INFORMATION TO USERS

This material was produced from a microfilm copy of the original document. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the original submitted.

The following explanation of techniques is provided to help you understand markings or patterns which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting thru an image and duplicating adjacent pages to insure you complete continuity.
2. When an image on the film is obliterated with a large round black mark, it is an indication that the photographer suspected that the copy may have moved during exposure and thus cause a blurred image. You will find a good image of the page in the adjacent frame.
3. When a map, drawing or chart, etc., was part of the material being photographed the photographer followed a definite method in "sectioning" the material. It is customary to begin photoing at the upper left hand corner of a large sheet and to continue photoing from left to right in equal sections with a small overlap. If necessary, sectioning is continued again — beginning below the first row and continuing on until complete.
4. The majority of users indicate that the textual content is of greatest value, however, a somewhat higher quality reproduction could be made from "photographs" if essential to the understanding of the dissertation. Silver prints of "photographs" may be ordered at additional charge by writing the Order Department, giving the catalog number, title, author and specific pages you wish reproduced.
5. PLEASE NOTE: Some pages may have indistinct print. Filmed as received.

Xerox University Microfilms
300 North Zeeb Road
Ann Arbor, Michigan 48106

75-9866

BENASSI, Victor Anthony, 1947-
EFFECTS OF CONCURRENT SCHEDULES OF
CONTINGENT AND NONCONTINGENT REINFORCEMENT
ON A SINGLE RESPONSE.

The City University of New York, Ph.D., 1975
Psychology, experimental

Xerox University Microfilms, Ann Arbor, Michigan 48106

EFFECTS OF CONCURRENT SCHEDULES OF CONTINGENT AND NONCONTINGENT REINFORCEMENT ON A SINGLE RESPONSE

by

Victor A. Benassi

A dissertation submitted to the Graduate
Faculty in Psychology in partial fulfillment
of the requirements for the degree of Doctor
of Philosophy, The City University of New York.

1974

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirements for the degree of Doctor of Philosophy.

6 Dec. 1974
date

Dr. R. N. Lanson Robert N Lanson
Chairman of Examining Committee

Dec. 11, 1974
date

Dr. F. Denmark Florence L. Denmark
Executive Officer

Dr. B. K. Cole

Dr. N. Hemmess

Dr. R. N. Lanson
Supervisory Committee

The City University of New York

Sincere thanks are due to my dissertation committee. I dedicate this manuscript to my wife and to the memory of my father.

ABSTRACT

A review of the positive noncontingent reinforcement literature was presented. The topics covered were "superstition," "noncontingent reinforcement during extinction," "auto-shaping," "positive conditioned suppression," "time-in to noncontingent reinforcement," and "concurrent schedules of contingent and noncontingent reinforcement." The emphasis of the discussion was on procedures, data, and theories.

In Experiment I, different groups of pigeons were first trained to key-peck according to either a 60 second, 120 second, or 240 second _t_-schedule in which the first response to occur during a three second t^D period was immediately reinforced. Subsequently, noncontingent reinforcement was superimposed on each baseline schedule. The temporal separation between the contingent and noncontingent reinforcers was systematically varied across sessions. During a later phase of the study, the response requirement for the reinforcement in the baseline schedule was removed, thus resulting in a schedule of total noncontingent reinforcement.

In Experiment II, pigeons were reinforced for the first response in a 60 second T cycle whenever it occurred in the interval. Noncontingent reinforcement was introduced and varied as in Experiment I, with the exception that not all experimental phases were covered.

A major finding from both studies was that subjects maintained about equal running response rates prior to contingent and noncontingent reinforcement across each of the experimental phases. Overall running response rates did not systematically vary throughout the study as a function of noncontingent reinforcement placement. The removal of the contingent baseline reinforcer in Experiment I (substituting noncontingent reinforcement) resulted in decreased rates prior to both noncontingent reinforcers. This finding demonstrated that response rates prior to the original noncontingent reinforcer were not independent of the presence of contingent reinforcement. The data also showed that post-reinforcement pause durations and the distribution of responses prior to contingent and noncontingent reinforcement varied as a function of the temporal separation between the two reinforcers. The results from the two experiments were related to previous research, and the value of schedules such as those employed was discussed.

CONTENTS

LIST OF TABLES viii

LIST OF FIGURES x

INTRODUCTION 1

- General Introduction
- Superstition
- Changeover from S_C^R to S_{NC}^R
  - Fixed interval-fixed time
  - Variable Interval-Variable Time
  - Fixed ratio - fixed time
  - Random interval - random time
  - Variable delay - fixed time
  - Summary
- S_{NC}^R Following Extinction
  - Conclusions and discussion
- Auto-shaping
  - Conclusion
- Positive Conditioned Suppression
  - Summary
- Time-in to Positive S_{NC}^R
  - Summary
- Concurrent S_C^R and S_{NC}^R Schedules
- General Conclusions

STATEMENT OF PURPOSE 43

EXPERIMENT I 46

- Method
  - Subjects
  - Apparatus
  - Procedure
- Results and Discussion
  - Response patterning
  - Response rate measures
  - Post-reinforcement pause
  - Ratio of response rates

EXPERIMENT II 99

- Method
  - Subjects
  - Apparatus

Procedure
Response patterning
Response rate measures
Post-reinforcement pause
Ratio of response rates

GENERAL DISCUSSION 113

REFERENCES 117

LIST OF TABLES

1. Temporal Intervals Between the Beginning of T Cycle and Noncontingent Reinforcement Delivery in Experiment I 49
2. Overall Corrected Response Rates (Responses/Sec) for Subjects 218 and 203. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 78
3. Overall Corrected Response Rates (Responses/Sec) for Subjects 455 and 483. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 79
4. Overall Corrected Response Rates (Responses/Sec) for Subjects 213 and 100. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 80
5. Overall Running Response Rates (Responses/Sec) for Subjects 218 and 203. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 82
6. Overall Running Response Rates (Responses/Sec) for Subjects 455 and 483. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 83
7. Overall Running Response Rates (Responses/Sec) for Subjects 213 and 100. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 84
8. Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule 94
9. Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule 95
10. Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule 96

11. Temporal Intervals Between the Beginning of T Cycle and Noncontingent Reinforcement Delivery in Experiment II 101

12. Overall Corrected Response Rates (Responses/Sec) for Subjects 404 and 50. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 107

13. Overall Running Response Rates (Responses/Sec) for Subjects 404 and 50. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented 108

14. Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule 112

LIST OF FIGURES

1. Percentage of responses in consecutive 5 second segments of a 60 second T cycle (Subject 218) . 51

2. Percentage of responses in consecutive 5 second segments of a 60 second T cycle (Subject 203) . 55

3. Percentage of responses in consecutive 10 second segments of a 120 second T cycle (Subject 455) . 59

4. Percentage of responses in consecutive 10 second segments of a 120 second T cycle (Subject 483) . 63

5. Percentage of responses in consecutive 20 second segments of a 240 second T cycle (Subject 213) . 67

6. Percentage of responses in consecutive 20 second segments of a 240 second T cycle (Subject 100) . 71

7. Mean post-reinforcement pause for subjects 218 and 203 at each temporal placement of S^{R}_{NC} within a 60 second T cycle 86

8. Mean post-reinforcement pause for subjects 455 and 483 at each temporal placement of S^{R}_{NC} within a 120 second T cycle 88

9. Mean post-reinforcement pause for subjects 213 and 100 at each temporal placement of S^{R}_{NC} within a 240 second T cycle 90

10. Percentage of responses in consecutive 5 second segments of a 60 second T cycle (Subject 404) . 102

11. Percentage of responses in consecutive 5 second segments of a 60 second T cycle (Subject 50) . . 104

12. Mean post-reinforcement pause for subjects 404 and 50 at each temporal placement of S^{R}_{NC} within a 60 second T cycle 109

INTRODUCTION

General Introduction

Firmly set at the foundation of the field of conditioning is the notion of contingency. A contingency is a rule which states a conditional relation between responses and stimuli (operant conditioning) or between stimuli and stimuli (classical conditioning). Schedules of stimulus presentation, including reinforcement and discriminative stimulus schedules, represent various blendings of such conditional relations.

As Pavlov (1927) used the term, contingency involved the pairing of stimuli. The rule usually stated that the unconditional stimulus (UCS) would occur some time after the presentation of the conditional stimulus (CS). It was not until Skinner's (1938) work that the significance of contingency as a relation between responses and stimuli became apparent. He made a case for the control of behavior by the arrangement of consequences. Control was achieved by the establishment of a dependency between the occurrence of a particular response and the presentation of a reinforcement. Recently, Schoenfeld and Farmer (1970) have made the definition of contingency more explicit: a contingency exists if the distribution of responses in time determines the subsequent distribution of reinforcement in time; if this relation is absent, i.e., if responding does not influence reinforcement occurrence, the requirements for noncontingency have been satisfied. Contingency and noncontingency may also be conceived in terms of the response class eligible for reinforcement. As a class of responses (Skinner, 1938) becomes larger, more of an organism's responses become eligible for reinforcement. Contingency and noncontingency anchor the end points of this response class continuum. Under this conception of contingency, all schedules are contingent, in the sense that the distribution of responses in time determines (to a greater or lesser extent) the distribution of reinforcers in time.

One end of the above continuum--noncontingency--has important implications for a general problem of behavior theory: the necessary and sufficient conditions for learning, where learning translates to the acquisition and maintenance of responses. The review of the literature to follow attempts to demonstrate that behavior comes under the control of reinforcement whether that reinforcement is contingent or noncontingent. It further attempts to demonstrate continuity between contingent and noncontingent schedules. The important point about reinforcement is that it controls behavior. The rationale for making that reinforcement contingent may have more to do with experimenters' biases and technological limitations (i.e., using conventional dependent variables it is difficult to measure specific responses under certain noncontingent schedules) than with contingency being more important in the acquisition and maintenance of behavior.

The review will be organized around topics which involve noncontingent positive reinforcement (S^R_{NC}). Schedules of noncontingent shock presentation will not be included, nor will much be said about noncontingent delivery of "neutral" stimuli (except when they are paired with S^R_{NC} as in the auto-shaping and positive conditioned suppression paradigms). The exclusion of these topics reflects problems of space and should not be taken to mean that the author believes that they are not related to the scope of the review. A major purpose of including research from varied areas of study is to demonstrate their interrelation when these so-called "different procedures" are classified in terms of independent variables.

Superstition

The research on superstition is important because it points out that reinforcement affects the frequency of responses whether or not responses produce the reinforcement. Yerkes (1916) noted that reinforcements often controlled responses of his orangutans even when the performance of those responses was "irrelevant" in the sense that reinforcers occurred independently of their emission. Later, Skinner (1948) performed his now famous demonstration of "superstitious" behavior. He delivered food to pigeons at either fixed or variable time intervals with no reference to ongoing behavior. Stereotyped response patterns such as head bobbing and turning were controlled despite the fact that an explicit contingency between a specific response and S^R was absent. The finding was discussed in terms of the effects of "adventitious contingencies": ". . . the bird happens to be executing some response as the (food) hopper appears, as a result it tends to repeat this response. If the interval before the next presentation is not so great that extinction takes place, a second 'contingency' is possible. This strengthens the response still further [p. 168]." The inter-reinforcement interval (IS^RT) was suggested as being a powerful variable determining the effectiveness of noncontingent reinforcement (S^R_{NC}) in conditioning particular responses. The shorter the IS^RT, the quicker the conditioning. Because a dependency was not established between the occurrence of a response and S^R_{NC}, Skinner noted that the form of a superstition could "drift" after repeated exposure to a schedule. Drift resulted because responses other than those making up the superstitious class might occur at the time of S^R_{NC} and thus would be reinforced. Skinner concluded that the term contingency may mean nothing more than a reinforcer reliably follows a response.

Herrnstein (1966) discussed the acquisition of superstitions in terms of response dominance, and the drift of superstitions in terms of the effects of reinforcing "other behavior." Skinner's pigeons developed responses such as head bobbing and turning because these behaviors were already dominant in the pigeons' repertoires. Behavioral drift occurred because no dependency existed between a specific response and reinforcement (S^R), thus permitting responses other than those constituting a particular superstitious class to be reinforced.

A replication of the superstition experiment was done by Staddon and Simmelhag (1971). They presented food to pigeons at fixed and variable time periods, independent of any specific responses. The animals developed two topographically distinct classes of responses: interim responses, which occurred just after S^R_{NC}, and terminal responses, which occurred just prior to S^R_{NC}. The former class was associated with times of low S^R probability and the latter with high S^R probability. When the authors compared rates of pecking under contingent and noncontingent schedules, they observed that pecking occurred at equal rates during both types of schedules. However, the location of pecking under S^R_{NC} was more variable than under contingent reinforcement (S^R_C). A specific response-reinforcer (R-S^R) contingency serves to decrease the variability of response location--thus serving a selection function (see also Staddon, 1972, 1973; Bolles, 1972). While Skinner (1948) and Herrnstein (1966) argued that S^R strengthened behavior preceding it, Staddon and Simmelhag (1971) emphasized that S^R directly determines what behavior will proceed it.

The major point from the review thus far is that an organism's behavior comes under the control of S^R even when a prescribed R-S^R contingency is absent. The power of a contingency is that it limits those responses which are eligible for S^R. From the start, the superstition paradigm posed problems from the standpoint of measurement. For example, dependent variables such as rate of response or post-reinforcement pause (the time from S^R to the next response) could not be easily used in the superstition experiment because the experimenter looks at gross movements in space which are then verbally described (Skinner, 1948; Kellogg, 1949; Davis and Hubbard, 1972). In their study, Staddon and Simmelhag (1971) used a complex topographical measurement scheme. However, this method is not entirely satisfactory because the recording of responses was done by a human observer. There are obvious limits on the number and kinds of measurements that can be accurately and reliably recorded by humans. For reasons such as these, many studies of S^R_{NC} involve giving subjects a specific history of S^R_C for making a particular response and then changing the schedule to one of S^R_{NC}. The interest is one of studying the effects of various parameters of S^R_{NC} on a specified response. The next section of this paper will review the literature relevant to this experimental tactic.

Changeover from S^R_C to S^R_{NC}

A way to assess the effectiveness of S^R_{NC} in maintaining specific responses is to give an organism a history of S^R_C and then switch to a schedule of S^R_{NC}. Studies of this type permit one to analyze changes in various dependent variable measures such as responses rate, post-reinforcement pause (PS^RP), and R-S^R intervals. The studies reported below have been subdivided on the basis of the type of S^R schedule investigated. Several studies could have been incorporated into more than one category, but have been placed into that one which seems most germane.

Fixed interval-fixed time. Skinner (1938) trained rats on a fixed interval 6 minute (FI 6') schedule, then placed them on a fixed time 6 minute (FT 6') schedule, and finally returned them to the FI schedule. Response rates were much lower during the S^R_{NC} phase. Herrnstein (1966), using FI 11" and FT 11" schedules, replicated Skinner's procedures and results with pigeons. He concluded that if behavior other than key-pecking was followed closely in time by S^R it would be more likely to occur again. As more "other" behaviors and less key-pecking were reinforced, their respective rates would increase and decrease. Edwards, West and Jackson (1968) replicated Herrnstein's procedures and results.

Zeiler (1968) exposed pigeons to FI- and FT-6 minute schedules. While response rates dropped considerably under the FT schedule, the "scalloping" pattern characteristic of FI schedules remained. Zeiler concluded that while response rates were determined by the presence or absence of a contingency, response patterning was controlled by the temporal parameters of the schedule in effect. Appel and Hiss (1962) trained pigeons on a FI 4 minute-FT 4 minute multiple schedule. Although they obtained higher rates in the FI component, temporal patterning developed and was maintained in both components.

Shull (1970, 1971) has shown that, in addition to response patterning, PS^RP lengths in FI schedules do not depend on the presence or absence of a contingency, although response rates do. The important determinant of PS^RP length is the value of the IS^RT.

Variable Interval-Variable Time. In variable schedules, S^R is presented after irregular intervals; the variable interval (VI) or variable time (VT) values specified (e.g., VI 2 minutes, VT 3 minutes) represent the means of the individual component intervals. In VI schedules a particular response is required at the end of each component interval; in VT schedules, S^R is delivered at the end of each interval independent of responding.

Zeiler (1968) found that response rates were lower in a VT 5 minute schedule when compared to a VI 5 minute schedule, a result consistent with those obtained with fixed schedules. Response patterning under the VT and VI schedules was similar and hence did not depend on the presence of a contingency.

The question of how much training on a contingent S^R schedule to maintain responding during S^R_{NC} was studied by Neuringer (1970). He gave pigeons three contingent S^Rs for key-pecking and then switched them to a variety of VT schedules (VT 30 seconds, 1 minute, 2 minutes). All pigeons maintained pecking during each phase of S^R_{NC}. The implication of Neuringer's study is that there is a relationship between the amount of training on contingent schedules and subsequent maintenance of responding on noncontingent schedules. The precise nature of this relation has yet to be experimentally determined.

Rescorla and Skucy (1969, Experiment 1) compared the effects of S^R_{NC} with those produced by an extinction procedure. They gave rats lever press training on a VI 2 minute schedule and then divided them into groups which either were continued on VI, placed on extinction, given S^R_{NC} according to a VT 2 minute schedule, or received S^R_{NC} on a VT 2 minute schedule with the addition that S^R_{NC} was never delivered within 5 seconds following a bar press. They found that, relative to extinction, S^R_{NC} "retarded" rate decrease even when a minimum R-S^R_{NC} interval was imposed. Several differences between the noncontingent and extinction results were noted: response rate reductions occurred more slowly across 20 sessions and reached a slightly higher asymptote in the S^R_{NC} group; when S^R_{NC} was presented on the VT 2 minute schedule during session 21 for the extinction group, these rats showed a marked rate increase, while the same procedure showed no effect in the S^R_{NC} groups (see also Halliday and Boakes, 1971; Boakes, 1973).

Rescorla and Skucy (1969) posit that relatively high rates could be expected during FT schedules following FI training because of the positively accelerated response rates produced by FI schedules. Such prior training sets up an "empirical correlation" between responses and S^R during exposure to FT. In VI schedules, such a temporal distribution is usually not present and this was one reason why they used a VI schedule. However, Rescorla and Skucy did not test the hypothesis that animals would maintain higher rates during S^R_{NC} when they were previously trained on a FI baseline. Lattal (1972) exposed rats to a multiple FI 1 minute - VI 1 minute schedule and then switched them to a multiple FT 1 minute - VT 1 minute schedule. He found that FT response rates were higher than VT response rates after initial FI-VI training. Also, the rats showed temporal response distributions in the two noncontingent components similar to patterns maintained by FI and VI schedules. Like Edwards, Peek and Wolfe (1970) and Rescorla and Skucy (1969), Lattal believes that the baseline schedule of S^R_C determines the degree to which responding is maintained during S^R_{NC}.

Lattal and Maxey (1971, Experiment 1) compared VI and VT schedules in a multiple schedule design. Rats were trained on a multiple VI 1 minute - VI 1 minute schedule. Subsequently, one, then both, components were changed to VT 1 minute. Consistent rate differences developed and were maintained between the VI and VT components. Performance in the VI component showed no systematic changes, while rates in VT gradually dropped when compared to rates during the VI phase of training. When both components were VT, rates in each dropped further (see also Wilkie, 1972; Boakes, 1973). When exteroceptive cues were removed from a multiple VI-VT schedule (making it a mixed schedule), and when the component values were relatively short, Lattal (1973) found that equally high rates were maintained in both components.

Fixed ratio - fixed time. The types of baseline schedules employed in studies of noncontingent reinforcement have typically been fixed or variable interval in order to permit continuity between the contingent and noncontingent phase of the experiments. Furthermore, the IS^RT distributions during S^R_{NC} have been approximately equal to those during S^R_C. It is also possible to give an organism a history on ratio schedules of S^R_C and then to expose it to a variety of S^R_{NC} schedules. To date, there has been relatively little work in this area. Edwards, Peek and Wolfe (1970) trained rats on fixed ratio (FR) baseline schedules and then switched the schedules such that S^R_{NC} was presented alone or at fixed times concurrent with the FR schedules. In addition, different $IS^R_{NC}T$ distributions were investigated along with manipulations of the size of the FR schedules. Subjects maintained higher rates when S^R_{NC} was presented concurrent with a FR schedule; and for a given FR schedule, rates were higher at the longer $IS^R_{NC}T$ distributions. When the $IS^R_{NC}T$ distribution was held constant, with the FR schedule systematically reduced, response rates dropped. When S^R_{NC} was presented alone, rates gradually decreased across successive sessions. In sum, the magnitude of rate decrease depended on the magnitude of change in either the FR or the $IS^R_{NC}T$ values.

Random interval - random time. A random interval (RI) schedule is one having a repeating time cycle (T) and a probability of S^R $(p(S^R))$ for the first response in each T. The ratio T/p is the predicted mean IS^RT when each T has at least one response occurring in it (Farmer, 1963). RI schedules become RT schedules when irregular pulse trains are substituted for responses. Thus, S^R_{NC} is delivered without respect to the organism's responses.

In all of the studies of interval schedules discussed above the frequency of S^R_{NC} has been approximately equal to the frequency employed during the baseline condition of S^R_C. Lachter (1970) trained pigeons on a 5 component multiple schedule in which each component was correlated with a different frequency of S^R_C(T= 0, 3, 6, 12, and 24 seconds; $p(S^R)= .10$). Parenthetically, the T= 0 schedule is one in which every response is eligible for S^R_C at the prevailing probability. Subsequently, all subjects were exposed to the following single component schedules of S^R_{NC} for 30 sessions each: FT 30 seconds, FT 60 seconds, FT 120 seconds, RT 30 seconds, RT 60 seconds, RT 120 seconds. During the noncontingent phases of the study, the stimuli remained the same as during the baseline condition. Following exposure to each S^R_{NC} value, the original multiple schedule baseline condition was recovered. The results showed that response rates in the presence of the components of the multiple schedule decreased with continued exposure to S^R_{NC} at all the $IS^R_{NC}T$ distributions studied; the rate decreases were greatest during the stimuli which were associated with the lowest response rates and lowest frequencies of S^R during RI training. The only exception to this finding involved the T cycle equal to 0 in which rates declined faster than rates under the other T cycles, possibly due to the large decrease in S^R frequency under the stimulus condition correlated with that schedule. Except where T = 0, response rates controlled by S^R_C determined the control over pecking during exposure to S^R_{NC}. Lachter (1970) and Lachter, Cole and Schoenfeld (1971) discussed the rate decreases observed during S^R_{NC} in terms of the extinction of a key peck response and the strengthening of "not responding" ($\not{R}$) (see also Schoenfeld and Farmer, 1970).

Cole (1973) trained pigeons on a multiple RI 60 second- RI 60 second schedule. He then added a RT 60 second schedule to the second component, thereby doubling its frequency. Next, while the S^R_{NC} schedule remained in effect, the $p(S^R_C)$ in the second component was systematically lowered until a value of zero was obtained. Subsequently, the birds were exposed to a series of single component schedules of S^R_{NC}, after which they were returned to the multiple RI - RT schedule. Key-pecking rates decreased as the frequency of concurrent S^R_C was decreased, and a low rate was maintained for 40 or more sessions of the single component RT schedules. The results were discussed in terms of the two classes of behavior that were available for S^R under S^R_C and S^R_{NC} schedules. One response class (key-pecking) must be part of the sequence which precedes S^R_C; in the other class, $\not{R}$ would precede S^R_{NC} and be strengthened as a result. When response classes are changed as a result of S^R_{NC} from responding (R) to $\not{R}$, the observed outcome is a drop in R rate.

