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Effects of Noncontingently Intruded Light and Shock on Fixed Interval Responding

James N. Chan

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.

1980

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ABSTRACT

Effects of Noncontingently Intruded Light and Shock
on Fixed Interval Responding

by

Ramesh Shah

Adviser: Dr. Brett Cole

Light (S^N) and Shock (S^{-R}), were noncontingently intruded on responding maintained on a fixed interval schedule of positive reinforcement (S^R). Starting from the placement near the end of the fixed interval cycle, the temporal placements of S^N and S^{-R} were systematically but independently shifted across different locations within the fixed interval, for each of the 12 subjects. These 12 subjects were divided into four groups of three each. These groups differed from each other only with respect to the variable of S^{-R} probability. During later phases of the experiment, only one stimulus at a time (first S^N alone and then S^{-R} alone) was intruded at the same temporal placements as those used previously.

Some of the principal findings were: a) The temporal relationship between S^N and S^R played a more critical role in producing changes in baseline behavior than that between $S^N$and S^{-R} or that between S^{-R} and S^R. b) When S^N occupied the terminal segment of the fixed interval, S^{-R} probability of 1.00 facilitated responding during S^N but S^{-R} probability of less than 1.00 suppressed responding during S^N. c) Following the removal of S^{-R} completely and presenting S^N alone, effects on the responding during S^N extinguished faster for the group with the S^{-R} probability of 1.00 than the same for the groups with intermediate S^{-R} probability.

CONTENTS

INTRODUCTION

The behavior of a living organism may be viewed as a continuous stream which goes through orderly changes as a result of (among other things) different stimuli impinging upon it. In any given experiment, one or more of these stimuli may be selected for manipulation. Experimental studies falling within different areas of the conditioning literature can be distinguished on the basis of the number, type and nature of manipulation of the stimuli manipulated.

[illegible] Schoenfeld (1960) provided an example of a paradigm for exploring stimulus effects on [illegible] operant behavior. [illegible] introduced an initially neutral stimulus [illegible] upon the baseline of behavior maintained on a [illegible] fixed interval schedule of [illegible] reinforcement [illegible], and varied the temporal location of [illegible] interval. [illegible] control [illegible] related [illegible]:

[illegible] b) [illegible] interval [illegible] and a [illegible] c) [illegible] stimulus [illegible] the next [illegible] stimulus but in a substantially increased [illegible] the stimulus onset through the end of the interval.

[illegible] conditioned [illegible]

stimulus itself may be of a positively reinforcing (... enaser, 1975) or a negatively reinforcing nature (Shaber, Hansen, ... Schoenfeld, 197..). When more than one type of intruded stimulus is used in a single setting, the possible permutations become manifold. The present experiment explores the effect of intruding two stimuli-light and electric shock - upon the food-maintained baseline behavior.

The paradigm for conditioning to which the present study is originally related is 'Conditioned Emotional Response' (C.E.R.). The basic procedure in ... studies is noncontingent intrusion of a pair of stimuli (an initially 'neutral' stimulus followed by a 'aversive' stimulus, generally referred to as CS and US, respectively, by the investigators who use this procedure upon a stable ... [illegible] ... [illegible] ... momic ... [illegible] ... US ... two ... stimuli.

[illegible] ... 1951. ... [illegible] ... a fixed interval schedule of ... [illegible] ... i, ... [illegible] ... [illegible] ... view of ... [illegible] ... [illegible] different investigators [illegible] have used [illegible] procedure. [illegible] [illegible], [illegible] 'anxiety' has often been replaced by the [illegible], 'fear'.

