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FACTORS AFFECTING THE CONDITIONED REINFORCING STRENGTH  
OF STIMULI IN DIFFERENTIAL REINFORCEMENT OF OTHER  
BEHAVIOR AND FIXED-TIME SCHEDULES

by

Alexander M. Myers

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

MASTER OF SCIENCE

in

Psychology

Approved:

Utah State University  
Logan, Utah.

1978

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Alexander Myers

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## ABSTRACT

Factors Affecting the Conditioned Reinforcing Strength  
of Stimuli in Differential Reinforcement of Other  
Behavior and Fixed-Time Schedules

by

Alexander M. Myers, Master of Science

Utah State University, 1978

Major Professor: Dr. Edward K. Crossman  
Department: Psychology

Two experiments were conducted in an attempt to provide a direct, response-independent test of the delay-reduction hypothesis of conditioned reinforcement. In both experiments, pigeons made observing responses, by pressing a treadle, for stimuli associated with the schedule component in effect. The consequences of an observing response were varied; an observing response produced: a) either the stimulus associated with the shorter component or the stimulus associated with the longer component depending on the schedule component in effect; b) the stimulus associated with the short component only; c) the stimulus associated with the long component only; or, d) neither stimulus (no consequence). In Experiment I, naive pigeons were initially exposed to a mixed schedule with two differential reinforcement of other (DRO) behavior components; 10 seconds and 30 seconds (Phase One). In the second phase the same birds were exposed to an identical schedule, but the components were fixed



time (FT) components (Phase Two). Reinforcement in both phases was six seconds access to food. In Experiment II, naive pigeons were exposed to both phases of Experiment I, but reinforcement density was altered. Each 10 second component was followed by 3 seconds of food and each 30 second component was followed by 9 seconds of food. In both experiments, differential observing behavior was maintained during the FT (Phase Two) procedure but not during the DRO (Phase One) procedure. In addition, equalizing reinforcement density (Experiment II) had the effect of altering the pattern of observing behavior but did not reverse or eliminate the preference shown for the stimulus associated with the shorter delay to reinforcement over the stimulus associated with the longer delay to reinforcement. It is suggested that some characteristic of the DRO procedure may have been responsible for the lack of differential observing. While the delay-reduction hypothesis of conditioned reinforcement was supported by the results of the FT procedure of both experiments, some amendments are required to account for the lack of differential observing during the DRO procedure. Reinforcement density appeared to have little effect upon observing behavior, but further research is advised concerning its effect upon observing response patterns.

(72 pages)

## INTRODUCTION

A reinforcer is a stimulus which, when presented as a consequence of a particular response, produces an increase in the future probability of that response. There are two types of stimuli which serve as reinforcers; these are known as unconditioned (primary) reinforcers and conditioned (secondary) reinforcers. Unconditioned reinforcers apparently acquire their reinforcing strength in the absence of learning. That is, they are stimuli essential to the existence of the organism and need no learning history to acquire their reinforcing function (e.g., food, air, water). Conditioned reinforcers, on the other hand, are formerly neutral stimuli (having no noticeable effect on behavior) which have acquired reinforcing strength through some association with unconditioned reinforcers.

The exact nature of this association between a conditioned and an unconditioned reinforcer has yet to be fully understood. While numerous hypotheses have been suggested to explain the relationship, most explanations have been forcibly disregarded in the light of damaging experimental data (see Fantino, 1976; and Gollub, 1976, for more complete accounts). There is one recently proposed theory, however, that has received some consistent empirical support. This particular hypothesis, introduced by Fantino (1969; 1976), is known as the "delay-reduction hypothesis" of conditioned reinforcement. It states that:

The reinforcing strength of a stimulus is determined, in part, by the length of the interval between the onset of the stimulus and the onset of the primary reinforcer. But

this interval length must be considered relative to the length of the interval measured from the onset of the preceding stimulus to the onset of the same primary reinforcer. In other words, the contribution of contiguity to the conditioned reinforcing strength of a stimulus must be considered in the context of how remote primary reinforcement had been prior to the onset of the stimulus. The greater the percentage improvement, in terms of contiguity, to primary reinforcement correlated with the onset of the stimulus, the greater its conditioned reinforcing strength. (Fantino, 1976, p. 314)

Stated still another way, this hypothesis claims that a stimulus paired with a relatively short delay to reinforcement (say 10 seconds) will have greater conditioned reinforcing strength than a stimulus associated with a longer delay to reinforcement (say 30 seconds).

This hypothesis has been studied and supported by recent studies using the concurrent chains and the observing paradigms. In the concurrent chains procedure, an organism is initially exposed to two concurrently available keys. Both keys are illuminated with identical hues. A response to either key will occasionally produce a stimulus change on the key just pecked, and the other key will darken. Responses in a terminal link (in the presence of this second stimulus) generally produce food reinforcement. Following food reinforcement, the initial links are reinstated. The dependent variable is choice, as measured by relative response rate during the initial links. The independent variable can involve manipulations of either the initial or terminal links--generally the latter.

A problem with this procedure is that indifference in relative response rate must be shown by the subject in the initial link prior to experimental manipulation. In other words, the percentage of total responses made to one key during the initial link must be

close to 50%. This is often quite difficult to obtain, as evidenced by the number of subjects reported in various studies (i.e., Fantino, 1969; Fantino & Hursh, 1973) which have required some form of correction procedure to ensure "rate indifference" (for example, Fantino & Hursh, 1973, shortened the terminal link on the nonpreferred side for three to five sessions). The problem with such correction procedures is that there may be some uncontrolled influence on the subsequent behavior of the organism.

The observing paradigm, on the other hand, seems much more parsimonious. It would appear from the literature that observing behavior is quickly and easily acquired by pigeons and no extra procedure, such as a correction procedure, need be implemented.

Auge (1973) describes the observing procedure succinctly:

An observing response is any response that results in exposure to a discriminative stimulus (Wyckoff, 1952). Typically, such a response converts a mixed schedule of reinforcement into a multiple schedule, thus producing a specific stimulus signalling the component schedule arranged at that particular time ... If an observing response does not occur, the reinforcement contingencies are not altered and the organism behaves in the presence of a stimulus common to the various components, i.e., a mixed schedule. Hence, in the observing response procedure, the actual reinforcement contingencies are not controlled by the organism but the stimulus in the presence of which the organism behaves is under the organism's control. (Auge, 1973, p. 429)

A study conducted by Browne, Dinsmoor, and Lawrence (1972) provides a very good example of how the observing procedure can be employed to study conditioned reinforcement. In this study, pigeons were exposed to a mixed random interval (RI) extinction (EXT) schedule of food reinforcement, signalled by a white response key. By making an observing response to a second response key, birds could

produce 1) a green key light if the RI component was in effect (S+) or a red key light if EXT was programmed (S-), 2) S+ when the RI component was scheduled but no stimulus change if EXT was programmed, 3) S- when EXT was scheduled but no stimulus change if the RI component was in effect, or, 4) no stimulus change. The results of this study showed that birds would observe only when the stimulus associated with the positive result (S+) was a possible consequence of an observing response.

The present study employed an observing procedure very similar to the Dinsmoor et al., 1972, study in an effort to assess the validity of the delay-reduction hypothesis of conditioned reinforcement. More specifically, the delay-reduction hypothesis was examined using two response-independent schedules of reinforcement and, in addition, reinforcement densities (defined here as reinforcement magnitude per unit time) that were either unequal (Experiment I) or equated (Experiment II) for two different schedules of reinforcement.

## REVIEW OF LITERATURE

Introduction

Differential reinforcement of other behavior schedules (DRO) generally involve the following procedure: The subject, in the experimental setting, is exposed to a particular stimulus, say a key light, and, provided a particularly defined response is not emitted, is reinforced after a fixed amount of time. If the particularly defined response (for example, a key peck or press) is made, the experimental setting is blacked out (that is, the house-lights and key lights are darkened) for a fixed amount of time. Following this blackout, houselights and key lights are again presented and the original DRO contingency is reinstated. Kaye and Hitzing (1976) have proposed a procedure to enhance DRO performance in pigeons, who reputedly have difficulty establishing good DRO behavior (that is, an almost non-existent response rate). Using their procedure, naive pigeons, following hopper training, are gradually exposed to the DRO contingency. Initially, pigeons are put on small DRO schedules; for example 2 seconds. Then, the length of the DRO schedule is increased by steps (e.g., 4 seconds, 6 seconds, 10 seconds ... ) until the appropriate DRO value is reached. A training procedure of this type is employed in this study.

Fixed time schedules (FT), on the other hand, generally involve a different procedure. Here, the subject in the experimental setting is also exposed to a particular stimulus and reinforced after a

fixed amount of time. The distinguishing feature of this schedule, as compared to the DRO schedule, is that responses have no scheduled consequence. That is, responses are neither punished nor directly reinforced. The DRO schedule requires, in essence, a non-response, whereas the FT schedule places no type of response requirement upon the subject.

The Delay-Reduction Hypothesis of  
Conditioned Reinforcement

In 1976, Fantino reviewed some of the literature examining choice and conditioned reinforcement. The most prominent theory discussed in this review was the delay-reduction hypothesis of conditioned reinforcement. "When applied to choice procedures, the delay-reduction hypothesis states that 1) organisms will choose the stimulus correlated with the greatest reduction in time to primary reinforcement and 2) preference will be greater the larger the difference in the delay reductions correlated with the chosen alternatives." (Fantino, 1976, p. 31)

Autor (1960) was perhaps the first to propose this delay-reduction hypothesis. In a study using the concurrent chains procedure, reinforcement was delivered in the terminal links according to variable interval (VI) schedules. Pigeons performing on this task exhibited response patterns in such a way that the relative number of responses on a key in the initial link matched the relative rate of reinforcement for that key. Herrnstein (1964a) also demonstrated this effect in pigeons and went further to show that preference (as measured by relative response rate in the initial links) was more highly

correlated with reinforcement rate than reinforcement probability (average number of reinforcements per response).

Herrnstein provided further support for the delay-reduction hypothesis in 1964b, when he exposed pigeons to a concurrent chains procedure with either a fixed interval (FI) schedule or a VI schedule of food reinforcement in the terminal links. He found that his subjects consistently preferred the response key associated with the VI terminal link, even though the average time to reinforcement was the same for both terminal links (15 sec). Herrnstein concluded that his subjects preferred the VI 15 sec link over the FI 15 sec link because the VI link occasionally presented a very short delay to reinforcement, whereas the FI link always presented a 15 sec delay to reinforcement. These results have received a considerable amount of support from other investigations (Bower et al., 1966; Fantino, 1967; Hursh & Fantino, 1973; Killeen, 1968a; Navarick & Fantino, 1975).

Dempsey and Lachter (1977) have provided some strong support for the delay-reduction hypothesis. In their study, pigeons were exposed to a two key concurrent chains procedure, with equal VI schedules programmed for the terminal links. It should be noted that either terminal link could be produced by a single peck during the initial link; therefore, this is really a discrete trials procedure. In any case, following a period of this schedule in which one key came to be preferred over the other in all birds, the terminal link VI schedules were manipulated so that the least preferred side became associated with an increased reinforcement frequency (shorter VI schedule) and the more preferred choice key became associated



with a decreased reinforcement frequency (longer VI schedule). There resulted a fairly sudden shift in preference from one choice key to the other, so that the formerly preferred choice key became the least preferred, and vice versa.

Richards (1975) used a combined cues technique to determine the functional control of a stimulus associated with delay to reinforcement during one component of a multiple schedule. This study was divided into three parts, or phases. Initially, 14 pigeons were placed on a multiple variable interval 1 min variable interval 1 min (mult VI 1 min VI 1 min) schedule for 35 sessions, with a red stimulus light paired with one VI 1 min component and a white stimulus light paired with the other VI 1 min component. In phase two, seven birds were assigned to an experimental condition and placed on a mult VI 1 min VI 1 min VI 1 min schedule of reinforcement. Here, an additional component was added to those of phase one. This component was similar to the other two components, only there was a 10 sec delay of reinforcement at the end of the VI completion and the component was paired with a white stimulus light which had a black line through it (LW). The other seven subjects were assigned to a control group which was also placed under a mult VI 1 min VI 1 min VI 1 min schedule of reinforcement. The only difference between this group and the experimental group was that the delay component was paired with a solid blue stimulus light. Following 30 sessions of phase two, all subjects received one session of phase three, where four stimuli were presented one at a time and which were not paired with reinforcement. The stimuli were: a red key, a white key, the LW key (white background with a black line through it), and a LR

key (red background with a black line through it). It was found that the experimental group's responding was reduced 45% by the presentation of the LR stimulus, whereas the control group's responding was not lowered at all. This was attributed to the pairing of the line with the reinforcement delay in phase two for the experimental group. This study demonstrates that a stimulus which is associated with a delay to reinforcement can acquire aversive characteristics when it is presented in a situation where other stimuli are not associated with reinforcement delays.