Variable delay - fixed time. In all of the studies above, response rate decreases were obtained with continued exposure to S^R_{NC}. Several studies have reported low but stable rates after many sessions of S^R_{NC}. However, none of these studies have shown rates during S^R_{NC} that were equivalent to rates during conditions of S^R_C. Lang and Mankoff (1973) trained a pigeon on a variable delay (VD) schedule having a T cycle of 15 seconds and a $p(S^R_C)$ of 1. A VD schedule is one in which S^R_C is presented at the end of each T cycle in which at least one response has occurred. After exposure to this condition for 31 sessions, S^R_{NC} was substituted for S^R_C; S^R_{NC} was delivered at the end of each T cycle whether or not a response occurred in the cycle. Other pigeons were trained on a 4 component VD multiple schedule, with each component having different T values and the same $p(S^R_C)$. After approximately 54 sessions, S^R_{NC} was substituted for S^R_C at the end of each T cycle. Response rates for the pigeons exposed to the single component schedule were maintained for 31 sessions at values near or above the rates obtained during the VD baseline. A similar finding was obtained for the multiple schedule subjects--S^R_{NC} delivered at the same T and p values employed during the VD baseline resulted in maintenance of rates for 55 or more sessions of S^R_{NC}. The authors suggested that since the VD schedule permitted S^R_C to be delivered at times other than immediately following a key peck, the difference between the patterns of behavior reinforced on the VD and S^R_{NC} schedules were small. That is, since $\not{R}$ may be reinforced on the VD schedule, when it is also reinforced on the S^R_{NC} schedule a minimal disruption in the total sequence of responding will occur. The Lang and Mankoff (1973) work is relevant to the delay of reinforcement literature (e.g., Skinner, 1938; Ferster, 1953; Dews, 1960; Azzi, Fix, Keller, and Rocha e Silva, 1964; Ferster and Hammer, 1965; Pierce, Hanford and Zimmerman, 1972). In the delay literature, the major independent variable of interest is the imposed delay between a specified response and S^R. Rates in delay schedules are usually lower than those controlled by similar no-delay contingent schedules (Cole, Lachter, and

Schoenfeld, 1973). Presumably, this difference is due to the reinforcing of $\not{R}$ in the delay procedure. Lang and Mankoff's data suggest that the important variable determining response rates in delay and S^R_{NC} schedules is the delay interval between responses and S^R, whether it is determined by the experimenter or the subject.

Summary. The typical result after a contingent reinforcement schedule is switched to a noncontingent one is a drop in response rates, although it has been shown that certain training procedures may produce similar rates under S^R_C and S^R_{NC} schedules. The rate decrease during S^R_{NC} has been found when RI, VI, FI, and FR contingent baseline schedules were employed. Another general finding is that the form of response patterning generated by temporally defined S^R_C schedules persists under similar S^R_{NC} schedules. Also, PS^RP lengths do not depend on the presence or absence of a $R\text{-}S^R$ contingency but rather on the IS^RT.

S^R_{NC} Following Extinction

In the preceding section, the interest was in the consequent effects of S^R. It is also reasonable to assume that S^R serves as a stimulus for further responding. A test of this notion is not possible using the type of designs employed above. The studies reviewed below provide some data on stimulus effects of S^R, unconfounded by their consequent effects. An analysis of these effects may contribute to a better understanding of S^R_{NC}.

Reid (1957) performed the first study of S^R_{NC} delivery after an extinction procedure. Rats, pigeons, and students were given various amounts of regular S^R_C (S^R_C for each response) training for lever pressing, key pecking, or playing a slot machine. Subsequently, extinction (S^R_C withheld) was carried out for three 30 minute sessions (rats and pigeons) or until the subject met a criterion of no responding for one and one-half consecutive minutes (students). When S^R_{NC} was presented after the exposure to extinction, all subjects made at least one response following S^R_{NC}. Reid discussed his results in terms of the concept of response chaining. During training, a rat, for example, learned a sequence of bar pressing, food eating, returning to the bar, and pressing again. S^R_C acquired a stimulus as well as a reinforcing role. In extinction, responses were never reinforced and thus decreased in frequency. When S^R_{NC} was presented, its stimulus characteristics were sufficient to produce a response. However, with repeated S^R_{NC} presentations, it could be expected that the contingent effects of S^R_{NC} would take hold and thereby strengthen other behavior.

Spradlin, et al. (1966) and Spradlin et al. (1969) studied the effects of presenting S^R_{NC} to mentally retarded children after they had been exposed to extinction procedures. The children were first given FI training. After extinction was completed (in both cases a criterion of no responding was established) S^R_{NC} was presented. Subjects responded after S^R_{NC}. In the 1969 study, a buzzer was also randomly presented. The results showed that eight of twelve subjects responded most during the 1 minute period following S^R_{NC}; only two responded most after the buzzer. Spradlin, et al. (1969) accounted for their findings by offering a chaining analysis similar to Reid's (1957).

Rescorla and Skucy (1969, Experiment 2) emphasized stimulus characteristics of S^R that are quite independent of its contingent effects: "These stimulus characteristics evoke a variety of behaviors in the organism, both learned and unlearned . . . food undoubtedly has a general excitatory effect, increasing activity and consequently the probability of bar pressing. In addition, food is a stimulus in the presence of which an animal has previously been reinforced for bar pressing [p. 384]." Thus, these authors believe that S^R_{NC} serves a general excitatory function, thus increasing many operant levels (including the response in question).

Lattal and Maxey (1971, Experiment 2) trained rats on a multiple VI 1 minute - VI 1 minute baseline. The second component was then changed to extinction. The schedule was then switched to VI 1 minute - VT 1 minute for one session. Five to six single session VI - VT probes were then interspersed between successive five session VI-Ext (extinction) conditions. Following the last probe, the VI component was also changed to extinction for 10, 20, or 30 sessions for different subjects. Single VT probe sessions were conducted to study the effects of S^R_{NC} after various amounts of extinction. Changeover from VI - VI to VI - Ext resulted in rate decreases in the Ext component. The VT probes generally increased rates in extinction with the effect dissipating somewhat across probes. The Ext - Ext procedure resulted in rate decreases in both components. The VT probes caused rate increases during both components. This effect became less dramatic with successive probes. The authors related the effects of the VT probes to response probability at various stages of extinction--the greater the probability, the more probable S^R_{NC} will be closely paired with a response. However, Rescorla and Skucy's (1969) results did not confirm this hypothesis (see below).

Lattal (1972) showed that when rats trained on a FI - VI baseline were later changed to FT - VT, they showed higher rates in the FT component. He also showed that when these animals were exposed to a sequence of multiple FI - VI to multiple Ext - Ext to multiple FT - VT, the rates of responding were higher in the FT component of the last schedule. The large rate increases when the FT - VT schedule followed Ext - Ext were not shortlived, lasting 11 sessions for one rat, 14 for another (these were the number of days at this condition). One rat did not show much rate increase in the VT component.

<u>Conclusions and discussion</u>. The above studies have shown that food can acquire stimulus properties as a

result of previous experimental histories. However, the effects produced by S^R_{NC} may be confounded by adventitious pairings of responses and S^R_{NC} and by the possibility that many novel stimuli intruded into an organism's behavior stream could cause an increase in responding. These two problems deserve some comment.

It is probably true that close response- S^R pairings occasionally occurred in the Lattal (1972) study and that these were sufficient to maintain responding across sessions. It would have been helpful if the author would have empirically determined response- S^R_{NC} intervals. Adventitious pairings do not, however, account for all of the responding maintained in these studies. For example, Rescorla and Skucy (1969, Experiment 2) introduced S^R_{NC} after differing amounts of extinction, that is, when different rates of responding were present. They found that response rates increased when S^R_{NC} was first delivered, but the increase did not systematically relate to the ongoing response rate when S^R_{NC} was presented. As in the Lattal (1972) study, Rescorla and Skucy did not determine actual response- S^R_{NC} intervals during extinction. Spradlin, et al. (1966) and Spradlin, et al. (1969) imposed minimum response-S^R intervals from one to four minutes, and found that their subjects responded. It appears, then, that S^R does have stimulus effects.

It might be posited that any abrupt stimulus change could be sufficient to initiate responding during

Ext. Razran (1939), for example, found an increase in the magnitude of a classically conditioned response when a novel stimulus was presented during extinction. In controlled studies, Spradlin, et al. (1969) and Campbell, et al. (1968) showed that S^R_{NC} produced much larger increments in rates during extinction than an auditory stimulus which had not been paired with S^R_C during baseline training. Estes (1943, 1948) demonstrated that a tone, paired with S^R_{NC} during a pre-training phase, produced increases in response rate when it was presented alone during an extinction phase which followed FI training (however, see Farthing, 1971). The conclusion to be drawn from this work is that S^R acquires its power to reinitiate responding during extinction as a function of its previous inclusion in the R-S^R-R sequence. It has been demonstrated that novel stimuli in and of themselves are not sufficient to produce the effects reported above, and that novel stimuli may acquire stimulus effects as a result of their prior pairing with S^R_{NC}.

Auto-shaping

The preceding research has established that S^R_{NC} can acquire stimulus effects as a result of its prior pairings with a response. Research also indicates that S^R_{NC} can generate and sustain consistent rates of particular responses when no R-S^R contingency is imposed. The method employed in these studies involves the delivery of S^R_{NC}

contingent upon the occurrence of a stimulus, not a response (Pavlov, 1927). Brown and Jenkins (1968) called this procedure auto-shaping, because of the behavioral effect it produced. They presented an eight second key-light which terminated with four seconds of food. If pigeons pecked the response key during the light, the light was terminated and the food hopper was presented. If no response occurred during the light the food was presented at the end of eight seconds. As a control, other birds received the same training as above except that the order of the hopper and keylight was reversed. They found that the key peck developed for all birds in the light-food group, but occurred in only two of 12 birds in the food-light group. The authors stated that

> . . . the emergence of the key-peck may be characterized as a process of auto-shaping on which a direction is imposed by the species-specific tendency of the pigeon to peck at things it looks at. The bird notices the onset of the light and perhaps makes some minimal motor adjustment to it. The temporal conjunction of reinforcement with noticing leads to orienting and looking toward the key. The species-specific look-peck coupling eventually yields a peck to the trial stimulus [p. 7].

Once this occurs, a peck- S^R contingency has been established.

In addition to pigeons, various auto-shaping procedures have been employed with rhesus monkeys (Sidman and Fletcher, 1968), squirrel monkeys (Gamzu and Schwan, 1974), quail (Gardner, 1969), rats (Davidson, et al., 1971), fish (Squier, 1969), dogs (Smith and Smith, 1972), and other organisms. In one study, Sidman and Fletcher (1968) employed a procedure similar to Brown and Jenkins'. Several differences included the use of rhesus monkeys as subjects, the pairing of the CS with an unlighted food tray (the food tray was lit when grain was presented in the Brown and Jenkins study), the random shift in locus of the key-light between three response keys, and food pellets were used as S^{R}_{NC}. All subjects responded within the first 60 light- S^{R}_{NC} pairings (compared to a range of 6 to 119 for Brown and Jenkins' pigeons). The results demonstrated that the acquisition of responding to the lighted key does not depend on a consummatory response to a lighted food tray. This finding argued against an explanation of responding to the lighted key as being a result of stimulus generalization from the lighted food tray. It also showed that the auto-shaping procedure does not demand that the subject's (rhesus monkey) responses to the key be the same as its responses to the S^{R}. Confirmation of this view comes from a study by Wasserman (1973), who showed that chicks would peck at a light signal which reliably predicted noncontingent heat. In light of data with pigeons, the issues pertaining to the above statements become blurred. For example, Schwartz (1973) found that auto-pecking would not develop when a tone served as the signal for food made available in a lighted hopper. Also, Moore (1973) and Jenkins and Moore (1973) showed that the topographies of key-pecking for pigeons differed, depending on whether food or water was used as S^R_{NC}. Pecking with food as S^R_{NC} was open beaked, sharp, and vigorous; pecking with water as S^R_{NC} was closed beaked, slow, and sustained. In any event, further systematic studies, both within and across species, are needed to clarify the problems.

Williams and Williams (1969) imposed a "negative contingency" between pecking during a trial and S^R delivery. Pecking during a light canceled the occurrence of the food at the end of that trial. If no response was made, S^R_{NC} was presented at the end of the trial. They found that pecking still occurred. One bird acquired between five and 20 S^R_{NC}s per session out of a possible 50. The authors point out the similarity of their procedure to classical conditioning and state that their results can best be explained by the principles which govern classically conditioned responses. Herrnstein and Loveland (1972, Experiment 4), using pigeons and a similar procedure to Williams and Williams, also found that birds pecked even though those pecks canceled S^R_{NC}.

Hursh, Navarick, and Fantino (1974) presented data which suggested that Williams and Williams (1969) may not have eliminated all contingent sources of S^R from their procedure. For example, each response during a trial terminated the key-light, and key-light offset could have being reinforcing since it immediately preceded S^R_{NC} on trials when no pecking occurred. Eliminating this source of S^R, Hursh, et al. found that pecking ceased in three of four pigeons studied (however, see Schwartz, 1972). Schwartz and Williams (1972a) further determined the contingent sources of S^R in the "negative contingency" paradigm. They compared key-pecking rates and preferences between response keys that were identical in terms of their association with S^R_{NC} (i.e., matched on stimulus-reinforcer characteristics). The keys differed in the contingencies imposed between key-pecking and S^R_{NC} presentation (i.e., response-reinforcer characteristics). Trials were randomly presented in which either a red or white response key was lit. Red key trials were set up so that a response prevented S^R_{NC} from being delivered; responses on white key trials had no scheduled effects. S^R_{NC}s during white key trials were yoked to match the S^R_{NC} frequency obtained on red key trials. There were also choice trials in which the red and white keys were both illuminated, with no S^R_{NC} being presented. All pigeons pecked more on the white key trials and preferred the white key on choice trials. Recently, Gamzu and Schwan (1974) suggested that species-variables may determine the extent to which responding is maintained in the "negative contingency" paradigm. Specifically, squirrel monkeys ceased responding in such a procedure.

Schwartz and Williams (1972b) have made detailed analyses of the direct and contingent effects of food presentation. When a "negative contingency" was in effect, pigeons' pecks were almost exclusively of short duration. When a "positive contingency" was in effect (i.e., pecking during a trial immediately resulted in S^R), pecks were of longer duration. Short pecks were insensitive to differential S^R, while longer duration pecks were amenable to such conditions. It was suggested that two classes of responding were controlled by S^R--a class which is directly enhanced by food presentation, and a class which is controlled by its consequences. The biological appropriateness of a pigeon's pecking when presented with food was emphasized (see also Seligman, 1970; Moore, 1973).

As mentioned above, Williams and his associates have stated that auto-shaping is consistent with both theory and data of classical conditioning. Several of the studies mentioned above resemble Pavlovian delay conditioning. Gamzu and Williams (1971) extended this work by employing a method which avoided any fixed or predetermined temporal relationship between the signal for S^R_{NC} and S^R_{NC}. A response key-light was periodically lit for 8.6 seconds but S^R_{NC} was not presented at the end of that period. Rather, there was a probability of .03 that S^R_{NC} would be presented at the beginning of each second of key illumination. Two conditions were studied: a differential condition in which the probability of S^R_{NC} was zero during inter-trial intervals (ITI) and .03 during each trial; and a nondifferential condition in which the probability of S^R_{NC} was .03 during ITIs and trials. Pecks were recorded but had no scheduled consequences. All birds developed pecking during the differential condition, but rates were near zero during the nondifferential condition. Gamzu and Schwartz (1973), Gamzu and Williams (1973), and Gonzalez (1973) replicated these findings. In all three studies, a precise relation between the key light and S^R_{NC} was not necessary. It was only necessary for the light to serve as a differential cue for S^R_{NC} (also see Bilbrey and Winokur, 1973). The low rates during the nondifferential condition suggested that adventitious S^R of pecking did not play a major role in the studies. Gamzu and Williams (1973) stated that "auto-shaping depends on the 'informativeness' of key illumination with respect to reinforcement. It seems likely to propose that the stimulus-reinforcer association . . . that is effective in auto-shaping is paradigmatically the same as the correlation that is effective in classical conditioning [p. 231]." (See also Rescorla, 1967.)

Ricci (1973) studied signal-S^R_{NC} intervals of 30 and 120 seconds. Pecks during the signal had no effects, and S^R_{NC} was presented at the end of each trial. All birds pecked during the signal, although the subjects in the 120 second condition took longer for pecking to develop. When either the 30 second or 120 second stimuli were subdivided into four sections, each differentially cued, birds showed a rate increase across the four sections. Birds exposed to only one stimulus cue did not show this "scalloping."

Conclusion. Inherent in the findings and positions presented in this section is the notion that the response class chosen for "operant" experiments has important implications for the data obtained. Skinner (1938) considered the operant to be a relatively arbitrary bit of behavior. Its topography and form are not so important as the fact that behavior can be measured and controlled by its consequences. This paraphrase is at the heart of the law of effect. Concerning Skinner's (1938) argument against "botanizing" responses, Herrnstein and Loveland (1972) have stated that

> . . . if it [Skinner's position] is not true, then there will be an incentive to botanize which is why we now find ourselves cutting through the botanical thicket of particular responses for particular species under particular circumstances. The law of effect has led us back to the problem of response topography via findings such as those reported here and their predecessors [auto-shaping] . . . certain writers . . . called for full or partial repeal of the law of effect. But that may be premature, for the law of effect promised no more than to account for behavior in terms of its consequences (however conceived), which should never have been taken as a guarantee that the account must be simple or short, or even that we can really avoid the 'thankless task' of botanizing behavior [p. 383].

The behavioral effects of the various auto-shaping procedures have direct bearing on the question of the necessary and sufficient conditions for learning. Skinner's (1948) analysis of S^{R}_{NC} emphasized that learning (i.e., the increased probability of an operant as a result of its contiguity to S^{R}) takes place whether a response produced a S^{R} or not. However, if a particular response is called for, then a contingency may be necessary. The auto-shaping paradigm as employed by Williams and his associates and others clearly meets the requirement for a noncontingent schedule as defined by Schoenfeld and Farmer (1970). (In the Brown and Jenkins [1968] study, key-pecking did influence the distribution of S^Rs in time.) The empirical power of the auto-shaping procedure is that it reliably generates particular responses; and the important conclusion to be drawn is that a contingent R-S^R relation is not always a necessary condition for the acquisition of so-called instrumental responses, although it may be sufficient (but see Breland and Breland, 1961; Seligman, 1970).

Positive Conditioned Suppression

The conditioned suppression paradigm involves first establishing a baseline schedule of S^R_C for making a specific response such as key-pecking or lever pressing. After a measure of stable performance is obtained, S^R_{NC} is presented contingent upon the termination of an exteroceptive cue. Procedurally, the conditioned suppression and auto-shaping paradigms are closely related. The major difference lies in the use of a contingently maintained baseline in the former paradigm. The discussion in this section will focus on the effects of S^R_{NC} on response rates both during and between CS (signal)-S^R_{NC} pairings.

Herrnstein and Morse (1957) trained pigeons on a 5 minute differential reinforcement of low rate (DRL) schedule of food S^R_C. In a DRL schedule, a response is reinforced only if it follows a previous response by some specific minimum time interval. After the DRL baseline was established, S^R_{NC} was presented one minute after the onset of a key-light signal, while the DRL schedule remained in effect. All birds showed marked increases in rate compared with baseline DRL-alone rates, with the largest increases occurring during the presentation of the signal. The authors concluded that the results could not be solely explained in terms of the adventitious pairing of responses with S^R_{NC}s. Their data indicated that abrupt rate increases were often not correlated with close temporal R-S^R_{NC} pairings. The authors did not suggest what might be responsible for the initial rate increases, but once they were developed adventitious R-S^R_{NC} pairings were sufficient to maintain them. Azrin and Hake (1969) suggested that the rate increases found in the previous study might be accounted for by the similarity between the baseline S^R_C and S^R_{NC}. Using a VI 1 minute baseline schedule and either a qualitatively or quantitatively different S^R_C and S^R_{NC}, Azrin and Hake obtained consistently low rates during a 10 second signal which preceded S^R_{NC}. The authors argued that a signal paired with any strong stimulus may come to suppress responding. In studies using similar S^R_C and S^R_{NC}, there could be an interaction of the two based on discriminative properties of the stimuli. They believe that an "emotional state" during the signal was associated with autonomic changes. Recent data by Kelly (1973a) did not bear out this speculation at least as far as heart rate and blood pressure were concerned. While he found response "suppression," no detectable changes were noted in his physiological measures.

Azrin and Hake's (1969) findings were at variance with those reported by Brady (1961). He trained rats on a VI 2 minute water schedule of water reinforcement and found that rates increased during a 5 minute signal which terminated with septal stimulation. This discrepancy suggests that the duration of the signal might be an important determiner of responding in the presence of the signal. Henton and Brady (1970), using rhesus monkeys as subjects and a DRL 30 second S^R_C baseline schedule, employed signal-S^R_{NC} values of 20, 40, and 80 seconds. They also used a delay procedure in which a minimum of 7.5 seconds was imposed between a response and S^R_{NC} in order to prevent close R-S^R_{NC} pairings. No change in rate occurred during the 20 and 40 second signal conditions, but during the 80 second signal condition, rates increased as compared to rates occurring at non signal-S^R_{NC} intervals. Meltzer and Brahlek (1970) employed a VI 2 minute baseline, qualitatively different S^R_C and S^R_{NC}, a range of signal-S^R_{NC} intervals from 6 to 120 seconds, and rats as subjects. They obtained low rates during the short signal-S^R_{NC} intervals and higher ones at the longest interval. Miczek and Grossman (1971) failed to obtain increases in rate during either 1, 2, or 3 minute signal-S^R_{NC} intervals which were superimposed onto a VI 45 second baseline schedule. It is not clear what procedural differences were responsible for this discrepant finding. Perhaps the different combinations of baseline schedules and signal-S^R_{NC} intervals were important.

In the preceding studies, the contribution of the baseline schedule of S^R_C to the obtained results was not assessed. Recent work has shown that the parameters of the baseline schedule may be an important determinant of responding during a signal which precedes S^R_{NC}. For example, Kelly (1973b) found that responding was "suppressed" during a 1 minute signal which preceded S^R_{NC} when a random ratio ($P(S^R_C)=.0125$ for each response) baseline schedule was in effect; responding was "accelerated" during similar signal-S^R_{NC} pairings which were superimposed on a DRL 45 second baseline. The increased and decreased responding during the signal resulted in many S^R_Cs being missed in both the DRL and random ratio schedules. This finding may lead some to speak of "maladaptive" behavior in the subjects. Perhaps a more profitable approach would be to further delineate the causes of this phenomenon. One possible direction would be to study changes in responding during the signal as a function of systematic variations of response rates and reinforcement rates via changes in baseline parameters, and to further study interactions with different signal-S^R_{NC} intervals (e.g., Smith, 1974).

A procedure involving use of a CS+ and CS- was employed by LoLordo (1971). Pigeons were trained on a VI 2 minute schedule of food (4 seconds access to grain) S^R_C. A CS+ was 20 seconds and terminated with eight seconds of access to grain. A CS- was also 20 seconds but was never followed by S^R_{NC}. LoLordo found that pigeons showed high rates in the presence of the CS+ compared to pre-CS+ periods. Rates in the presence of the CS- were relatively unaffected when compared to pre-CS- periods. It had been previously reported that a conditioned response opposite in direction to that controlled by a CS+ was acquired to the CS- when shock was the noncontingent stimulus (Rescorla and LoLordo, 1965). LoLordo suggested that the pecking observed during the CS+ was consistent with results from auto-shaping studies. LoLordo's data did not replicate those from studies in which short signal-S^R_{NC} intervals were investigated. In order to test if the use of a CS- was responsible for his discrepant findings, he omitted the CS- and still got consistently high rates during the CS+.

LoLordo, McMillan, and Riley (in press) extended the auto-shaping formulation of conditioned suppression. Pigeons were trained to either key-peck or treadle-press on a DRL 12 second (limited hold 4 second) schedule for four seconds access to grain. Half of the birds in both groups received a tone signal, the other half a key light signal. The signal was always 20 seconds and terminated with 10 seconds access to grain. When the light was the signal, rates increased during the signal for subjects who were trained to key-peck for S_C^R. The same CS produced key-pecking and suppression of treadle-pressing for subjects who were trained to treadle-press for S_C^R. The tone CS produced inconsistent results across all subjects (see also Schwartz, 1973). The authors stated that the increased rates of pecking for the birds trained to peck and the substitution of pecking for treadle-pressing for the birds trained to treadle-press demonstrates the relevance of the auto-shaping literature to studies of positive conditioned suppression. It was not clear to the authors why the birds did not peck the speaker when the signal was a tone (see also Schwartz, 1973).