[illegible] (19[illegible]) conducted a series of [illegible] aimed at analyzing the effective [illegible] of [illegible] conditioned 'anxiety' response. [illegible] to be a function of both [illegible] [illegible] [illegible]. It [illegible] found that the [illegible] concomitant [illegible] [illegible]. [illegible] a positive [illegible] [illegible], and [illegible] the [illegible] [illegible] [illegible], [illegible], [illegible] [illegible] (in [illegible] Schaub, [illegible]). The [illegible]: a) [illegible] greater the [illegible], the [illegible] conditioned [illegible] differential [illegible]. b) [illegible] intensity, the greater [illegible] conditioned [illegible]. c) [illegible] intensity, the greater [illegible] suppression. [illegible] the effect of [illegible] ratio [illegible] number of [illegible] [illegible]. [illegible] found that [illegible] interval [illegible] lengthened from [illegible] to [illegible] seconds [illegible] greater depression [illegible] [illegible] [illegible] number of [illegible] combination increases the [illegible] great effect of the [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] (19[illegible]) has reviewed the findings of a number of [illegible] studies aimed at understanding the role of various [illegible] [illegible] [illegible]

[illegible]line behavior; some of these are summarized here. [illegible], [illegible] and [illegible] (19[illegible]) found the degree of conditioned suppression to be related to an [illegible] of reinforcements. In [illegible] study, the behavior of rats under different durations of [illegible] was [illegible] only to the extent that they did not [illegible] [illegible] of [illegible] reinforcements [illegible]. [illegible] and [illegible] (19[illegible]b) [illegible] the behavior [illegible] is [illegible]. [illegible] a preshock stimulus upon the behavior [illegible] that [illegible] closer [illegible] was the [illegible] interval [illegible] reinforcement [illegible] similar (19[illegible]), [illegible] fixed interval, [illegible] the degree of [illegible]. [illegible] 7, [illegible] rates of responding [illegible] during a preshock [illegible] rates which [illegible]. [illegible] have also [illegible] on behavior [illegible] differentiating reinforcement [illegible]. Lockman [illegible] found that when [illegible] paired with a mild shock [illegible] on [illegible] behavior, the rate of responding during [illegible] instead of being [illegible]creased. After reviewing different studies [illegible] the [illegible] variables under the [illegible] paradigm, Lockman (19[illegible]7) concludes that when [illegible] conditioning procedures are held constant, substantial differences [illegible] effects of [illegible] stimulus [illegible] as a function of the [illegible] of reinforcement [illegible] the operant behavior, differences not only of degree but even on occasion of direction.

Rescorla (1967) believes that contingency rather than contiguity is the crucial variable in Pavlovian conditioning. The term 'contingency' refers to the relative probability of US occurrence given the prior occurrence or nonoccurrence of CS. Thus according to Rescorla the proper control group for assessing the degree of Pavlovian conditioning is not a group which involves explicitly nonpaired presentation of CS and US (since this is also a kind of contingency - a negative contingency) but a "truly random" control condition in which CS and US occur randomly, thus allowing for their chance pairing on some occasions. Rescorla (1968) found that equal probability of shock (US) in the presence and absence of tone (CS) produced no conditioned suppression while the same probability of US given only during CS produced substantial conditioning. Also, when four different probabilities of US in the presence and absence of CS were explored, amount of conditioning was higher the greater the probability of US during CS and was lower the greater the probability of US in the absence of CS. Rescorla interpretes these data to support his theory that the basic dimension of Pavlovian conditioning is the CS-US contingency rather than CS-US pairing. A finding contrary to Rescorla's contingency theory has been reported by Kremer & Kamin (1971). In their study, a 'truly random' control procedure was found to produce reliable suppression to CS during testing. Further, the degree of conditioned suppression was found to be related to the average CS-US interval despite the absence of any contingency.

Kamin (1968, 1969) performed an extensive series of studies aimed at analysing the effects of pairing two CS with one US in a CER paradigm. One of his findings was that prior training with one CS partially or completely 'blocks' conditioning of a new CS presented jointly with the old CS. Redundancy or non-informativeness of the newly added CS was found to be the crucial determinant of this blocking phenomenon. Kamin also found that when a compound CS is paired with a US without prior training with either element of compound, the stronger or more 'salient' element of the compound prevents the weaker element from being conditioned - the phenomenon of 'overshadowing'.