Auge (1974) used five adult pigeons in an observing paradigm to examine the effects of context on the establishment of a conditioned reinforcer. Birds were exposed to a multiple fixed ratio X fixed interval 30 sec (mult FR X FI 30 sec) schedule of reinforcement, where X was either 20, 30, 100, 140, or 200. The FR X component was paired with a red key light; the FI 30 sec component was a green key light. Following training, the key light was white, and the birds were on a mixed FR X FI 30 sec schedule unless they made a response to another key (Observing Key). Such an observing response would change the color of both keys from white to the color of the component in effect. Later, birds were exposed to similar situations where only red key color could be produced or only green could be produced. If, for example, only red could be produced, an observing response would change the key colors only when the FR X component was in effect--observing responses at other times had no consequence. Auge's results showed that birds would observe only when the shortest component could be observed for.

In other words, when the FR value was 20 or 30, the subjects would only maintain their observing behavior if the red stimulus was a possible consequence of such behavior. When the FR value was 100, 140, or 200, birds would only make observing responses when the green stimulus was an occasional consequence of such a response. Auge concluded that the shorter inter-reinforcement interval stimulus was necessary for the maintenance of observing behavior.

This study provides strong support for the delay-reduction hypothesis, but there are several procedural problems. First, all but one subject was exposed to only one FR value. This means that a group study was performed with only one subject in each group. It would have been more appropriate to have used a multiple baseline procedure and have tested all subjects on all FR values. Also, only median inter-reinforcement interval data are presented. These may or may not have been representative of the subjects' performance. Finally, there is a different response requirement in the two components, FR and FI. FR and FI schedules typically produce different local response rates. The study has been supported, however, by two other studies that correct for these problems. Branch, in 1970, used two different VI schedules (30 sec and 120 sec) and found that observing responses occurred at a higher rate during the VI 30 sec component than during the 120 sec component. Jwaideh and Mulvaney (1976) also used VI 30 sec and VI 120 sec components in an observing paradigm (three-key), and demonstrated that the VI 30 sec stimulus was a reinforcer (maintained and increased observing responses) because it signalled a higher-value consequence than the mixed

stimulus, and the stimulus associated with the 2 min VI was a punisher because it signalled a lower-valued consequence than the mixed stimulus.

In 1969b, Fantino, using the concurrent chains procedure, used three different pairs of identical VI schedules as initial links (VI 600 sec, VI 120 sec, and VI 40 sec). The terminal links were always VI 30 sec and VI 90 sec. Results showed that choice proportions in the initial links matched the relative rates of reinforcement in the terminal links only when the intermediate initial link duration was in effect. Fantino suggests that this supports the formulation that "choice behavior is determined by the degree of reduction in the expected time to primary reinforcement signified by entry into one terminal link, relative to the degree of reduction signified by entry into the other terminal link." (Fantino, p. 730, 1969b). This finding has received further support in studies conducted by Fantino (1969a); Fantino and Squires (1971); Duncan and Fantino (1972); Duncan and Fantino (1972); and Fantino and Hursh, (1973). The Duncan and Fantino (1972) study added further to this formulation by showing that pigeons in their study were sensitive to the momentary likelihood of reinforcement. Hursh and Fantino (1973) also showed, using VI 60 sec initial schedules and simple fixed, versus mixed-interval schedules in the terminal links, that the distribution of responses during the concurrent initial links was accurately described by "the relative inverse delay of reinforcement squares."

#### The Response as a Factor in Choice

The importance of the interreinforcement responses emitted by

an organism on that organism's subsequent behavior has been questioned for some time. Neuringer and Schneider (1968) attempted to separate the effects of interreinforcement time and interreinforcement responses in an effort to determine the relative importance of each. In this study, a blackout occurred following each nonreinforced response under FR and FI schedules of reinforcement. Manipulating the blackout duration in the FR component kept the number of interreinforcement responses constant, but varied the interreinforcement time. Manipulating the blackout duration in the FI component kept interreinforcement time constant but varied the number of interreinforcement responses. As interreinforcement time increased, so did postreinforcement and post-blackout pauses. Neuringer and Schneider interpreted this to mean that it is interreinforcement time which controls responding and not interreinforcement responses.

Crossman, Heaps, Nunes, and Alferink (1974), however, performed a similar experiment and obtained different results. They trained pigeons on a multiple FR x FR 2 plus timeout schedule in which the value of x was manipulated. In one experiment, work time (the time between the first response and the last response on the schedules) was equated for both components. In a second experiment, interreinforcement intervals were equated for both components. In both cases, as the value of x increased, so did the difference between the postreinforcement pauses of the two components. The authors concluded that "Because the fixed-ratio x component contained a larger number of responses than the fixed-ratio plus time out component, the relatively longer pause preceding the fixed-ratio x indicates that number of responses played a significant role in

determining the length of the post-reinforcement pause" (Crossman et al., p. 115, 1974). This conclusion was further supported by a recent study (as yet unpublished) conducted by Nunes et al.

Fantino (1968) exposed six pigeons to the concurrent chains procedure where the terminal links of the chains were associated with equal frequencies of reinforcement, but where the response requirement was different. Three birds chose between fixed-interval (FI) and differential reinforcement of high rates (DRH) schedules, while the remaining three birds chose between FI and differential reinforcement of low rates (DRL) schedules. All subjects preferred the chain without the response rate requirements, suggesting that, at least in this case, response requirements do have an effect on choice behavior.

Killeen (1968) conducted a similar study which produced different results than Fantino's study. He conducted a concurrent chains study which consisted of four experiments. Three of these experiments were run as control experiments; they were baseline, return to baseline, and unequal reinforcement frequencies. Experiment 2, the remaining experiment, presented the subjects with a choice between a VI terminal link schedule and a differential reinforcement of other behavior (DRO) terminal link schedule. All pigeons remained indifferent to these schedules. Killeen cautions the reader, though, in his conclusion; "Although the present study provides evidence that preference is independent of response rate, we cannot conclude that an organism is insensitive to the amount of work entailed in the procurement of reinforcement" (Killeen, p. 34, 1968).

Two experiments by Fantino and Moore (1975) using the concurrent chains procedure examined this issue further. In the first experiment, pigeons were indifferent between a response dependent tandem variable time (VT) FR schedule and a response independent VT schedule when the response dependent schedule required a small number of responses. In Experiment 2, "The pigeons preferred a periodic, response-independent schedule to a periodic, response-dependent schedule that shared a feature with a require-rate schedule: there was a requirement to respond early in the interreinforcement interval, when responding produced reinforcement only later." (Fantino & Moore, 1975, p. 339). The authors concluded from this that pigeons "prefer a second schedule to the extent that the response contingencies of the first schedule must be satisfied during discriminable periods of nonreinforcement" (Fantino & Moore, 1975, p. 339).

Wallace, in an unpublished doctoral dissertation, attempted to replicate Duncan and Fantino's (1972) study in which pigeons showed extreme preferences for simple FI schedules over equal-length chain FI FI schedules. Wallace exposed his pigeons to an identical concurrent chains procedure, only the terminal links consisted of a simple fixed time (FT) schedule and an equal-length chain FT FT schedule. Removing the response requirement in this way greatly lowered the preference for the simple FT schedule. Wallace reached the same conclusion Fantino and Moore (1975) reached; namely, "Preference was determined by the necessity of emitting a response

at some period of time before reinforcement in the terminal link." (Wallace, unpublished doctoral dissertation, 1973, p. XII).

In summary, the role of the response in choice behavior is still largely undetermined. The majority of the data would seem to suggest that the response requirements of a particular schedule of reinforcement do affect the subsequent behavior of the organism, but the actual extent of that effect has yet to be fully understood.

In the present study, both fixed time (FT) and differential reinforcement of other behavior (DRO) schedules are examined. The DRO schedule, of course, permits no response and is therefore a more perfect response-independent procedure than the FT schedule which permits inconsequential responses. There is a drawback to the DRO procedure, however, which makes a comparison between the two procedures necessary. The DRO procedure does require what is in essence a non-response or a zero rate of responding. A response in the DRO procedure is always followed by a blackout or some similar adverse consequence. Fantino, in the 1968 study previously described, has shown that rate requirements may inhibit some types of responding. It is therefore conceivable that the zero rate requirement of the DRO procedure will have an adverse effect on the observing behavior of the birds in the present study. If this is the case, subjects may exhibit different observing rates during the FT procedure than during the DRO procedure.

#### Density of Reinforcement as a Factor in Choice

Reinforcement density is defined here as reinforcement magnitude



per unit time. One way to make a distinction between these two terms, reinforcement density and reinforcement magnitude, is to examine Auge's 1973 study. In this study, one component in a two component multiple schedule was followed by two seconds of grain presentation. The other component, of equal length, was followed by ten seconds of grain presentation. In this case, after one component, a particular magnitude of reinforcement is presented; either a magnitude of 2 seconds continuous access to grain or a magnitude of 10 seconds continuous access to grain. If, however, the amount of time in which grain was available is totalled for each component at the end of an hour session, in which thirty components of the 2 second magnitude and thirty components of the 10 second magnitude are presented to the subject, it could be said that the component with 2 seconds of reinforcement presented a total of 60 seconds access to grain, while the other component presented a total of 300 seconds access to grain. The density of reinforcement for the two components, then, would be 60 seconds per hour and 300 seconds per hour, respectively. The major distinction, then, between reinforcement magnitude and reinforcement density is that reinforcement magnitude refers to continuous reinforcement, while reinforcement density refers to the amount of time reinforcement was available over a particular time period.

Much of the work done in this area has dealt with reinforcement magnitude alone; that is, without consideration for magnitude per time; and therefore much of the literature reviewed here will be concerned with magnitude of reinforcement. It should be understood,

however, that magnitude and density of reinforcement are closely related to one another.

Perhaps the most notable investigation carried out thus far in the examination of reinforcement magnitude and its effect on choice was Auge's 1973 study. In this experiment, pigeons were exposed to a multiple FI 1 min FI 1 min schedule of food reinforcement, where one component (paired with a red key light) was followed by 10 sec access to grain reinforcement and the other component (paired with a green key light) was followed by 2 sec access to grain reinforcement. All subjects were then placed on an observing procedure, in which an observing response would convert a mixed FI 1 min FI 1 min schedule into a mult FI 1 min FI 1 min schedule by producing one of the two discriminative stimuli. The results showed that the occasional presentation of the red stimulus (associated with the 10 sec duration) after an observing response was necessary for the maintenance of observing behavior. Auge concluded that varying the reinforcement magnitude was functionally the same as varying the rate of reinforcement. This interpretation that rate and magnitude of reinforcement may be functionally equivalent is supported by studies performed by Mariner and Thomas (1969) and TenEyck (1970). TenEyck (1970) goes further to say that rate and duration of reinforcement may be reducible to a single variable; rate of reinforcement-time. This notion appears quite similar to density of reinforcement.

Various other studies have shown reinforcement magnitude to play an important role in an organism's behavior (Schwartz, 1969;

Calef et al., 1972; Davey et al., 1975; Lowe et al., 1974; Mellgren et al., 1975). The role of reinforcement density has yet to be compared to that of response requirements or delay to reinforcement, however. Thus far, no study has been undertaken to separate these three variables and study their effect on an organism's choice behavior or their interaction with one another.

#### Statement of the Problem

The review of the literature shows that three variables may have an effect on the choice behavior of an organism, or on the conditioned reinforcing strength of a stimulus. These three variables (delay to reinforcement, response requirement, and density of reinforcement) have yet to be separately examined for their interactions with each other and their effects on choice behavior. The purpose of the present study is to first examine the effects of delay to reinforcement in two response-independent observing procedures. Second, using the same parameters as the first experiment, experiment two will equate reinforcement density for the two components in the observing paradigm. If reinforcement delay alone is the important variable in determining the strength of a conditioned reinforcer, pigeons should prefer the shortest component in each procedure. That is, they should observe only when the stimulus associated with the shortest component is a possible consequence of an observing response. If response requirements are important in choice behavior, then the expected preference for the shorter component should be reduced or eliminated entirely.

It should be noted that the two response-independent schedules used have differing response requirements. One of the schedules is a fixed time (FT) schedule which requires no response, but permits responses to occur. The other schedule is a differential reinforcement of other behavior (DRO) schedule which neither requires nor permits responses to occur. While the response requirement is the same in both schedules (that is, no requirement), there is a difference in that the DRO schedule has a response contingency. That is, responses will be punished by the onset of a blackout period. Thus, the DRO schedule requires a zero rate of response. If reinforcement density is the critical variable in determining the strength of a conditioned reinforcer, a preference should be seen for the short component in Experiment I, but indifference should occur in Experiment II (subjects will cease to observe).