Several of the studies reported above obtained low rates of responding during the signal-S_{NC}^R interval. Meltzer and Brahlek (1970) and Kelly (1973b), by making fine grain analyses of their data, showed that when "suppression" occurred it tended to be restricted to the latter portion of the signal interval. This temporal discrimination was similar to that obtained when shock was used as the non-contingent stimulus (Millenson and Hendry, 1967).

A different kind of temporal discrimination has been found between signal-S_{NC}^R pairings when a response contingency is attached to the presentation of the signal-S_{NC}^R pairing. Specifically, Hake and Powell (1970) studied the suppressive and positively reinforcing effects of superimposing signal-S_{NC}^R pairings on a VI 3 minute baseline. The same bar press response that determined S_C^R

delivery on the baseline schedule also produced the signal-S^R_{NC} pairings according to a FI 2 minute schedule. Responding prior to signal-S^R_{NC} pairings was positively accelerated. Control rats who received the signal-S^R_{NC} pairings on a FT 2 minute schedule did not show the effect. Lever pressing was "suppressed" during the signal (10 seconds long). The authors did not make a fine grain analysis of responding throughout the signal.

Summary. A number of independent variables have been shown to affect the behavioral pattern obtained during and between signal-S^R_{NC} pairings which have been superimposed on an ongoing S^R_C baseline. The major ones are the baseline schedule of S^R_C, the quality and quantity of S^R_C and S^R_{NC}, the signal-S^R_{NC} interval, the presence or absence of a response contingency to produce signal-S^R_{NC} pairings, and the response class measured. There have been no studies of the probability that a signal will be followed by S^R_{NC}. If, for example, pigeons were exposed to probabilistic signal-S^R_{NC} pairings, and if responding during the signal is at least partly determined by the auto-shaping procedure involved, it might be expected that low probability pairings would produce a lower asymptotic performance than higher probability pairings (see Gonzalez, 1973). Secondly, no one has investigated the relation between the frequency of signal-S^R_{NC} presentations relative to baseline S^R_Cs.

In terms of the broader scope of this review (i.e., the analysis of methodologies, data, and theories concerning S^R_{NC}), it might prove helpful to consider the behavioral effects during the signal-S^R_{NC} interval in terms of a continuum of rate, instead of in terms of "suppression" or "facilitation." In the final analysis, these dichotomies always refer to behavioral output which can be counted. The causes of the various effects are the parameters of independent variables in force. Viewed in this way, associations of "good" or "adaptive" with certain effects and "bad" or "maladaptive" with others may lose their plausibility (see also Kelly, 1973b).

Time-in to Positive S^R_{NC}

A schedule of stimulus presentation which has recently received attention is termed "time-in to positive S^R_{NC}." Responses during time-out produce a time period during which S^R_{NC} occurs according to some schedule. Time-in schedules are complementary to so-called time-out from positive reinforcement schedules. (Leitenberg, 1965). In time-in schedules if an organism does not respond during periods of time-in, a time-out follows. D'Andrea (1971) conceptualizes responding during time-in as the avoidance of time-out. A more general approach is to consider both schedules as two sides of the same coin. This approach permits an analysis in terms of the schedules parameters only, thereby demonstrating the continuity between time-in and time-out.

In the first reported study directly bearing on the issue of time-in, Ferster and Skinner (1957) showed that pigeons would key-peck according to a VI schedule which would produce S^R_{NC} 60 seconds after the VI requirement had been satisfied. However, quantitative data were not presented.

Baer (1960) permitted children to watch cartoons. Responses on a lever caused the cartoons to stay on for three, five, or 10 seconds (the time-in values differed across subjects). In one group, if a subject did not respond on the lever, a time-out period began as soon as the specified time-in interval elapsed. A time-out consisted of the interruption of the audio and video of the movie projector; a time-out lasted until another response occurred. Responses during a time-in period reset the clock and the interval began anew. In a second group, with the time-out procedure the same as above, a response during time-in added the value of the time-in interval to the interval between that response and the next time-out period, thereby resulting in cumulated time-in periods. The results of the first group showed that the rate of lever pressing was closely related to the beginning of time-out periods. Subjects would typically respond, view the cartoon, be timed-out, and respond again. The second group's performance was characterized by "avoidance" behavior. Generally, subjects would respond sufficiently to prevent the occurrence of time-out periods.

Baer's (1960) study did not include a quantitative analysis of response rates at the different time-in values. Thomas (1965), using pigeons, studied the following parameters: time-in intervals, 20, 30, 60, and 120 seconds; time-out interval, 10 seconds; S^R_{NC} schedule during time-in, VT 3 minutes (one pigeon also exposed to VT 1 minute); a four second R-S^R_{NC} minimum interval during time-in was programmed to limit adventitious pairings. Each response during time-in reset the time-in clock. Responses during time-out had no effect. Rates during time-in decreased as the time-in interval increased. The bird, exposed to the VT 1 minute S^R_{NC} schedule, produced results consistent with the VT 3 minute subjects, although the absolute rates were lower in the former schedule.

Using rats, D'Andrea (1971) varied the time by which a response postponed the next time-out (from 3.75 to 100 seconds). A VT schedule of S^R_{NC} was in effect during time-in. Also, a minimum R-S^R_{NC} interval of three seconds was imposed during time-in periods. Response rates during time-in first increased to a maximum and then decreased as the interval by which a response delayed the onset of a time-out was lengthened. No systematic changes in rate were observed when the three second R-S^R_{NC} delay interval was removed. The author argued that because a R-S^R_{NC} delay interval was imposed, his findings were inconsistent with an analysis in terms of adventitious reinforcement of responding during time-in. However, the R-S^R_{NC} interval does not guarantee that a S^R_{NC} that occurs three seconds after a response does not affect that response. The R-S^R_{NC} interval is as much a part of the total schedule variables as any other parameter. It might be expected that D'Andrea would have obtained an effect due to the delay interval had he increased the minimum delay interval to larger values.

Neuringer (1973) studied the effects of four independent variables on time-in schedules: rate of S^R_{NC} during time-in; duration by which a key-peck postponed the next time-out; pattern of S^R_{NC} during time (FT vs. VT); and presence or absence of exteroceptive stimuli during time-in and time-out. Response rates for pigeons were a function of the duration of time-in values; pecks which produced relatively long time-in intervals generated low rates of pecking, while pecks which produced relatively short time-in intervals generated high rates, a finding consistent with data reported earlier by Thomas (1965) (compare with D'Andrea, 1971). Rates did not vary systematically as the average frequency of S^R_{NC} during time-in increased. This result differed from data provided by Thomas (1965) and D'Andrea (1971), both of whom found higher rates in time-in for denser S^R_{NC} schedules. Neuringer attributed the discrepancy to procedural differences. Response patterning during time-in under VT and FT schedules was consistent with Zeiler's (1968) data. Lastly, cueing time-in and time-out resulted in a close temporal relation between inter-response times and time-in values.

Summary. Formally, time-in schedules meet Schoenfeld and Farmer's (1970) requirement for contingency. Within the time-in limits, responding does determine the distribution of S^R in time, in that if no responses are made S^R_{NC} occurs either at a low frequency (Thomas, 1965; D'Andrea, 1971) or not at all (Baer, 1960; Neuringer, 1973). In addition, a contingency exists between responding and the time-out intervals. Time-in schedules do represent a class of "S^R_{NC}" schedules in that S^R_{NC} during time-in intervals occurs independently of particular responses. This type of paradigm is similar to the procedures employed in delay of S^R_C studies. That is, in a delay of S^R_C schedule, S^R is delivered some time period after the occurrence of a specific response; however, the exact response that S^R closely follows in time is not predetermined by the schedule variable. Perhaps the most significant point to be learned from the time-in literature is that a close conceptual relationship exists between schedules of contingent, delayed, and noncontingent reinforcement. The relationship appears to be between response class and S^R schedule.

Concurrent S^R_C and S^R_{NC} Schedules

The last area of research to be discussed deals with concurrent schedules of S^R_C and S^R_{NC}. A concurrent schedule is one in which two or more schedules are programmed simultaneously and independently (Catania, 1966). Certain phases of the Cole (1973) study and the positive conditioned suppression paradigm illustrate such schedules. This section will review further research on this topic.

Brownstein and Pliskoff (1968) programmed S^R_{NC} for pigeons from two sources. S^R_{NC} from one source was presented in the presence of an amber chamber light, and from the other source in the presence of a blue chamber light. The two schedules ran concurrently but S^R_{NC} from either source was delivered only when the correlated stimulus was lit. A single key-peck alternated stimulus conditions. The results were consistent with those obtained from similar contingent concurrent schedules: the relative time that a schedule was in effect varied directly with the relative rate of S^R_{NC} that the schedule produced.

Rachlin and Baum (1972) trained pigeons to peck a response key for S^R_C according to a VI schedule. A VT schedule was programmed concurrently so that birds obtained S^R_C for pecking as well as S^R_{NC}. With the two schedules kept constant, the magnitudes of S^R_C and S^R_{NC} were varied; subsequently, with magnitudes kept constant, the frequencies of the schedules were varied. A similar procedure was also run in which a minimum R-S^R_{NC} interval of two seconds was imposed. The results showed that the rate of key-pecking was inversely related to the amount of S^R_{NC} so that more pecking occurred when either the magnitude or frequency of S^R_{NC} was less than either the magnitude or frequency of S^R_C.

This finding held up when a two second R-S^R_{NC} interval was imposed. The finding that rate of pecking on a single response key was inversely related to the frequency of S^R_{NC} has been replicated by Cole (1973) and by Benassi, Weil, and Lanson (1974).

General Conclusions

When contingent S^R schedules are employed, an experimenter typically has little difficulty in choosing a response to measure. However, many noncontingent S^R schedules pose problems. Even if a history of S^R_C is given to a subject, when the schedule is changed to S^R_{NC}, rates of conventionally defined responses (e.g., key-pecking, lever-pressing) usually decline to zero or near-zero levels over time. The difficulty in maintaining control of such responses has not, of course, been universal. The work on mixed schedules of S^R_C and S^R_{NC}, auto-shaping, positive conditioned suppression, and variable delay are cases in point. Another possible schedule of stimulus presentation which could permit a study of the effects of S^R_{NC} on a particular response class involves the use of the concurrent S^R_C - S^R_{NC} paradigm (discussed above). In such a schedule S^R_{NC} presentations are superimposed on a schedule of S^R_C. The rationale for such a schedule would be that S^R_C would maintain a prescribed response. Changes in rate of that response could be studied as a function of changes in parameters of S^R_{NC}.

STATEMENT OF PURPOSE

The present experiments were designed to further examine the effects of schedules of S^R_{NC} which are programmed concurrently with schedules of S^R_C. Rachlin and Baum (1972) and Cole (1973) employed procedures which assessed the effects of such schedules on a single response. Those studies, however, were not concerned with precise control of the temporal separation between the delivery of S^R_C and S^R_{NC}. The studies reported below investigated the effects on a single response of two schedules correlated with respect to the time between the occurrence of S^R_C and S^R_{NC}. The first response during the first three seconds (Experiment I) or any time (Experiment II) in the T cycle was immediately followed by S^R_C. Some time after the beginning of a cycle S^R_{NC} was presented. The time between the beginning of a T cycle and S^R_{NC} was systematically varied across sessions.

The experimental design permitted a study of several questions:

1. What variations in response distributions occur throughout a T cycle as a function of the temporal separation variable? It is known that response patterning under schedules of total S^R_{NC} resembles that generated by similar schedules of S^R_C. Zeiler (1968), for example, obtained "scalloping" with both FI and FT schedules.

2. How do overall rates of responding during T cycles differ as a function of the introduction of S^R_{NC} to, and then variation of locus within, the baseline schedule of S^R_C? Rachlin and Baum (1972) and Cole (1973) found that S^R_{NC} added to a baseline S^R_C schedule produced a drop in overall response rates as the frequency of S^R_{NC}, relative to S^R_C, was increased. Those studies differed from the present work in that the authors employed either variable or random time schedules, and they did not control for the temporal separation between S^R_C and S^R_{NC}.

3. Do animals maintain higher rates prior to S^R_C or S^R_{NC} depending on where in a T cycle S^R_{NC} is presented? The literature on multiple schedules of S^R_C and S^R_{NC} indicates that rates are higher in the S^R_C component (Lattal and Maxey, 1971; Wilkie, 1972; Boakes, 1973). However, Lattal (1973) reported evidence showing that nearly equal rates could be maintained in two components of a mixed schedule of S^R_C and S^R_{NC}. Although this latter study differed procedurally from the present work, it was similar in that S^R_{NC} presentation was not cued by an exteroceptive stimulus.

4. On its most general level, the present studies permit analyses of the effects of an added noncontingent stimulus on behavior maintained by a contingent stimulus. Variation of the temporal separation between S^R_C and S^R_{NC} permits exploration of a range of stimulus functions. Part of the rationale for employing this type of paradigm comes from work by Farmer and Schoenfeld (1966). They found that

when a light stimulus was intruded onto a FI baseline at different temporal separations from S_C^R different behavioral effects resulted. It was clear that the various effects were a function of the relation between S_C^R and the intruded stimulus. The present work is procedurally similar to Farmer and Schoenfeld's except that the noncontingent stimulus is the same as S_C^R. This tactic will provide some comparison data between schedules in which the intruded stimulus is "neutral" or a "primary reinforcer."

To facilitate an understanding of the t-schedules employed in the experiments to follow, some background material will be presented. The rationale of these schedules has been outlined by Schoenfeld and his associates (1972). A t-schedule consists of a repeating time cycle, T. Each cycle contains t^D periods when S^R is available according to some probability and t^Δ periods when S^R is available at a lower probability. In most studies, the probability of S^R in t^D and t^Δ have been set at one and zero, respectively. The proportion of T occupied by t^D is called $\overline{T}$. The first response in t^D is reinforced, and subsequent responses in that cycle are not reinforced. In Experiment I, three baseline schedules of S_C^R were studied to assess the generality of the findings. When S_{NC}^R was added, it occurred at different absolute temporal values from S_C^R in the different groups, but the same relative separation between S_C^R and S_{NC}^R was always maintained.

EXPERIMENT I

Method

Subjects. Six experimentally naive female White Carneaux pigeons, between six and eight years old, were maintained at 80% ± 3% of their *ad libitum* body weights by supplemental feeding following experimental sessions. Water and grit were available in the home cages.

Apparatus. The center response key of a three-key Lehigh Valley Electronics unit (Model # 1519C) was continuously illuminated by amber light during experimental sessions. Approximately 25 grams were required to produce key switch closure. The two side keys were not used in the experiment. Both S^R_C and S^R_{NC} were delivered for three seconds through a lighted grain hopper located directly below the center key. All timing functions were discontinued during S^Rs. A deflector directed a continuously lit houselight toward the ceiling of the unit. Ventilation and masking noise were provided by a blower in the chamber and by an external fan. All logic functions were controlled by BRS Electronics digital logic circuitry. Data were gathered on Sodeco counters.

Procedure. All subjects were trained to peck the center response key by the method of successive approximations (Ferster and Skinner, 1957), after which they received 100 regular reinforcements. The subjects were then randomly assigned to one of three experimental groups and given the following baseline training:

1. Group I - Subjects 218 and 203 were immediately exposed to a schedule in which T = 60 seconds and $\overline{T}$ = 1. After two sessions they were placed on their terminal baseline schedule, with T = 60 seconds and $\overline{T}$ = .05.

2. Group II - Over three sessions, the t-schedule for subjects 455 and 483 was changed from 60 seconds to 120 seconds, with $\overline{T}$ = 1 in both schedules. The subjects were then placed on their terminal baseline schedule, with T = 120 seconds and $\overline{T}$ = .025.

3. Group III - Over seven sessions, the t-schedule for subjects 100 and 213 was changed from 60 seconds to 120 seconds, to 240 seconds, with $\overline{T}$ = 1 in all three schedules. They were then placed on their terminal baseline schedule, with T = 240 seconds and $\overline{T}$ = .0125.

For each of the three groups, when they were exposed to their terminal baseline schedules t^D was set at three seconds. S^R_C was delivered for the first response in t^D and was never presented in a cycle if a response did not occur in t^D. During baseline all reinforcements were response contingent. There were 25 T cycles each experimental session. If subjects responded in t^D each cycle, they would obtain 25 S^R_Cs.

Following 30 days of terminal baseline training, S^R_{NC} was added to each of the baseline schedules. Across sessions, the temporal separation between the beginning of a T cycle (S^R_C) and S^R_{NC} delivery was systematically varied. These temporal intervals are presented in Table 1 in their order of introduction into the experiment. When S^R_{NC} was included in the study, the subjects would always obtain 25 S^R_{NC}s. With rare exception all subjects were run seven days each week.

Table 1 shows, for example, that in Phase 2 for 15 sessions subjects were maintained on their baseline schedule with S^R_{NC} presented at either 50, 100, or 200 seconds into the T cycle. Phase 3 through 6 represent the remainder of the parametric values of temporal placement investigated. Several experimental values were redetermined (phases 7, 8, 11, 12, and 13). A further manipulation involved dropping the response requirement in t^D; S^R_{NC1} was presented at the beginning of each T cycle; the previously S^R_{NC2} was presented at the middle of each T cycle (phase 9) and then at the latter part of each T cycle (phase 10).

Results and Discussion

The data for all measures were taken from the last five sessions at each experimental phase. When used, means were calculated for each session; and the mean and standard deviation of those values were used as data points. The decision to run eight instead of 15 sessions for the recovery and total S^R_{NC} phases was made because the data

Table 1

Temporal Intervals Between the Beginning of T Cycle and Noncontingent Reinforcement Delivery in Experiment I

	Temporal Intervals		
Phase	Group I 60"[218/203]	Group II 120"[455/483]	Group III 240"[100/213]
1	Baseline (30)*	Baseline (30)*	Baseline (30)*
2	50" (15)	100" (15)	200" (15)
3	40" (15)	80" (15)	160" (15)
4	30" (15)	60" (15)	120" (15)
5	20" (15)	40" (15)	80" (15)
6	10" (15)	20" (15)	40" (15)
7	50" (8)	100" (8)	200" (8)
8	30" (8)	60" (8)	120" (8)
9	**30" (8)	**60" (8)	**120" (8)
10	**50" (8)	**100" (8)	**200" (8)
11	50" (8)	100" (8)	200" (8)
12	10" (8)	20" (8)	40" (8)
13	Baseline (8)	Baseline (8)	Baseline (8)

* The number of sessions run at an experimental point are given in parentheses.

** S^{R}_{NC} delivered at values shown and at beginning of T cycle.

from these phases were fairly stable based on standard deviations. Also, no systematic deviation was observed from sessions four to eight of the 15 session phases.

Because a three second t^D was used, subjects would miss S_C^Rs if a response did not occur during t^D. Actually, the subjects only occasionally missed S_C^Rs and these instances did not systematically effect the results.

Response patterning. Figures 1-6 provide a measure of the distribution of responses throughout T cycles for the 60, 120, and 240 second T cycle groups. T cycles were divided into 12 equal and consecutive time bins of five, 10, or 20 seconds, for the three groups. Responses were accumulated depending on their temporal location within a cycle. Each figure has been constructed to permit a comparison of response patterning prior to S_C^R with response patterning prior to S_{NC}^R. The data represent the mean percentage of total responses in a session that occurred during each of the time segments. The most prominent feature of the figures is the consistency of the results both within and across groups. The following statements fairly well describe the results:

(1.) Baseline--the general trend was for subjects to make increasingly more responses as the time to S_C^R came closer.

(2.) S_{NC}^R at 50, 100, or 200 seconds--The subjects paused after S_C^R, showed an initial percentage increase, and

Figure 1. Percentage of responses in consecutive 5 second segments of a 60 second T cycle. The separate figures represent data for subject 218 at the different S^R_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^R_{NC}, while the functions from N to 12 represent responding from S^R_{NC} delivery to the end of the T cycle.

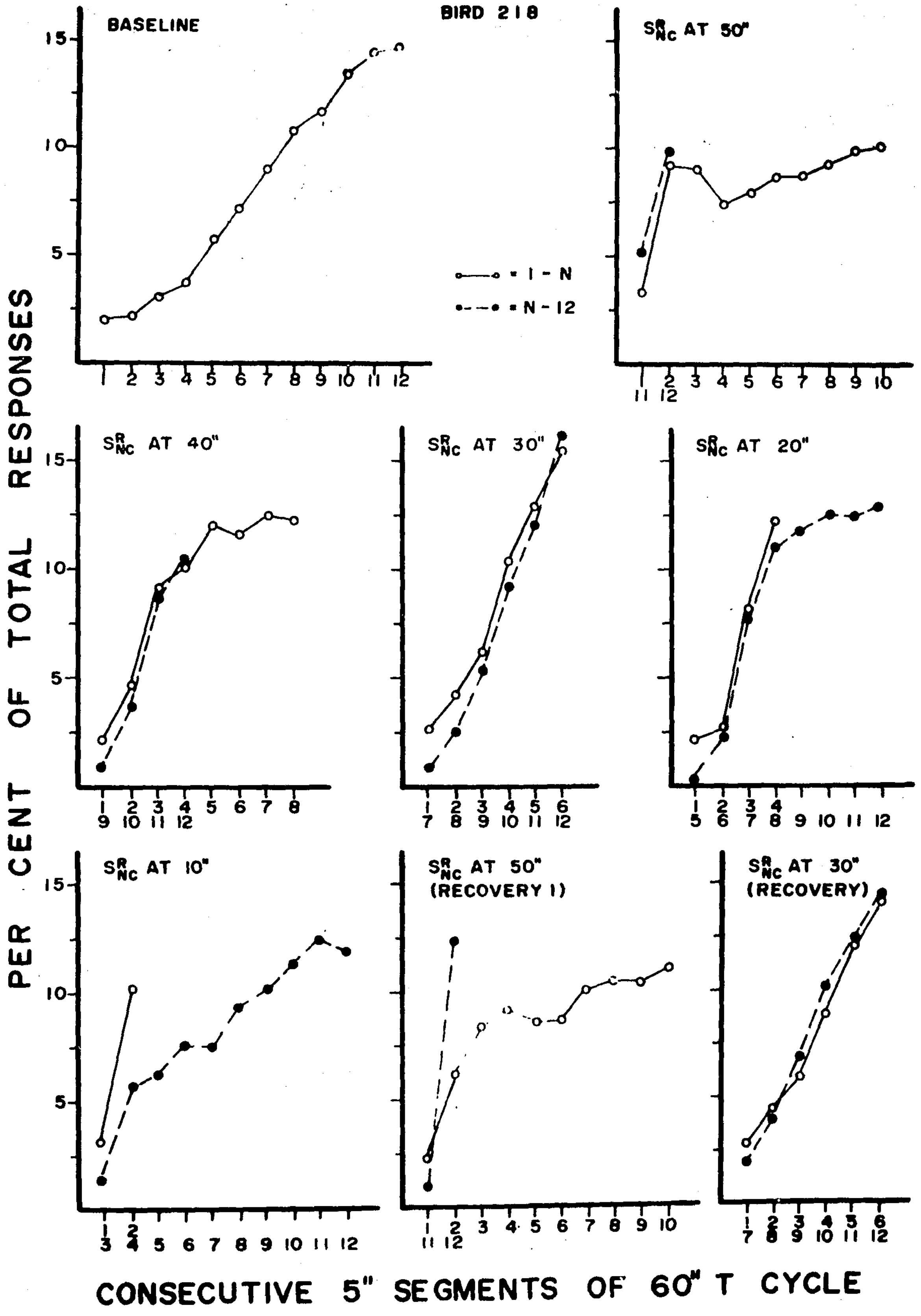

BIRD 218
BASELINE
S^R_{NC} AT 50"
S^R_{NC} AT 40"
S^R_{NC} AT 30"
S^R_{NC} AT 20"
S^R_{NC} AT 10"
S^R_{NC} AT 50" (RECOVERY I)
S^R_{NC} AT 30" (RECOVERY)
○—○ = 1 - N
●--● = N - 12
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 5" SEGMENTS OF 60" T CYCLE
5
10
15
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10
11 12
1 2 3 4 5 6 7 8
9 10 11 12
1 2 3 4 5 6
7 8 9 10 11 12
1 2 3 4 9 10 11 12
5 6 7 8
1 2 5 6 7 8 9 10 11 12
3 4

