
Shock												
First 5	0	0	0	0	0	0	0	2	3	29	0	9
Last 5	0	0	0	0	0	0	0	2	3	4	0	1
Extinction-Timeout												
First 5	0	0	0	1	0	0	0	0	0	0	0	0
Last 5	0	0	1	1	0	0	0	0	0	8	0	0

Table 6

(Continued)

	Black Out						Total Escape					
Bird Number	8		12		10		2		4		5	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline												
First 5	1	0	149	175	0	0	27	51	0	0	186	164
Last 5	0	0	87	99	0	0	0	4	0	0	251	255
Extinction												
First 5	0	0	74	121	0	0	1	3	27	41	17	89
Last 5	0	0	10	26	0	0	4	29	5	33	5	56
Shock												
First 5	0	0	3	23	0	0	2	16	1	8	2	30
Last 5	0	0	1	17	0	0	0	0	21	56	0	0
Extinction-Timeout												
First 5	0	0	0	12	0	0	1	0	22	48	0	0
Last 5	0	0	0	0	0	0	0	2	0	1	0	0

were made in that session. Although this ratio measure does not reveal how many timeout responses were made, it does indicate the distribution of responses. These figures, along with the means, provide a clear picture of the timeout responding pattern. With rare exception, the only instances where timeout responses during S+ exceeded those emitted during S- were in the baseline phase of the experiment. The increase in timeout responding during the extinction phase is also apparent. All but four of the birds showed a higher proportion of timeout responding during S- in the extinction phase. In the last two phases, shock and timeout extinction, the number of timeout responses gradually decreased, reaching zero for most birds in the timeout extinction phase. The ratios, however, remain high since the timeout responses during S+ tended to drop out sooner than those during S-.

Figure 2 serves as a representative graph of the effects of the four different experimental phases on timeout responding for Bird 3. The baseline phase shows some initial timeout responding which drops off in the later sessions (10-15). The initiation of the extinction phase illustrated a marked acceleration in timeout responding during S- and only a small increase during S+. The shock segment of the experiment resulted in moderate timeout responding during S- and zero responding during S+. All timeout responding was eliminated during the final extinction timeout phase. This graph represents the trend of timeout responding for those birds who demonstrated more than a minimal amount of timeout responding.

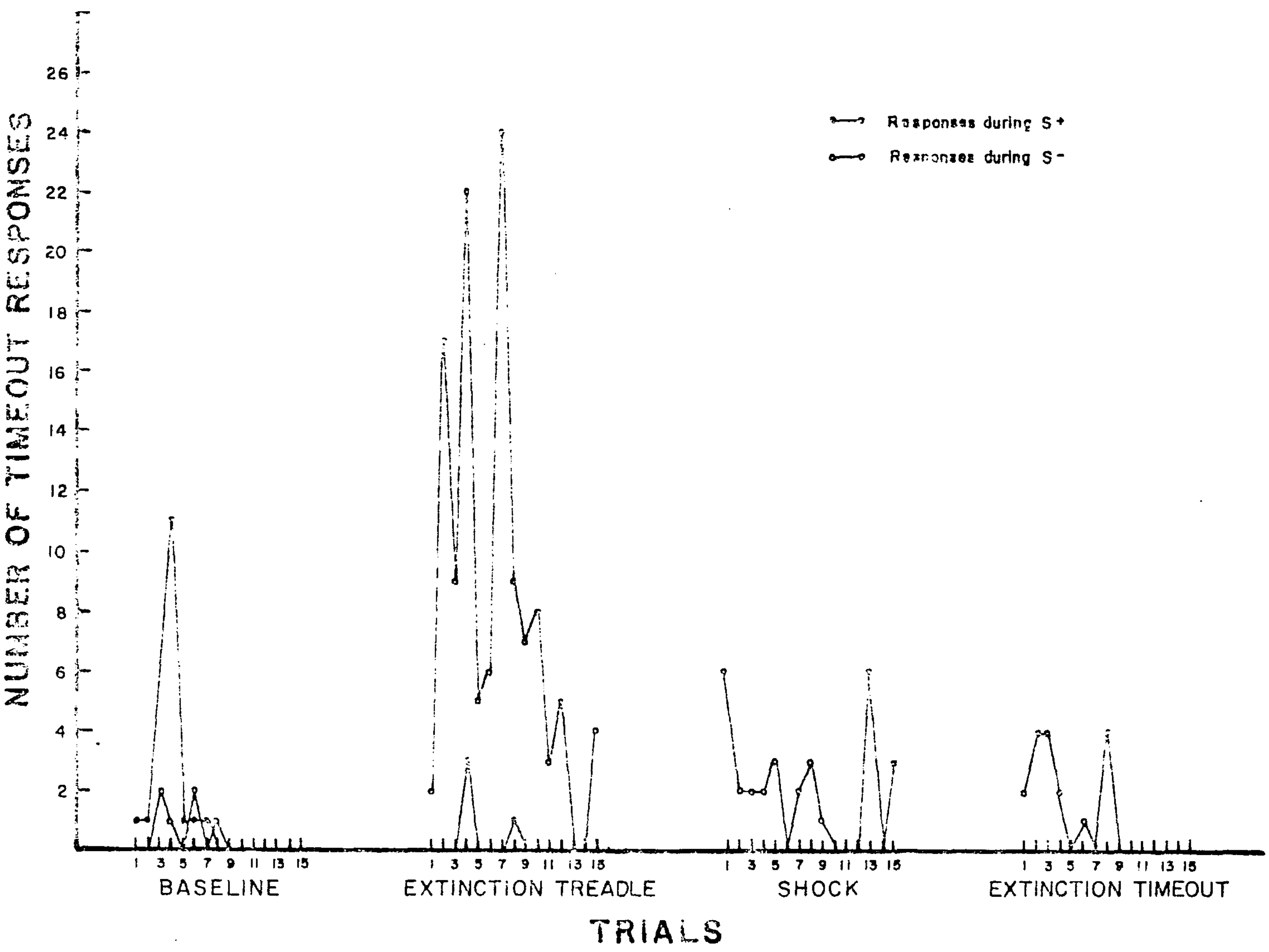

Figure 2. Daily timeout responding for Bird 3.