EXPERIMENT I  
REINFORCEMENT DELAY AND RESPONSE INDEPENDENCE

Method

Subjects

Five experimentally naive adult pigeons (B1, B2, B6, B7, B9), maintained between 75 and 85% of their free-feeding weight served as subjects. All five birds were Homers (*Columba livia domestica*), bred and raised at Utah State University. Sex and age of the pigeons did not play a role in their selection as subjects.

Apparatus

A three-key pigeon chamber, measuring 40.6 cm x 40.6 cm x 40.6 cm, provided the experimental setting for all subjects. The three plexiglass keys were located on the front wall of the chamber, 24.1 cm above the grid floor. Each key was separated from the other keys by a distance of 3.8 cm, with the two side keys positioned 12.7 cm from the sides of the chamber. The side keys were not used and remained dark. Each key had a diameter of 1.9 cm, and a minimum force of 7 g (0.07 N) was required to operate it. A treadle was located in the bottom right corner of the front panel, approximately 5.1 cm from the side of the chamber and 1.3 cm above the grid floor. This treadle measured 3.8 cm x 4.4 cm and required an operating force of about 7 g (0.07 N). An opening for the food hopper (5.1 cm x 6.4 cm) was also situated on the front panel of the chamber, equidistant from the two side panels of the chamber and

and 10.2 cm above the floor. The hopper was illuminated by a 28 V dc light (GE 2450) during hopper presentation. A 115-125 V ac, 7 W light (Sylvania 7C7) served as a houselight for the chamber, and was located in the center of the chamber ceiling. White noise was continuously present in the experimental room in an attempt to mask any extraneous sounds. Experimental conditions were controlled by conventional relay and timing circuitry, and data were recorded on digital counters, a Gerbrands cumulative recorder, and running time meters. A BRS/LVE Photosensor unit (Ph-901/221-10) was used to initiate the reinforcement timers. The Photobeam consisted of a Norelco Holland 1820 bulb. The Photobeam was broken when the subject's head entered the hopper opening.

Procedure: Phase One: Differential Reinforcement of Other Behavior (DRO)

Due to the reported difficulty in maintaining an absence of key-pecking behavior with pigeons on differential reinforcement of low rate (DRL) and differential reinforcement of other behavior (DRO) schedules, experimental naivete was essential. A new procedure, similar to that employed by Kaye and Hitzing (1976), was implemented to enhance DRO performance. This procedure is described below.

Hopper training. Each subject was placed in the experimental chamber in a food-deprived state (75-85% free food weight). The food hopper, filled with Purina Racing Pigeon Checkers, was presented with the hopper light until the subject ate continuously for six seconds. Following this, the hopper was lowered for 10

seconds and then again presented for 6 seconds. The interval between hopper presentations was increased gradually until the subject was eating reliably when the inter-food-interval (IFI) was 60 seconds and hopper presentation time was 6 seconds. At this point, a photosensor was employed to initiate the 6 second access to food. When the subject's head and beak entered the hopper opening, the beam was broken and the 6 second timer began.

DRO training. Once the hopper training period was completed, each subject was exposed to a DRO schedule of reinforcement. A white center key was transilluminated during each IFI, and darkened during food delivery. Initially, the DRO was 2 seconds. Subjects were exposed to the following conditions, in sequence, with a minimum of 30 reinforcers delivered per condition: DRO 2 sec, DRO 3 sec, DRO 4 sec, DRO 5 sec, DRO 7 sec, DRO 10 sec, DRO 12 sec, DRO 15 sec, DRO 20 sec, DRO 25 sec, DRO 30 sec. Reinforcement here, and in the rest of Experiment I, was 6 seconds access (as timed by the photosensor) to Purina Racing Pigeon Checkers. A key-pecking response at any time during the session produced a 45 second blackout, during which both the keylight and the houselight were terminated. A treadle was also present in this experimental condition; however, a treadle press had no scheduled consequence. If any of the birds pecked the center key more than twice during any of the above conditions, a criterion of 15 trials without a keypeck was imposed prior to advancing conditions. For example, if a subject keypecked three times during the 30 trials of DRO 12 seconds, that subject remained in the DRO 12 second condition

until 15 reinforcers were delivered in the absence of a key pecking response. Each trial consisted of the time between the offset of one reinforcement period and the onset of the next reinforcement period.

Multiple schedule training. After the subject acquired and exhibited stable DRO 30 sec performance, it was exposed to a multiple DRO 10 sec DRO 30 sec (mult DRO 10 sec DRO 30 sec) schedule of reinforcement. Under this condition, the center key was illuminated with red light while the DRO 10 sec component was scheduled, or green light if the DRO 30 sec component was in effect. Scheduled components alternated at random after reinforcement, with the restriction that no more than three of the same components occurred in succession. As before, a keypeck interrupted the component in effect and resulted in a 45 second blackout. Upon termination of the blackout, the schedule component was reinitiated. For example, if a keypeck occurred halfway through the DRO 30 sec component, a 45 second blackout took place and then the DRO 30 sec component started again. Key pecks during the blackout reset the blackout timer, so that the last keypeck was followed by 45 seconds of blackout. If a keypeck occurred during reinforcement presentation, the blackout period commenced immediately following reinforcement--before the next component began. Treadle presses were recorded but had no programmed consequence.

Sessions were terminated after 24 reinforcements, and were conducted once a day, six or seven days per week. All subjects were exposed to this mult DRO 10 sec DRO 30 sec schedule for at



least 18 sessions. An attempt was made to keep the number of DRO 10 sec components and DRO 30 sec components equal across sessions. In other words, whenever possible, each session of 24 reinforcers was divided equally into 12 DRO 10 sec components and 12 DRO 30 sec components. If a session did come out unequal (e.g., 11 DRO 10 sec components and 13 DRO 30 sec components), an attempt was made to reverse the unequalness of the components in the next session (e.g., 13 DRO 10 sec components and 11 DRO 30 sec components). This latter procedural step was adopted because of Wellman's (1976) suggestion that the number of reinforcers paired with a stimulus, as compared to the number of reinforcers paired with a second stimulus, may effect the conditioned reinforcing strength of the conditioned reinforcer.

Baseline observing procedure. Following multiple schedule training the center key was transilluminated with white light. A peck to this key resulted, as before, in a 45 second blackout of both the keylight and the houselight. The scheduled conditions during this phase of the experiment were identical to those in the previous, multiple schedule, phase, but with the following restrictions. First, by replacing the red and green colors on the key with white light, the mult DRO 10 sec DRO 30 sec schedule was changed to a mixed DRO 10 sec DRO 30 sec (mix DRO 10 sec DRO 30 sec) schedule. In this manner, no discriminative stimuli were available to signal which programmed component was in effect. Second, a treadle press had a consequence. Here a treadle response changed the center key from white to the stimulus color associated with the

component in effect. For example, if the DRO 30 sec component was scheduled, a treadle press changed the key color from white to green; if the DRO 10 sec component was scheduled, key color changed from white to red. In either case, the stimulus change ( $S_0$ ) which followed the treadle (or observing) response ( $R_0$ ) persisted until a) the component ended and reinforcement was delivered, or, b) a keypeck occurred and a blackout period commenced. If a keypeck occurred after an observing response (while the discriminative stimulus was available), the key color following blackout termination was white. In addition, reinforcement was never delivered within three seconds of an observing response. (This was part of an effort to avoid any direct pairing of the treadle response with reinforcement (food).) In all phases of this experiment, food was delivered irregardless of whether an observing response was made, provided no keypeck occurred to delay that delivery. Multiple, or subsequent, treadle presses were recorded.

To sum up this phase of the experiment, a treadle press ( $R_0$ ) changed a mix DRO 10 sec DRO 30 sec schedule into a mult DRO 10 sec DRO 30 sec schedule of food reinforcement, by providing the discriminative stimulus which was associated with the component in effect. Under any stimulus arrangement, a peck to the lit key resulted in the usual blackout condition. The stimulus color following any blackout was white. Therefore,  $S_0$  remained in effect either until reinforcement was presented or a keypeck occurred.

Manipulations in the observing procedure. There were four manipulations in the observing procedure. Subjects were divided

into two groups, with the only difference between groups being the sequence of conditions (See Table 1). In each condition an observing response, or treadle press, produced a different result than an identical observing response in the other conditions. (In no condition, however, did  $R_o$  affect food delivery in any other way than to postpone it for a maximum of 3 seconds.) See Table 1 for the sequence of conditions for each subject and the number of sessions devoted to each condition. Conditions changed once a stability criterion was met after 18 sessions by the subject. (The exception to this was the No Consequence (NC) condition which was terminated after the 12th session.) This stability criterion required that the subject's observing response probability (number of trials with at least one  $R_o$  divided by total number of trials) for the immediately preceding two sessions did not vary more than 5% from the mean of the previous three sessions.

The four observing conditions were:

- 1) Baseline (B) or  $S^{10}$  and  $S^{30}$ . In this condition, an observing response produced either of the two stimuli associated with the schedule components. That is, a treadle press changed the key color from white to red if the DRO 10 sec component ( $S^{10}$ ) was programmed, or from white to green if the DRO 30 sec component ( $S^{30}$ ) was in effect. This procedure was identical to the baseline observing procedure described earlier.
- 2)  $S^{10}$  only. Here, a treadle press resulted in a stimulus change (white-to-red) only if the DRO 10 sec component was in effect.

Table 1  
 Sequence of Conditions and Number of Sessions  
 Devoted to each Condition for each Subject  
 in Experiment I, Phases One and Two.

---

Condition	<u>Sequence A</u>					
	<u>Phase One (DRO)</u>			<u>Phase Two (FT)</u>		
	B1	B6	B9	B1	B6	B9
M	18	18	21	12	12	12
B	20	33	26	18	20	18
S <sup>10</sup>	25	18	18(6)	18	19	18
S <sup>30</sup>	18	18	18	18	18	18
NC	13	18	12	12	12	12

---

Condition	<u>Sequence B</u>			
	<u>Phase One (DRO)</u>		<u>Phase Two (FT)</u>	
	B2	B7	B2	B7
M	18	18	12	12
B	20	27	18	19
S <sup>30</sup>	26	18	18	19
S <sup>10</sup>	18	19	18	18
NC	12	18	12	12

---

M = Multiple DRO (FT) 10 sec, DRO (FT) 30 sec

B = Baseline observing (S<sup>10</sup> and S<sup>30</sup>)

S<sup>10</sup> = S<sup>10</sup> only

S<sup>30</sup> = S<sup>30</sup> only

NC = No Consequence

An observing response during the DRO 30 sec component was recorded but had no scheduled consequence.

3) S<sup>30</sup> only. This condition was identical to the previous condition, S<sup>10</sup> only, except that the consequence of R<sub>0</sub> was reversed. In this case, a treadle press had an effect (white-to-green) only when the DRO 30 sec component was programmed. All other observing responses were recorded but had no scheduled effect.

4) No consequence (NC). During this condition, all treadle presses were recorded, but none had a programmed consequence. That is, an observing response produced no change in the stimulus color.

Procedure: Phase Two: Fixed  
Time (FT) Schedules

Upon completion of Phase One, each subject was exposed to an identical procedure where fixed-time (FT) schedules were employed instead of the DRO schedules of Phase One. Under FT schedules, subjects were reinforced after a fixed amount of time, regardless of the subjects' behavior. All apparatus was identical in both phases. Hopper training and DRO training were excluded from the procedures of this phase. Training began with multiple schedule training.

Multiple schedule training. Immediately upon completion of the last DRO NC observing condition of Phase One, subjects were exposed to a multiple FT 10 sec FT 30 sec (mult FT 10 sec FT 30 sec) schedule of reinforcement. The only difference between this condition and the multiple schedule training condition in Phase

One was that now keypecks were recorded but had no scheduled consequence. See Table 1 for the sequence of conditions for each subject and the number of sessions devoted to each Phase Two condition.

Baseline observing procedure. Again, this condition was identical to the previous, Phase One, condition, with the exception that keypecks were recorded but had no programmed consequence. In summary, a treadle press ( $R_0$ ) changed a mix FT 10 sec FT 30 sec schedule into a mult FT 10 sec FT 30 sec schedule of food reinforcement, by providing the discriminative stimulus which was associated with the component in effect (red for FT 10 sec, green for FT 30 sec). The stimulus change ( $S_0$ ) following the treadle press ( $R_0$ ) remained in effect until reinforcement was presented.