Figure 1. (continued)

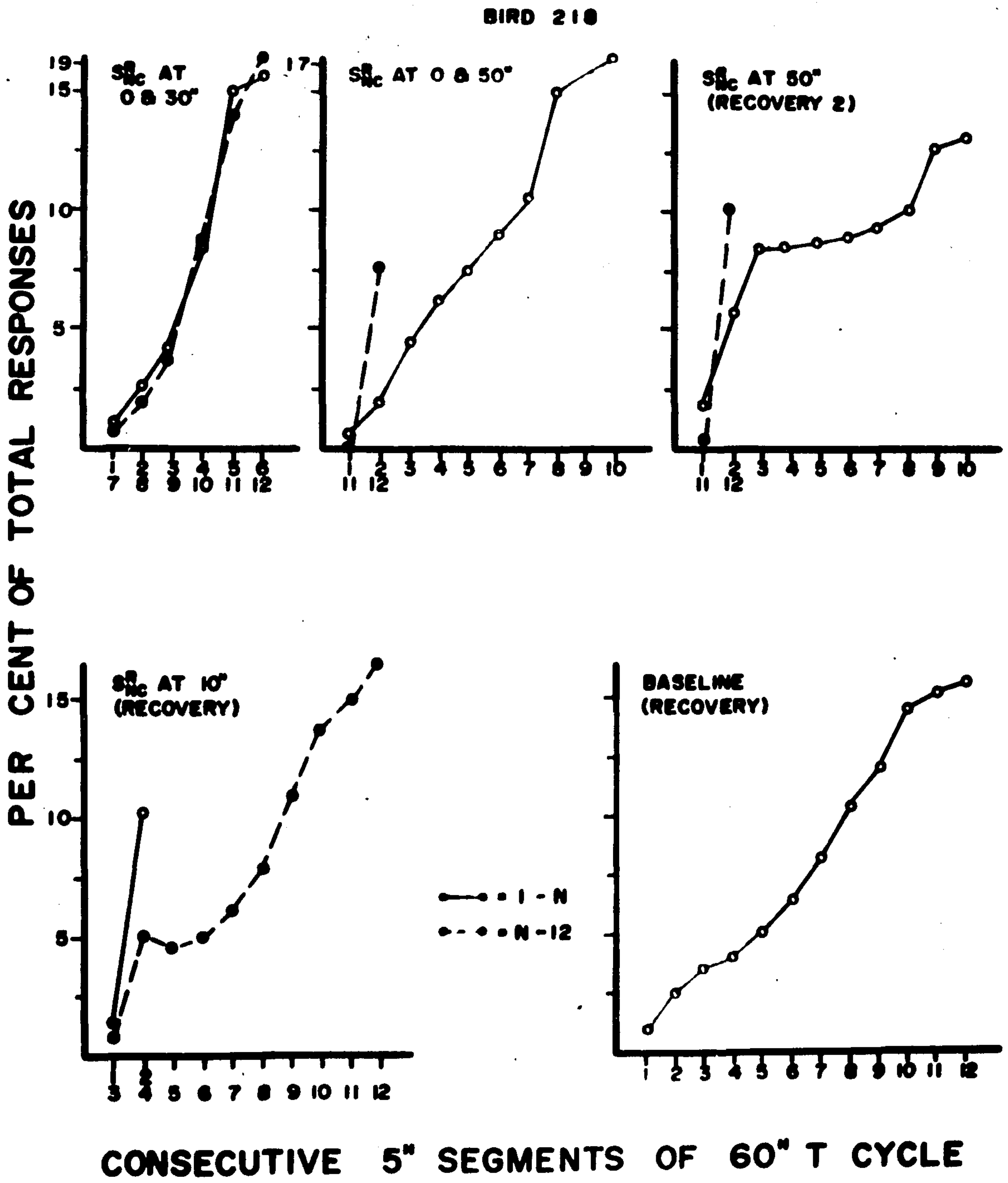

BIRD 218
SR NC AT 0 & 30"
SR NC AT 0 & 50"
SR NC AT 50" (RECOVERY 2)
SR NC AT 10" (RECOVERY)
BASELINE (RECOVERY)
1 - N
N - 12
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 5" SEGMENTS OF 60" T CYCLE
19
17
15
10
5
1 2 3 4 5 6
7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10
11 12
1 2 3 4 5 6 7 8 9 10 11 12

Figure 2. Percentage of responses in consecutive 5 second segments of a 60 second T cycle. The separate figures represent data for subject 203 at the different S^{R}_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^{R}_{NC}, while the functions from N to 12 represent responding from S^{R}_{NC} delivery to the end of the T cycle.

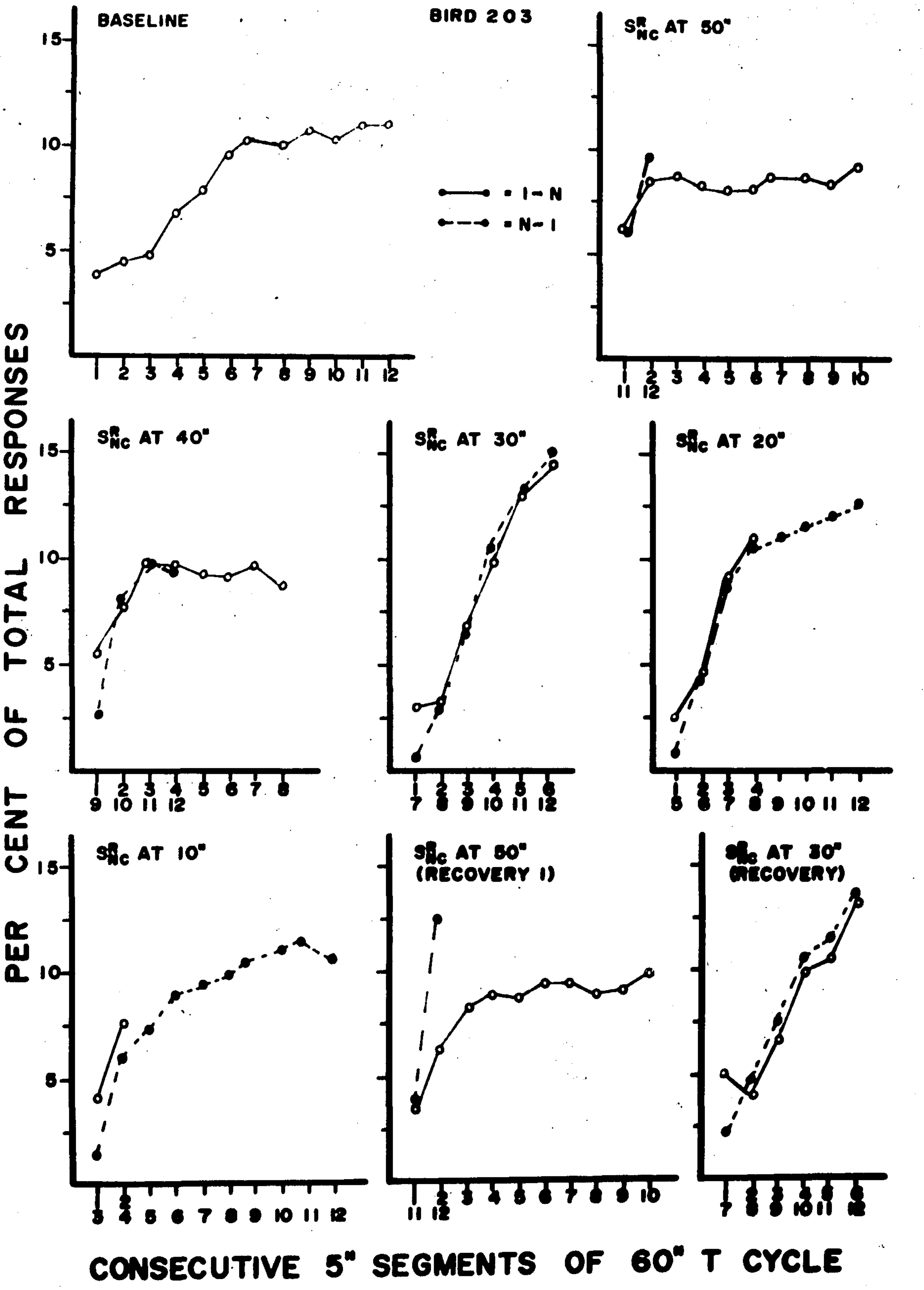

BIRD 203
BASELINE
S^R_{NC} AT 50"
S^R_{NC} AT 40"
S^R_{NC} AT 30"
S^R_{NC} AT 20"
S^R_{NC} AT 10"
S^R_{NC} AT 50" (RECOVERY I)
S^R_{NC} AT 30" (RECOVERY)
—— = I – N
– – – = N – I
5
10
15
1 2 3 4 5 6 7 8 9 10 11 12
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 5" SEGMENTS OF 60" T CYCLE

Figure 2. (continued)

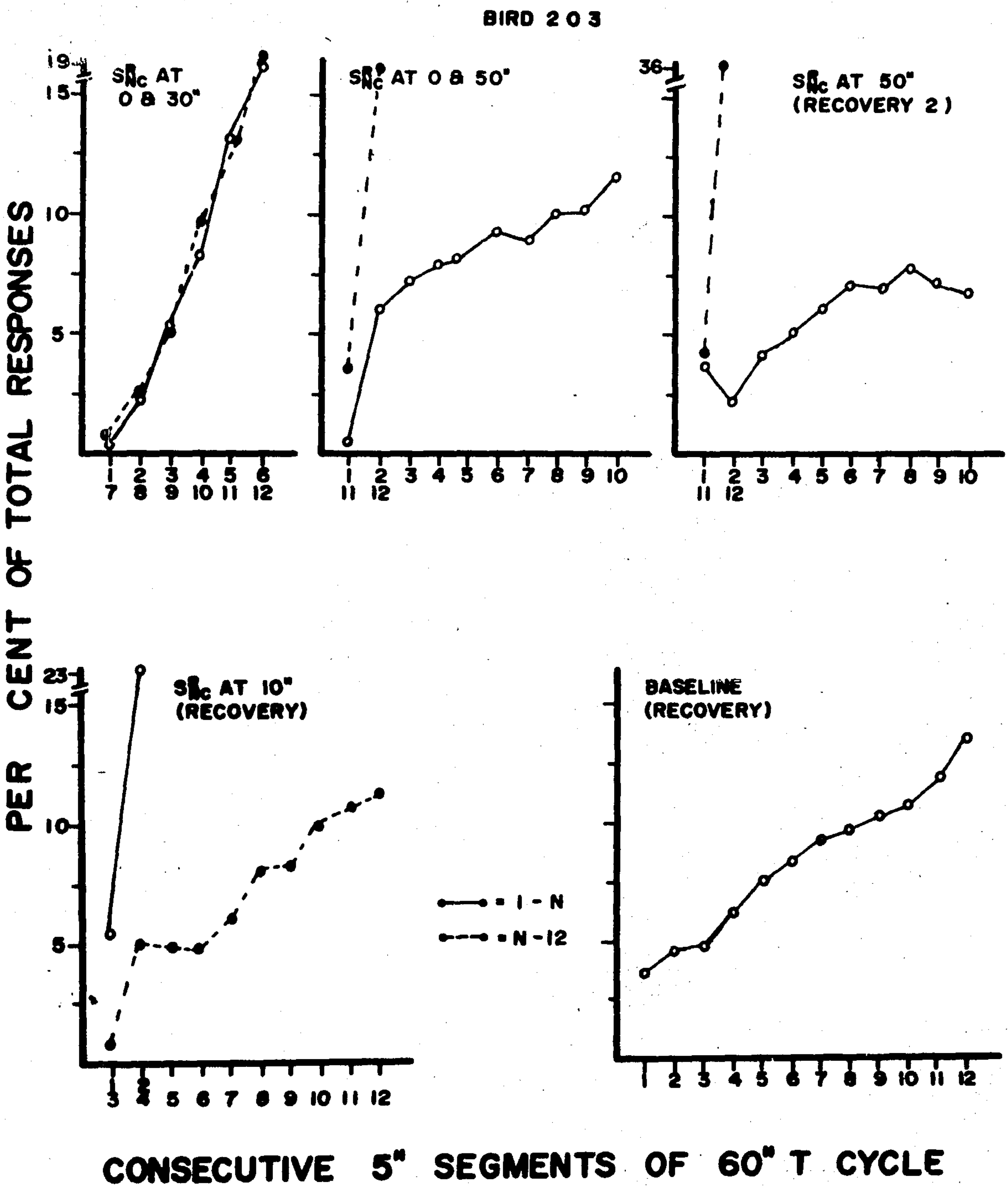

BIRD 2 0 3
PER CENT OF TOTAL RESPONSES
S^R_{NC} AT 0 & 30"
19
15
10
5
1 2 3 4 5 6
7 8 9 10 11 12
S^R_{NC} AT 0 & 50"
1 2 3 4 5 6 7 8 9 10
11 12
36
S^R_{NC} AT 50" (RECOVERY 2)
1 2 3 4 5 6 7 8 9 10
11 12
23
S^R_{NC} AT 10" (RECOVERY)
1 2
3 4 5 6 7 8 9 10 11 12
= 1 - N
= N - 12
BASELINE (RECOVERY)
1 2 3 4 5 6 7 8 9 10 11 12
CONSECUTIVE 5" SEGMENTS OF 60" T CYCLE

Figure 3. Percentage of responses in consecutive 10 second segments of a 120 second T cycle. The separate figures represent data for subject 455 at the different S^R_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^R_{NC}, while the functions from N to 12 represent responding from S^R_{NC} delivery to the end of the T cycle.

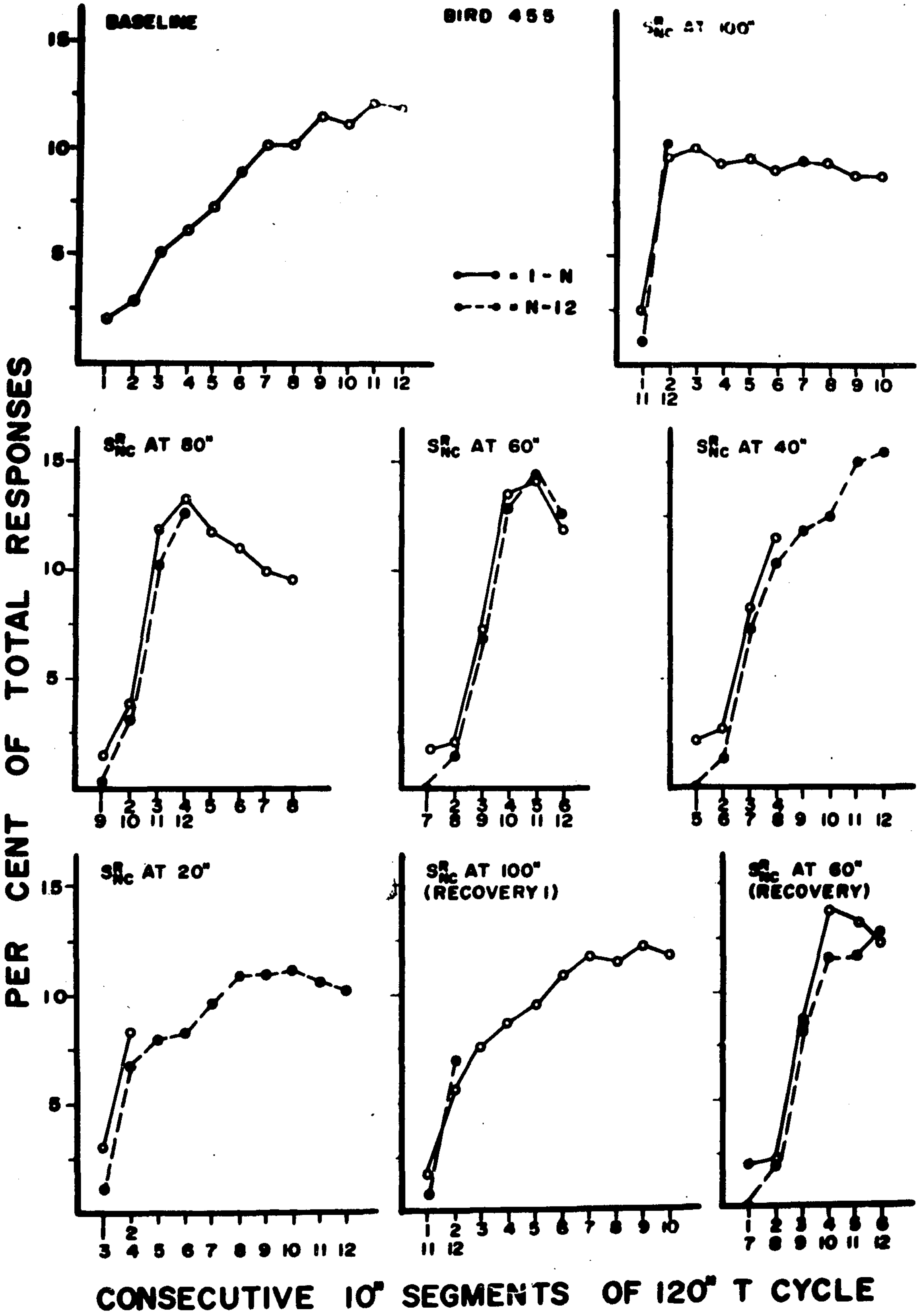

BASELINE
BIRD 455
S^R_{NC} AT 100"
●—● = 1 - N
●--● = N-12
S^R_{NC} AT 80"
S^R_{NC} AT 60"
S^R_{NC} AT 40"
S^R_{NC} AT 20"
S^R_{NC} AT 100" (RECOVERY I)
S^R_{NC} AT 60" (RECOVERY)
15
10
5
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 10" SEGMENTS OF 120" T CYCLE

Figure 3. (continued)

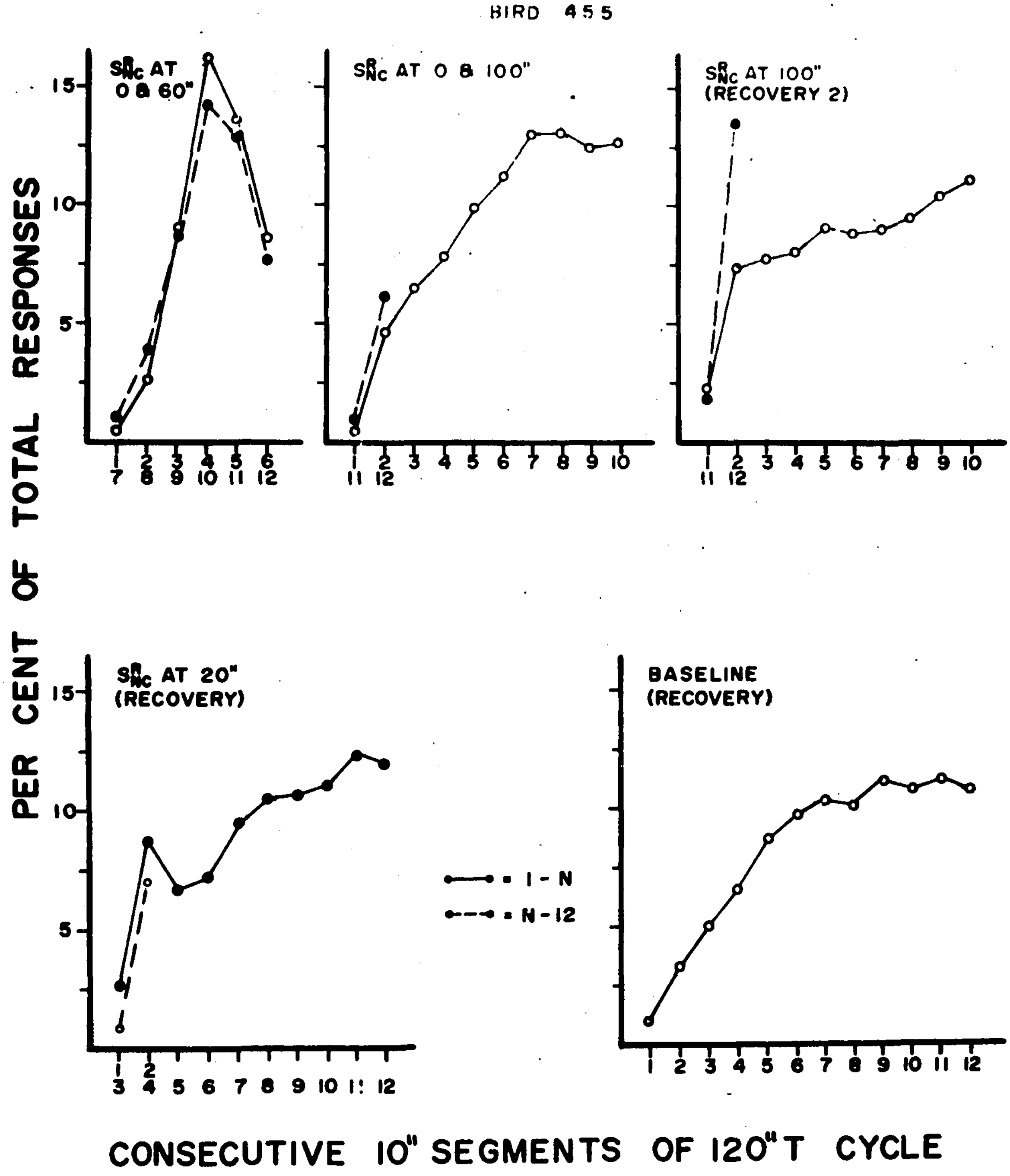

BIRD 455
PER CENT OF TOTAL RESPONSES
S^R_{NC} AT 0 & 60"
S^R_{NC} AT 0 & 100"
S^R_{NC} AT 100" (RECOVERY 2)
S^R_{NC} AT 20" (RECOVERY)
BASELINE (RECOVERY)
5
10
15
●—● = 1 - N
●--● = N - 12
1 2 3 4 5 6
7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10
11 12
1 2
3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
CONSECUTIVE 10" SEGMENTS OF 120" T CYCLE

Figure 4. Percentage of responses in consecutive 10 second segments of a 120 second T cycle. The separate figures represent data for subject 483 at the different S^R_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^R_{NC}, while the functions from N to 12 represent responding from S^R_{NC} delivery to the end of the T cycle.