CHAPTER IV

DISCUSSION

The present study has demonstrated several major points. First, auditory stimulus control of treadle pressing and key pecking in a multiple schedule can be established in pigeons. Second, these responses are not independent, in that positive behavioral contrast did occur, suggesting the presence of response interaction. And lastly, the S- component of the multiple VI 1-minute extinction schedule does have properties resulting in more subject-initiated timeout responses than in the S+ (VI) component. Explanations of this finding are cautionary due to the variability and individual-subject differences in the data. These later two points are reviewed in detail.

The presence of behavioral contrast in a multiple schedule in which different stimuli successively signal different experimental conditions requiring different responses is contrary to previous findings (Premack, 1969; Scull & Westbrook, 1973). Premack used rats as subjects in a wheel running-bar pressing multiple schedule. Although he did report that changes in one component affected behavior in the other component, only one rat out of the three showed positive contrast. Scull and Westbrook suggested that Premack's results could have been a consequence of the response topography. The difference in effort involved for the two responses could certainly have contributed to an interaction.

The experiment by Scull and Westbrook used pigeons as subjects with treadle presses and key pecks as the required responses and examined the positive behavioral contrast. Only one of their eight subjects showed even a small contrast effect. If a further experiment where a key peck-bar peck contingency was imposed, three of the four subjects did show positive contrast. Thus, the similar response topography (pecking) seemed to be the important variable leading to the occurrence of positive contrast. The result that behavioral contrast depends on the operant has been supported in other investigations (Hemmes, 1973; Westbrook, 1973). Both studies obtained positive contrast when pigeons pecked a key, but not when they pressed a bar.

The results reported by Scull and Westbrook are unclear since the failure to obtain contrast may have been due to having topographically different responses (peck-press) in the two components of the multiple schedule, or the results may have been due to the unique characteristics of the required treadle response. Research by Hemmes, for example, has shown that some behavioral phenomena, such as contrast, may depend on the operant under investigation. Scull and Westbrook consider the possibility "that the failure to observe contrast on keypecking in the key peck-bar press condition was due to some factor involved in the failure to obtain contrast on barpressing, rather than to different responses being employed..." (p. 518). The present study refutes both accounts since contrast was obtained with a key peck-bar press contingency. There were several differences between the present study and that by Scull and Westbrook that could explain their failure to obtain contrast. One difference that perhaps played a contributing factor was the unequal experimental history for each bird in terms of treadle-press and key-peck training. For all their subjects, bar presses had been reinforced on a variety of complex schedules prior to the experiment, whereas they were naive to key pecking. Indeed, the three birds extinguished in the bar-press component of the multiple schedule took longer to extinguish and showed greater variability than the three subjects extinguished on the key-peck component of the multiple schedule. Thus, uneven experience involving the two required responses could bias the interactions in the multiple schedule where positive behavioral contrast is normally expected. Changes in the rate of response in one component of a multiple schedule as a result of changes in the reinforcement schedule of the other component may not be as predictable when markedly different histories for the two responses are present.

A more feasible explanation for the contradictory results involves the method for presenting the response apparatus during the multiple schedule. Scull and Westbrook controlled the chamber such that when the key component was in effect, the key was lit and the bar was absent. Therefore the pigeons could not make errorful responses on the bar. When the reinforcement contingency for bar pressing was in effect, the key was darkened. Since pigeons have a very low probability of pecking a darkened key (Terrace, 1966), the environment was controlled such that only one type of response could be made at one time. Alternative responses, or "errorful" responses were not possible. There was no behavioral history of responding on the wrong manipulandum during a discriminative stimuli.

Perhaps this restriction of schedule interaction was the contributing factor in the failure to obtain contrast. The subjects were not required to make a discrimination in order to obtain reinforcement. The multiple schedule may have been functioning more as two separate independent schedules since different stimuli signaled different responses and no response interaction was possible.

Their explanation that extinction of one response should increase the birds' tendency to make that response in the other "constant" component was not tenable in their investigation since the opportunity to make the competing response in the VI component was not available.

The present finding that positive behavioral contrast occurs when two topographically different responses are used in a multiple schedule is important for several reasons. The result demonstrates that there was generalization across responses. That is, the effects of treadle pressing interacted with key pecking in the VI 1-minute schedule and also the key pecking producing timeouts. When shock was initiated for treadle pressing, timeout responding dropped for most birds who had been making timeout responses during the extinction phase. The use of different responses in the multiple schedule was not effective in eliminating the effect of generalization. Perhaps if key pecking had been used throughout the experiment for all responses (S+, S-, and timeout), the number of timeouts would have been higher since confusion due to the requirement of multiple responses would have been eliminated.

This finding of behavioral contrast is also important because of the theoretical implications for research into the interactions that exist in multiple schedules. Hitherto, research has indicated that when topographically different responses are used in a multiple schedule, the two remain independent without any generalization effects.