While valuable information has been gained from these studies, the preoccupation with linking the finding of conditioned suppression to the concept of 'anxiety' has put certain paradigmatic constraints upon the studies in the field, e.g., in most of the CER studies CS always precedes US. The extension of the paradigm to the reversed order of CS and US might produce results of interest. Among the few studies using backward conditioning procedure in the CER paradigm, Kamin (1963) did not find evidence of conditioned suppression when backward conditioning procedure was used. Heth & Rescorla (1973) on the other hand found that CS acquired properties of conditioned punisher following its pairing with US in a reverse order.

In the previously described study by Farmer & Schoenfeld (1966), light alone was intruded upon the fixed interval baseline and responding was found to be suppressed during the light at all intermediate temporal placements. Some studies have used positively reinforcing stimuli (food, water, brain stimulation) as US and have found suppression of responding during CS (Azrin & Hake, 1969). One would hesitate to view these effects in terms of 'anxiety'. The important issue to be raised is that of determining the necessary and sufficient conditions for the conditioned suppression (or any other) effect under the extended CER paradigm.

While conditioned suppression is the widely reported finding in CER studies across a variety of organisms (e.g., rats: Annau & Kamin, 1961; cats: Brady & Conrad, 1960; pigeons: Hoffman, Fleshler & Jensen, 1963; goldfish: Geller, 1963), conditioned facilitation has been found under certain experimental conditions (Sidman, Herrnstein & Conrad, 1957; Blackman, 19[illegible]a). Meltzer & Brahlek (1970) found a transition from conditioned suppression to conditioned facilitation as a result of increasing the duration of CS paired with a "positive" US. Explication of such critical parameters also contributes toward determination of the necessary and sufficient conditions for the effects of suppression or facilitation under the CER paradigm.

There has been a relative neglect of studying the temporal interrelationships among all three stimuli which comprise the CER paradigm (and not just the temporal relationship between CS and US). There are a few studies which have analysed the relationship of the baseline reinforcement schedule with conditioned suppression (e.g., Brady, 1955; Lyon, 1963). The influence exerted by scheduling variables may be viewed as strictly temporally determined (Schoenfeld & Cole, 1972). However, since most CER studies use a VI schedule of baseline reinforcement, the temporal relationships of CS and US with the baseline reinforcer have been either obscured or rendered irreproducibly irregular.

Another problem associated with the use of the VI baseline schedule arises from the fact that most studies use CS durations equal to or greater than the mean VI value. As a result of this, any changes in response rates during CS are very likely to influence the frequency of the baseline reinforcer, leading to the possible confounding of the SR frequency variable with the main independent variables.

Most investigators in the field of CER have focused on the responding during CS as a dependent variable and have considered any overall changes in the baseline rates only as transient phenomena. Davis, Malmott & Hurwitz (1976) found that there were significant and long-lasting suppressant effects of CS-US pairings on the overall baseline rates themselves in two of the three experimental conditions studied by them. A number of other studies have also reported similar suppression of overall baseline rates along with CS rates (Blackman, 1968a;Gottwald, 1967; Orme-Johnson & Yarczower, 1974; Geller, 1963; Scobie, 1972). The results of any CER study should be analysed in terms of both of these possible influences, namely, the effect on the rate of responding during CS and that on the overall baseline rate. A given manipulation may succeed in producing only one or the other effect, instead of both.

The design of the present experiment is an attempt not only to go beyond the limitations of the traditional CER paradigm, but also to contribute to finding the necessary and sufficient conditions for suppression or facilitation under the CER paradigm. The baseline responding is maintained with a fixed interval schedule of response-contingent 'positive' reinforcement (food). Two stimuli are noncontingently intruded upon the baseline behavior. One of these stimuli (light) is of an intially neutral nature, i.e., having no effect on behavior upon its initial presentation. The other stimulus (electric shock) has a disruptive effect on behavior upon its initial presentation. These two intruded stimuli are traditionally referred to as CS and US but in the present study they are labelled as S^N and S^{-R} respectively. The three manipulated variables are: 1) The temporal location of S^N within the baseline fixed interval. 2) The temporal location of S^{-R} within the baseline fixed interval. 3) Probability of S^{-R}.