Manipulations in the observing procedure. Here, again, the conditions were the same as before in Phase One, except that keypecks were recorded but had no scheduled effect. Each subject in Phase Two received the same sequence of conditions he received in Phase One. The four observing conditions were identical to those in Phase One. Conditions changed after 18 sessions (except for the NC condition which was terminated after 12 sessions). The stability criterion of Phase One was dropped since subjects either demonstrated stability by the 18th session or never stabilized at all.

### Results

In order to examine the results of Experiment I, each subject's treadle pressing, or observing responses, were recorded. Previous

research cited in the observing response literature has examined observing response behavior using two measures. The first of these measures used either the total, or the mean number of observing responses in each condition for each schedule component (cf., Dinsmoor et al., 1972). For example, using the parameters incorporated in the present study, the mean and/or the total number of treadle presses by a subject would be obtained for both the  $S^{10}$  and  $S^{30}$  components during each of the five observing conditions (M, B,  $S^{10}$  only,  $S^{30}$  only, NC).

While the mean number of observing responses per session was obtained for each subject in each condition of the present study, the probability of an observing response ( $P(R_o)$ ) was viewed as a more appropriate measure. Therefore,  $P(R_o)$ s were also calculated for each subject in each condition of the present study. The probability of an observing response was defined as the number of trials in which at least one observing response occurred divided by the total number of trials. A trial was defined as the period of time between the offset of one reinforcement period and the onset of the next reinforcement period. This other technique for measuring observing response behavior (cf., Auge, 1973) was valuable in the present study because of two factors. First, the two components were of different lengths (10 seconds and 30 seconds) and, second, the lengths of trials in Phase One of both experiments were variable, due to the potential blackout period following any keypeck. The  $P(R_o)$  measure was not affected when a DRO trial became quite long, due to one or several blackout periods, or when

a large number of treadle presses were made in a single trial. For example, since the 30 second component was longer than the 10 second component, more treadle presses could have been made during the 30 second component, even if the rate of treadle pressing was the same for both components. The  $P(R_o)$  measure at least partially controlled this confounding variable.

Phase One. Figure 1A shows the mean and standard deviation of the probability of an observing response ( $P(R_o)$ ) per session for the last five days of each condition for each bird in Experiment I, Phase One. Table 2 shows the same data in numerical form. The data in Figure 1 are shown in the sequential order to which each bird was exposed.

As can be seen in both Figure 1A and Table 2, there was no consistent preference for either the  $S^{10}$  or the  $S^{30}$  discriminative stimulus. Subject B1 demonstrated a decreasing  $P(R_o)$  across conditions. Subject B2 showed a similar effect. There was an initial rise in treadle pressing in the baseline (B) condition (it should be remembered that the M condition provides only an operant level of treadle pressing and that the treadle press response had no effect upon the stimulus conditions), but each subsequent condition was correlated with a decrease in  $P(R_o)$ . Subject B6 produced an extremely low level of treadle pressing, with identical  $P(R_o)$ s for the  $S^{10}$  and  $S^{30}$  conditions. Subject B7 produced a higher  $P(R_o)$  during the last five days of the  $S^{10}$  condition than during the last five days of the  $S^{30}$  condition, but the No Consequence (NC) condition produced the highest  $P(R_o)$  of all the conditions. There were also extremely large standard deviations for the  $S^{10}$  and





Figure 1. A) The mean ( $\bar{X}$ ) and standard deviation(s) of the probability of an observing response ( $P(R_0)$ ) for the last five days of each condition for each subject in Experiment I, Phase One. Bars represent the means and the standard deviations are represented by the slash lines. Data are shown in the sequential order to which each bird was exposed.

B) The mean ( $\bar{X}$ ) number of observing responses ( $R_0$ ) per session during each condition for each subject in Experiment I, Phase One. Data are shown in the sequential order to which each bird was exposed.

Figure 1A.

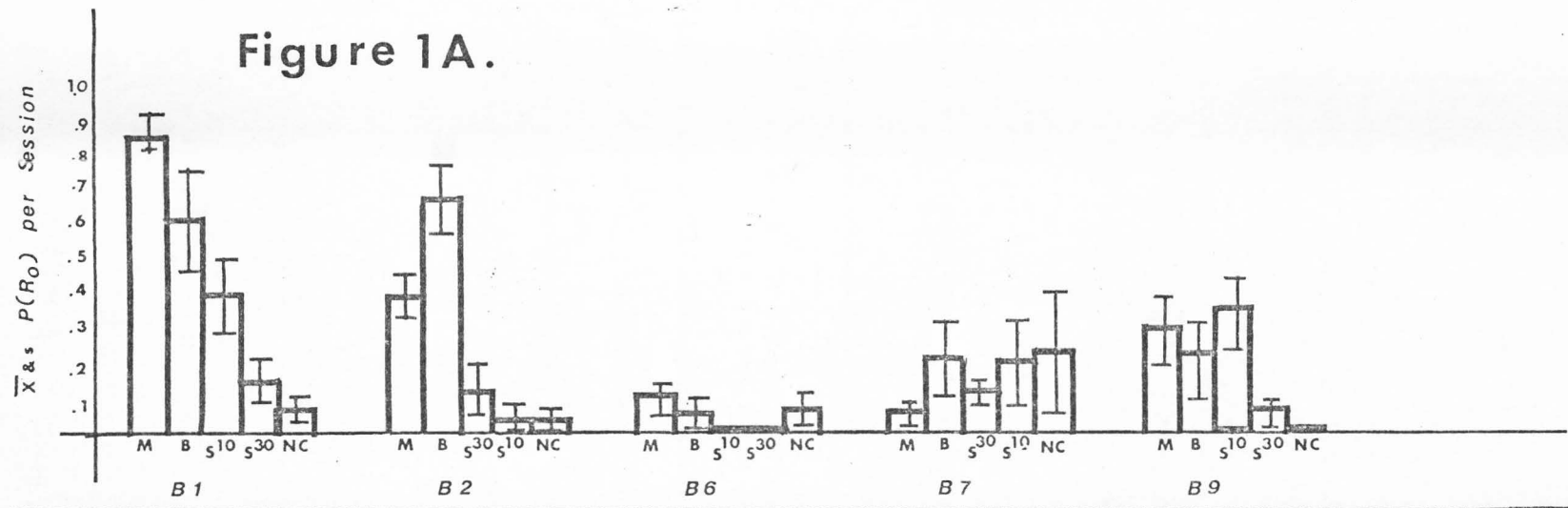


Figure 1B.

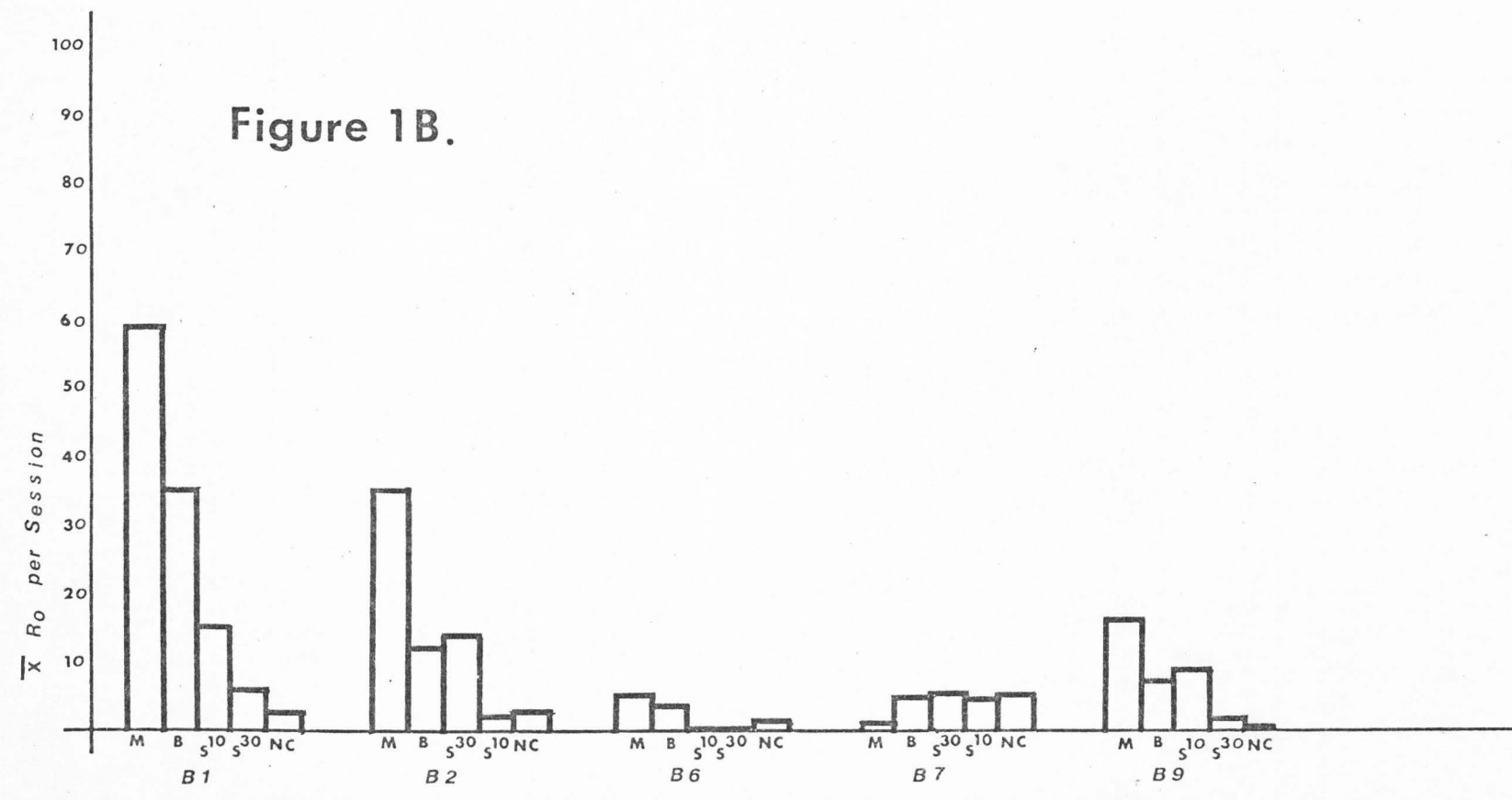


Table 2

Mean ( $\bar{X}$ ) and Standard Deviation(s) of the Probability of an Observing Response ( $P(R_0)$ )  
per Session for the Last 5 Days of each Condition for each Subject.

Experiment I, Phases One and Two.

<u>Experiment I</u>		<u>Phase One</u>			
<u>Subject</u>	M	B	$S^{10}$	$S^{30}$	NC
	$\bar{x}(S)$				
B1	.858(.055)	.592(.141)	.382(.1)	.15 (.063)	.072(.032)
B2	.384(.055)	.652(.095)	.048(.032)	.126(.071)	.04 (.028)
B6	.098(.045)	.048(.055)	.008(.017)	.008(.017)	.056(.055)
B7	.064(.032)	.206(.105)	.198(.114)	.114(.032)	.224(.167)
B9	.286(.095)	.208(.105)	.334(.095)	.056(.032)	.008(.017)
			[S10-2 0(0)]		
<u>Subject</u>	M	B	<u>Phase Two</u> $S^{10}$	$S^{30}$	NC
B1	.032(.017)	.918(.032)	.858(.071)	.292(.063)	.346(.152)
B2	.258(.045)	.798(.032)	.428(.055)	.242(.032)	.206(.077)
B6	.116(.1)	.158(.217)	.158(.126)	.04 (.028)	.124(.071)
B7	.634(.095)	.716(.126)	.824(.063)	.276(.089)	.45 (.077)
B9	0 (0)	.064(.032)	.166(.063)	.08 (.045)	.148(.095)

NC conditions for this subject. Subject B9 showed an elevated  $P(R_o)$  during the  $S^{10}$  condition. However, a second  $S^{10}$  condition was run following the completion of the NC condition for this subject, and a zero level of treadle pressing was obtained, suggesting that in this case treadle pressing was not under good stimulus control. The data for this extra condition is shown under the  $S^{10}$  condition for this bird in Figure 1 and Table 2 (brackets).

Figure 1B shows the mean number of observing responses ( $R_o$ ) per session for each of the subjects in Experiment I, Phase One. Table 3 shows the same data in numerical form. Data in Figure 1B are shown in the sequential order to which each bird was exposed.

As can be seen in both Figure 1B and Table 3, no consistent difference was found between the mean number of  $R_o$ 's per session under either the  $S^{10}$  or the  $S^{30}$  conditions. Two subjects made more observing responses during the  $S^{10}$  condition than during the  $S^{30}$  condition (B1, B9) while one subject (B2) made more responses in the  $S^{30}$  condition and the remaining two subjects (B6, B7) showed no real preference.