The third major point of the present investigation involves the timeout responding. The low rate and high variability of the timeout responding could be attributed to several factors other than the effect of generalization across responses. A review of several studies examining "self-imposed" timeout responding in piegons revealed that the duration of the timeout was positively related to the number of responses made. This conclusion is obvious since the shorter the timeout period, the greater the number of timeouts can be made in a session. However, those studies using a 30-sec timeout (Coughlin, 1973; Rilling et al., 1969; von Sturmer et al., 1974) tended to report more variability and lack of responding than those studies using a 5-sec (Terrace, 1971) and 10-sec (Rilling et al., 1973) timeout period. The present study employed a 30-sec timeout requirement similar to that used by Coughlin. In this way, the results would be more comparable and evaluations of the aversiveness of S- could be made without the previously cited confounding variables. Perhaps a more accurate measure of the reinforcing effects of timeout would involve a shorter duration of the timeout period. This change would allow for more responses to be made that could perhaps lead to more meaningful comparisons. Group comparisons in the present study were not enlightening due to this timeout response rate problem.

One fairly consistent finding derived from the present study was that more timeout responses were emitted during the S- component than during the S+ component. This finding suggests that there are certain properties associated with the extinction component of the multiple schedule that increase the probability of timeout responses. The purpose of the present study was to determine, through the use of differing timeout consequences for each group, why the timeout responding occurs. The group comparisons in the present study did not provide any strong evidence to contribute to an explanation. A review of the possible predictions, based on the two major hypothetical formulations, should lead to suggestions for further research that would provide more reliable evidence.

The stimulus change hypothesis suggests that an increase in the amount of stimulus change would increase the reinforcing value of a timeout. Therefore, the theory would predict that, as the amount of stimulus change increases, timeout responding would also increase. The production of timeouts should have been greatest for the total escape group since this group experienced the greatest amount of stimulus change. Although this finding was evidenced in the present study, it was not reliable enough to warrant strong conclusions. The blackout group should have also demonstrated a high amount of timeout responding due to the large change in visual stimulation. This group was crucial for resolving the controversy represented by the two hypotheses. If the subjects had responded on the timeout key in order to escape from the S-, timeout responding for the blackout group would have been ineffective and, therefore, minimal. Since timeout responding was rare for some birds throughout the experiment, these subjects had only limited experience with the contingencies and conclusions about the lack of responding for animals in this and the remaining groups are also impossible.

Proponents of the escape hypothesis would argue that the greatest number of timeout responses should have been emitted by the groups eliminating the S-, that is, the tone-off and total-escape groups. The additional blackout for the total-escape group should not have caused any difference in timeout responding when compared to the tone-off group.

Another prediction that would have been supported by the stimulus change hypothesis was that, although timeout responding would occur in the decreased- and increased-intensity groups, there should have been no differences between the two since the "absolute" change between the two groups was comparable. More timeout responding should have occurred in the tone-off group since the change in auditory stimulation was larger. If the S- were a conditioned aversive stimulus as hypothesized by the escape theory, then an increase in intensity should have increased the aversiveness, while a decrease in intensity would have diminished the aversiveness. Accordingly, more timeout responses should have been emitted by the decreased-intensity group and virtually no responding should have occurred for the increased-intensity group. Finally, both theories would have predicted no responding for the no-change control group, a finding which was supported by the present study.

It is unfortunate that these predictions could not be adequately tested by the present investigation. However, the integrity and logic of the predictions based on the two hypotheses are still intact and await further examination. There are several improvements over the present study that could eliminate the problems in timeout responding which were encountered. Pilot research into the reinforcing and punishing effects of different timeout durations would be helpful in selecting the length of timeout periods. Some studies (Azrin, 1961; Dardano, 1971) have employed a procedure where the subjects have both a timeout and timein key. This strategy allows the animal to control the length of the timeout period. Using this approach, a better dependent measure would be the amount of time spent in timeout.

It may also be beneficial to simplify the study by using only the key-pecking response and omit the treadle response. There seems to be no value in using the two responses if they are not independent as demonstrated by the present findings.

Another change that would lead to a more rigorous experiment would be the use of a different aversive stimulus. Employing shock with pigeons has always been an unreliable and difficult undertaking. The shock grid floor which was reported by Bitterman (1972) to be an improvement over the shock electrode technique proved to be disappointing at best. The aversiveness of the shock tended to vary according to the foot resistance, amount of urination and defecation, and the wiring connections. Although all animals did receive aversive shocks (verified through observation), the reliability was poor. Perhaps a better and more easily controlled stimulus would be a loud, abrasive noise or a blast of air directed at the subject. A further consideration would be to use varying exposures to the S- as an index of aversiveness. Terrace (1971) demonstrated that the pigeons tended to emit the majority of their timeout responses during the initial presentation of the stimulus S-. The average number of timeout responses declined as the subjects experienced more sessions.

A matching procedure aimed at equating subjects based on their initial base rate of timeout responding would also be necessary in order to reduce variability and help control the problem of high individual differences.

Although further investigations should control many of the variables that have confounded the interpretation of this and previous research, the final explanation may not be as simple as the escape hypothesis or stimulus change hypothesis would suggest. Rather the results may support an interactional interpretation that could be clearly demonstrated if the design of the present study were used. This interactional model could explain the various predictions made by the major theories in this area of investigation. The different degrees of stimulus change as the consequence of a timeout response (from high intensity to completely off) could allow for different degrees of escape from the S-. The number of timeout responses may prove to be a function of the change in the aversiveness of the stimulus situation. Therefore, any change in the stimulus complex could contribute to the amount of escape provided.

A last, alternative, explanation should be included in the present discussion. That is, the viability of the phenomenon is questionable. Researchers in the area of subject-initiated timeout responding have often reported extreme variability and lack of timeout responding in their subjects (Coughlin, 1973; Rilling et al., 1969; Terrace, 1971).

A further observation made by these investigators, also reported in the present study, was that timeout responding declined as the number of sessions increased. Additional research may demonstrate that timeout responding during a multiple discrimination schedule is not a robust, predictable phenomenon.