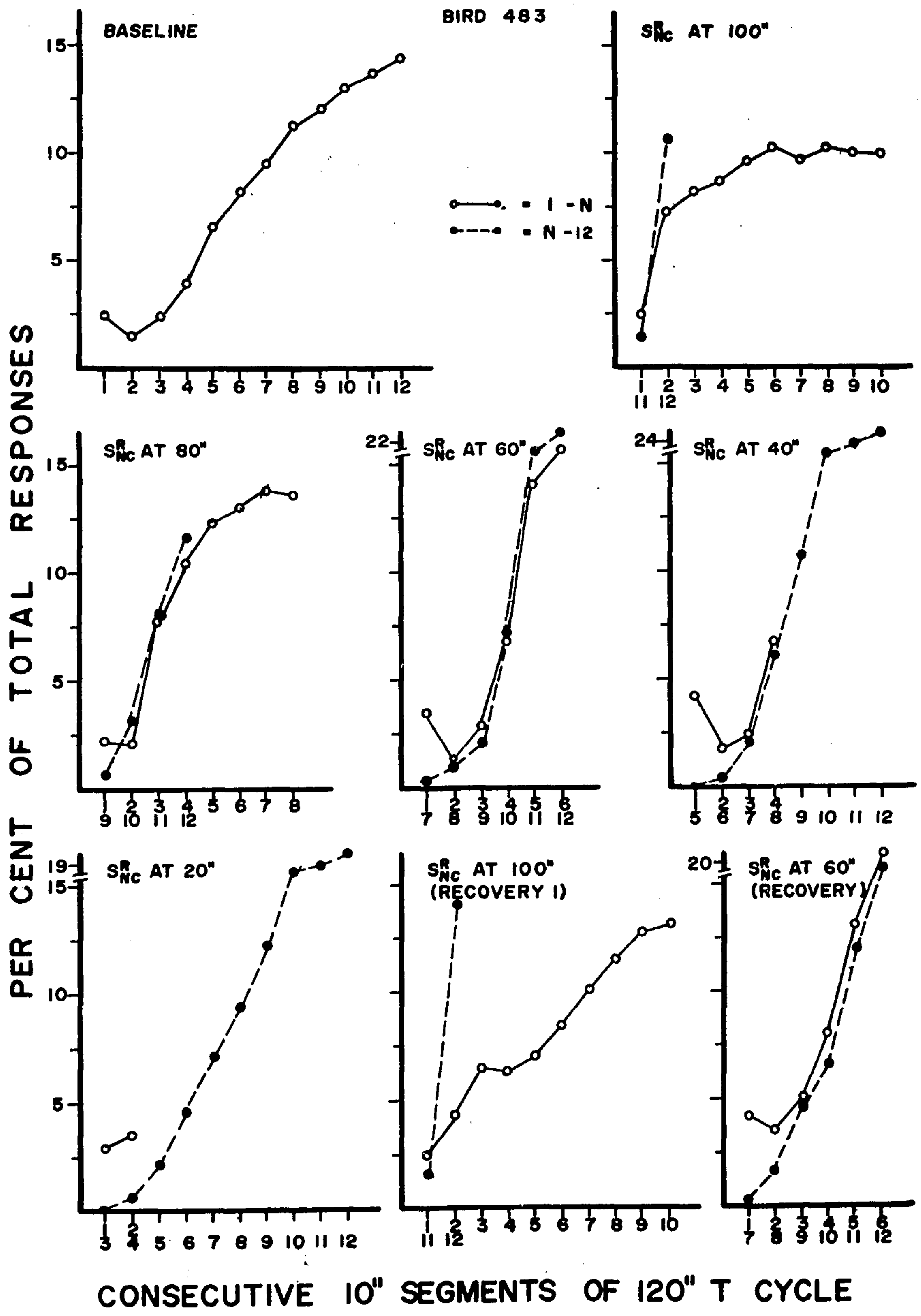

BIRD 483
BASELINE
S$^R_{NC}$ AT 100"
S$^R_{NC}$ AT 80"
S$^R_{NC}$ AT 60"
S$^R_{NC}$ AT 40"
S$^R_{NC}$ AT 20"
S$^R_{NC}$ AT 100" (RECOVERY I)
S$^R_{NC}$ AT 60" (RECOVERY)
= 1 - N
= N - 12
15
10
5
22
24
19
20
1 2 3 4 5 6 7 8 9 10 11 12
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 10" SEGMENTS OF 120" T CYCLE

Figure 4. (continued)

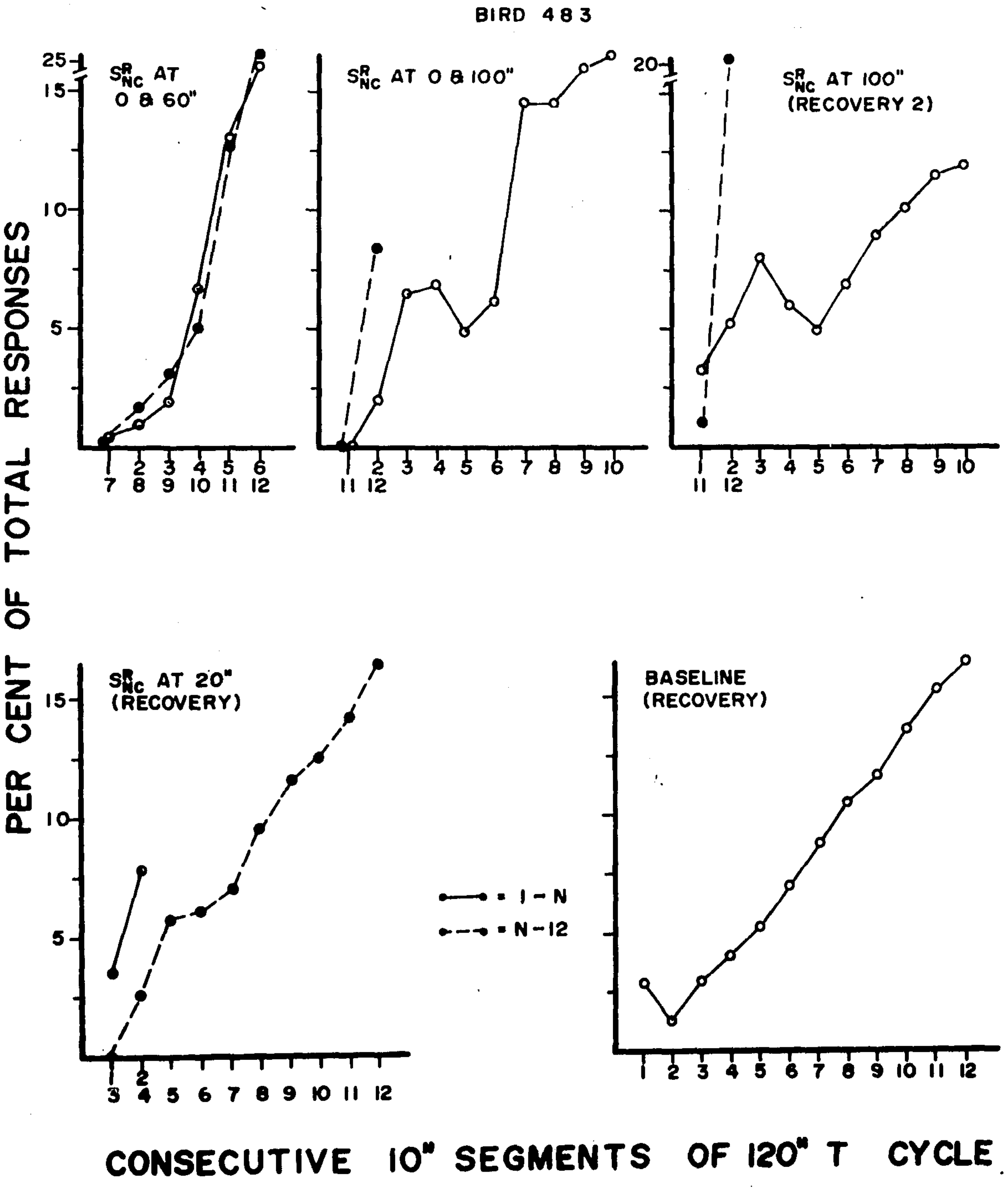

BIRD 483
PER CENT OF TOTAL RESPONSES
S^R_{NC} AT 0 & 60"
25
15
10
5
1 2 3 4 5 6
7 8 9 10 11 12
S^R_{NC} AT 0 & 100"
1 2 3 4 5 6 7 8 9 10
11 12
20
S^R_{NC} AT 100" (RECOVERY 2)
1 2 3 4 5 6 7 8 9 10
11 12
S^R_{NC} AT 20" (RECOVERY)
1 2
3 4 5 6 7 8 9 10 11 12
= 1 − N
= N − 12
BASELINE (RECOVERY)
1 2 3 4 5 6 7 8 9 10 11 12
CONSECUTIVE 10" SEGMENTS OF 120" T CYCLE

Figure 5. Percentage of responses in consecutive 20 second segments of a 240 second T cycle. The separate figures represent data for subject 213 at the different S^R_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^R_{NC}, while the functions from N to 12 represent responding from S^R_{NC} delivery to the end of the T cycle.

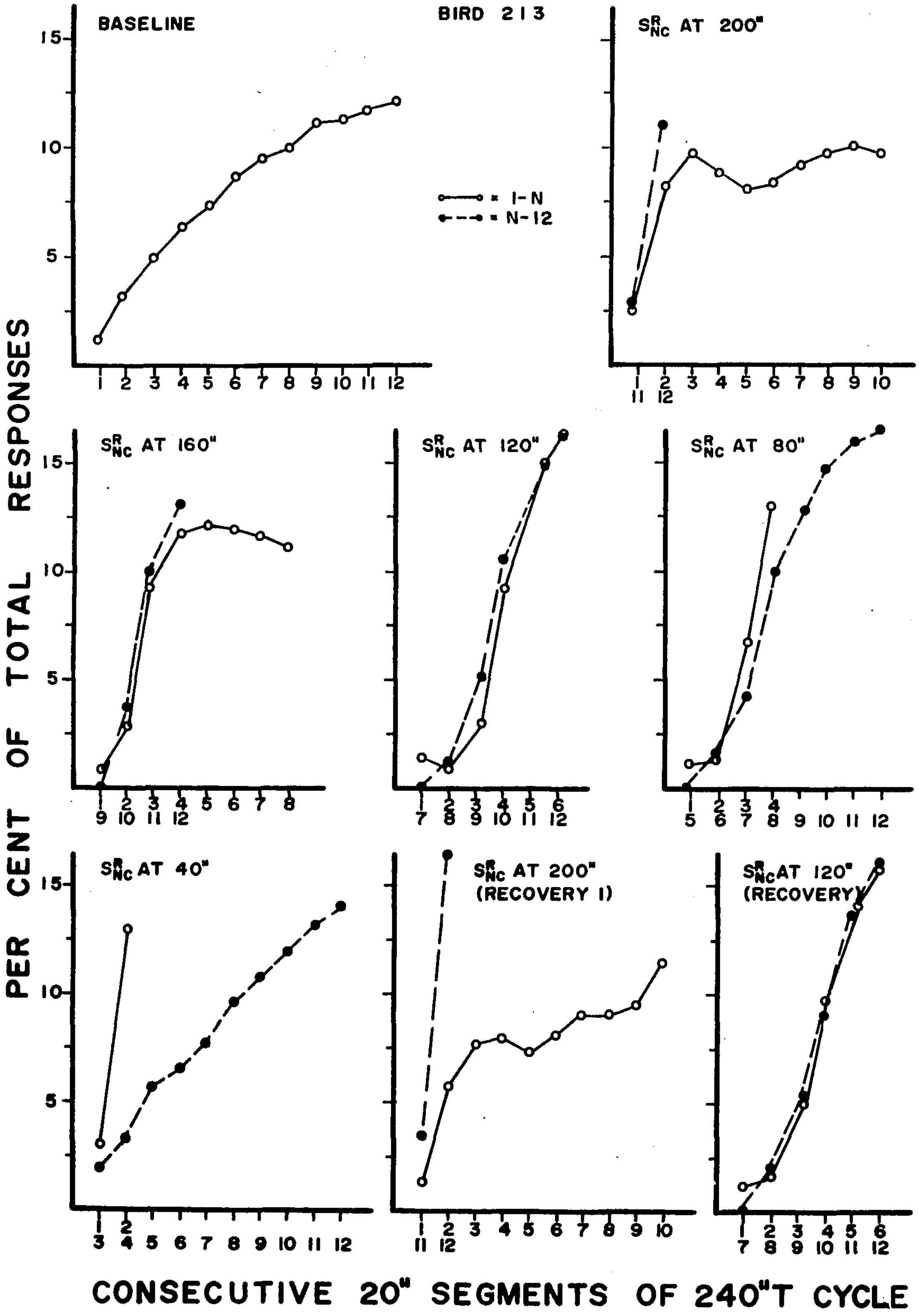

BIRD 213
BASELINE
S^R_{NC} AT 200"
S^R_{NC} AT 160"
S^R_{NC} AT 120"
S^R_{NC} AT 80"
S^R_{NC} AT 40"
S^R_{NC} AT 200" (RECOVERY I)
S^R_{NC} AT 120" (RECOVERY)
○—○ = I-N
●- -● = N-12
PER CENT OF TOTAL RESPONSES
5
10
15
1 2 3 4 5 6 7 8 9 10 11 12
CONSECUTIVE 20" SEGMENTS OF 240"T CYCLE

Figure 5. (continued)

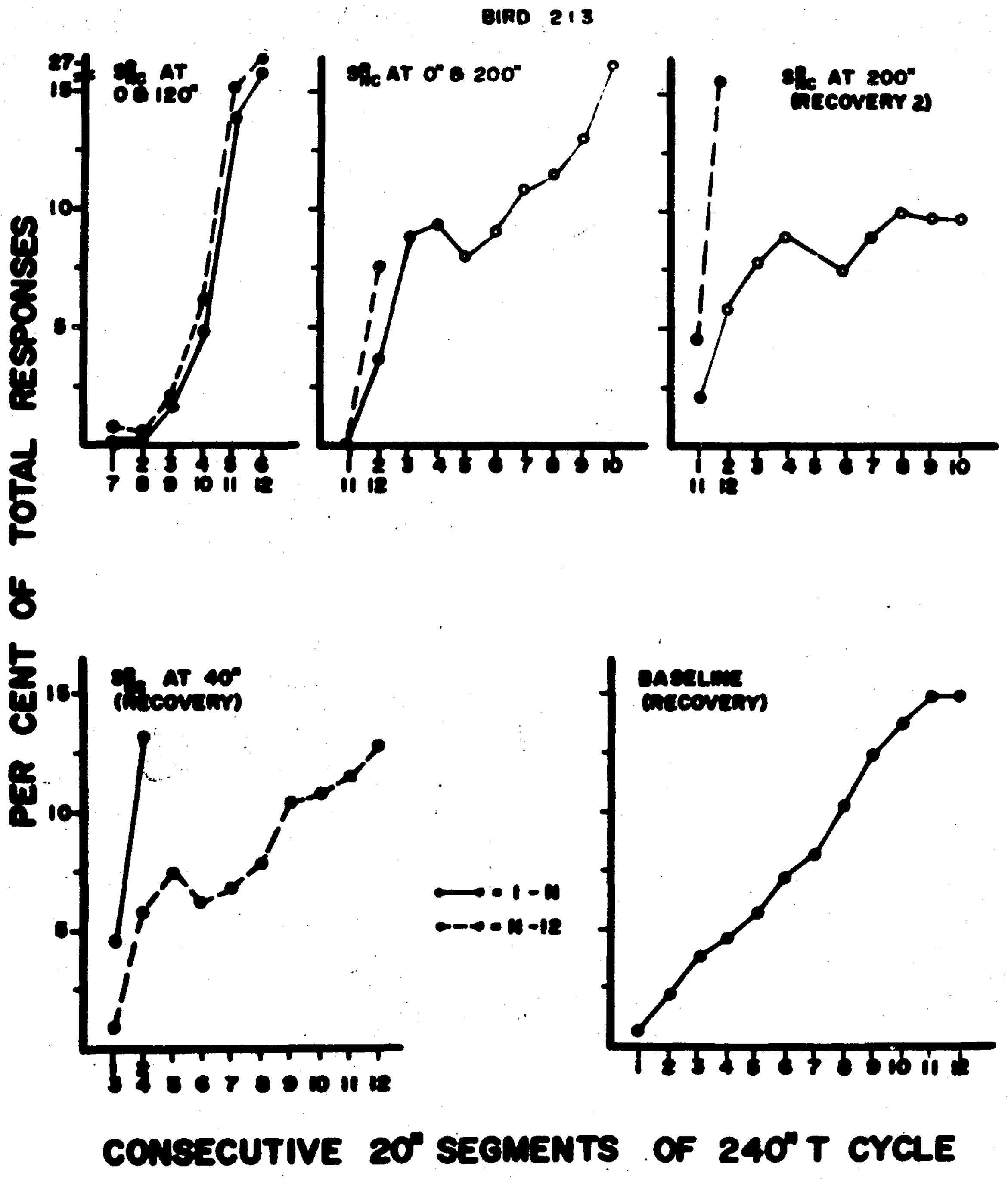

BIRD 213
S^R_nc AT 0 & 120"
S^R_nc AT 0" & 200"
S^R_nc AT 200" (RECOVERY 2)
S^R_nc AT 40" (RECOVERY)
BASELINE (RECOVERY)
PER CENT OF TOTAL RESPONSES
27
15
10
5
1 2 3 4 5 6
7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10
11 12
3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
= 1 - 11
= 11 - 12
CONSECUTIVE 20" SEGMENTS OF 240" T CYCLE

Figure 6. Percentage of responses in consecutive 20 second segments of a 240 second T cycle. The separate figures represent data for subject 100 at the different S^R_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^R_{NC}, while the functions from N to 12 represent responding from S^R_{NC} delivery to the end of the T cycle.

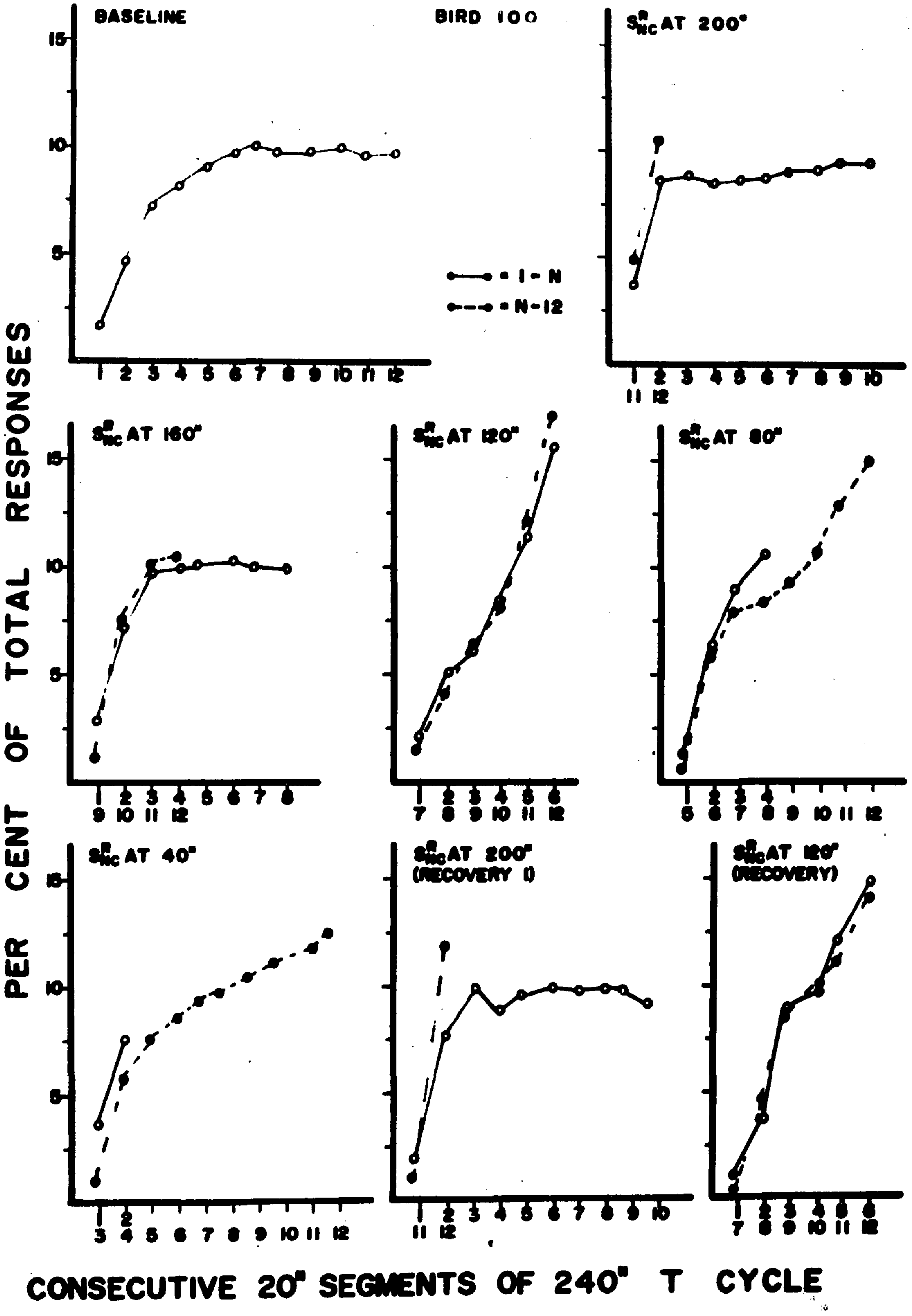
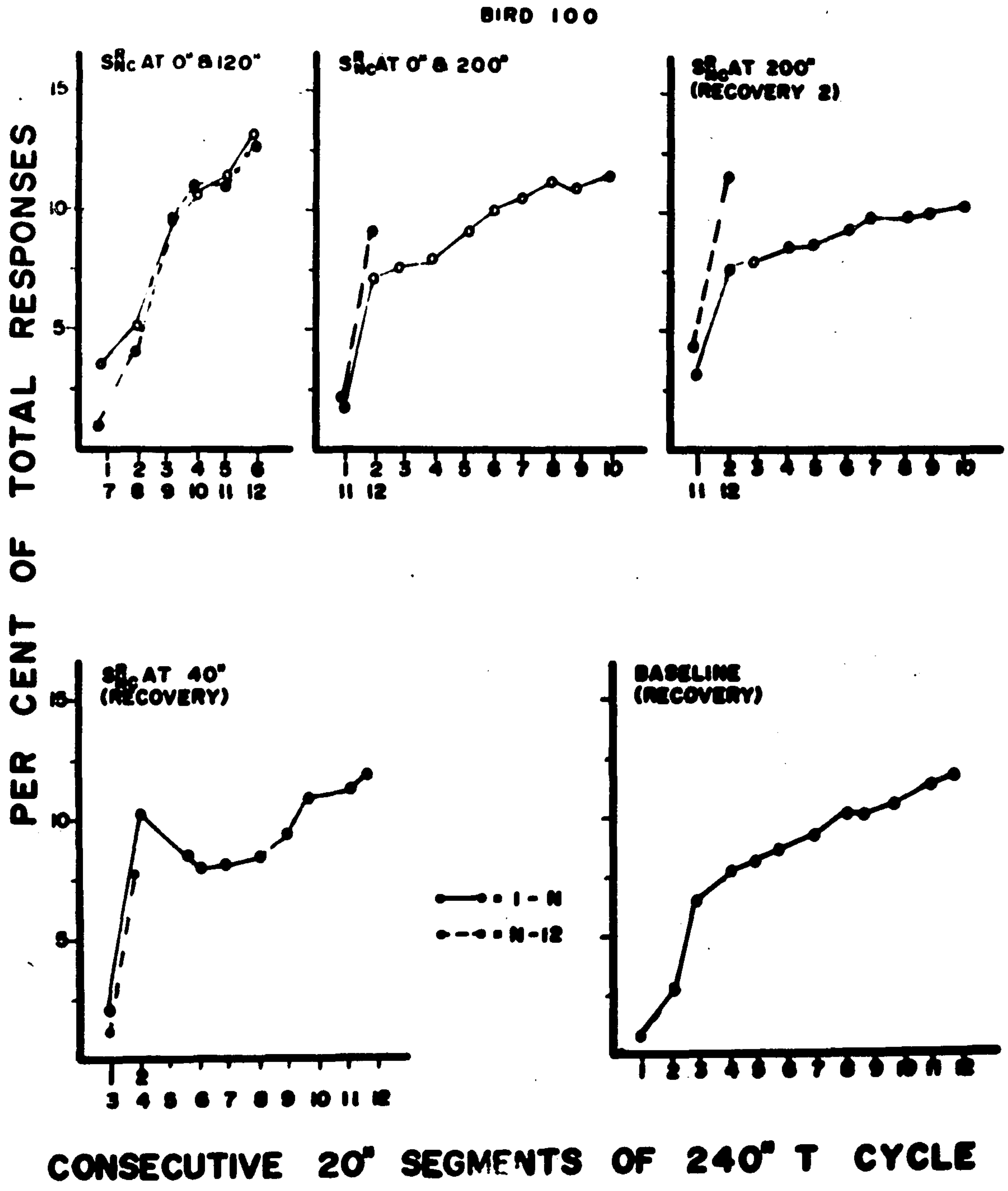

BASELINE
BIRD 100
S^R_{NC} AT 200"
S^R_{NC} AT 160"
S^R_{NC} AT 120"
S^R_{NC} AT 80"
S^R_{NC} AT 40"
S^R_{NC} AT 200" (RECOVERY I)
S^R_{NC} AT 120" (RECOVERY)
= 1 - N
= N - 12
5
10
15
1 2 3 4 5 6 7 8 9 10 11 12
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 20" SEGMENTS OF 240" T CYCLE

Figure 6. (continued)


BIRD 100
S^R_NC AT 0" & 120"
S^R_NC AT 0" & 200"
S^R_NC AT 200" (RECOVERY 2)
S^R_NC AT 40" (RECOVERY)
BASELINE (RECOVERY)
15
10
5
1 2 3 4 5 6
7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10
11 12
1 2
3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
I - N
N - 12
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 20" SEGMENTS OF 240" T CYCLE

then made a fairly constant percentage of responses until S^R_{NC}. After a pause there was an increased percentage of responses into the next cycle.