The proportion of total time for the two DRO components was calculated for each subject and each observing condition in order to determine whether the ideal proportion of DRO 10 sec component time to DRO 30 sec component time (.33 or 10/30) was maintained in all conditions of the phase. This was done by dividing the total component time (that is, the cumulative total of the trial durations, including blackouts) of the DRO 10 sec schedule by the total component time of the DRO 30 sec schedule. Ideally, in

Table 3

Mean ( $\bar{X}$ ) Number of Observing Responses ( $R_o$ ) per Session for each Condition for each Subject.

(Total  $R_o$  per Number of Sessions.) Experiment I, Phases One and Two.

Subject	<u>Phase One</u>					<u>Phase Two</u>				
	M	B	S <sup>10</sup>	S <sup>30</sup>	NC	M	B	S <sup>10</sup>	S <sup>30</sup>	NC
<u>Experiment I</u>										
B1	58.71	35.20	15.16	6.00	2.85	9.92	24.00	45.44	17.61	15.5
B2	34.56	11.75	1.89	13.19	2.67	16.58	25.67	17.5	13.33	8.17
B6	5.11	3.55	.39	.33	1.06	2.92	6.65	13.63	2.17	1.92
B7	1.06	4.93	4.89	5.28	5.06	18.83	41.06	33.5	18.32	13.25
B9	16.33	7.08	8.72	1.56	.25	1.75	1.78	4.28	4.17	2.75
			[S <sup>10</sup> -2 .17]							

the absence of all keypecking, the daily total component time for the DRO 10 sec schedule would be 120 sec (10 sec per component times 12 presentations of that component), and the daily total component time for the DRO 30 sec schedule would be 360 sec (30 sec per component times 12 presentations of that component). This would provide an ideal proportion of time in the DRO 10 component of .33 (or 10/30 or 120/360). Deviations from this ideal proportion would be the result of keypeck-produced blackouts. It was found that deviations did occur in several of the birds (see Appendix B), but no reliable or consistent trends were exhibited. In other words, it seems unlikely that the lack of differential observing in this phase was due to changes in the lengths of the scheduled components.

Phase Two. Figure 2A shows the mean and standard deviation of the probability of an observing response ( $P(R_O)$ ) per session for the last 5 days of each condition for each bird in Experiment I, Phase Two. Table 2 shows the same data in numerical form. Again, data in Figure 2 are shown in the sequential order to which each bird was exposed.

In this phase, where the DRO components were changed to FT components, all five subjects demonstrated higher  $P(R_O)$ s during the  $S^{10}$  condition than the  $S^{30}$  and NC conditions. (See Figure 2A and Table 2) Four of the five birds (B1, B6, B7, B9) produced  $P(R_O)$ s during the last five days of the  $S^{30}$  condition that were lower than that of the NC condition.

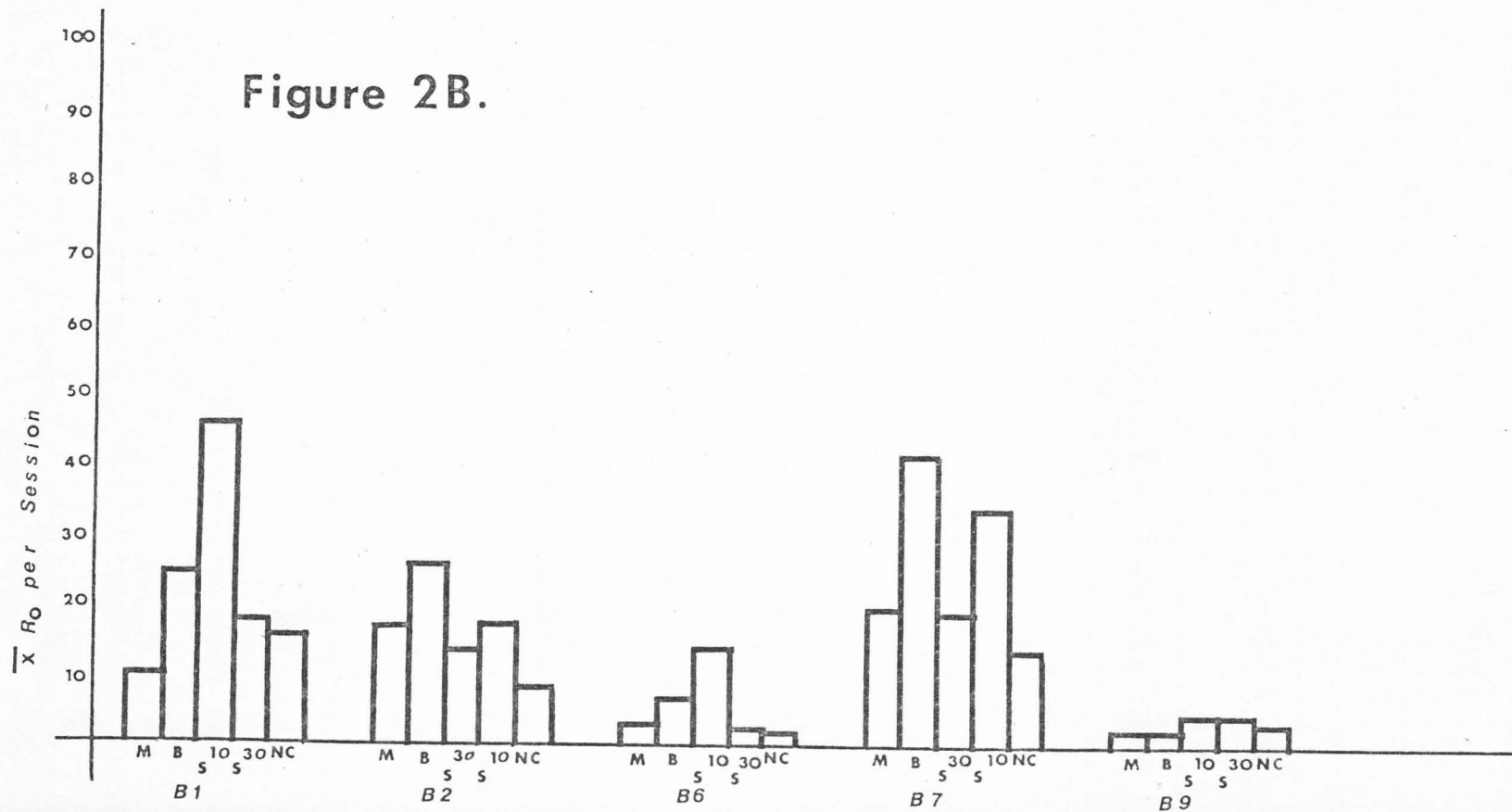
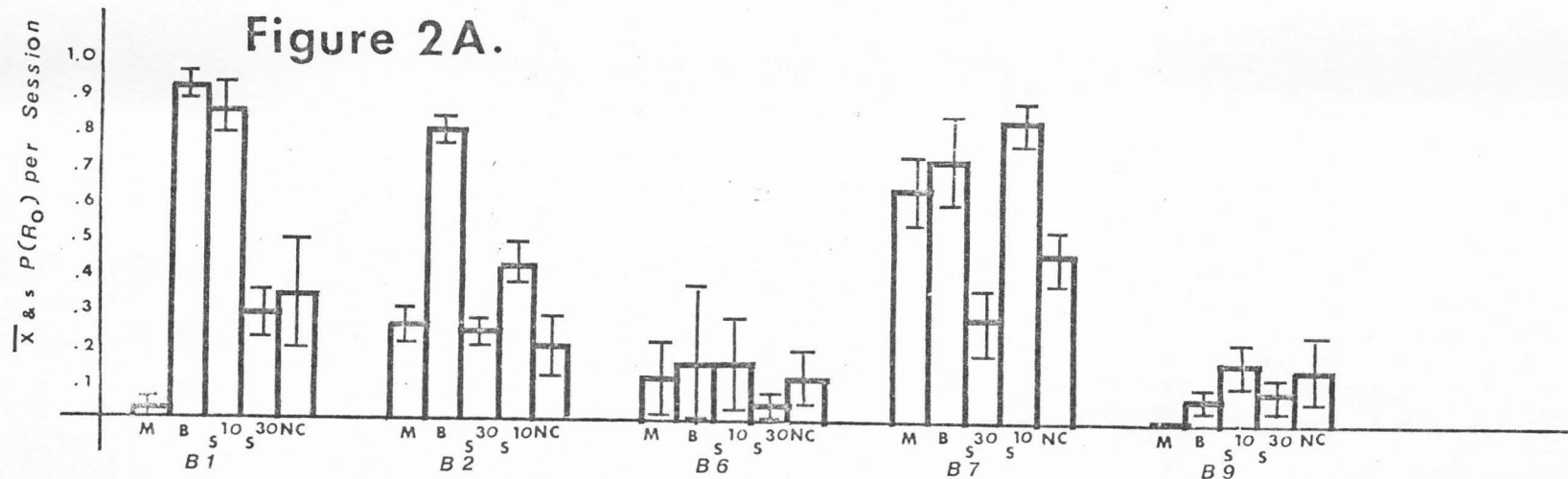
Figure 2B and Table 3 present the mean number of observing responses per session for each of the subjects in Experiment I,

Figure 2A



Figure 2. A) The mean ( $\bar{X}$ ) and standard deviation(s) of the probability of an observing response ( $P(R_i)$ ) for the last 5 days of each condition for each subject in Experiment I, Phase Two. Bars represent the means and the standard deviations are represented by the slash lines. Data are shown in the sequential order to which each bird was exposed.

B) The mean ( $\bar{X}$ ) number of observing responses ( $R_i$ ) per session during each condition for each subject in Experiment I, Phase Two. Data are shown in the sequential order to which each bird was exposed.



Phase Two. Data in Figure 2B are shown in the sequential order to which each subject was exposed. This figure, and its corresponding table, show that four birds (B1, B2, B6, B7) treadle pressed more often in the  $S^{10}$  condition than in the  $S^{30}$  condition. Subject B9, the remaining subject, also treadle pressed more often, on the average, in the  $S^{10}$  condition than in the  $S^{30}$  condition, but the effect was minimal (4.28 and 4.17, respectively).

As compared to Phase One of this experiment, the observing response data in Phase Two were much more consistent. Phase One data showed no consistent differences in observing response behavior. In Phase Two, where the components were changed from DRO to FT, the data demonstrated that there was a clear preference, in the majority of the subjects, for the  $S^{10}$  stimulus over the  $S^{30}$  stimulus, as measured by the probability of an observing response per session and mean number of observing responses per session. In addition, a higher  $P(R_O)$  and a greater mean number of observing responses per session were obtained during the  $S^{10}$  condition than in the NC condition. The  $P(R_O)$  data also showed that the birds had higher  $P(R_O)$ s in the NC condition than in the  $S^{30}$  condition (four out of five birds in Phase Two).

No consistent order presentation (sequence of conditions) effects were observed in either phase of Experiment I.

The keypeck data for both phases of Experiment I were analyzed in terms of the probability of a keypeck ( $P(Rs)$ ) per session for the last 5 days of each condition for each subject. This was calculated by dividing the number of trials in which at least one keypeck occurred by the total number of trials. In brief, neither

the keypecking data of Phase One nor the keypecking data of Phase Two demonstrated a consistent trend towards keypecking one particular stimulus condition over another (see Appendix A). The rate of keypecking, however, was higher during the FT procedure (Phase Two) than it was during the DRO procedure (Phase One), as would be expected due to the DRO "nonresponse" contingency.

EXPERIMENT II  
REINFORCEMENT DENSITY, REINFORCEMENT DELAY,  
AND RESPONSE INDEPENDENCE

Introduction

Experiment I, while providing a test of the delay-reduction hypothesis of conditioned reinforcement, overlooked one variable which may have influenced the obtained results. This variable was reinforcement density (reinforcement magnitude per unit time). In Experiment I, the 10 sec component had a richer density of reinforcement than the 30 sec component in that it was associated with 36 seconds of food per minute. The 30 second component was paired with only 12 seconds of food availability per minute. This may have contributed to the preference for the  $S^{10}$  stimulus over the  $S^{30}$  stimulus by the subjects in Experiment I, Phase Two.

Experiment II was an attempt to overcome this problem. All conditions were identical to the conditions in Experiment I, with the exception of reinforcement duration. Overall density of reinforcement (total seconds access to food) was equalized for the two schedule components (DRO 10 sec, DRO 30 sec or FT 10 sec, FT 30 sec) by delivering 3 seconds access to food after each 10 second component and 9 seconds access to food after each 30 second component. By doing this, each component was associated with 18 seconds of food availability per minute, while the two stimuli associated with the components still signalled the

appropriate delay-to-reinforcement. The subjects in Experiment II were experimentally naive.