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Appendix A

Group Composition Based on Matched Discrimination Indices of Each Bird

	Decreased Intensity			Increased Intensity			No Change		
Bird	1	9	17	3	18	19	7	11	13
	.78	.82	.68	.79	.74	.83	.76	.96	.69
	Total Escape			Tone Off			Black Out		
Bird	2	4	5	6	15	20	8	12	10
	.61	.81	.75	.81	.79	.67	.91	.75	.71

Appendix B

Daily Record of Treadle and Key Peck Response Rates Per Second in Both Components for the Baseline and Extinction Phases

Increase Intensity

Bird Number	3				18				19			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	.50	.29	.64	.14	.58	.43	.26	.10	.52	.30	.47	.20
	.44	.30	.58	.13	.22	.17	.47	.35	.06	.02	.61	.42
	.44	.29	.63	.14	.03	.01	.17	.09	.55	.15	.45	.09
	.29	.26	.28	.04	.00	.00	.05	.03	.29	.15	.34	.12
	.43	.27	.59	.11	.00	.00	.37	.25	.41	.25	.36	.04
	.34	.21	.55	.09	.00	.00	.76	.48	.36	.16	.42	.09
	.39	.21	.65	.13	.00	.00	.98	.76	.25	.12	.42	.09
	.27	.18	.37	.04	.00	.00	.63	.37	.21	.14	.42	.09
	.27	.17	.60	.09	.00	.00	.69	.37	.24	.09	.49	.09
	.35	.23	.58	.04	.10	.03	.48	.17	.18	.06	.35	.09
	.37	.25	.64	.14	.25	.12	.40	.13	.28	.03	.60	.08
	.41	.24	.52	.08	.14	.09	.36	.10	.28	.16	.48	.17
	.28	.12	.55	.12	.15	.05	.36	.11	.25	.10	.80	.09
	.39	.13	.55	.12	.20	.12	.29	.09	.20	.07	.32	.06
	.38	.19	.56	.15	.18	.07	.55	.31	.51	.18	.44	.04
Extinction	.03	.00	1.05	.54	.01	.00	.78	.55	.09	.01	.64	.39
	.06	.00	.99	.58	.01	.01	.78	.47	.02	.00	.74	.51
	.01	.00	.82	.66	.01	.01	.76	.46	.01	.00	.66	.43
	.00	.00	.82	.49	.01	.00	.92	.55	.00	.00	.67	.49
	.00	.00	.77	.49	.01	.00	.76	.53	.00	.00	.58	.43
	.00	.00	.87	.52	.01	.00	.89	.47	.00	.00	.61	.50
	.00	.00	.75	.63	.00	.00	.71	.41	.00	.00	.60	.42
	.01	.00	.86	.51	.00	.00	.83	.54	.01	.00	.78	.57
	.02	.00	.74	.60	.00	.00	.92	.68	.00	.00	.77	.63
	.03	.00	.91	.50	.00	.00	.91	.62	.01	.00	.84	.57
	.05	.00	.99	.56	.00	.00	.74	.47	.00	.00	.65	.53
	.03	.00	.90	.54	.00	.00	.90	.66	.01	.00	.73	.54
	.02	.00	1.02	.44	.00	.00	1.32	.58	.00	.00	.86	.62
	.02	.00	1.16	.59	.00	.00	.94	.68	.00	.00	.76	.69
	.02	.00	1.10	.66	.00	.00	.84	.59	.01	.00	.92	.69

Decrease Intensity

Bird Number	1				9				17			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	.34	.08	1.20	.19	.30	.06	.57	.09	.23	.13	.34	.11
	.39	.11	1.10	.22	.25	.05	.54	.12	.15	.05	.32	.12
	.51	.08	1.18	.08	.20	.05	.47	.20	.17	.06	.31	.08
	.65	.12	.98	.01	.40	.14	.56	.18	.16	.06	.21	.07
	.55	.09	.99	.03	.34	.08	.48	.11	.19	.07	.29	.09
	.40	.01	.99	.23	.28	.11	.46	.04	.28	.09	.37	.11
	.31	.03	.76	.13	.32	.13	.75	.09	.19	.08	.33	.12
	.43	.18	.77	.02	.27	.09	.62	.16	.26	.14	.37	.17
	.33	.13	.68	.05	.35	.05	.76	.15	.20	.12	.32	.10
	.31	.08	.73	.03	.43	.09	.69	.08	.23	.12	.37	.08
	.42	.10	.83	.02	.30	.05	.68	.08	.23	.08	.48	.09
	.30	.07	.79	.08	.30	.07	.84	.11	.19	.07	.46	.11
	.57	.19	1.09	.08	.30	.09	.88	.10	.23	.10	.47	.14
	.60	.14	1.18	.05	.33	.11	.66	.12	.22	.11	.58	.12
	.45	.09	1.24	.03	.29	.05	.68	.13	.14	.07	.52	.16
Extinction	.04	.00	1.54	1.13	.00	.00	.91	.73	.02	.00	1.21	.79
	.04	.00	1.42	.98	.00	.00	.95	.73	.01	.00	.76	.41
	.03	.00	1.46	.97	.01	.00	1.23	.98	.01	.00	1.03	.77
	.05	.01	1.47	1.11	.00	.00	1.28	1.01	.01	.00	1.01	.14
	.07	.00	1.44	.68	.00	.00	1.24	.91	.00	.00	.97	.79
	.00	.00	1.45	.75	.04	.00	.95	.78	.00	.00	1.24	.83
	.05	.00	1.17	.68	.00	.00	.92	.72	.00	.00	1.03	.46
	.07	.00	1.46	.81	.00	.00	.77	.71	.00	.00	1.10	.49
	.11	.00	1.42	.57	.01	.00	.86	.60	.00	.00	1.30	.78
	.03	.00	1.49	.45	.01	.00	.90	.58	.00	.00	1.62	.77
	.00	.00	1.32	.59	.00	.00	.87	.57	.00	.00	1.31	.45
	.01	.00	1.55	.69	.00	.00	.87	.80	.00	.00	1.29	.83
	.00	.00	1.31	.87	.00	.00	1.00	.83	.00	.00	1.40	.94
	.01	.00	1.42	.54	.00	.00	.89	.60	.00	.00	1.22	.87
	.00	.00	1.43	.37	.00	.00	.94	.56	.00	.00	1.22	.80