The novel feature is that the traditionally locked relationship of CS (S^N) and US (S^{-R}) is removed and the temporal placements of both of these stimuli are systematically, but independently, varied. It should be noted that the present study's focus on contiguity (temporal relationships) is in contrast with Rescorla's emphasis on the dimension of contingency, i.e., the probability of US given the prior occurrence of CS in comparison to the probability of US given the prior nonoccurrence of CS.

The following are some of the questions raised in the present study. Under the CER paradigm, out of three possible temporal relationships, namely, that between S^N and S^R, that between S^N and S^{-R} and that between S^{-R} and S^R, which ones exert a critical influence on the pattern of fixed interval responding? What is the functional relationship between S^{-R} probability and the degree of conditioned suppression (or facilitation)? How does the extinction course of conditioned suppression of facilitation under S^{-R} probability of 1.00 compare with that under S^{-R} probability of less than 1.00?

METHOD

Subjects

Twelve female white Carneau pigeons, 5 years old at the start of the experiment, were housed in their individual home cages. Each bird was given free access to food grain and weighed every day until the range of variation in its weight over five consecutive days did not exceed 15 grams. The median of these five weights was accepted as each bird's free feeding weight. The subjects were then given 5 grams of food per day until their weights decreased to 80% of the free feeding level. From then on they were fed approximately 15 grams daily until the beginning of the experiment, in order to stablize their weights at the 80% level. The subjects were weighed prior to and at the end of each experimental session. Grain supplements were provided following each session to maintain their weights at the 80% level.

Apparatus

The experimental space was a three-key Lehigh Valley Electronics pigeon chamber Model No. 1519C. Only the center key was used as the response key under this experiment. A minimum force of 25 grams operated the key. White noise was continuously present during all sessions to mask extraneous sounds. The houselight was on at all times during the sessions. Experimental conditions were programmed by BRS electronics (Digi-Bit) logic modules, precision clock, probability generator and Grason Stadler shock generator. Data were recorded on Sodeco counters and a Gerbrands cumulative recorder.

Procedure

After training each bird to approach the food hopper from any location in the experimental chamber at the sound of the hopper, the key pecking response was shaped. The reinforcement (S^R) was initially 3 seconds' and finally 4 seconds' access to mixed grain. To strengthen the key pecking response, each bird was put on a regular reinforcement schedule until one hundred reinforcers had been delivered. After a few sessions of FI 15 sec. and FI 30 sec., the subjects were exposed to the baseline reinforcement schedule of FI 60 sec. with 6 sec. limited hold at the beginning of each 60 sec. interval. Starting with the first baseline session, all experimental sessions had a constant duration of 30 minutes or thirty 60 sec. cycles, excluding the reinforcement times. The responses occurring during reinforcement presentation had no programmed effect. Thirty daily baseline sessions were run for each bird. After about half of the baseline sessions, birds 5 and [illegible] were temporarily put back on regular reinforcement schedule and FI 60 sec., in order to increase their very low response rate. To ensure adequate response rates, reinforcement duration was increased from 3 to 4 seconds for the rest of the experiment, for all birds.

The food reinforcement schedule that prevailed for the baseline sessions continued to be in effect for the ensuing experimental manipulations. The basic manipulations in this experiment consisted of intruding two noncontingent stimuli at systematically and independently varying temporal locations within each 60 sec. cycle. The two stimuli were <u>1</u>) a 6 sec. white light (S^{L}) behind the response key and <u>2</u>) an electric shock (S^{-L}) of 2 mA. intensity and 25 msec. duration. All shocks were delivered through two silver chain electrodes tied around the wings of the subjects. The feathers from under their wings were plucked to allow the chain electrodes to come in contact with the skin. Before every session an electrode jelly (EKG sol) was rubbed into the exposed skin under each wing to clear the dirt and thereby facilitate clean contact. A retractable cord connected to the shock generator, via a switch, entered the experimental chamber through its ceiling. Two alligator clips attached to the cord's other end were connected to the silver chains tied around the wings of the subject at the start of each session. The retractable cord allowed the subject free movement in the box without any entanglement with the cord.