### Method

#### Subjects

Three experimentally naive adult pigeons (B5, B8, B10), maintained between 75 and 85% of their free-feeding weight served as subjects. All three birds were Homers (*Columba livia domestica*), bred and raised at Utah State University. Sex and age did not play a role in their selection as subjects.

#### Apparatus

The apparatus was identical to that described in Experiment I.

#### Procedure: Phase One: Differential Reinforcement of Other Behavior (DRO)

This phase of this experiment was identical to Phase One of Experiment I with the following exception: Reinforcement density was equalized by delivering 3 seconds access to food after each DRO 10 sec component and 9 seconds access to food after each DRO 30 sec component. In this way, each component was associated with 18 seconds of food availability per minute, while the two stimuli associated with the components signalled the appropriate delay-to-reinforcement (10 seconds or 30 seconds). As in Experiment I, the reinforcement timers were initiated when the subject's head entered the food hopper.

The procedures for hopper training, DRO training, multiple schedule training, baseline observing, and the manipulations of

the observing procedure were, with the exception of the reinforcement density changes just described, the same as those described in Experiment I. See Table 4 for the sequence of conditions for each subject and the number of sessions devoted to each condition. The stability criterion for changing conditions was the same as in Experiment I, Phase One.

Procedure: Phase Two: Fixed time (FT) Schedules

Upon completion of Phase One, Experiment II, two subjects (the third S, B8, was dropped due to an injury) were exposed to an identical procedure where fixed time schedules were employed instead of DRO schedules. The apparatus was the same in both phases. Hopper training and DRO training were excluded from the procedure of this phase. Training began with multiple-schedule training.

Multiple schedule training. Immediately upon completion of the last DRO NC observing condition of Phase One, Experiment II, subjects were exposed to a multiple FT 10 sec FT 30 sec (mult FT 10 sec FT 30 sec) schedule of reinforcement. The only difference between this condition and the multiple schedule training condition of Phase One was that keypecks were recorded but had no scheduled consequence.

Baseline observing procedure. This condition was the same as the baseline observing procedure in Phase One, Experiment II, except that keypecks were recorded but had no programmed consequence.

Table 4

Sequence of Conditions and Number of Sessions Devoted to each Condition for each Subject in Experiment II, Phases One and Two.

Sequence A				
Condition	Phase One (DRO)		Phase Two (FT)	
	B10		B10	
M	18		12	
B <sub>10</sub>	30		18	
S <sup>10</sup>	25		18	
S <sup>30</sup>	19		18	
NC	12		12	

Sequence B				
Condition	Phase One (DRO)		Phase Two (FT)	
	B5	B8	B5	--
M	18	18	12	
B <sub>30</sub>	23	18	18	
S <sup>30</sup>	21	18	18	
S <sup>10</sup>	18	18	18	
NC	12	12	12	

M = Multiple DRO (FT) 10 sec, DRO (FT) 30 sec

B = Baseline observing (S<sup>10</sup> and S<sup>30</sup>)

S<sup>10</sup> = S<sup>10</sup> only

S<sup>30</sup> = S<sup>30</sup> only

NC = No Consequence



Manipulations in the observing procedure. Here again, the conditions were the same as in Phase One, Experiment II, except for the effect of the keypeck. Each subject in Phase Two received the same sequence of conditions it received in Phase One. See Table 4 for the sequence of conditions for each subject and the number of sessions devoted to each Phase Two condition. The four observing conditions were identical to those in Phase One, Experiment II. Conditions were changed after 18 sessions (except for the NC condition which was terminated after 12 sessions).

### Results

The measuring techniques used in Experiment II were identical to those of Experiment I. Summarizing briefly, they were: 1) the probability of an observing response per session for each condition and each subject, and 2) the mean number of observing responses per session for each condition and subject. For definitions and further details, the reader is advised to refer back to the beginning of the results section of Experiment I.

Subjects in Experiment II were exposed to identical conditions as the subjects in Experiment I, with one exception. The exception was that an attempt was made to equalize the reinforcement density of the two schedule components in Experiment II. This was done by presenting 3 seconds of reinforcement following each 10 second component (DRO 10 sec in Phase One; FT 10 sec in Phase Two) and 9 seconds of reinforcement following each 30 second component (DRO 30 sec in Phase One; FT 30 sec in Phase Two). This produced an average reinforcement density of 18 seconds food availability per minute for

each schedule component. In Experiment I, where reinforcement availability was always 6 seconds, the reinforcement density was 36 seconds food availability per minute for the 10 second component and 12 seconds food availability per minute for the 30 second component.

Phase One. As in Experiment I, the schedule components employed in Phase One were DRO 10 seconds and DRO 30 seconds. Figure 3A shows the mean and standard deviation of the probability of an observing response ( $P(R_o)$ ) per session for the last 5 days of each condition for each bird in Experiment II, Phase One. The data are shown in the sequential order to which each bird was exposed. Table 5 presents the same data in numerical form.

Of the three subjects in this first phase of Experiment II, two (B5, B8) showed slightly higher  $P(R_o)$ s during the last 5 days of the  $S^{10}$  condition than during the last 5 days of the  $S^{30}$  condition. Due to the rather large standard deviations encountered in these conditions for these birds, however, no difference can be clearly shown. The remaining subject (B10) showed an increasing  $P(R_o)$  across conditions. As in the first phase of Experiment I, there was no consistent preference for either the  $S^{10}$  or the  $S^{30}$  discriminative stimulus, as measured by  $P(R_o)$ .

Figure 3B and Table 6 present the mean number of observing responses ( $R_o$ ) per session for each of the subjects in Experiment II, Phase One. As usual, the figure presents the data in the order to which each bird was exposed.



Figure 3. A) The mean ( $\bar{X}$ ) and standard deviation(s) of the probability of an observing response ( $P(R_0)$ ) for the last 5 days of each condition for each subject in Experiment II, Phase One. Bars represent the means and the standard deviations are represented by the slash lines. Data are shown in the sequential order to which each bird was exposed.

B) The mean ( $\bar{X}$ ) number of observing responses ( $R_0$ ) per session during each condition for each subject in Experiment II, Phase Two. Data are shown in the sequential order to which each bird was exposed.

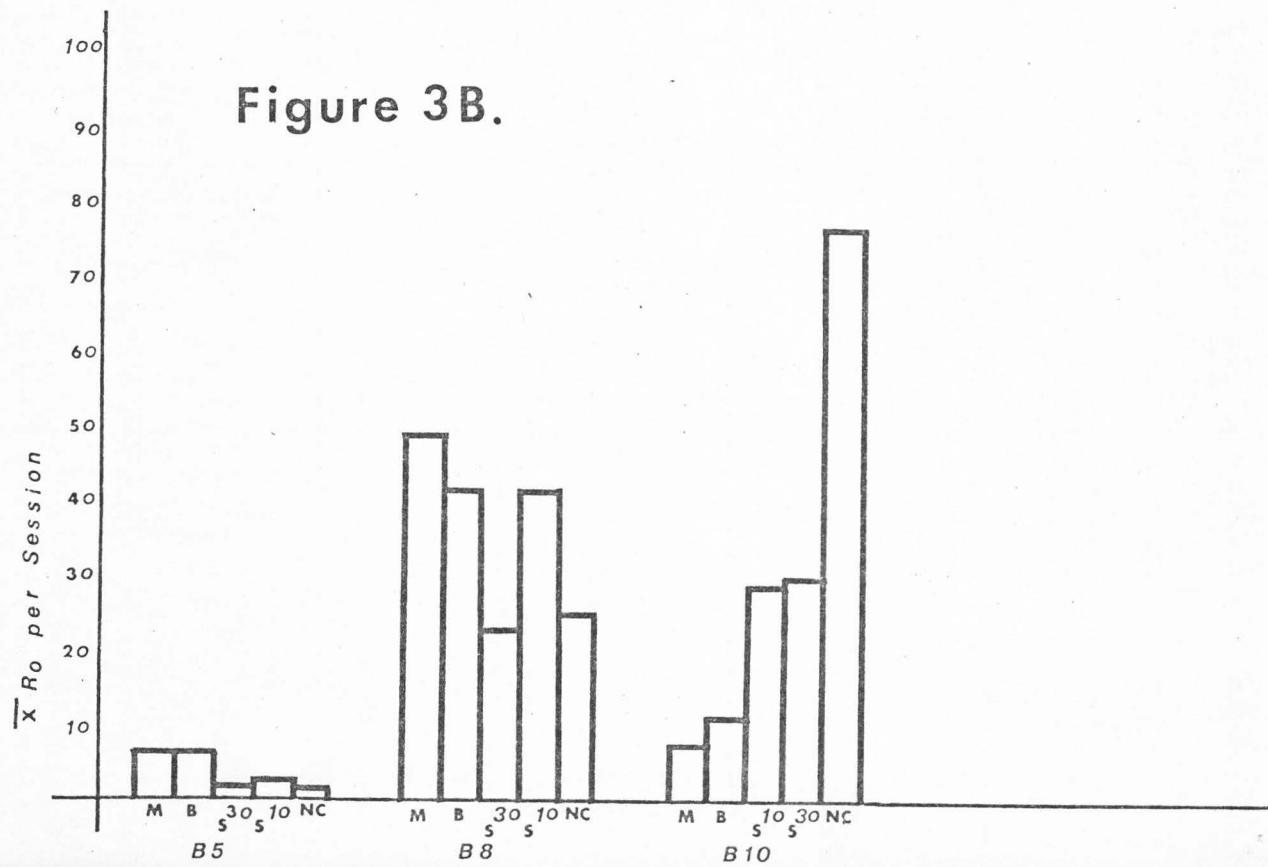
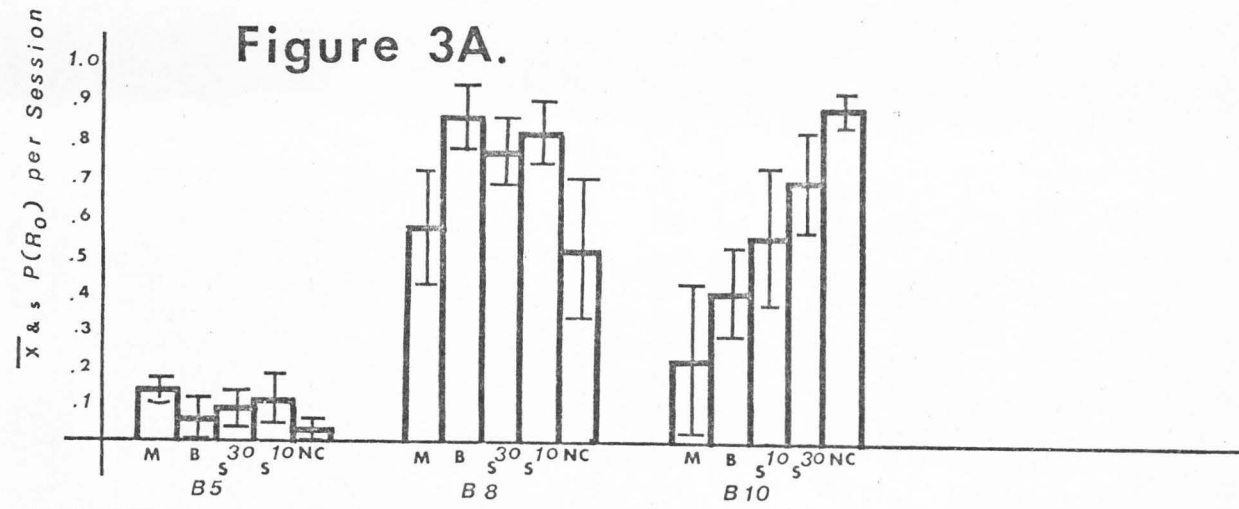


Table 5

Mean ( $\bar{X}$ ) and Standard Deviation(s) of the Probability of an Observing Response ( $P(R_o)$ ) for the last 5 days of each condition for each subject. Experiment II, Phases One and Two.

Experiment II	M	B	Phase One		NC
			S <sup>10</sup>	S <sup>30</sup>	
B5	.14 (.028)	.056(.061)	.114(.063)	.09 (.045)	.032(.032)
B8	.568(.148)	.858(.087)	.816(.084)	.766(.084)	.51 (.182)
B10	.216(.192)	.392(.118)	.54 (.182)	.684(.13)	.882(.045)
	$\bar{x}(s)$				

Experiment II	M	B	Phase Two		NC
			S <sup>10</sup>	S <sup>30</sup>	
B5	.644(.095)	.612(.089)	.576(.055)	.186(.022)	.584(.134)
B8	--	--	--	--	--
B10	.442(.095)	.626(.055)	.926(.032)	.384(.084)	.836(.122)

Table 6

Mean ( $\bar{X}$ ) Number of Observing Responses ( $R_o$ ) per Session for each Condition for each Subject  
 (Total  $R_o$ /number of sessions). Experiment II, Phases One and Two.