No Change

Bird Number	7				11				13			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	.36	.26	.42	.15	.27	.16	.01	.00	.46	.24	.35	.13
	.29	.19	.31	.06	.28	.20	.01	.00	.33	.22	.22	.08
	.37	.19	.36	.13	.27	.19	.01	.00	.35	.23	.19	.06
	.26	.17	.27	.04	.42	.30	.02	.00	.17	.11	.12	.04
	.26	.14	.34	.04	.35	.19	.00	.00	.29	.20	.28	.10
	.24	.14	.29	.05	.32	.26	.00	.00	.17	.10	.08	.02
	.27	.20	.33	.03	.45	.29	.00	.00	.25	.14	.08	.02
	.32	.24	.26	.12	.32	.29	.00	.00	.33	.17	.19	.03
	.28	.17	.40	.03	.39	.29	.00	.00	.28	.19	.13	.05
	.26	.14	.31	.02	.31	.17	.00	.00	.27	.14	.14	.05
	.17	.09	.26	.02	.39	.27	.00	.00	.23	.14	.09	.03
	.28	.12	.37	.11	.36	.18	.00	.00	.22	.09	.16	.03
	.23	.10	.34	.06	.26	.11	.00	.00	.20	.07	.15	.03
	.23	.07	.30	.03	.30	.07	.00	.00	.27	.09	.29	.04
	.26	.06	.31	.07	.22	.12	.00	.00	.68	.40	.38	.07
					.32	.16	.00	.00				
Extinction	.06	.04	.45	.21	.08	.04	.00	.00	.05	.02	.44	.25
	.04	.03	.40	.29	.01	.00	.00	.00	.05	.02	.44	.25
	.02	.02	.41	.30	.03	.02	.00	.00	.03	.01	.38	.17
	.06	.03	.41	.18	.03	.04	.00	.00	.01	.00	.57	.34
	.02	.01	.50	.27	.00	.00	.00	.00	.01	.00	.46	.31
	.03	.01	.50	.26	.00	.00	.00	.00	.01	.00	.45	.27
	.04	.00	.61	.24	.00	.00	.00	.00	.00	.00	.28	.16
	.00	.00	.60	.20	.00	.00	.00	.00	.01	.00	.47	.34
	.03	.01	.61	.15	.00	.00	.00	.00	.00	.00	.47	.32
	.02	.01	.76	.19	.00	.00	.00	.00	.00	.00	.44	.33
	.07	.01	.65	.21	.01	.00	.00	.00	.00	.00	.48	.25
	.05	.01	.50	.14	.00	.00	.00	.00	.00	.00	.61	.31
	.04	.01	.47	.17	.01	.00	.00	.00	.00	.00	.54	.34
	.01	.01	.51	.11	.00	.00	.00	.00	.00	.00	.59	.27
	.01	.01	.49	.21	.00	.00	.00	.00	.00	.00	.52	.26

Tone Off

Bird Number	6				15				20			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	.27	.24	.65	.14	.36	.18	.51	.20	.24	.14	.77	.23
	.35	.32	.49	.18	.62	.37	.58	.09	.36	.21	.80	.19
	.47	.35	.50	.15	.60	.28	.67	.15	.33	.26	.73	.23
	.33	.25	.52	.13	.65	.23	.69	.15	.33	.24	.81	.17
	.24	.17	.53	.18	.54	.30	.53	.13	.10	.10	1.21	.23
	.31	.18	.56	.20	.32	.10	.78	.20	.34	.22	1.10	.21
	.21	.11	.56	.10	.49	.16	.58	.20	.35	.19	1.30	.23
	.38	.21	.42	.11	.56	.19	.76	.14	.36	.14	1.14	.40
	.36	.14	.50	.05	.61	.20	.73	.23	.41	.21	1.17	.16
	.27	.09	.57	.08	.46	.17	.56	.16	.23	.11	.72	.24
	.31	.10	.50	.03	.45	.16	.74	.24	.32	.21	.91	.12
	.23	.16	.53	.16	.53	.16	.77	.31	.26	.15	1.01	.20
	.24	.19	.37	.14	.51	.24	.93	.35	.37	.22	1.00	.18
	.29	.23	.53	.20	.55	.26	.98	.30	.25	.10	.96	.12
	.26	.13	.57	.12	.59	.18	1.09	.11	.38	.23	1.02	.08
Extinction	.16	.02	.60	.31	.21	.01	1.10	.59	.02	.01	1.65	1.16
	.08	.01	.66	.40	.10	.02	.65	.50	.02	.01	1.63	1.17
	.05	.00	.27	.22	.11	.00	.90	.59	.01	.00	1.31	.96
	.06	.00	.47	.19	.02	.00	1.12	1.14	.01	.00	1.43	1.06
	.08	.00	.53	.32	.02	.00	.88	.77	.03	.00	1.30	.72
	.03	.00	.67	.37	.03	.00	1.12	1.00	.00	.00	.98	.82
	.01	.00	.66	.42	.04	.00	1.07	.70	.00	.00	1.07	.69
	.03	.00	.71	.42	.04	.00	1.32	1.13	.06	.00	1.02	.50
	.06	.00	.84	.41	.01	.00	1.55	1.52	.01	.00	.92	.66
	.03	.00	.77	.50	.02	.00	1.62	1.33	.06	.00	.96	.71
	.01	.00	.76	.61	.01	.00	1.15	.77	.02	.00	.85	.49
	.01	.00	.76	.54	.03	.00	1.55	1.42	.00	.00	.77	.63
	.03	.00	.71	.42	.02	.00	1.37	1.31	.03	.00	.72	.48
	.04	.00	.85	.50	.07	.00	1.32	1.01	.06	.00	.84	.38
	.03	.00	.82	.42	.04	.00	1.12	.88	.02	.00	.74	.43