(3.) S^R_{NC} at 40, 80, or 160 seconds--The subjects showed the same general pattern described in the previous phase.

(4.) S^R_{NC} at 30, 60, or 120 seconds--At this phase, S^R_{NC} was presented at the middle of the T cycle. The response patterning prior to S^R_C and S^R_{NC} for all subjects was generally indistinguishable. Subjects paused after each S^R and then showed an increasing percentage of responses into the next S^R.

(5.) S^R_{NC} at 20, 40, or 80 seconds--All subjects showed a pause after S^R_C, and then an increased percentage of responses into S^R_{NC}. After a pause, they made an increasing percentage of responses into the next cycle.

(6.) S^R_{NC} at 10, 20, or 40 seconds--All subjects showed the same pattern described in (5.).

(7.) Recovery of S^R_{NC} at 50, 100, and 200 seconds--The data were similar to the first determinations except that most subjects showed a gradual increase in the percentage of responses per segment between S^R_C and S^R_{NC}.

(8.) and (9.) S^R_{NC} at 30, 60, or 120 seconds; and S^R_{NC} at 10, 20, or 40 seconds--The findings replicated those from the first determinations.

(10.) S^R_{NC} at 0 and 30, 60, or 120 seconds--The distributions of responses for all subjects were similar to those obtained when S^R_C was part of the schedules.

(11.) $\underline{S^R_{NC}}$ <u>at 0 and 50, 100, or 200 seconds</u>--The subjects paused after S^R_{NC1} and then showed an increasing percentage of responses into S^R_{NC2}. After a pause, they made an increasing percentage of responses into the next cycle.

(12.) <u>Recovery of Baseline</u>--The findings replicated those from the first determinations.

Except for the conditions involving a very short and very long temporal separation between S^Rs (e.g., phases 2 and 6), the subjects tended to respond into the S^R_1 preceded by a longer IS^RT as follows. The distributions into S^R_1 closely resembled those which occurred into the S^R_2 preceded by a shorter IS^RT, until the point when S^R_2 would have occurred. From that point to S^R_1 animals tended to make a fairly constant output when S^R_1 was noncontingent, or show an increasing output when S^R_1 was contingent. The recovery phases in which S^R_{NC} was preceded by a longer IS^RT generally produced results similar to those obtained when S^R_C was preceded by a longer IS^RT. When differential temporal cues between S^R_C and S^R_{NC} were removed (i.e., when S^R_{NC} was delivered at the middle of a cycle), response patterning into S^R_C and S^R_{NC} was largely indistinguishable (phases 4 and 8). This finding held up when differential temporal cues were absent and both S^Rs were noncontingent (phase 9). Lastly, when contingency cues were removed with temporal cues still present (phase 10), the subjects responded with an increasing number of responses into the S^R preceded by a longer time since the previous S^R. In both phases 9 and 10, overall response rates and rates into S^R_{NC1} and S^R_{NC2} were lower than in similar schedules (phases 4 and 6) in which S^R_C was included. The above results indicate that FT schedules do not necessarily generate progressive rate increases throughout the T cycle (the percent of responses per time segment could be transformed into a rate measure). In several phases, the responding into S^R_{NC} looked more like the "break run" characteristic of fixed ratio schedules than like patterning controlled by fixed time (FI and FT) schedules. Since previous studies have employed different procedures than used here (e.g., Zeiler, 1968; Lattal, 1972), comparisons are difficult to make. Nonetheless, the present data suggest that particular forms of response patterning are a function of the parameters of the independent variables in force.

Response rate measures. Tables 2, 3, and 4 provide the means, standard deviations, and medians for overall corrected response rates (total responses divided by total session time) at each experimental phase. The data for phases 1 through 6 showed no systematic changes either within or across groups. Rates were not consistently recovered for all subjects at the recovery phases (7, 8, 11,

Table 2

Overall Corrected Response Rates (Responses/Sec) for Subjects 218 and 203.
Means, Standard Deviations (S.D.), and Medians
Across All Experimental Phases Are Presented

	Time Between Start of T Cycle and S^R_{NC} Delivery												
	Baseline	50"	40"	30"	20"	10"	50"	30"	30"*	50"*	50"	10"	Baseline
218:													
Mean	.83	1.06	.87	.94	.91	.92	1.26	1.26	.84	.94	1.47	1.33	1.85
S.D.	.14	.12	.05	.06	.04	.19	.14	.22	.10	.11	.15	Lost data	.24
Median	.84	1.04	.93	.94	.92	.87	1.33	1.24	.85	.92	1.50	1.38	1.87
203:													
Mean	.76	.75	.68	.63	.77	.69	.67	.49	.39	.48	.41	.47	.64
S.D.	.03	.07	.04	.04	.01	.12	.06	.03	.06	.03	.06	.05	.08
Median	.78	.77	.66	.63	.78	.62	.67	.50	.41	.47	.42	.45	.63

*In this phase both S^Rs were noncontingent.

Table 3

Overall Corrected Response Rates (Responses/Sec) for Subjects 455 and 483.
Means, Standard Deviations (S.D.), and Medians
Across All Experimental Phases Are Presented

	Time Between Start of T Cycle and S^R_{NC} Delivery												
	Baseline	100"	80"	60"	40"	20"	100"	60"	60"*	100"*	100"	20"	Baseline
455:													
Mean	.41	.74	.39	.50	.46	.75	.83	.54	.25	.41	.53	.68	.99
S.D.	.05	.05	.03	.06	.06	.05	.16	.03	.09	.11	.13	.07	.13
Median	.42	.72	.50	.49	.45	.76	.90	.53	.21	.38	.52	.66	1.04
483:													
Mean	.47	.48	.40	.23	.22	.30	.38	.24	.11	.06	.24	.22	.29
S.D.	.11	.04	.01	.02	.02	.03	.08	.03	.01	.05	.02	.02	.07
Median	.41	.48	.41	.23	.23	.30	.41	.24	.10	.04	.25	.21	.30

*In this phase both S^Rs were noncontingent.

Table 4

Overall Corrected Response Rates (Responses/Sec) for Subjects 213 and 100.
Means, Standard Deviations (S.D.), and Medians
Across All Experimental Phases Are Presented

	Time Between Start of T Cycle and S^R_{NC} Delivery												
	Baseline	200"	160"	120"	80"	40"	200"	120"	120"*	200"*	200"	40"	Baseline
213:													
Mean	.56	.56	.48	.35	.40	.44	.39	.38	.22	.13	.42	.41	.51
S.D.	.05	.04	.02	.03	.05	.05	.06	.02	.04	.07	.07	.01	.04
Median	.53	.56	.48	.36	.41	.47	.37	.38	.22	.12	.38	.40	.50
100:													
Mean	.46	.57	.54	.51	.47	.48	.51	.60	.43	.36	.51	.52	.66
S.D.	.05	.03	.03	.08	.03	.06	.06	.04	.03	.05	.06	.05	.06
Median	.46	.57	.55	.49	.47	.48	.50	.62	.43	.36	.52	.50	.64

*In this phase both S^Rs were noncontingent.

12, 13). There were consistent and sharp decreases during the total S^R_{NC} phases (9, 10) except for subject 218.

Tables 5, 6, and 7 provide means, standard deviations, and medians for running response rates (total responses divided by total session time after post-reinforcement time was subtracted) at each experimental phase. Across phases 1 through 6 there were no systematic changes in rate when either within- or across-group comparisons were made. The recovery phases (7, 8, 11, 12, 13) did not show a consistent pattern of recovered rates for all subjects. Rates decreased during the total S^R_{NC} phases (9, 10) with the exception of subject 218.

The running and corrected response rates of subject 218 changed dramatically at phase 7. Upon observation by the experimenter, it was determined that the bird's topography of key-pecking changed from a head-thrusting to a beak-fluttering movement. No reliable nor obvious topographic changes were noted in the other subjects throughout the experiment.

Neither the corrected nor the running response rates showed consistent variation across experimental phases, although the corrected rates tended to show more variability across conditions. This difference in across-condition variability for the two measures may be a special feature of the present procedure. The PS^RP data presented below indicated that the particular locus of S^R_{NC} in the T cycle affected the durations of PS^RPs after S^R_C and S^R_{NC}.

Table 5

Overall Running Response Rates (Responses/Sec) for Subjects 218 and 203. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented

	Time Between Start of T Cycle and S^R_{NC} Delivery												
	Baseline	50"	40"	30"	20"	10"	50"	30"	30"*	50"*	50"	10"	Baseline
218:													
Mean	1.21	1.22	1.31	1.53	1.40	1.32	1.68	1.84	1.55	1.63	2.07	2.00	2.53
S.D.	.11	.12	.08	.09	.06	.13	.16	.19	.22	.15	.29	Lost data	.20
Median	1.22	1.21	1.26	1.54	1.41	1.25	1.74	1.81	1.48	1.69	2.00	2.05	2.63
203:													
Mean	.88	.83	.80	.90	1.04	.85	.83	.65	.69	.67	.68	.71	.83
S.D.	.04	.07	.05	.06	.03	.12	.05	.04	.06	.02	.06	.10	.13
Median	.89	.85	.80	.90	1.05	.83	.83	.63	.68	.68	.66	.71	.78

*In this phase both S^Rs were noncontingent.

Table 6

Overall Running Response Rates (Responses/Sec) for Subjects 455 and 483.
Means, Standard Deviations (S.D.), and Medians
Across All Experimental Phases Are Presented

	Time Between Start of T Cycle and S^R_{NC} Delivery												
	Baseline	100"	80"	60"	40"	20"	100"	60"	60"*	100"*	100"	20"	Baseline
455:													
Mean	.57	.89	.89	.84	.76	.90	1.03	.80	.43	.58	.66	.84	1.19
S.D.	.10	.05	.10	.07	.06	.05	.14	.12	.12	.11	.01	.05	.07
Median	.57	.88	.90	.81	.77	.92	1.10	.84	.37	.58	.67	.83	1.21
483:													
Mean	.62	.59	.63	.58	.57	.58	.54	.58	.46	.27	.48	.44	.51
S.D.	.07	.06	.01	.06	.04	.04	.10	.01	.08	.10	.08	.06	.11
Median	.59	.58	.64	.61	.57	.61	.57	.57	.46	.20	.47	.42	.56

*In this phase both S^Rs were noncontingent.

Table 7

Overall Running Response Rates (Responses/Sec) for Subjects 213 and 100. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented

	Time Between Start of T Cycle and S^R_{NC} Delivery												
	Baseline	200"	160"	120"	80"	40"	200"	120"	120"*	200"*	200"	40"	Baseline
213:													
Mean	.66	.65	.67	.66	.68	.61	.51	.66	.59	.23	.53	.52	.73
S.D.	.03	.03	.02	.02	.09	.02	.05	.02	.05	.05	.07	.05	.01
Median	.66	.63	.68	.65	.74	.61	.51	.67	.59	.22	.53	.53	.74
100:													
Mean	.53	.63	.64	.66	.59	.57	.60	.78	.58	.43	.57	.61	.78
S.D.	.03	.01	.02	.09	.03	.05	.04	.05	.02	.05	.05	.06	.07
Median	.53	.64	.66	.64	.60	.57	.59	.78	.56	.44	.58	.65	.80

*In this phase both S^Rs were noncontingent.

The corrected rate measure included PS^RPs. When PS^RPs were not included in the rate calculation, as with running rate, the across-condition changes in rate were generally smaller than observed in corrected rates. This analysis suggests that the running rate measure is probably a better indicator of actual changes in responding as a function of changes in the independent variable.

Post-reinforcement pause. The PS_C^RP and PS_{NC}^RP measures were determined by calculation of the mean time between S^R and the first response following S^R. Figures 7, 8, and 9 provide the data. Except for several reversals, the results were consistent both within and across groups. The following statements characterize the trends in the data (for explanation of the phases see Table 1):

(1.) Phases 1 through 4--At phase 2 both PS_C^RP and PS_{NC}^RP measures were lower than the PS_C^RP values for baseline. Also, PS_C^RP were slightly longer in duration than PS_{NC}^RPs, with the exception of subject 455 (however, in this, and several conditions in which the PS^RP values were of similar length, there was considerable overlap in standard deviations for the measures). From phase 3 to 4, all subjects showed continued increases in both measures. At phase 4, when S_{NC}^R was presented at the middle of the T cycle, both measures were approximately equal in duration for all subjects.

(2.) Phases 5 and 6--During phases 5 and 6 the PS_C^RP values consistently decreased across all subjects.

Figure 7. Mean post-reinforcement pause for subjects 218 and 203 at each temporal placement of S^{R}_{NC} within a 60 second T cycle.

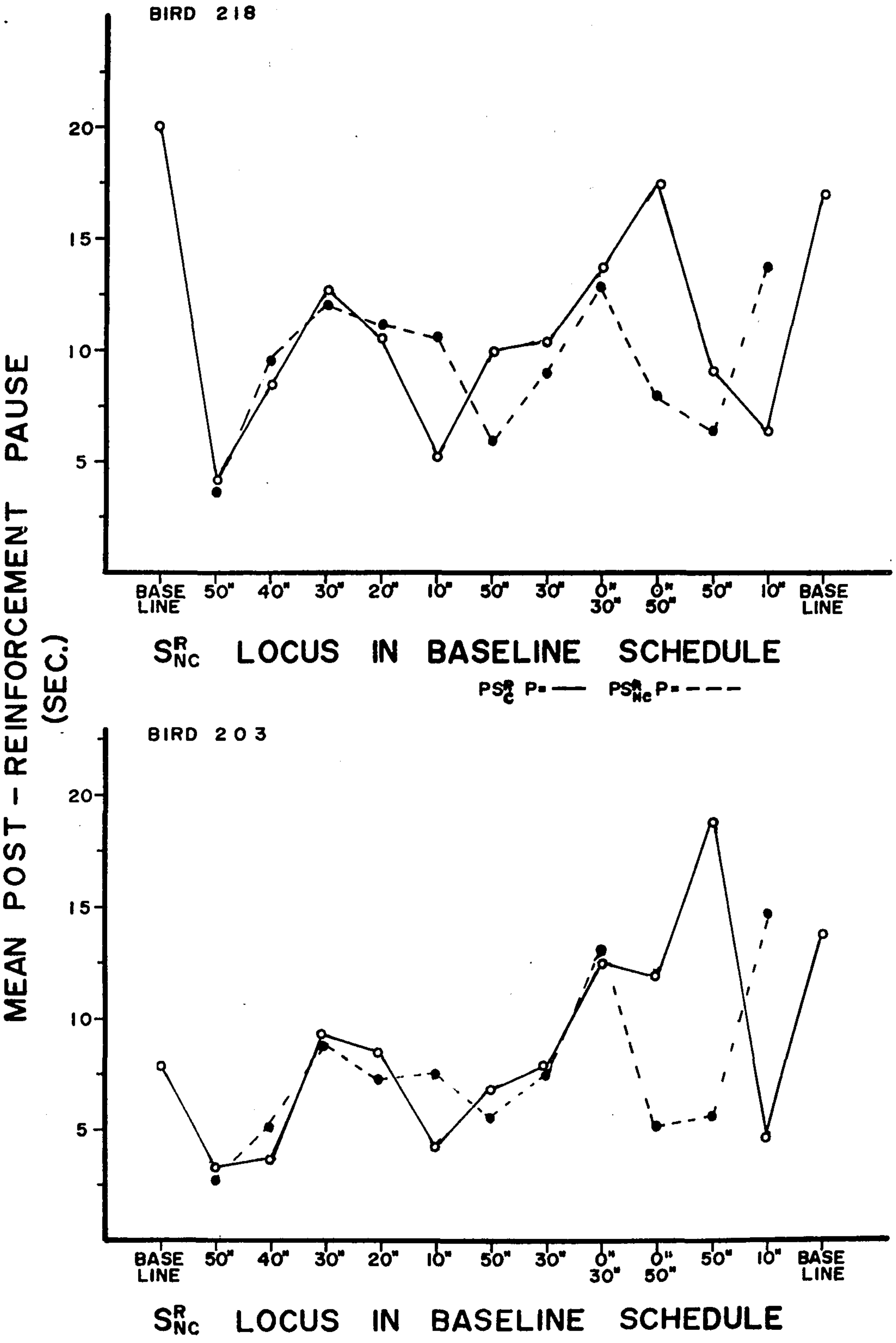

BIRD 218
MEAN POST - REINFORCEMENT PAUSE (SEC.)
20
15
10
5
BASE LINE
50"
40"
30"
20"
10"
50"
30"
0" 30"
0" 50"
50"
10"
BASE LINE
S^R_{NC} LOCUS IN BASELINE SCHEDULE
$PS^R_C P$ = ——
$PS^R_{NC} P$ = - - - -
BIRD 203
20
15
10
5
BASE LINE
50"
40"
30"
20"
10"
50"
30"
0" 30"
0" 50"
50"
10"
BASE LINE
S^R_{NC} LOCUS IN BASELINE SCHEDULE

Figure 8. Mean post-reinforcement pause for subjects 455 and 483 at each temporal placement of S^R_{NC} within a 120 second T cycle.

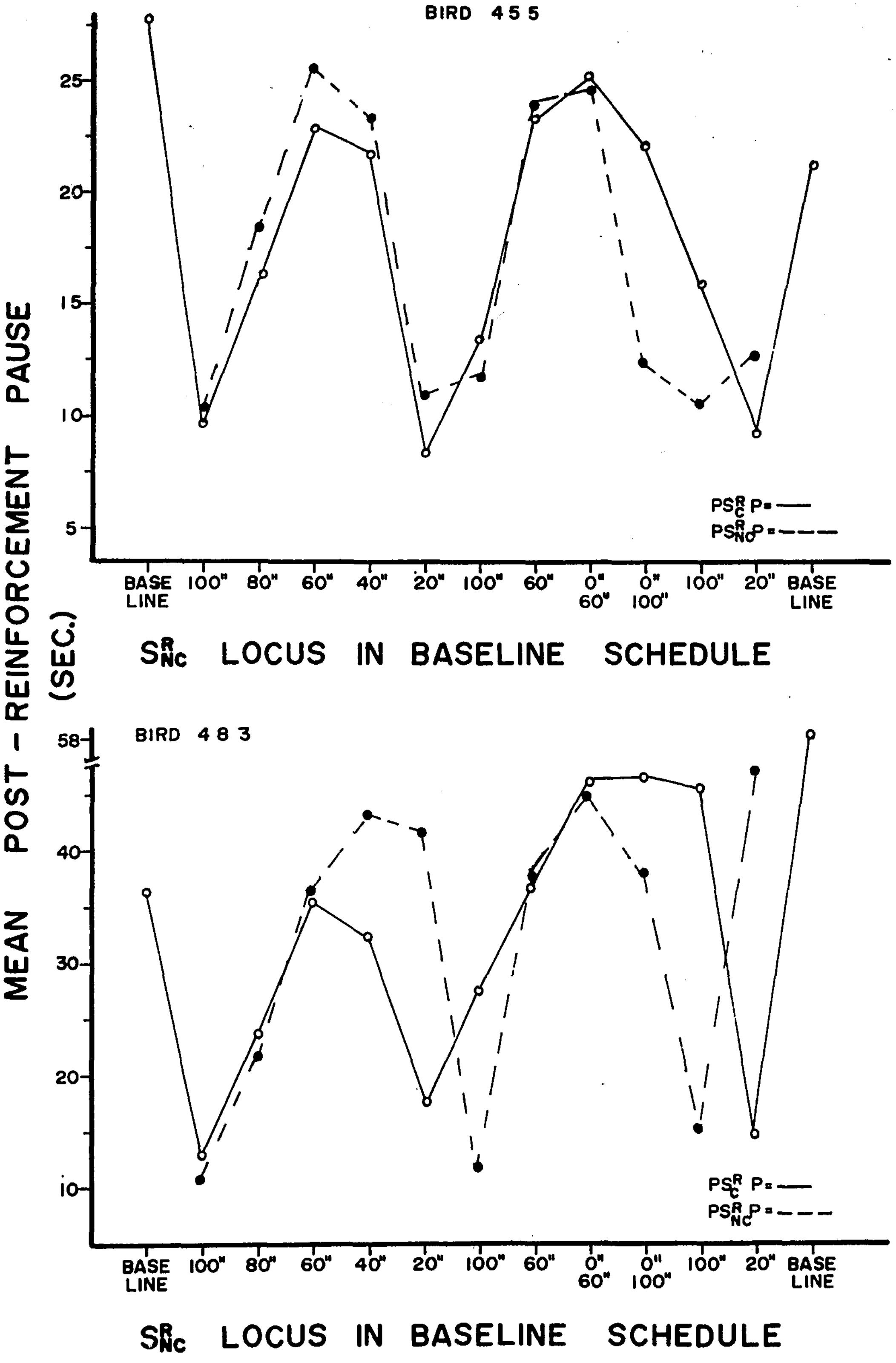
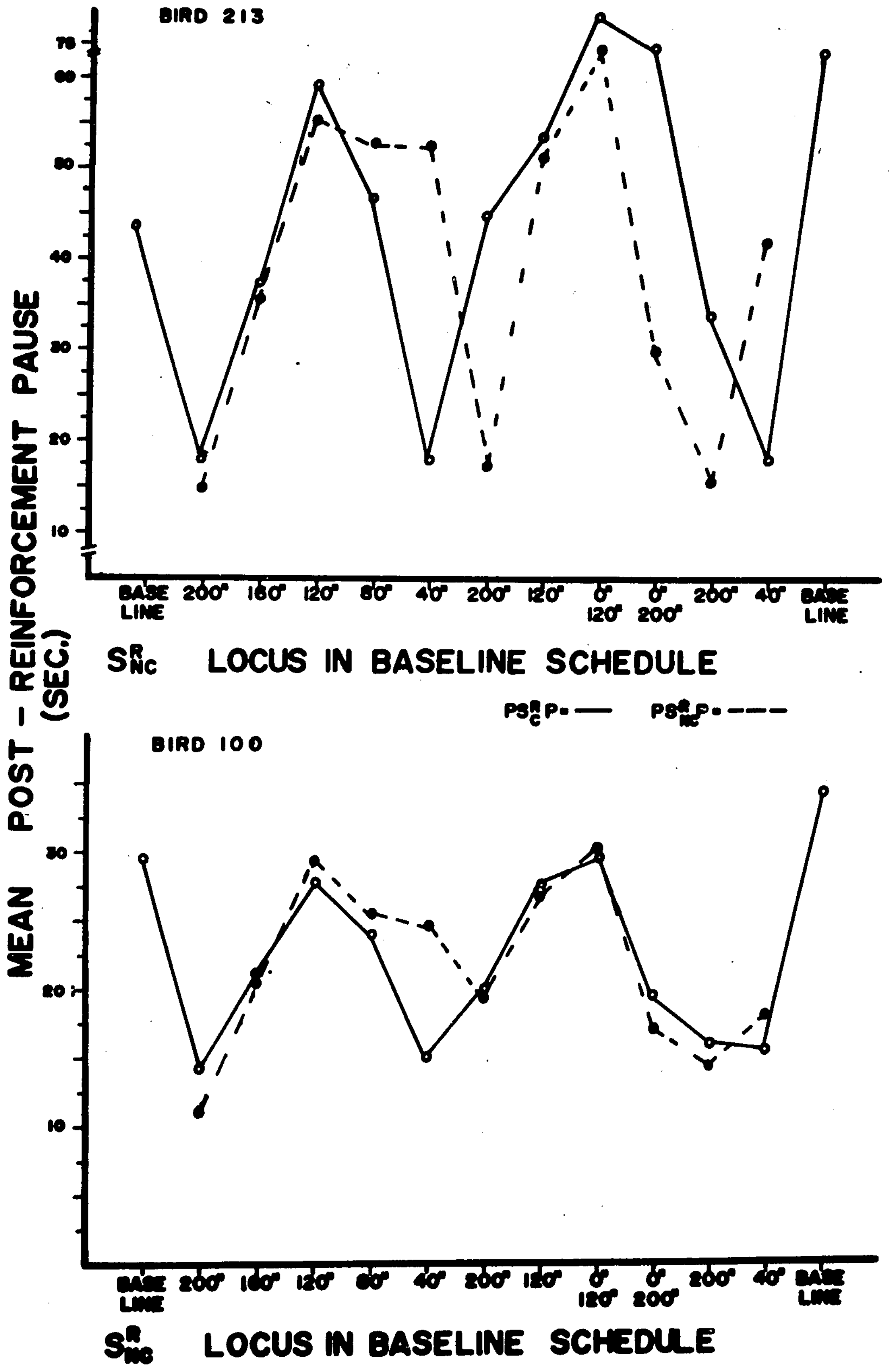

BIRD 455
MEAN POST - REINFORCEMENT PAUSE (SEC.)
25
20
15
10
5
PS^R_CP = ——
PS$^R_{NC}$P = - - -
BASE LINE
100"
80"
60"
40"
20"
100"
60"
0" 60"
0" 100"
100"
20"
BASE LINE
S$^R_{NC}$ LOCUS IN BASELINE SCHEDULE
BIRD 483
58
40
30
20
10
PS^R_CP = ——
PS$^R_{NC}$P = - - -
BASE LINE
100"
80"
60"
40"
20"
100"
60"
0" 60"
0" 100"
100"
20"
BASE LINE
S$^R_{NC}$ LOCUS IN BASELINE SCHEDULE

Figure 9. Mean post-reinforcement pause for subjects 213 and 100 at each temporal placement of S^{R}_{NC} within a 240 second T cycle.