Experiment II	<u>Phase One</u>					<u>Phase Two</u>				
	M	B	S <sup>10</sup>	S <sup>30</sup>	NC	M	B	S <sup>10</sup>	S <sup>30</sup>	NC
B5	6.22	6.13	2.57	1.57	1.50	18.83	25.94	20.44	11.22	30.83
B8	48.89	41.50	41.83	22.17	24.67	--	--	--	--	--
B10	7.67	11.23	28.88	29.84	76.42	21.08	21.5	70.89	36.00	73.00

Both Figure 3B and Table 6 show that the average number of observing responses per session was larger during the  $S^{10}$  condition than during the  $S^{30}$  condition for subjects B5 and B8. No clear difference was obtained in these conditions for B10.

As in Experiment I, Phase One, the proportion of total time for the two DRO components was calculated for each subject and each observing condition in order to determine whether the ideal proportion of DRO 10 sec component time to DRO 30 sec component time (.33 or 10/30) was maintained in all conditions of the phase. This was done by dividing the total component time (that is the cumulative total of the trial durations, including blackouts) of the DRO 10 sec schedule by the total component time of the DRO 30 sec schedule. Ideally, in the absence of all keypecking, the daily total component time for the DRO 10 sec schedule would be 120 sec (10 sec per component times 12 presentations of that component), and the daily total component time for the DRO 30 sec schedule would be 360 sec (30 sec per component times 12 presentations of that component). This would provide an ideal proportion of time in the DRO 10 sec component of .33 (or 10/30 or 120/360). Deviations from this ideal proportion would be the result of keypeck-produced blackouts. Few deviations occurred in the three birds employed in this phase (see Appendix B). Therefore, the lack of differential observing in this phase was not due to changes in the lengths of the scheduled components.

Phase Two. As in Experiment I, the schedule components employed in Phase Two were FT 10 seconds and FT 30 seconds. Due to an injury, subject B8 was dropped from the experiment at this point.



Figure 4A and Table 5 present the mean and standard deviation of the probability of an observing response ( $P(R_o)$ ) per session for the last 5 days of each condition. The figure presents the data in the order to which each bird was exposed.

As can be seen in both Figure 4A and Table 5, both subjects demonstrated suppressed  $P(R_o)$ s during the last 5 days of the  $S^{30}$  condition, as compared to the  $P(R_o)$ s obtained in the  $S^{10}$  and NC conditions. For one bird (B10), the  $P(R_o)$  for the last 5 days of the NC condition was below that of the  $S^{10}$  condition. The other subject, B5, showed similar  $P(R_o)$ s in the B,  $S^{10}$ , and NC conditions.

For both birds, the average number of observing responses in the  $S^{10}$  condition was almost twice that of the  $S^{30}$  condition, as shown in Figure 4B and Table 6. It should be noted as well that, for both birds, the average number of observing responses per session was higher in the NC condition than in any other condition.

As compared to Phase One of this experiment, there is a more noticeable difference between the  $S^{10}$  and the  $S^{30}$  conditions as measured by  $P(R_o)$  and mean number of observing responses per session in Phase Two. Phase One showed no differences in observing response behavior. Phase Two, however, demonstrated that there was a decrease in preference, as measured by  $P(R_o)$  and mean number of treadle presses per session, during the  $S^{30}$  condition. That is, while the  $P(R_o)$  and the mean number of observing responses per session were high during both the  $S^{10}$  and NC conditions, the same measures were low during the  $S^{30}$  condition for both birds.



Figure 4. A) The mean ( $\bar{X}$ ) and standard deviation(s) of the probability of an observing response ( $P(R_0)$ ) for the last 5 days of each condition for each subject in Experiment II, Phase Two. Bars represent the means and the standard deviations are represented by the slash lines. Data are shown in the sequential order to which each bird was exposed.

B) The mean ( $\bar{X}$ ) number of observing responses ( $R_0$ ) per session during each condition for each subject in Experiment II, Phase Two. Data are shown in the sequential order to which each bird was exposed.

Figure 4A.

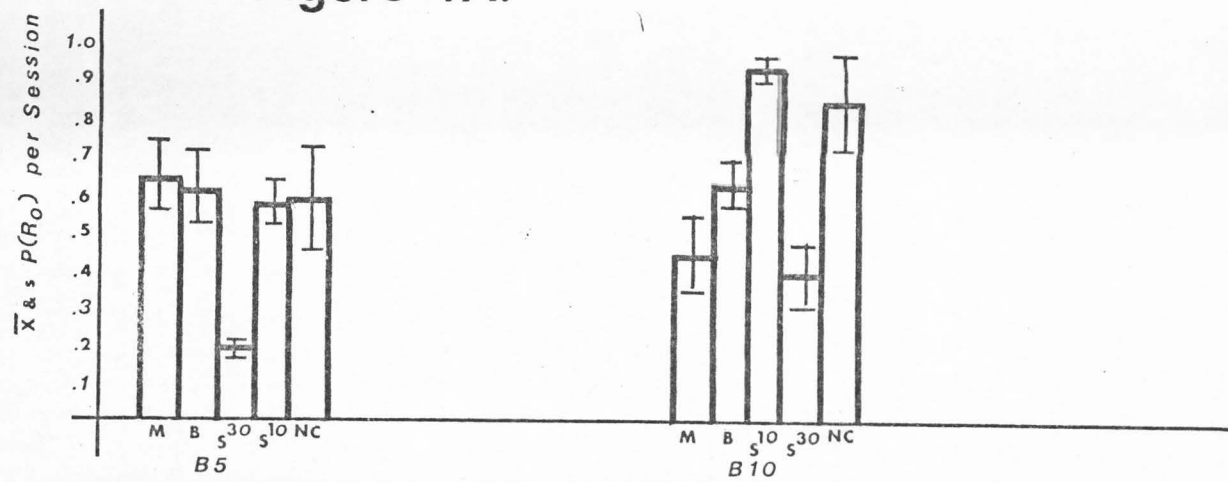
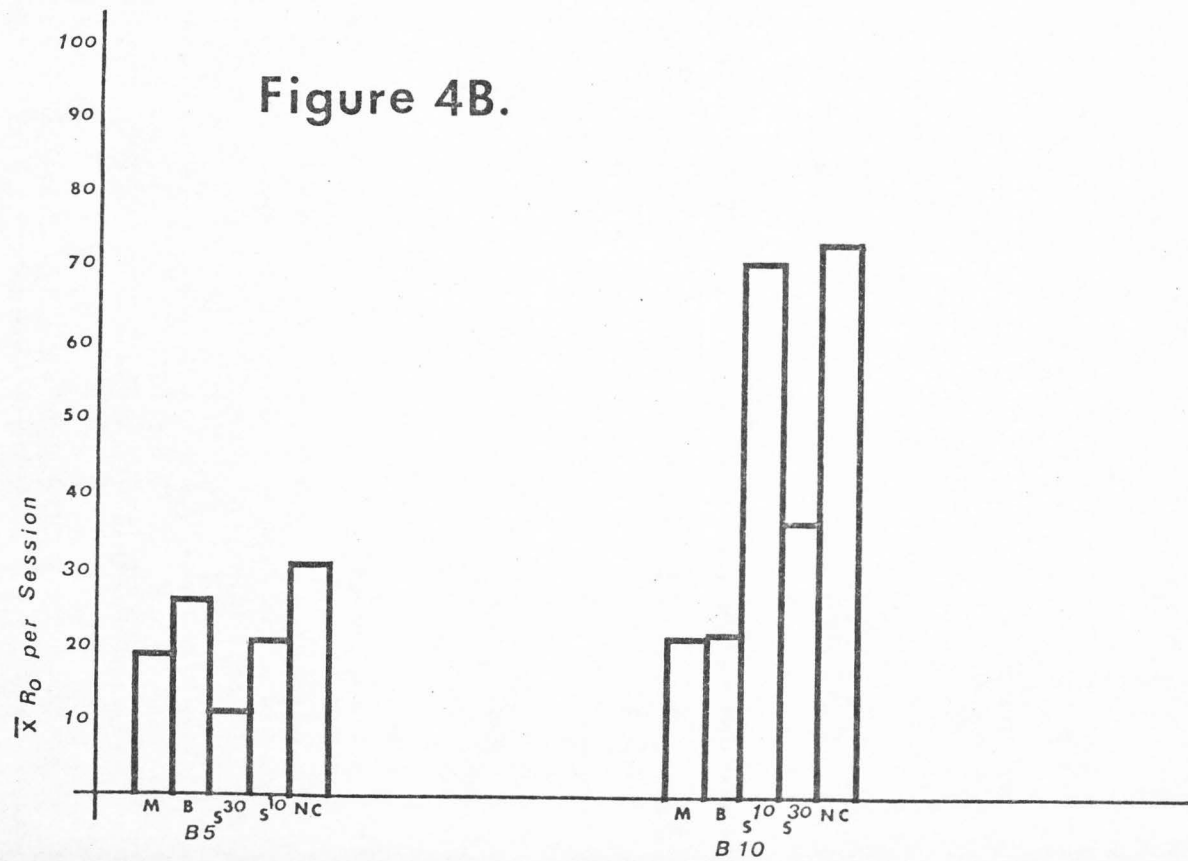


Figure 4B.



No consistent order presentation (sequence of conditions) effects were observed in either phase of Experiment II.

As in Experiment I, the keypeck data for both phases of Experiment II were analyzed in terms of the probability of a keypeck ( $P(Rs)$ ) per session for the last 5 days of each condition for each subject. This was calculated by dividing the number of trials in which at least one keypeck occurred by the total number of trials. In brief, neither the keypecking data of Phase One nor the keypecking data of Phase Two demonstrated a consistent trend towards keypecking one particular stimulus condition over another (See Appendix A).

## DISCUSSION

Experiment I was an attempt to examine the delay-reduction hypothesis of conditioned reinforcement by presenting subjects with mixed 10 second, 30 second response-independent schedules (where the components were, initially, DRO schedules and, later, FT schedules) in an observing paradigm. According to the delay-reduction hypothesis of conditioned reinforcement, a stimulus paired with a relatively short delay to reinforcement (in this case 10 seconds) will be a stronger conditioned reinforcer than another stimulus paired with a longer delay to reinforcement (in this case 30 seconds) (Fantino, 1976). While this hypothesis has received empirical support from studies employing the concurrent chains procedure (e.g., Fantino, 1969a; 1969b) and from studies employing the observing response procedure (e.g., Auge, 1974), recent studies (e.g., Fantino & Moore, 1975; Wallace, 1973) have suggested that there may be a confounding variable, namely response-requirements, that is the determining factor of the conditioned reinforcing strength of a stimulus. Experiment I of the present study, therefore, was an attempt to examine the relative conditioned reinforcing strength of two stimuli (one paired with a relatively short delay to reinforcement, the other paired with a longer delay to reinforcement) in the absence of response requirements. If response requirement variables were unimportant in determining the conditioned reinforcing strength of a stimulus, then the results of the present experiment should be

similar to the prediction of the delay-reduction hypothesis of conditioned reinforcement. That is, the presentation of the shorter of the two stimuli should have maintained more observing behavior (as measured by the probability of an observing response and the mean number of observing responses per session) than the presentation of the longer of the two stimuli. On the other hand, if response requirement variables were important, the presentation of either stimulus should have had little or no effect upon the probability or mean number of observing responses per session.

Experiment II was an attempt to examine the effects of density of reinforcement on the conditioned reinforcing strength of a stimulus. Density of reinforcement, defined here as reinforcement magnitude per unit time, has often been overlooked in many of the studies that purport to test the delay-reduction hypothesis of conditioned reinforcement. For instance, in Experiment I of the present study, 6 seconds access to food reinforcement was presented following each schedule component. This meant that each 10 second component was associated with a density of 36 seconds of food access per minute, while each 30 second component was associated with a density of only 12 seconds access per minute. It could have been, therefore, that the subjects in Experiment I, Phase Two (the FT schedule components; where differential observing was demonstrated) that demonstrated higher  $P(R_0)$ s (probability of an observing response) and mean number of observing responses ( $R_0$ ) per session in the  $S^{10}$  condition than in the  $S^{30}$  condition, were demonstrating preference

for the richer density of reinforcement associated with the  $S^{10}$  discriminative stimulus rather than a preference for the shorter delay to reinforcement associated with that same stimulus. In other words, density of reinforcement may be a critical variable in determining the conditioned reinforcing strength of a stimulus.