Black Out

Bird Number	8				12				10			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	.38	.11	.44	.07	.20	.07	.71	.32	.37	.31	.24	.08
	.43	.08	.55	.05	.17	.11	.56	.20	.32	.24	.25	.10
	.37	.17	.39	.02	.11	.11	1.10	.21	.37	.27	.29	.11
	.37	.06	.40	.06	.20	.10	.66	.43	.36	.20	.31	.14
	.26	.07	.40	.08	.39	.20	.57	.23	.39	.24	.38	.11
	.54	.16	.40	.07	.21	.10	.79	.33	.37	.27	.32	.11
	.44	.12	.36	.07	.35	.11	.77	.32	.31	.20	.39	.13
	.34	.04	.39	.08	.29	.09	.83	.16	.63	.24	.44	.05
	.19	.08	.28	.12	.35	.14	.58	.11	.43	.18	.39	.06
	.16	.01	.47	.16	.24	.11	.59	.22	.51	.22	.42	.07
	.16	.04	.29	.06	.26	.10	.63	.17	.46	.23	.41	.04
	.31	.11	.35	.03	.22	.06	.60	.26	.40	.21	.39	.06
	.39	.11	.35	.05	.23	.09	.73	.20	.34	.17	.38	.08
	.37	.10	.36	.04	.27	.16	.48	.07	.43	.19	.40	.07
	.30	.05	.34	.06	.31	.12	.73	.16	.41		.53	.12
Extinction	.03	.02	.32	.26	.09	.00	.98	.69	.09	.04	.68	.42
	.01	.00	.35	.28	.08	.01	.88	.64	.17	.07	.67	.32
	.01	.00	.31	.23	.03	.00	.97	.69	.05	.03	.54	.34
	.02	.00	.52	.33	.08	.01	.93	.67	.08	.04	.63	.35
	.06	.01	.48	.32	.02	.00	.87	.89	.05	.02	.68	.42
	.03	.00	.59	.43	.07	.00	.97	.69	.12	.03	.68	.41
	.03	.00	.79	.48	.08	.00	.92	.66	.07	.04	.58	.44
	.00	.00	.76	.56	.02	.00	.81	.49	.08	.05	.77	.44
	.01	.00	.73	.53	.06	.00	.87	.59	.04	.01	.71	.41
	.00	.00	.99	.68	.02	.00	.85	.61	.03	.00	.66	.38
	.00	.00	.76	.72	.02	.00	.84	.52	.03	.01	.74	.43
	.00	.00	1.26	1.03	.05	.00	.67	.39	.05	.01	.77	.49
	.00	.00	1.17	.92	.08	.00	.72	.41	.02	.01	.63	.33
	.01	.00	1.57	1.01	.06	.00	.80	.46	.01	.00	.53	.29
	.00	.00	1.11	.86	.22	.00	.77	.41	.01	.01	.56	.44

Total Escape

Bird Number	2				4				5			
	Treadle		Key		Treadle		Key		Treadle		Key	
	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	.30	.15	.73	.47	.40	.29	.24	.16	.66	.42	.34	.59
	.23	.12	.72	.51	.43	.32	.17	.03	.62	.46	.58	.34
	.22	.10	.74	.55	.31	.26	.19	.04	.52	.17	.52	.11
	.25	.10	.82	.51	.37	.26	.26	.06	.16	.15	.82	.30
	.18	.08	.66	.38	.41	.22	.28	.05	.22	.17	.75	.31
	.04	.01	.78	.63	.38	.15	.28	.09	.10	.39	.76	.26
	.19	.10	.71	.48	.40	.16	.23	.03	.37	.30	.61	.36
	.33	.11	.73	.43	.46	.20	.28	.07	.35	.34	.88	.35
	.21	.09	.71	.48	.48	.24	.26	.05	.33	.29	1.18	.75
	.15	.06	.68	.47	.34	.24	.24	.07	.28	.21	1.04	.55
	.12	.04	.65	.39	.34	.20	.20	.08	.31	.21	.98	.48
	.14	.04	.75	.54	.32	.17	.19	.08	.29	.23	1.04	.47
	.17	.04	.68	.39	.37	.16	.27	.08	.25	.17	.72	.21
	.18	.04	.67	.42	.40	.23	.22	.06	.36	.34	1.18	.30
	.23	.07	.67	.35	.45	.27	.21	.07	.34	.34	.74	.29
Extinction	.04	.01	.95	.63	.08	.07	.33	.27	.04	.00	1.40	.83
	.05	.00	.86	.61	.06	.03	.35	.28	.03	.00	1.43	.71
	.02	.00	.93	.74	.03	.02	.43	.25	.03	.00	1.13	.50
	.03	.00	.90	.63	.02	.01	.39	.33	.01	.00	.88	.64
	.02	.00	.64	.53	.01	.00	.37	.30	.02	.00	.97	.61
	.03	.00	.88	.66	.03	.00	.20	.12	.00	.00	1.19	.73
	.02	.00	.63	.42	.02	.00	.20	.10	.00	.00	1.42	.87
	.04	.00	.96	.61	.03	.00	.37	.22	.00	.00	1.58	1.09
	.04	.00	1.08	.70	.00	.01	.43	.34	.00	.00	1.52	.87
	.04	.00	.99	.86	.02	.01	.49	.34	.01	.00	1.37	.87
	.02	.00	.78	.58	.01	.01	.57	.34	.00	.00	1.48	.97
	.03	.00	.96	.61	.01	.00	.57	.44	.00	.00	1.16	.74
	.02	.00	1.19	.76	.01	.00	.59	.47	.00	.00	1.38	1.06
	.01	.00	1.08	.66	.00	.00	.63	.40	.00	.00	1.57	.61
	.02	.00	1.17	.77	.00	.00	.50	.37	.01	.00	1.70	1.18