BIRD 213
70
60
50
40
30
20
10
BASE LINE
200°
160°
120°
80°
40°
200°
120°
0° 120°
0° 200°
200°
40°
BASE LINE
S^R_{NC} LOCUS IN BASELINE SCHEDULE
$PS^R_C P$ = ——
$PS^R_{NC} P$ = - - - -
MEAN POST - REINFORCEMENT PAUSE (SEC.)
BIRD 100
30
20
10
BASE LINE
200°
160°
120°
80°
40°
200°
120°
0° 120°
0° 200°
200°
40°
BASE LINE
S^R_{NC} LOCUS IN BASELINE SCHEDULE

With the exception of subject 203 at phase 5, all $PS^R_{NC}P$s were longer than their matching PS^R_CP values. There were no systematic increases or decreases in $PS^R_{NC}P$s across the subjects, with the exception of subject 455.

(3.) Phases 7 and 11--Phases 7 and 11 were direct replications of phase 2. Whereas in phase 2 both measures were generally equal in duration, in phases 7 and 11 the PS^R_CPs were consistently longer, with the exception of subject 100 at phase 7.

(4.) Phases 8, 12, and 13--These phases were direct replications of phases 4, 6, and 1, respectively. The findings were consistent with those obtained from the initial determinations.

(5.) Phases 9 and 10--These phases consisted of total S^R_{NC}. The results paralleled those from similar phases in which S^R_C was included. There was some variability across subjects in terms of the absolute values of the PS^RPs under conditions of total S^R_{NC}.

In summary, the PS^RP data indicated that the values after S^R_C and S^R_{NC} were determined by the joint control exerted by the temporal separation variable and by the length of IS^RTs which preceded S^R_C and S^R_{NC}. The IS^RTs per se did not determine the length of PS^RPs after S^Rs. Confirmation of this comes from a comparison of phase 2 with phase 6 and phase 3 with phase 5. In these phase comparisons, times between successive S^Rs were equivalent. The difference was in whether S^R_C or S^R_{NC} was preceded by a longer $IS^{R}T$. Inspection of Figures 7-9 indicates that although the $PS^{R}Ps$ tended to be longer after S^{R}_{C} in phase 2 and after S^{R}_{NC} in phase 6, the absolute values were longer after S^{R}_{NC}. In general, a similar trend occurred in phases 3 and 5. When S^{R}_{NC} was presented in the middle of the T cycle (phase 4), $PS^{R}Ps$ after S^{R}_{C} and S^{R}_{NC} did not systematically differ. This particular finding was consistent with Shull's (1971) data on the lengths of $PS^{R}Ps$ after S^{R}_{C} and S^{R}_{NC} in temporally equated schedules.

Ratio of response rates. Mean running response rates were separately determined for (1) responding from the beginning of a T cycle to S^{R}_{NC}, and for (2) responding from S^{R}_{NC} to the beginning of the next T cycle (i.e., into S^{R}_{C}). Tables 8, 9, and 10 provide the ratios of these rates across experimental phases. A ratio was calculated in the following manner:

$$\frac{\text{Rate into } S^{R}_{NC}}{\text{Rate into } S^{R}_{NC} + \text{Rate into } S^{R}_{C}}$$

Values of .5, less than .5, or greater than .5 signify that rates into S^{R}_{NC} were equal to, less than, or greater than rates into S^{R}_{C}. Ratios are presented only for running rates because a measure unconfounded by $PS^{R}P$ time was preferred. Since running rate measures do not include $PS^{R}Ps$, it was possible to assess actual changes in responding frequency into S^{R}_{C} and S^{R}_{NC} across the experimental phases without the

Table 8

Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule*

S^R_{NC} Locus in Baseline:	Ratio of Rates	
	#218	#203
50 sec.	.41	.50
40 "	.51	.48
30 "	.50	.51
20 "	.52	.51
10 "	.56	.51
50' "	.35	.33
30 "	.50	.49
** 0 " and 30 sec.	.51	.48
** 0 " and 50' "	.40	.33
50 "	.31	.17
10 "	.55	.71

* See text for formula for rate ratios.

** In this phase both S^Rs were noncontingent.

Table 9

Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule*

S^R_{NC} Locus in Baseline:	Ratio of Rates #455	Ratio of Rates #483
50 sec.	.43	.41
40 "	.63	.50
30 "	.48	.46
20 "	.50	.36
10 "	.50	.63
50 "	.48	.36
30 "	.50	.50
** 0 " and 30 sec.	.50	.52
** 0 " and 50 "	.40	Data lost
50 "	.39	.24
10 "	.51	.41

* See text for formula for rate ratios.

** In this phase both S^Rs were noncontingent.

Table 10

Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule*

S^R_{NC} Locus in Baseline:	Ratio of Rates	
	#213	#100
50 sec.	.45	.45
40 "	.48	.49
30 "	.50	.48
20 "	.47	.48
10 "	.57	.47
50 "	.44	.43
30 "	.51	.51
** 0 " and 30 sec.	.49	.50
** 0 " and 50 "	Data lost	.50
50 "	.42	.44
10 "	.62	.53

* See text for formula for rate ratios.

** In this phase both S^Rs were noncontingent.

confounding of PS^RP.

No consistent differences in rates prior to S_C^R or S_{NC}^R were found across experimental manipulations. A large number of values fell within a range of plus or minus .10 of .50, thus indicating that subjects tended to respond into S_C^R and S_{NC}^R at generally equal rates. It is interesting to note that although the overall running rates prior to S_C^R and S_{NC}^R did not systematically change as a function of the temporal position of S_{NC}^R in the T cycle, the distributions of those rates did differ. This effect can be observed by inspection of the response patterning data in Figures 1-6. Although differences in local rates occurred, generally, an overall equilibrium was maintained. (The reader should be cautioned that the data in the figures include PS^RPs.) The present experimental design did not permit further analysis of this phenomenon.

The above results add to the growing literature that response rates prior to S_{NC}^R can occur at high and reliable rates. Specifically, particular values of schedules known as variable delay, mixed S_C^R-S_{NC}^R, autoshaping, and positive conditioned suppression have produced this result. The latter two of these procedures closely resemble Pavlov's (1927) paradigm of pairing a "neutral" stimulus (CS) with an unconditioned one (UCS). The only known free operant studies (not employing an exteroceptive stimulus) to show that S_{NC}^R can maintain response rates equal to S_C^R were done by Lang and Mankoff (1973) and by

Lattal (1973). The present study represents an addition to these special cases and further brings into focus the view that the effects of S^R_{NC} on particular responses are a function of the parameters of S^R_{NC} delivery, and its contact with ongoing responding.

While it was true that rates prior to S^R_{NC} were at times higher than or about equal to those prior to S^R_C, it cannot be assumed that S^R_{NC} rates were independent of the S^R_C variable. When S^R_C was changed to S^R_{NC} (phases 9 and 10) overall response rates as well as rates prior to both S^R_{NC}s decreased substantially, with the exception of subject 218. Thus, in the schedules studied here, it appears that in order for S^R_{NC} to control high rates, S^R_C may be necessary.

EXPERIMENT II

In Experiment I, the value of t^D was three seconds for each of the groups. In Experiment II, the subjects were reinforced for the first response in a 60 second T cycle no matter where in the interval it occurred. Such a t-schedule can be considered as fixed-interval-by-the-clock (Schoenfeld and Cole, et al., 1972). The interest was in determining if the data obtained in Experiment I were a special result of the use of a three second t^D value.

Method

Subjects. Two experimentally naive female White Carneaux pigeons, between six and eight years old, were maintained at 80% ± 3% of their *ad libitum* body weights by supplemental feeding following experimental sessions. Water and grit were available in the home cages.

Apparatus. Same as Experiment I.

Procedure. Subjects 50 and 404 were trained to peck the center response key by the method of successive approximations, after which they received 100 regular reinforcements. In the next session the subjects were exposed to a 60 second T cycle, with $\overline{T} = 1$. The first response in each T cycle (whenever it occurred) was immediately reinforced. This baseline schedule remained in effect throughout the experiment.

Following 20 days of baseline training, S^R_{NC} was added to the baseline schedule. The procedure was the same as in Experiment I, with two exceptions: (1) The first response in each T cycle produced S^R_C. (2) Not all of the phases covered in Experiment I were explored. The values of the independent variable are presented in Table 11. The subjects were successively exposed to phases 1 through 6, followed by a redetermination of two values of the independent variable.

As in Experiment I, the data for all of the analyses were based on the last five sessions at the experimental phases. Both subjects obtained 25 S^R_Cs at all phases of the study; when S^R_{NC} was included they always obtained 25 S^R_{NC}s.

Response patterning. Figures 10 and 11 provide the data for the percentage of total responses that occurred during each of the consecutive time segments. Since the results closely paralleled those obtained in similar phases of Experiment I, a detailed summary will not be made. When S^R_{NC} was at 50 seconds, subject 404 showed a trend of an increasing percentage of responses between the beginning of a T cycle and S^R_{NC}. This finding was obtained for the first determination and the recovery phase. At phase 7 subject 50 showed a steadily increasing percentage of responses in successive time segments between the beginning of the cycle and S^R_{NC}.

Table 11

Temporal Intervals Between the Beginning of T Cycle and Noncontingent Reinforcement Delivery in Experiment II

Phase	Temporal Intervals	
1	Baseline	(20)*
2	50"	(15)
3	40"	(15)
4	30"	(15)
5	20"	(15)
6	10"	(15)
7	50"	(8)
8	30"	(8)

*The number of sessions run at an experimental point are given in parentheses.

Figure 10. Percentage of responses in consecutive 5 second segments of a 60 second T cycle. The separate figures represent data for subject 404 at the different S^{R}_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^{R}_{NC}, while the functions from N to 12 represent responding from S^{R}_{NC} delivery to the end of the T cycle.

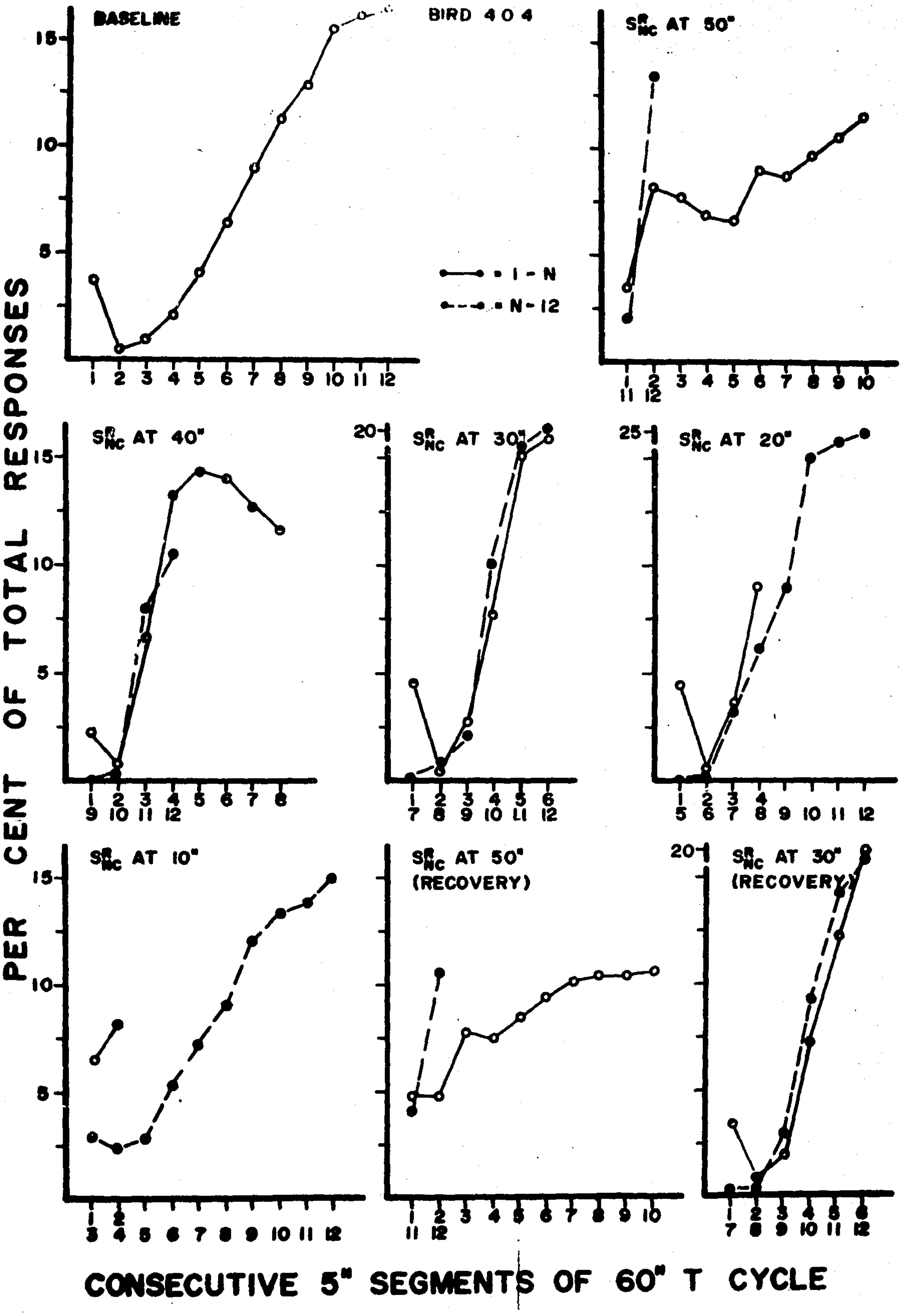
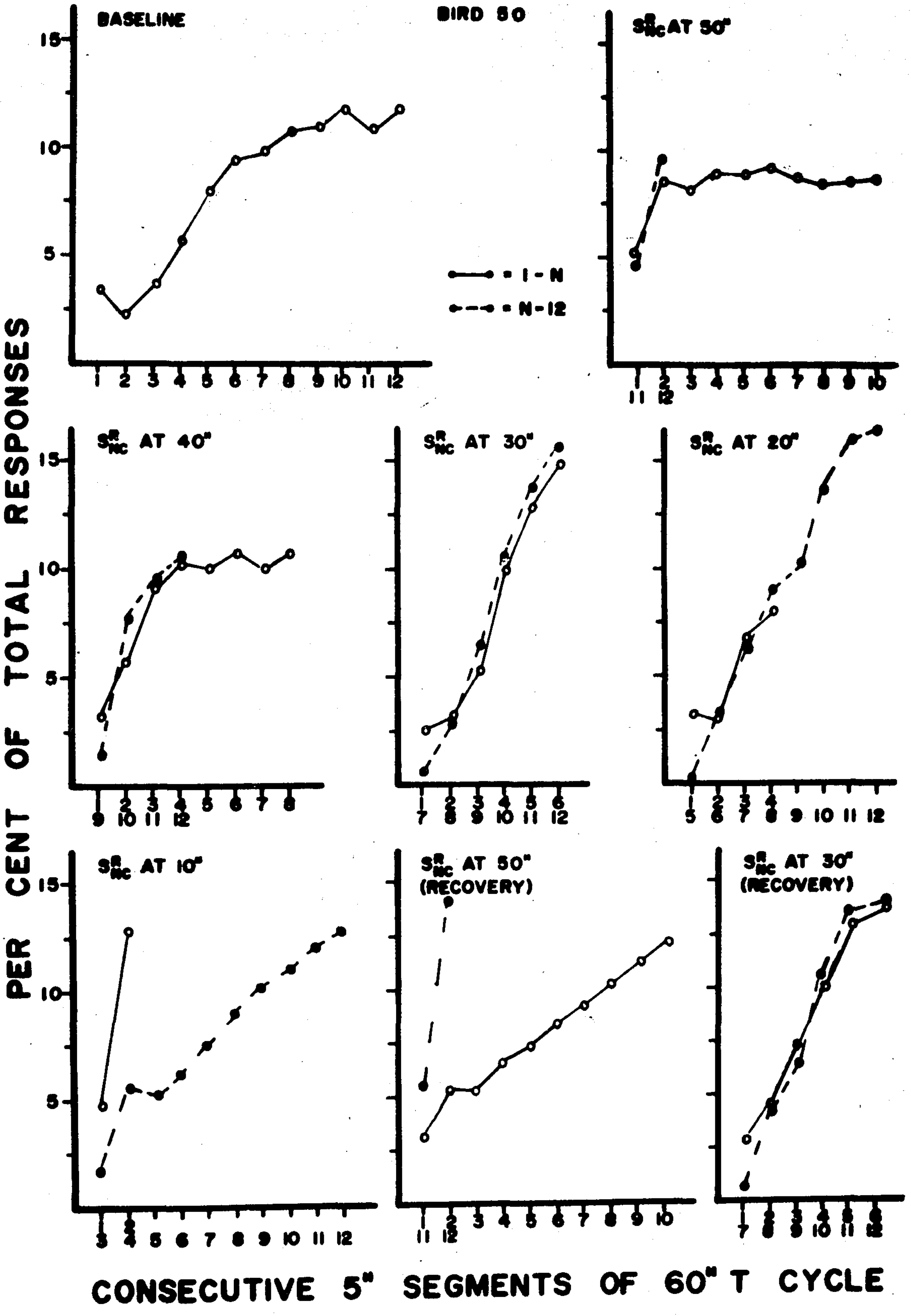

BASELINE
BIRD 404
S^R_{NC} AT 50"
●—● = I - N
●--● = N - 12
S^R_{NC} AT 40"
S^R_{NC} AT 30"
S^R_{NC} AT 20"
S^R_{NC} AT 10"
S^R_{NC} AT 50" (RECOVERY)
S^R_{NC} AT 30" (RECOVERY)
PER CENT OF TOTAL RESPONSES
CONSECUTIVE 5" SEGMENTS OF 60" T CYCLE
5
10
15
20
25
1 2 3 4 5 6 7 8 9 10 11 12

Figure 11. Percentage of responses in consecutive 5 second segments of a 60 second T cycle. The separate figures represent data for subject 50 at the different S^R_{NC} loci. The functions from 1 to N represent responding from the beginning of the T cycle to S^R_{NC}, while the functions from N to 12 represent responding from S^R_{NC} delivery to the end of the T cycle.


BASELINE
BIRD 50
S^R_{NC} AT 50"
= I - N
= N - 12
S^R_{NC} AT 40"
S^R_{NC} AT 30"
S^R_{NC} AT 20"
S^R_{NC} AT 10"
S^R_{NC} AT 50" (RECOVERY)
S^R_{NC} AT 30" (RECOVERY)
PER CENT OF TOTAL RESPONSES
5
10
15
1 2 3 4 5 6 7 8 9 10 11 12
CONSECUTIVE 5" SEGMENTS OF 60" T CYCLE

The finding of an increasing percentage of responses prior to S^R_{NC} when S^R_{NC} was delivered toward the end of the T cycle was also noted in several subjects in Experiment I, mainly at recovery phases. It is not clear whether these data represent a temporal discrimination or some other effect. There was some evidence that the finding, at least for several subjects, may have been due to increased variability. The standard deviations of data points in these instances were larger than those when a change in response patterning was not noted at recovery phases.

Response rate measures. Table 12 provides the means, standard deviations, and medians for corrected response rates at each experimental phase. No consistent trend appeared across placements. The data from phases 7 and 8 did not result in close recovery of the first determinations at those S^R_{NC} values.

Table 13 provides the same measures as Table 6 for running response rates. No systematic trends across phases emerged. Phases 7 and 8 did not produce close approximations of the rates obtained from the first determinations of those S^R_{NC} values.

Post-reinforcement pause. PS^R_CP and $PS^R_{NC}P$ measures were calculated as in Experiment I. The data in Figure 12 are nearly in complete agreement with those from similar phases of Experiment I.

Table 12

Overall Corrected Response Rates (Responses/Sec) for Subjects 404 and 50. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented

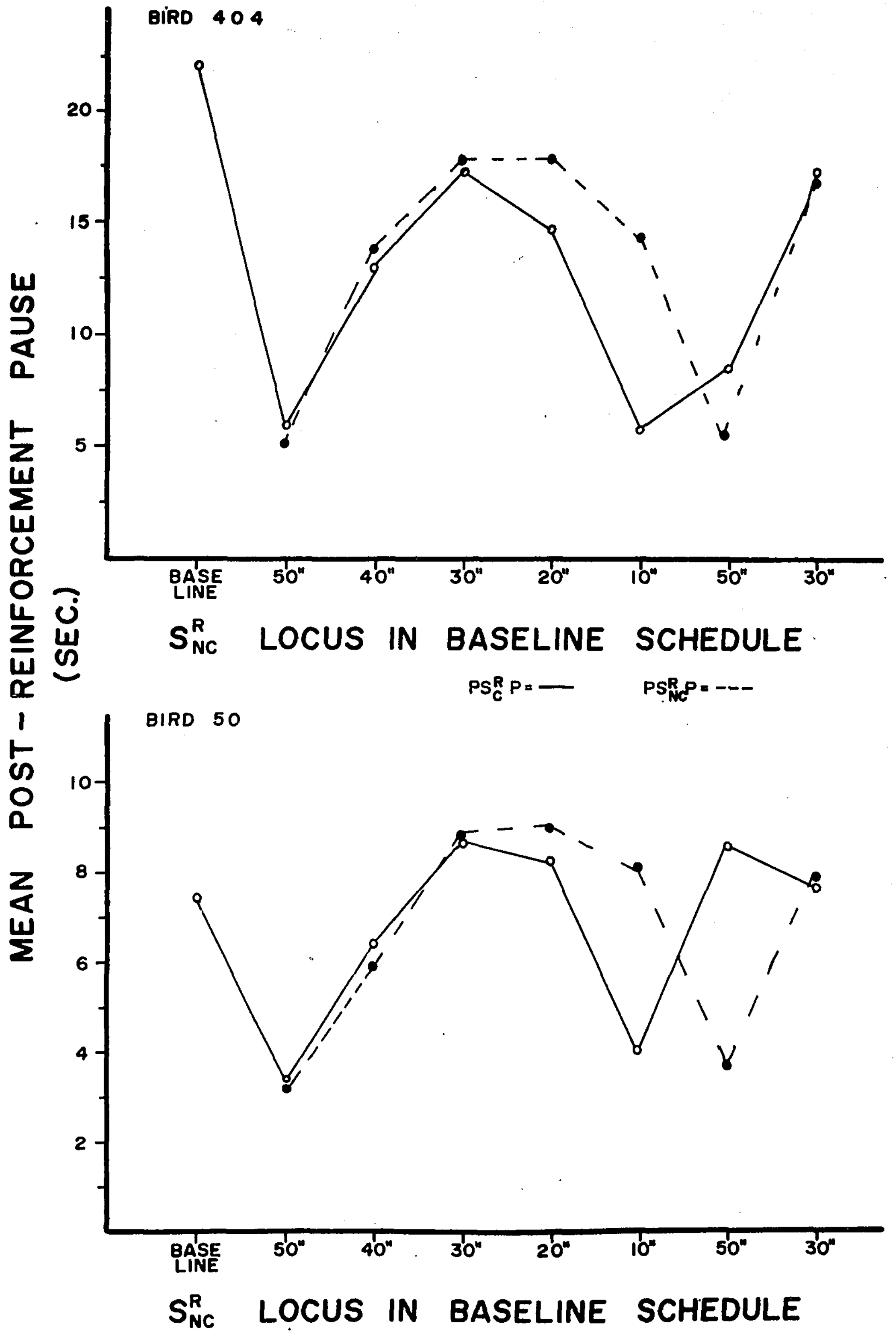
	Time Between Start of T Cycle and S^{R}_{NC} Delivery							
	Base-line	50"	40"	30"	20"	10"	50"	30"
404:								
Mean	.68	.85	.66	.83	.55	.78	.76	.88
S.D.	.06	.03	.03	.07	.01	.05	.01	.08
Median	.67	.83	.68	.81	.54	.82	.76	.86
50:								
Mean	.43	.51	.63	.36	.35	.57	.39	.46
S.D.	.02	.06	.05	.03	.07	.04	.07	.05
Median	.44	.50	.64	.37	.36	.59	.37	.45

Table 13

Overall Running Response Rates (Responses/Sec) for Subjects 404 and 50. Means, Standard Deviations (S.D.), and Medians Across All Experimental Phases Are Presented

	Time Between Start of T Cycle and S^{R}_{NC} Delivery							
	Base-line	50"	40"	30"	20"	10"	50"	30"
404:								
Mean	.70	.62	1.12	.84	.76	.87	.51	1.00
S.D.	.04	.06	.04	.06	.09	.08	.08	.07
Median	.72	.61	1.11	.82	.80	.86	.48	.99
50:								
Mean	.80	.94	.84	1.16	.78	.99	.96	1.17
S.D.	.10	.02	.05	.05	.01	.08	.05	.11
Median	.76	.94	.84	1.15	.78	.98	.96	1.19

Figure 12. Mean post-reinforcement pause for subjects 404 and 50 at each temporal placement of S^R_{NC} within a 60 second T cycle.