Following the baseline sessions, the subjects were divided into 4 groups of 3 each, roughly equated for their overall response rates. Birds #1, #2, and #3 belonged to group 1; #4, #5, and #6 to group 2; #7, #8, and #9 to group 3; and #10, #11, and #12 to group 4. Shock probability was the only parameter varied across the groups, the probability values being 1.00, .5, .25, and .12 respectively for groups 1, 2, 3, and 4.

The schematic diagram presented in figure 1 provides a quick summary of all phases of the present experiment. The detailed descriptions of all experimental phases are provided in Tables 1, 2 and 3. Table 1 describes the nature and sequence of all within-group manipulations carried out under part A of the experiment. The experimental steps of part B which aimed at measuring the effects of intruding shock alone upon the fixed interval responding are described in Table 2. In this part of the experiment only bird #3 and #4 were used, with their respective shock probabilities of 1.00 and .5. Part C of the experiment, described in Table 3, also used birds #3 and #4 and determined if the shocks (at the intensity and duration used in this experiment) could substantially suppress the rate of key pecking when contingently delivered upon every response. The reported data and calculations are based on the last 3 sessions from each phase in part A and last 2 sessions from each phase in part B and part C.

FIGURE 1

A schematic diagram summarizing the sequence of all manipulations conducted in the present experiment.