Appendix C

Number of Timeout Responses Emitted Per Session For Each Bird

		Increase Intensity						Decrease Intensity					
	Bird Number	3		18		19		1		9		17	
		S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	1	1	0	5	4	30	30	0	0	0	0	2	0
	2	1	0	20	22	27	50	0	0	0	0	0	0
	3	0	2	8	8	12	16	0	0	0	0	0	0
	4	11	1	9	15	3	3	1	0	0	0	0	1
	5	1	0	4	12	4	1	0	0	0	0	0	0
	6	1	2	1	2	3	0	0	0	0	0	0	0
	7	1	0	1	3	3	0	0	0	0	0	0	0
	8	0	1	0	0	5	1	0	0	0	0	0	0
	9	0	0	1	5	1	1	0	0	0	0	0	0
	10	0	0	6	6	5	2	0	0	0	0	0	0
	11	0	0	0	4	0	2	0	0	0	0	0	0
	12	0	0	1	2	10	2	0	0	0	1	0	0
	13	0	0	0	1	2	1	0	0	0	0	0	0
	14	0	0	0	2	1	1	0	0	0	0	0	0
	15	0	0	6	7	2	2	0	0	0	0	0	0
Extinction	1	0	2	0	1	1	4	0	0	0	0	0	2
	2	0	17	0	1	1	0	0	0	0	0	0	1
	3	0	9	2	6	2	3	3	47	0	0	1	1
	4	3	22	0	3	0	0	0	37	0	0	0	0
	5	0	5	0	1	0	1	4	16	0	0	0	0
	6	0	6	0	5	2	0	1	7	0	0	0	8
	7	0	24	0	0	1	1	2	5	0	0	0	5
	8	1	9	0	1	0	1	1	4	0	0	0	4
	9	0	7	0	0	1	3	0	6	0	0	0	0
	10	0	8	0	1	0	1	0	6	0	0	0	3
	11	0	3	0	0	0	3	0	1	0	0	0	0
	12	0	5	0	0	0	0	0	5	0	0	0	0
	13	0	0	1	9	0	0	0	5	0	0	0	0
	14	0	0	4	20	1	1	0	2	0	0	0	2
	15	0	4	0	7	0	1	0	0	0	0	0	0

		Increase Intensity						Decrease Intensity					
	Bird Number	3		18		19		1		9		17	
		S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Shock	1	0	6	0	4	0	0	0	2	0	0	1	0
	2	0	2	0	0	0	0	0	1	0	0	0	0
	3	0	2	0	1	0	0	0	0	0	0	0	0
	4	0	2	0	0	0	1	0	0	0	0	0	1
	5	0	3	0	0	0	1	0	0	0	0	0	1
	6	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	2	0	0	0	0	0	0	0	0	0	0
	8	0	3	0	0	0	1	0	0	0	0	0	0
	9	0	1	0	1	0	0	0	0	0	0	0	0
	10	0	0	0	0	1	1	0	4	0	0	0	0
	11	0	0	0	0	2	12	2	7	0	0	0	0
	12	0	0	0	4	4	1	7	13	0	0	0	0
	13	0	6	2	6	0	1	0	9	0	0	0	0
	14	0	0	1	4	1	1	0	7	0	0	0	0
	15	0	3	0	2	0	1	0	5	0	0	0	0
	16							0	3	0	0	0	0
No shock- Ext TO	1	0	2	0	0	2	1	0	6	0	0	0	0
	2	0	4	0	1	0	0	0	3	0	0	0	0
	3	0	4	0	3	0	0	0	4	0	0	0	0
	4	0	2	0	2	0	0	0	5	0	0	0	0
	5	0	0	0	0	0	0	0	2	0	0	0	0
	6	0	1	0	1	0	4	1	12	0	0	0	0
	7	0	0	0	0	0	1	1	5	0	0	0	0
	8	0	4	0	0	0	0	1	4	0	0	0	0
	9	0	0	0	2	0	0	63	41	0	0	0	0
	10	0	0	0	0	0	0	66	23	0	0	0	0
	11	0	0	0	0	0	0	18	13	0	0	0	0
	12	0	0	0	0	0	0	27	13	0	0	0	0
	13	0	0	0	0	0	0	1	17	0	0	0	0
	14												
	15												

		No Change						Tone Off					
	Bird Number	7		11		13		6		15		20	
		S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	1	16	6	2	0	0	0	1	0	0	0	0	0
	2	4	0	1	0	0	0	0	0	0	0	1	0
	3	2	5	6	0	0	1	0	0	1	0	0	0
	4	0	1	1	0	0	0	0	0	0	0	0	0
	5	0	1	1	0	0	0	0	0	0	0	0	0
	6	0	0	1	0	0	0	0	0	0	0	0	0
	7	0	0	3	0	0	0	0	0	0	0	0	0
	8	0	1	3	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	1	0	0	0	0	0	1	0	0	0
	12	0	0	0	0	1	0	0	0	0	0	0	0
	13	0	0	2	0	0	0	0	0	0	0	0	0
	14	0	0	2	2	2	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	0	0	0	0	0
	16							0	0	0	0	0	0
Extinction	1	0	0	4	7	0	0	0	0	0	0	0	0
	2	0	0	1	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	1	0	0	0	0	0	0	0
	4	0	0	0	1	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	14	0	0	0	0	0	0	0	0	0	0
	7	2	7	0	0	0	0	0	0	0	0	0	0
	8	0	6	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	2	5	0	0	0	0
	10	0	0	1	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	1	0	1	0	0
	12	0	1	0	0	0	0	0	0	0	0	4	15
	13	0	0	0	0	0	0	0	0	0	0	4	13
	14	0	0	0	0	0	0	2	4	0	0	1	9
	15	0	0	0	0	0	0						