Experiment II attempted to equalize the reinforcement densities of the two schedule components, while keeping all other conditions identical to the conditions in Experiment I. Each 10 second component was followed by 3 seconds access to food, and each 30 second component was followed by 9 seconds access to food. In this way, each component was associated with a density of 18 seconds of food availability per minute, while the two stimuli associated with the components still signalled the appropriate delay-to-reinforcement. All subjects were experimentally naive.

If reinforcement density was not an important variable in Experiment I, then the results of Experiment II should have been very similar to the results obtained in Experiment I. If, on the other hand, reinforcement density was an important factor in determining the conditioned reinforcing strength of the stimuli, differential observing should have been reduced (relative to Experiment I) or eliminated.

#### Response Independence: DRO vs. FT Schedules

Preference for one component over the other was measured by altering the consequences of an observing response and noting differences in mean number of observing responses per session and in the probability of an observing response for the different observing response



conditions. The results of both experiments demonstrated that, during exposure to DRO schedule components, the subjects showed a complete lack of differential responding on the observing treadle during the observing conditions (B,  $S^{10}$ ,  $S^{30}$ , NC). When they were later exposed to the FT schedule components, however, all subjects showed a preference for the  $S^{10}$  stimulus over the  $S^{30}$  stimulus, as measured by both the probability of an observing response ( $P(R_o)$ ) and the mean number of observing responses ( $R_o$ ) per session during the appropriate conditions. (See Figures 1, 2, 3, and 4 and their corresponding tables.)

There could be several reasons for this difference in control for the two response-independent schedules. One reason, mentioned earlier, could be the zero rate requirement that is contingent in the DRO components. In essence, the DRO schedule requires that a nonresponse occur. This, then, would influence the choice, or observing, behavior of the subjects in a similar manner as did the DRL and DRH schedules in Fantino's 1968 study. Briefly, in this study (Fantino, 1968), birds could choose between fixed interval (FI) and either differential reinforcement of low rates (DRL) or differential reinforcement of high rates (DRH) schedules in a concurrent chains paradigm. Subjects consistently preferred the FI schedule over the response rate requirement schedules. From this, Fantino concluded that response rates do have an effect on choice behavior.

Another reason for the difference obtained for the two response-independent procedures could be the keypeck-produced blackout

included in the DRO procedure. If a subject pecked the stimulus key at any time during the trial, a 45 second blackout period occurred. This had the effect of lengthening the trial (the time period between the offset of one reinforcement period and the onset of the next reinforcement period). Should the keypeck have occurred after a treadle press (in the presence of the discriminative stimulus) (and it did, occasionally, for all of the subjects), the observing response might have been punished by a subsequent onset of a blackout period. Also, the discriminative stimuli were therefore not always followed by reinforcement, since a keypeck to one of the discriminative stimuli would terminate the stimulus. Therefore, the discriminative stimuli (one or both) may not have been predictive of reinforcement. During the FT components, on the other hand, keypecks had no scheduled consequence.

Whatever the reason for the lack of differential observing during the DRO schedules, however, it would have to be said that the delay-reduction hypothesis of conditioned reinforcement was not supported. For a hypothesis to be correct, the predictions derived from the hypothesis must always be empirically correct. When a situation arises where the predictions are not verified, such as in the present case with DRO schedules, then the hypothesis must either be amended or discarded. Further research is required before any final decision can be made, however, it seems quite clear, from the present study, that some amendments are required before the delay-reduction hypothesis can be accepted. It is conceivable, for example, that this hypothesis is not applicable to schedules with

aversive, or punishing, characteristics such as the keypeck produced blackout incorporated in the present study.

One final comment concerning the DRO procedure of the present study should be stated. It should be noted that this procedure was similar to certain autoshaping procedures. For example, the white, mix, stimulus could be thought of as a variable length intertrial interval (ITI) and the discriminative stimuli (red and green) could be thought of as independent conditioned stimuli. In the autoshaping paradigm, this would generally result in elicited keypecking directed at one or both of the conditioned stimuli. While, in the present situation, elicited keypecking was not clearly demonstrated, it is interesting to note that the subjects, at one point or another during the DRO procedure seemed to go from a near zero rate of keypecking to a relatively high rate of keypecking for several sessions, and then back down to a relatively low level of keypecking. While this result can only be expressed anecdotally in the present case, and while there were individual differences, it is interesting to note that first, the typical autoshaping results were not obtained and, second, that this rather sudden rise and then fall in the rate of keypecking occurred. Further research is again suggested to examine this effect.

#### FT Schedules and the Magnitude of Differential Observing

Another point that should be made is that the results obtained during the FT procedure of these experiments, while showing differential observing, are not as clear cut as the "typical" results

obtained in other observing response studies (cf., Auge, 1973; 1974; Dinsmoor et al., 1972). For example, Auge (1974) produced results that were more extreme than those of this study. He found that the probability of an observing response ( $P(R_O)$ ) per session was very high during baseline conditions (between .9 and 1.0, usually), equally high during the condition where only the most positive stimulus was available, and much lower during the condition where only the least positive stimulus was available (approaching zero on a downward trend, usually). Mulvaney et al., (1974) reported that the least positive or negative stimulus suppressed observing responses in such a way as to lower the observing rate in the baseline condition, as compared to the condition where the more positive stimulus was the only stimulus available, and raised the observing rate in the no consequence condition, as compared to the condition where only the negative stimulus was available.

In the present study, this clear cut, extreme difference between the observing conditions was absent. A clear difference did exist in the FT procedure, but no wide spread occurred in the  $P(R_Os)$  for mean numbers of observing responses per session for the  $S^{10}$  and  $S^{30}$  conditions. This may be indicative of some interaction between response requirements and delay reduction. That is, removing the response requirements may weaken the effect that delay-reduction variables have on determining the conditioned reinforcing strength of a stimulus.

#### The Effects of Equalizing Reinforcement Density

When reinforcement density was equalized under the FT schedules,

observing behavior was still maintained, but a different pattern was obtained in this experiment compared to Experiment I. Rather than demonstrating a large amount of observing behavior (as measured by  $P(R_o)$  and mean number of observing responses per session) during the  $S^{10}$  condition (Experiment I, Phase Two), the birds in Experiment II (Phase Two) demonstrated a suppressed (as compared to the  $S^{10}$  and NC conditions) or low level of observing behavior during the  $S^{30}$  condition. The  $S^{30}$  discriminative stimulus had a strong suppressive effect when it was the only possible outcome of an observing response. Further research is advised to determine whether this effect was due to other confounding variables besides reinforcement density. Some history effect, for example, may have influenced the results. Naive birds could be exposed to the conditions of Phase Two, Experiment II, without prior exposure to Phase One, Experiment II. It is possible that the green  $S^{30}$  stimulus acquired aversive properties during the DRO (Phase One) conditions, and this effect carried over to the FT (Phase Two) conditions. Although there was no evidence of this in Experiment I, the change in reinforcement density (from Experiment I to Experiment II) (That is, making the reinforcement densities equal for the two components) may have produced this effect. Finally, it should be stated that during the FT (Phase Two) conditions of Experiment II, the delay-reduction hypothesis of conditioned reinforcement received support similar to that received in Experiment I, Phase Two.

Summary and Concluding Comments

In the present study, the influence of response requirements, delay-reduction to reinforcement, and reinforcement density on the conditioned reinforcing strength of a stimulus has been examined. The results showed that under one response-independent procedure, namely fixed-time schedules, observing behavior was maintained, but the results obtained under such a procedure were smaller in effect than in traditional observing response studies. Differential reinforcement of other behavior (DRO) schedules did not maintain differential observing behavior to the  $S^{10}$  and  $S^{30}$  stimuli. While the delay-reduction hypothesis of conditioned reinforcement was supported by the results of the FT procedure (Phase Two) of both Experiment I and II (in that the stimulus associated with the shorter delay to reinforcement maintained more observing behavior than did the stimulus associated with a longer delay to reinforcement), it was not supported by the results of the DRO procedure (Phase One) of Experiment I and II. Therefore, further research is required to determine how this hypothesis could be amended to fit the present data. Finally, reinforcement density appeared to have little effect upon observing behavior in the present study. Observing patterns were altered when reinforcement density was equated for the two components, but not reversed or eliminated.

It would appear from both the present study and existing literature that the delay-reduction hypothesis of conditioned reinforcement is a viable hypothesis in certain situations. Certain findings, however, indicate that this particular hypothesis falls short of explaining the nature of the association between

a conditioned and an unconditioned reinforcer. It does not, for example, explain why differential observing was not observed in the DRO procedure of the present study. Nor does it explain the relatively weak (as compared to traditional observing response studies) effect found when response requirements are eliminated (the FT procedure of the present study; cf., Wallace, 1973) nor the shift in observing response patterns when reinforcement density is equated for two unequal-length components. In short, there are still factors involved in the association between a conditioned and an unconditioned reinforcer which are as yet unaccounted for.

One possibility could be that no one single factor (such as delay to reinforcement) is responsible for the relationship between a conditioned and an unconditioned reinforcer. It may be that several of these factors combine to impart a greater relative conditioned reinforcing strength to one of two (or more) stimuli with equal histories of unconditioned reinforcement. Further research is necessary to determine whether one or several interacting variables determine the conditioned reinforcing strength of a stimulus.

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## Appendix A

Mean ( $\bar{X}$ ) and Standard Deviation(s) of the Probability of a  
 Keypeck Response (P(Rs)) for the Last 5 Days of  
 each Condition. Experiment I, Phases One and Two.

Experiment I					
<u>Subject</u>	M	B	<u>Phase One</u>		
			S <sup>10</sup>	S <sup>30</sup>	NC
$\bar{x}(s)$					
B1	0(0)	.51 (.126)	.168(.032)	0(0)	.016(.022)
B2	.048(.055)	.024(.032)	.056(.045)	.016(.022)	.032(.032)
B6	.292(.1)	.048(.055)	0(0)	.048(.032)	0(0)
B7	.032(.055)	.344(.071)	.266(.197)	.366(.114)	.116(.11)
B9	.08 (.045)	.124(.063)	.164(.084)	.242(.063)	.218(.032)
[.168(.032)]					
<u>Phase Two</u>					
<u>Subject</u>	M	B	S <sup>10</sup>	S <sup>30</sup>	NC
B1	.048(.032)	.566(.089)	.816(.063)	.194(.022)	.016(.022)
B2	.36 (.095)	.516(.045)	.168(.032)	.08 (.028)	.082(.045)
B6	.3 (.152)	.04 (.055)	.04 (.045)	.016(.022)	0(0)
B7	.71 (.138)	.976(.022)	.984(.022)	1.0(0)	.944(.032)
B9	.318(.1)	.566(.114)	.26 (.095)	.174(.071)	.134(.084)

## Appendix A

Mean ( $\bar{X}$ ) and Standard Deviation(s) of the Probability of a  
 Keypeck Response (P(Rs)) for the Last 5 Days of each  
 Condition. Experiment II, Phases One and Two.

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<u>Experiment II</u>		<u>Phase One</u>			
<u>Subject</u>	M	B	S <sup>10</sup>	S <sup>30</sup>	NC
B5	.242(.055)	.14 (.089)	.072(.063)	.09 (.063)	.082(.063)
B8	.082(.063)	.09 (.055)	.032(.032)	.024(.055)	.016(.022)
B10	0(0)	0(0)	.008(.017)	0(0)	.072(.055)

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		<u>Phase Two</u>			
<u>Subject</u>	M	B	S <sup>10</sup>	S <sup>30</sup>	NC
B5	.46 (.028)	.276(.084)	.276(.063)	.016(.022)	.19 (.11)
B8	--	--	--	--	--
B10	0(0)	.032(.032)	.032(.032)	.032(.032)	.016(.022)
	$\bar{x}(s)$				

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## Appendix B

Proportion of Total DRO 10 Sec Component Time for each  
 Subject and each Observing Condition (Total DRO  
 10 sec Time Divided by Total DRO 30 sec Time)  
 Ideal Proportion = .33 (10 sec/30 sec)

Subject	Condition			
	B	S <sup>10</sup>	S <sup>30</sup>	NC
Experiment I				
B1	.61	.55	.33	.29
B2	.37	.32	.40	.34
B6	.31	.36	.35	.33
B7	.55	.51	.43	.41
B9	.24	.42(.40)	.25	.35
Experiment II				
B5	.31	.35	.33	.28
B8	.48	.33	.32	.34
B10	.40	.31	.32	.31