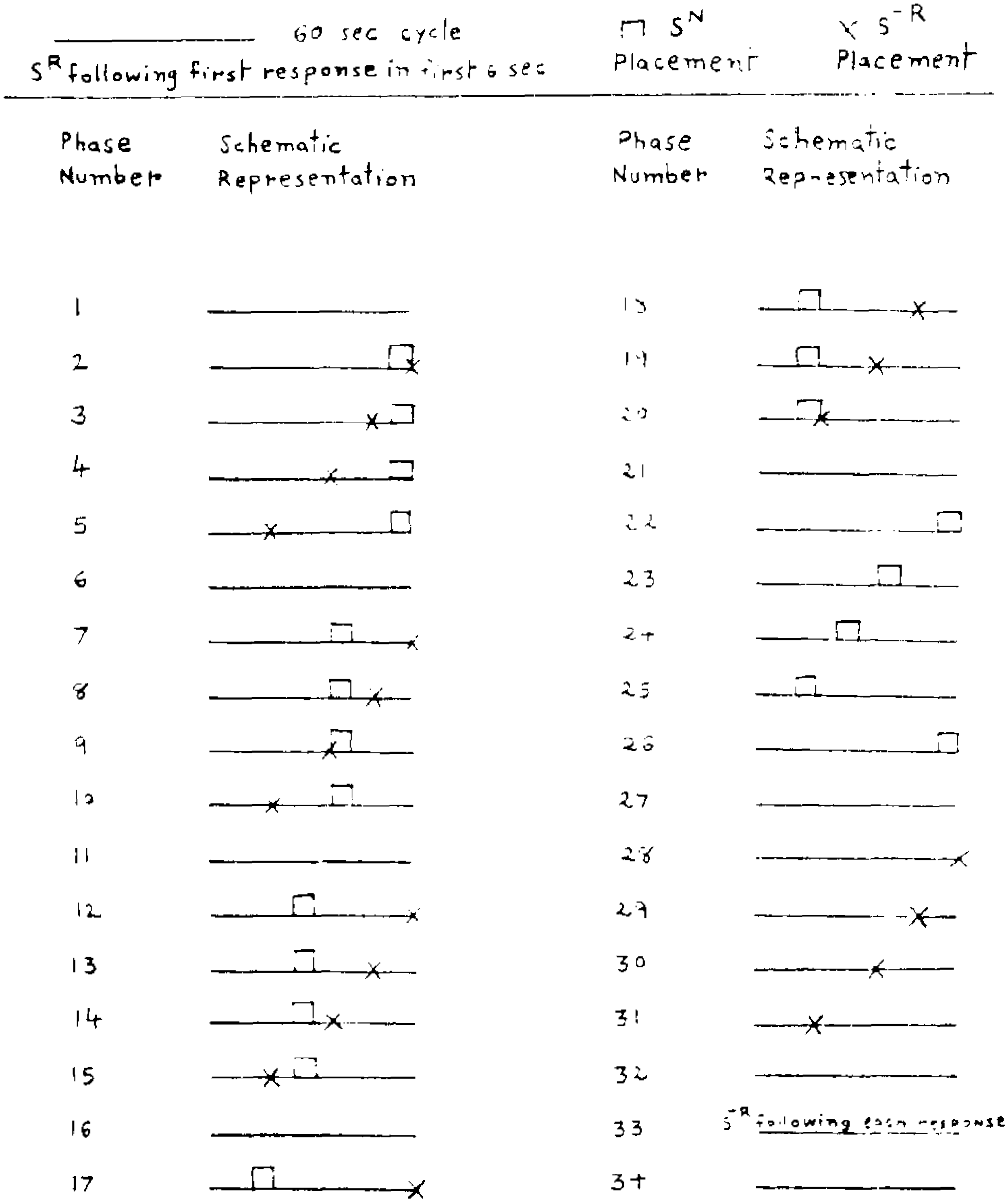

60 sec cycle
S^R following first response in first 6 sec
S^N Placement
S^{-R} Placement
Phase Number
Schematic Representation
Phase Number
Schematic Representation
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
S^{-R} following each response
34

Table 1

The sequence of within group manipulations carried out in Part A of the experiment.

Phase number	number of sessions	Temporal position within each 60-sec. cycle of	
		Light (S^{D})	Shock (S^{-R})
1 (Baseline)	30	--	--
2	30	54-59.99 sec.	60 sec.
3	7	"	45
4	7	"	30
5	7	"	15
6 (Baseline Recovery)	7	--	--
7	7	36-41.99	60
8	7	"	45
9	7	"	30
10	7	"	15
11 (Baseline Recovery)	7	--	--
12	7	24-29.99	60
13	7	"	45
14	7	"	30
15	7	"	15
16 (Baseline Recovery)	7	--	--
17	7	12-17.99	60
18	7	"	45
19	7	"	30
20	7	"	15
21 (Baseline Recovery)	7	--	--
22	7	54-59.99	--
23	7	36-41.99	--
24	7	24-29.99	--
25	7	12-17.99	--
26	7	54-59.99	--

Table 2

The sequence of manipulations carried out in <u>Part B</u> of the experiment.*

Phase number	Number of sessions	Temporal position within each 60-sec. cycle of Light (S^{D})	Shock (S^{-D})
27 (Baseline Recovery)	5	--	--
28	5	--	[illegible]
29	5	--	4
30	5	--	30
31	5	--	1

* Only birds [illegible] and [illegible] were used, with S^{-D} probability of 1.0 and .5 respectively.

Table 3

The sequence of manipulations in Part C of the experiment.*

Phase number	Number of sessions	Light (S^{D})	Shock (S^{-R})
32 (Baseline Recovery)	5	--	--
33	5	--	contingent upon every response
34 (Baseline Recovery)	5	--	--

*Only birds [illegible]3 and [illegible]4 were used.

RESULTS

Part A

Figure 2 shows the effect of S^{-R} placement on responding in S^N and non-S^N portions of the 60-sec. fixed interval. Most of the functions are found to be flat (parallel to the abscissa) which means that manipulating S^{-R} placement did not have a differential effect on either S^N responding or non-S^N responding. This nondifferential effect was consistent across different S^N placements as well as across different probabilities of S^{-R}. An exception to this dominant trend was that when S^N appeared in the last 6 seconds of the fixed interval, moving S^{-R} away from the end of the fixed interval resulted in a moderate increment in S^N responding for the group with S^{-R} probability = 1.00.