		No Change						Tone Off					
	Bird Number	7		11		13		6		15		20	
		S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Shock	1	0	0	1	0	0	0	0	1	0	1	0	1
	2	0	0	0	0	0	0	0	1	0	0	0	4
	3	0	0	0	0	0	0	0	0	0	0	0	3
	4	0	0	0	0	0	0	0	0	0	2	0	0
	5	0	0	0	0	0	0	0	0	3	26	0	1
	6	0	0	0	0	0	0	0	0	2	29	0	0
	7	0	0	0	0	0	0	0	0	1	4	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	1	0	6	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	1	3	3	0	0
	12	0	0	0	0	0	0	0	1	0	0	0	0
	13	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	0	0	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	0	0	1	0	1
No Shock-	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	1	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	2	0	0	0	0
	7	0	0	1	0	0	0	0	2	0	0	0	2
	8	0	0	0	0	0	0	0	0	0	1	0	2
	9	0	1	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	2	0	0	0	0	0	4	0	1
	12	0	0	1	1	0	0	0	0	0	3	0	0

		Black Out						Total Escape					
	Bird Number	8		12		10		2		4		5	
		S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Baseline	1	1	0	32	44	0	0	4	10	0	0	125	130
	2	0	0	15	29	0	0	7	9	0	0	80	72
	3	0	0	14	23	0	0	9	12	0	0	48	37
	4	0	0	43	22	0	0	4	13	0	0	16	0
	5	0	0	45	57	0	0	3	7	0	0	17	25
	6	0	0	38	38	0	0	0	7	1	0	14	19
	7	0	0	54	51	0	0	5	12	0	0	47	36
	8	0	0	17	36	0	0	0	4	0	0	42	43
	9	0	0	21	35	1	0	0	1	0	0	44	43
	10	0	0	11	11	0	0	1	0	0	0	50	54
	11	0	0	9	17	0	0	0	0	0	0	51	53
	12	0	0	10	18	0	0	0	0	0	0	54	52
	13	0	0	16	25	0	0	0	0	0	0	50	47
	14	0	0	24	31	0	0	0	3	0	0	62	53
	15	0	0	19	13	0	0	0	1	0	0	44	50
	16	0	0	18	12	0	0						
Extinction	1	0	0	14	22	0	0	0	0	0	0	4	18
	2	0	0	10	17	0	0	0	0	0	0	1	15
	3	0	0	12	20	0	0	0	3	21	23	4	20
	4	0	0	21	31	0	0	0	0	3	18	4	22
	5	0	0	17	31	0	0	1	0	3	0	4	14
	6	0	0	4	20	0	0	0	3	3	0	0	4
	7	0	0	0	8	0	8	0	4	0	1	0	1
	8	0	0	2	16	0	0	1	12	0	1	0	1
	9	0	0	1	11	0	0	3	5	3	0	0	3
	10	0	0	2	13	0	0	1	1	0	1	1	9
	11	0	0	2	7	0	0	0	1	1	1	1	8
	12	0	0	8	14	0	0	0	1	0	5	0	12
	13	0	0	0	1	0	0	0	7	0	6	3	12
	14	0	0	0	2	0	0	3	10	2	8	1	14
	15	0	0	0	2	0	0	1	10	2	13	0	10

		Black Out						Total Escape					
	Bird Number	8		12		10		2		4		5	
		S+	S-	S+	S-	S+	S-	S+	S-	S+	S-	S+	S-
Shock	1	0	0	1	2	0	0	0	4	1	6	1	21
	2	0	0	1	4	0	0	1	6	0	2	0	1
	3	0	0	0	3	0	0	1	6	0	0	1	8
	4	0	0	0	3	0	0	0	0	0	0	0	0
	5	0	0	1	11	0	0	0	0	0	0	0	3
	6	0	0	2	5	0	0	0	0	1	1	0	0
	7	0	0	1	5	0	0	0	0	0	0	0	0
	8	0	0	1	3	0	0	0	0	5	9	0	0
	9	0	0	1	2	0	0	0	0	7	11	0	0
	10	0	0	0	0	0	0	0	0	3	9	0	0
	11	0	0	0	0	0	0	0	0	1	5	0	0
	12	0	0	0	3	0	0	0	0	9	17	0	0
	13	0	0	1	10	0	0	0	0	6	13	0	0
	14	0	0	0	3	0	0	0	0	0	8	0	0
	15	0	0	0	1	0	0	0	0	5	13	0	0
No Shock-	1	0	0	0	0	0	0	0	0	16	25	0	0
	2	0	0	0	0	0	0	1	0	6	18	0	0
	3	0	0	0	3	0	0	0	0	0	2	0	0
	4	0	0	0	7	0	0	0	0	0	2	0	0
	5	0	0	0	2	0	0	0	0	0	1	0	0
	6	0	0	0	7	0	0	0	1	0	2	0	0
	7	0	0	0	0	0	0	0	0	0	3	0	0
	8	0	0	0	0	0	0	0	0	0	4	0	0
	9	0	0	0	0	0	0	0	0	0	2	0	0
	10	0	0	0	0	0	0	1	0	0	4	0	0
	11	0	0	0	0	0	0	0	0	0	2	0	0
	12	0	0	0	0	0	0	0	0	0	1	0	0
	13	0	0	0	0	0	0	0	9	0	0	0	0