BIRD 404
20
15
10
5
BASE LINE
50"
40"
30"
20"
10"
50"
30"
S^R_{NC} LOCUS IN BASELINE SCHEDULE
$PS^R_C P$ = ——
$PS^R_{NC} P$ = - - -
BIRD 50
10
8
6
4
2
BASE LINE
50"
40"
30"
20"
10"
50"
30"
S^R_{NC} LOCUS IN BASELINE SCHEDULE
MEAN POST - REINFORCEMENT PAUSE (SEC.)

Ratio of response rates. Rate ratios, shown in Table 14, were determined as in Experiment I. The results were consistent with those obtained in Experiment I.

Table 14

Ratio of Running Response Rates into S^R_C and S^R_{NC} as a Function of the Locus of S^R_{NC} in the Baseline Schedule*

S^R_{NC} Locus in Baseline	Ratio of Rates	
	#404	#50
50 sec.	.36	.45
40 "	.43	.51
30 "	.48	.49
20 "	.46	.42
10 "	.60	.60
50 "	.34	.36
30 "	.49	.51

* See text for the formula for rate ratios.

GENERAL DISCUSSION

The results from Experiments I and II demonstrate that the intruded stimulus paradigm (Farmer and Schoenfeld, 1966) has potential as a design for assessing effects of noncontingent reinforcement. By establishing and keeping in force a baseline schedule of S^R_C, responding was maintained so that the effects of the parameters of S^R_{NC} on that responding could be determined. Part of the difficulty with many of the independent and dependent variables discussed in the Introduction was that with continued exposure to S^R_{NC} measured rates of responding declined to zero or near-zero levels. The methodology employed in the present investigations offers one possible solution to the problem.

Experiments I and II reported above indicated that S^R_{NC} had clear effects on key-pecking. At the same time, it should be re-stated that this control was not independent of the fact that S^R_C was part of the total schedule variable. In fact, variations in the dependent variables were a result of the temporal positioning of S^R_{NC} with respect to S^R_C. Lattal (1973) has shown that when different exteroceptive stimuli for a two component multiple schedule of S^R_C and S^R_{NC} were removed, rats maintained equivalent rates in the two components when IS^RTs were equated and component lengths were relatively short. Perhaps very different results would have been obtained in the present experiments if the intervals between successive S^Rs were differentially cued.

Farmer and Schoenfeld (1966) developed the intruded stimulus paradigm in order to study the effects of stimuli added to a baseline maintained by S^R_C. Across sessions, pigeons received a 6 second change in key light color at different temporal loci within a FI 60 second schedule. The effects of the intruded stimulus depended on the temporal locus of the intrusion. In a subsequent study, Snapper, Schoenfeld, and Shimoff (1971) employed a procedure similar to Farmer and Schoenfeld's except for the use of electric shock as the intruded stimulus. Several comparisons between those studies and the present one seem noteworthy.

In the Farmer and Schoenfeld study, intrusion of the light toward the beginning of the interval had little effect on responding relative to responding when only the FI was in effect. Overall response rates were reduced when the stimulus was placed toward the end of the interval (immediately before S^R_C). The addition of the stimulus in the middle of the interval resulted in positively accelerated response rates prior to the intruded stimulus and the S^R_C. The rate increases prior to S^R_C were larger than those prior to the intruded stimulus.

Snapper, Schoenfeld, and Shimoff found that the addition of a .05 ma. shock toward the beginning and the middle of a fixed interval resulted in response rate increases leading to the shock, followed by response rate increases terminated by S^R_C. The rates preceding the shock were higher when it was located in the middle of the interval. For both of these conditions, the response rate increases prior to S^R_C were larger than those preceding the shock. Shock presentation immediately before S^R_C resulted in progressive rate increases into the shock and S^R_C, but overall response rates were decreased when compared to responding maintained only by S^R_C.

The data from the present experiments indicated that higher response rates were maintained prior to the intruded stimulus (S^R_{NC}) than in the two studies cited above when comparisons were made between similar temporal loci of intrusion. For example, addition of S^R_{NC} in the middle of each of the fixed intervals investigated produced indistinguishable response rates prior to S^R_{NC} and S^R_C. Also, presenting S^R_{NC} just prior to S^R_C did not result in an overall reduction of response rate as in the Farmer and Schoenfeld and Snapper, Schoenfeld, and Shimoff studies. The extent to which the data resulted from the use of food as the intruded stimulus remains to be fully determined. Perhaps the use of some other reinforcing stimulus would provide pertinent data (e.g., electrical stimulation of the brain [ESB]). In addition to serving as a reinforcer, at very mild intensities ESB would resemble Farmer and Schoenfeld's "neutral" stimulus. At very strong intensities, ESB would be similar to Schoenfeld, Snapper, and

Shimoff's "aversive" stimulus. Thus, through the parametric manipulation of a single stimulus, an individual subject comparison can be made of so-called "neutral," "reinforcing" and "aversive" intruded stimuli.

REFERENCES

REFERENCES

Appel, J. B. and Hiss, R. H. The discrimination of contingent from non-contingent reinforcement. *Journal of Comparative and Physiological Psychology*, 1962, *55*, 37-39.

Azrin, N. H. and Hake, D. F. Positive conditioned suppression: Conditioned suppression using positive reinforcers as the unconditioned stimuli. *Journal of the Experimental Analysis of Behavior*, 1969, *12*, 167-173.

Azzi, R., Fix, D. S. R., Keller, F. S. and Rocha e Silva, M. I. Exteroceptive control of response under delayed reinforcement. *Journal of the Experimental Analysis of Behavior*, 1964, *7*, 159-162.

Baer, D. M. Escape and avoidance response of pre-school children to two schedules of reinforcement withdrawal. *Journal of the Experimental Analysis of Behavior*, 1960, *3*, 155-158.

Benassi, V. A., Weil, J. and Lanson, R. N. Temporal variations between contingent and probabilistic noncontingent reinforcement. Paper read at American Psychological Association Meeting, New Orleans, August 30 - September 3, 1974.

Bilbrey, J., and Winokur, S. Controls for and constraints on auto-shaping. *Journal of the Experimental Analysis of Behavior*, 1973, *20*, 323-332.

Boakes, R. A. Response decrements produced by extinction and by response-independent reinforcement. Journal of the Experimental Analysis of Behavior, 1973, 19, 293-302.

Bolles, R. C. Reinforcement, expectancy, and learning. Psychological Review, 1972, 79, 394-409.

Brady, J. V. Motivational-emotional factors and intracranial self-stimulation. In D. E. Sheer (Ed.), Electrical Stimulation of the Brain. Austin: University of Texas Press, 1961, Chapter 30.

Breland, K. and Breland, M. The misbehavior of organisms. American Psychologist, 1961, 16, 661-664.

Brown, P. and Jenkins, H. M. Auto-shaping of the pigeon's key peck. Journal of the Experimental Analysis of Behavior, 1968, 11, 1-8.

Brownstein, A. J. and Pliskoff, S. S. Some effects of relative reinforcement rate and changeover delay in response-independent concurrent schedules of reinforcement. Journal of the Experimental Analysis of Behavior, 1968, 11, 683-688.

Campbell, P., Phillips, E., Fixsen, D. and Chumbaugh, C. Free operant response reinstatement during extinction and time-contingent (DRO) reward. Psychological Reports, 1968, 22, 563-569.

Catania, A. C. Concurrent operants. In W. K. Honig (Ed.), Operant Behavior: Areas of Research and Application. New York: Appleton-Century-Crofts, 1966.

Cole, B. K. Experiment 3: Schedules of concurrently contingent and noncontingent reinforcement. In F. J. McGuigan and D. B. Lumsden (Eds.), _Contemporary Approaches to Conditioning and Learning_. Washington: V. H. Winston and Sons, 1973.

Cole, B. K., Lachter, G. D. and Schoenfeld, W. N. Experiment 1: Variable delay of reinforcement. In F. J. McGuigan and D. B. Lumsden (Eds.), _Contemporary Approaches to Conditioning and Learning_. Washington: V. H. Winston and Sons, 1973.

D'Andrea, T. Avoidance of timeout from response-independent reinforcement. _Journal of the Experimental Analysis of Behavior_, 1971, _15_, 319-325.

Davidson, A. B., Davis, D. J. and Cook, L. A rapid automatic technique for generating operant key-press behavior in rats. _Journal of the Experimental Analysis of Behavior_, 1971, _15_, 123-127.

Davis, H. and Hubbard, J. An analysis of superstitious behavior in the rat. _Behaviour_, 1972, _43_, 1-12.

Dews, P. B. Free-operant behavior under conditions of delayed reinforcement. I. CRF - type schedules. _Journal of the Experimental Analysis of Behavior_, 1960, _3_, 221-234.

Edwards, D. D., Peek, V. and Wolfe, F. Independently delivered food decelerates fixed ratio rates. _Journal of the Experimental Analysis of Behavior_, 1970, _14_, 301-307.

Edwards, D. D., West, J. R., and Jackson, V. The role of contingencies in the control of behavior. *Psychonomic Science*, 1968, *10*, 39-40.

Estes, W. K. Discriminative conditioning. I. A discriminative property of conditioned anticipation. *Journal of Experimental Psychology*, 1943, *32*, 150-155.

Estes, W. K. Discriminative conditioning. II. Effects of a Pavlovian conditioned stimulus upon a subsequently established operant response. *Journal of Experimental Psychology*, 1948, *38*, 173-177.

Farmer, J. Properties of behavior under random interval reinforcement schedules. *Journal of the Experimental Analysis of Behavior*, 1963, *6*, 607-616.

Farmer, J. and Schoenfeld, W. N. Varying temporal placement of an added stimulus in a fixed-interval schedule. *Journal of the Experimental Analysis of Behavior*, 1966, *9*, 142-148.

Farthing, G. W. Effect of a signal previously paired with free food on operant response rates in pigeons. *Psychonomic Science*, 1971, *23*, 343-344.

Ferster, C. B. Sustained behavior under delayed reinforcement. *Journal of Experimental Psychology*, 1953, *45*, 27-45.

Ferster, C. B. and Hammer, C. Variables determining the effects of delay in reinforcement. *Journal of the Experimental Analysis of Behavior*, 1965, *8*, 243-254.

Ferster, C. B. and Skinner, B. F. Schedules of Reinforcement. New York: Appleton-Century-Crofts, 1957.

Gamzu, E. and Schwan, E. Autoshaping and automaintenance of a key-press response in squirrel monkeys. Journal of the Experimental Analysis of Behavior, 1974, 21, 361-371.

Gamzu, E. and Schwartz, B. The maintenance of key pecking by stimulus-contingent and response-independent food presentation. Journal of the Experimental Analysis of Behavior, 1973, 19, 65-72.

Gamzu, E. and Williams, D. R. Classical conditioning of a complex skeletal response. Science, 1971, 171, 923-925.

Gamzu, E. and Williams, D. R. Associative factors underlying the pigeon's key-pecking in auto-shaping procedures. Journal of the Experimental Analysis of Behavior, 1973, 19, 225-232.

Gardner, W. M. Auto-shaping in bobwhite quail. Journal of the Experimental Analysis of Behavior, 1969, 12, 279-281.

Gonzalez, F. A. Effects of partial reinforcement (25%) in an autoshaping procedure. Bulletin of Psychonomic Science, 1973, 2(5A), 299-301.

Hake, D. F. and Powell, J. Positive reinforcement and suppression from the same occurrence of the unconditioned stimulus in a positive conditioned suppression procedure. Journal of the Experimental Analysis of Behavior, 1970, 14, 247-257.

Halliday, M. S. and Boakes, R. A. Behavioral contrast and response-independent reinforcement. Journal of the Experimental Analysis of Behavior, 1971, 16, 429-434.

Henton, W. W. and Brady, J. V. Operant acceleration during a pre-reward. Journal of the Experimental Analysis of Behavior, 1970, 13, 205-209.

Herrnstein, R. J. Superstition: A corollary of the principles of operant conditioning. In W. K. Honig, Operant Behavior: Areas of Research and Application. New York: Appleton-Century-Crofts, 1966.

Herrnstein, R. J. and Loveland, R. J. Food-avoidance in hungry pigeons, and other perplexities. Journal of the Experimental Analysis of Behavior, 1972, 18, 369-383.

Herrnstein, R. J. and Morse, W. H. Some effects of response independent positive reinforcement on maintained operant behavior. Journal of the Experimental Analysis of Behavior, 1957, 50, 461-467.

Hursh, S. R., Navarick, D. J. and Fantino, E. "Automaintenance": the role of reinforcement. Journal of the Experimental Analysis of Behavior, 1974, 21, 117-124.

Jenkins, H. M. and Moore, B. R. The form of the auto-shaped response with food or water reinforcers. Journal of the Experimental Analysis of Behavior, 1973, 20, 163-181.

Kelly, D. D. Long term prereward suppression in monkeys unaccompanied by cardiovascular conditioning. Journal of the Experimental Analysis of Behavior, 1973a, 20, 93-104.

Kelly, D. D. Suppression of random-ratio and acceleration of temporally spaced responding by the same prereward stimulus in monkeys. *Journal of the Experimental Analysis of Behavior*, 1973b, *20*, 363-373.

Kellogg,W. N. "Superstitious" behavior in animals. *Psychological Review*, 1949, *56*, 172-175.

Lachter, G. D. Some temporal parameters of non-contingent reinforcement. *Journal of the Experimental Analysis of Behavior*, 1970, *16*, 207-217.

Lachter, G. D., Cole, B. K. and Schoenfeld, W. N. Response rate under varying frequency of non-contingent reinforcement. *Journal of the Experimental Analysis of Behavior*, 1971, *15*, 233-236.

Lang, J. and Mankoff, R. Experiment 2: Variable delay and noncontingent reinforcement. In F. J. McGuigan and D. B. Lumsden (Eds.), *Contemporary Approaches to Conditioning and Learning*. Washington: V. H. Winston and Sons, 1973.

Lattal, K. A. Response-reinforcer independence and conventional extinction after fixed-interval and variable-interval. *Journal of the Experimental Analysis of Behavior*, 1972, *18*, 133-140.

Lattal, K. A. Response-reinforcer dependence and independence in multiple and mixed schedules. *Journal of the Experimental Analysis of Behavior*, 1973, *20*, 265-271.

Lattal, K. A., and Maxey, G. C. Some effects of response-independent reinforcers in multiple schedules. *Journal of the Experimental Analysis of Behavior*, 1971, *16*, 225-231.

Leitenberg, H. Is time-out from positive reinforcement an aversive event? Psychological Bulletin, 1965, 64, 428-441.

LoLordo, V. M. Facilitation of food-reinforced responding by a signal for response-independent food. Journal of the Experimental Analysis of Behavior, 1971, 15, 49-55.

LoLordo, V. M., McMillan, J. C. and Riley, A. L. The effects upon food-reinforced pecking and treadle-pressing of auditory and visual signals for response-independent food. Learning and Motivation, in press.

Meltzer, D., and Brahlek, J. A. Conditioned suppression and conditioned enhancement with the same positive UCS: An effect of CS duration. Journal of the Experimental Analysis of Behavior, 1970, 13, 67-73.

Miczek, K. A. and Grossman, S. P. Positive conditioned suppression: effects of CS duration. Journal of the Experimental Analysis of Behavior, 1971, 15, 243-247.

Millenson, J. R., and Hendry, D. P. Quantification of response suppression in conditioned anxiety training. Canadian Journal of Psychology, 1967, 21, 242-252.

Moore, B. R. The role of directed Pavlovian reactions in simple instrumental learning in the pigeon. In R. A. Hinde and J. Stevenson-Hinde (Eds.), Constraints on Learning. New York: Academic Press, 1973.

Neuringer, A. Superstitious key pecking after three peck-produced reinforcements. Journal of the Experimental Analysis of Behavior, 1970, 13, 127-134.

Neuringer, A. Pigeons respond to produce periods in which rewards are independent of responding. Journal of the Experimental Analysis of Behavior, 1973, 19, 39-54.

Pavlov, I. P. Conditioned Reflexes. Trans. by G. V. Anrep. London: Oxford University Press, 1927.

Pierce, C. H., Hanford, P. V. and Zimmerman, J. Effects of different delay of reinforcement procedures on variable-interval responding. Journal of the Experimental Analysis of Behavior, 1972, 18, 141-146.

Rachlin, H. and Baum, W. M. Effects of alternative reinforcement: Does the source matter? Journal of the Experimental Analysis of Behavior, 1972, 18, 231-241.

Razran, G. H. S. Decremental and incremental effects of distracting stimuli upon the CRS of 24 adult human subjects (inhibition and disinhibition?). Journal of Experimental Psychology, 1939, n.v., 24.

Reid, R. L. The role of the reinforcer as a stimulus. British Journal of Psychology, 1957, 49, 292-309.

Rescorla, R. A. Pavlovian conditioning and its proper control procedures. Psychological Review, 1967, 74, 71-80.

Rescorla, R. A and LoLordo, V. M. Inhibition of avoidance behavior. Journal of Comparative and Physiological Psychology, 1965, 59, 406-412.

Rescorla, R. A. and Skucy, J. C. Effect of response-independent reinforcers during extinction. Journal of Comparative and Physiological Psychology, 1969, 67, 381-389.

Ricci, J. A. Key pecking under response-independent food presentation after long simple and compound stimuli. *Journal of the Experimental Analysis of Behavior*, 1973, *19*, 509-516.

Schoenfeld, W. N., Cole, B. K., Blaustein, J., Lachter, G. D., Martin, J. M. and Vickery, C. *Stimulus Schedules: The t- Systems*. New York: Harper and Row, 1972.

Schoenfeld, W. N. and Farmer, J. Reinforcement schedules and the behavior stream. In W. N. Schoenfeld (Ed.), *The Theory of Reinforcement Schedules*. New York: Appleton-Century-Crofts, 1970.

Schwartz, B. The role of positive conditioned reinforcement in the maintenance of keypecking which prevents delivery of primary reinforcement. *Psychonomic Science*, 1972, *28*, 277-278.

Schwartz, B. Maintenance of key pecking by response-independent food presentation: The role of the modality of the signal for food. *Journal of the Experimental Analysis of Behavior*, 1973, *20*, 17-22.

Schwartz, B. and Williams, D. R. The role of the response-reinforcer contingency in negative automaintenance. *Journal of the Experimental Analysis of Behavior*, 1972a, *17*, 351-357.

Schwartz, B. and Williams, D. R. Two different kinds of key peck in the pigeon: Some properties of responses maintained by negative and positive response-reinforcer contingencies. Journal of the Experimental Analysis of Behavior, 1972b, 18, 201-216.

Seligman, M. E. P. On the generality of the laws of learning. Psychological Review, 1970, 77, 406-418.

Shull, R. L. The response-reinforcement dependency in fixed-interval schedules of reinforcement. Journal of the Experimental Analysis of Behavior, 1970, 14, 55-60.

Shull, R. L. Postreinforcement pause duration on fixed-interval and fixed-time schedules of food reinforcement. Psychonomic Science, 1971, 23, 77-78.

Sidman, M. and Fletcher, F. G. A demonstration of auto-shaping with monkeys. Journal of the Experimental Analysis of Behavior, 1968, 11, 307-310.

Skinner, B. F. The Behavior of Organisms. New York: Appleton, 1938.

Skinner, B. F. "Superstition" in the pigeon. Journal of Experimental Psychology, 1948, 38, 168-172.

Smith, J. B. Effects of response rate, reinforcement frequency, and the duration of a stimulus preceding response-independent food. Journal of the Experimental Analysis of Behavior, 1974, 21, 215-221.

Smith, S. G. and Smith, W. M. Auto-shaping: A three-manipulanda technique for dogs. Psychological Record, 1972, 22, 377-380.

Snapper, A. G., Schoenfeld, W. N. and Shimoff, E. H. Varying temporal location and intensity of an added electrical stimulus in a fixed-interval schedule. Proceedings of the 79th Annual Convention, APA, 1971, 705-706.

Spradlin, J. E., Fixsen, D. L. and Girardeau, F. L. Reinstatement of an operant response by the delivery of reinforcement during extinction. Journal of Experimental Child Psychology, 1969, 7, 96-100.

Spradlin, J. E., Girardeau, F. L. and Hom, G. L. Stimulus properties of reinforcement during extinction of a free operant response. Journal of Experimental Child Psychology, 1966, 4, 369-390.

Squier, L. H. Auto-shaping key response with fish. Science, 1969, 17, 177-178.

Staddon, J. E. R. Temporal control and the theory of reinforcement schedules. In R. M. Gilbert and J. R. Millenson (Eds.), Reinforcement: Behavioral Analyses. New York: Academic Press, 1972.

Staddon, J. E. R. On the notion of cause, with applications to behaviorism. Behaviorism, 1973, 1, 25-73.

Staddon, J. E. R. and Simmelhag, V. L. The "superstition" experiment: A reexamination of its implications for the principle of adaptive behavior. Psychological Review, 1971, 78, 3-43.

Thomas, J. R. Time-out avoidance from a behavior-independent contingency. Psychonomic Science, 1965, 3, 217-218.

Wasserman, E. A. Pavlovian conditioning with heat reinforcement produces stimulus-directed pecking in chicks. Science, 1973, 181, 875-877.

Wilkie, D. M. Variable-time reinforcement in multiple and concurrent schedules. Journal of the Experimental Analysis of Behavior, 1972, 17, 59-66.

Williams, D. R. and Williams, H. Auto-maintenance in the pigeon: Sustained pecking despite contingent non-reinforcement. Journal of the Experimental Analysis of Behavior, 1969, 12, 511-520.

Yerkes, R. S. The mental life of monkeys and apes: A study of ideational behavior. Behavior Monograph, 1916, 3, No. 12.

Zeiler, M. D. Fixed and variable schedules of response independent reinforcement. Journal of the Experimental Analysis of Behavior, 1968, 11, 405-414.