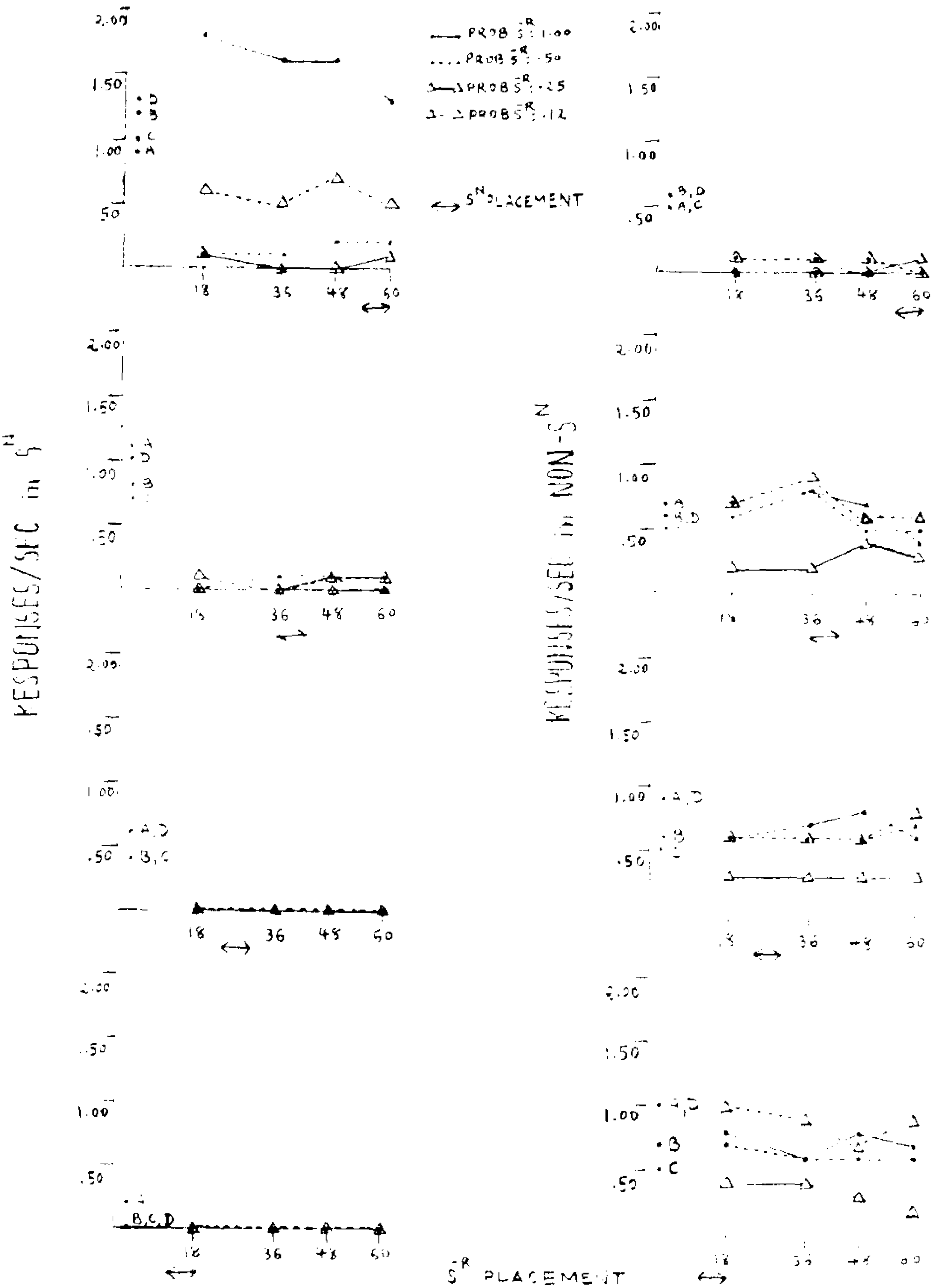
The baseline rates of responding in the corresponding portions of the fixed interval for the respective groups are plotted at the extreme left in each panel (pair of axes). Comparisons of S^N responding or non-S^N responding with the corresponding baseline rates allow the following statements:

a) When S^N was intruded in the last 6 seconds of the interval S^N responding was facilitated for the group with S^{-R} probability = 1.00, it was almost completely suppressed for the groups with intermediate S^{-R} probability (.50 and .25), and it was partially suppressed for the group with the lowest S^{-R} probability (.12). At all other S^N placements, S^N responding was reduced to near zero level for all S^{-R} probability groups.

b) For all S^{-R} probability groups, when S^N appeared during 54-59.99 sec. non-S^N responding was reduced near zero level, while at other S^N placements non-S^N responding was either maintained at the corresponding baseline level or was reduced below it. The individual functions for

figure 2

Response rates in S^N and non-S^N portion of the fixed interval as a function of S^{-R} placement. The four left hand panels (pairs of asces) represent effects on S^N responding and the four right hand panels represent effects on non-S^N responding. S^N panel is constant in a given panel but varies as one moves vertically from panel to panel. The four functions in each panel represent the four groups of subjects differing with respect to S^{-R} probability. The response rates in the corresponding portions of the preceding baselines are plotted at the extreme left in each panel, with the data points A, B, C and D representing the four groups with S^{-R} probability of 1.00, .50, .25 and .12 respectively. All response rates are based on averaging over 90 cycles (comprising the last three sessions at each experimental point). The response rates of the three subjects in each group are combined in order to derive group averages.


PROB S^R: 1.00
PROB S^R: .50
PROB S^R: .25
PROB S^R: .12
S^N PLACEMENT
RESPONSES/SEC in S^N
RESPONSES/SEC in NON-S^N
S^R PLACEMENT
18
36
48
60
2.00
1.50
1.00
.50

all subjects showing the distribution of responding in the fixed interval under tho experimental phases 1 to 20 (refer to Table 1 in Method section) have been described in a set of 12 figures placed in Appendix A. Since S^{-R} placement was found to show no differential effect on responding in any portion of the fixed interval all data have been averaged over the four S^{-R} placements in the subsequent analysis of the results pertaining to Part A of the experiment.

The differential effect of S^{-R} probability on S^{N} responding under the experimental condition of S^{N}: 54-59.99 sec. described in statement 'a' above is shown separately in figure 3. For comparison the relative rates of non-S^{N} responding are also plotted in figure 3. The function relating S^{N} responding (when S^{N} occupies the last 6 seconds of the interval) with S^{-R} probability is nonmonotonic (J-shaped). At very low S^{-R} probability S^{N} responding is moderately suppressed, at intermediate S^{-R} probabilities it is almost totally suppressed while at S^{-R} probability of 1.00 S^{N} responding is facilitated. By contrast, the relative rates of responding in the non-S^{N} portions of the fixed interval were unaffected by the variation in S^{-R} probability.

Figure 4 shows the effect of S^{N} placement on S^{N} responding and non-S^{N} responding for the four groups with different probabilities of S^{-R}. Since the response rates during the baselines preceding each S^{N} placement were not identical, relative instead of absolute rates are plotted on the ordinate. At the S^{N} placement in the last 6 seconds of the fixed interval, S^{N} responding was a differential function of S^{-R} probability (also see Figure 3). As the S^{N} placement was moved away from the terminal 6 seconds of the fixed interval, S^{N} responding dropped to a very low level at each S^{N} placement for all groups. Non-S^{N} responding on the other hand dropped to a very low level, for all groups when S^{N}

figure 3

S^N responding and non-S^N responding as functions of S^{-R} probability under the condition of S^N placement: 54-59.99 sec. All response rates are averaged over the four S^{-R} placements and over the three subjects of each S^{-R} probability group. The response rates are plotted as relative rates (percents of response rates in the corresponding portion of the fixed interval in the preceding baseline).

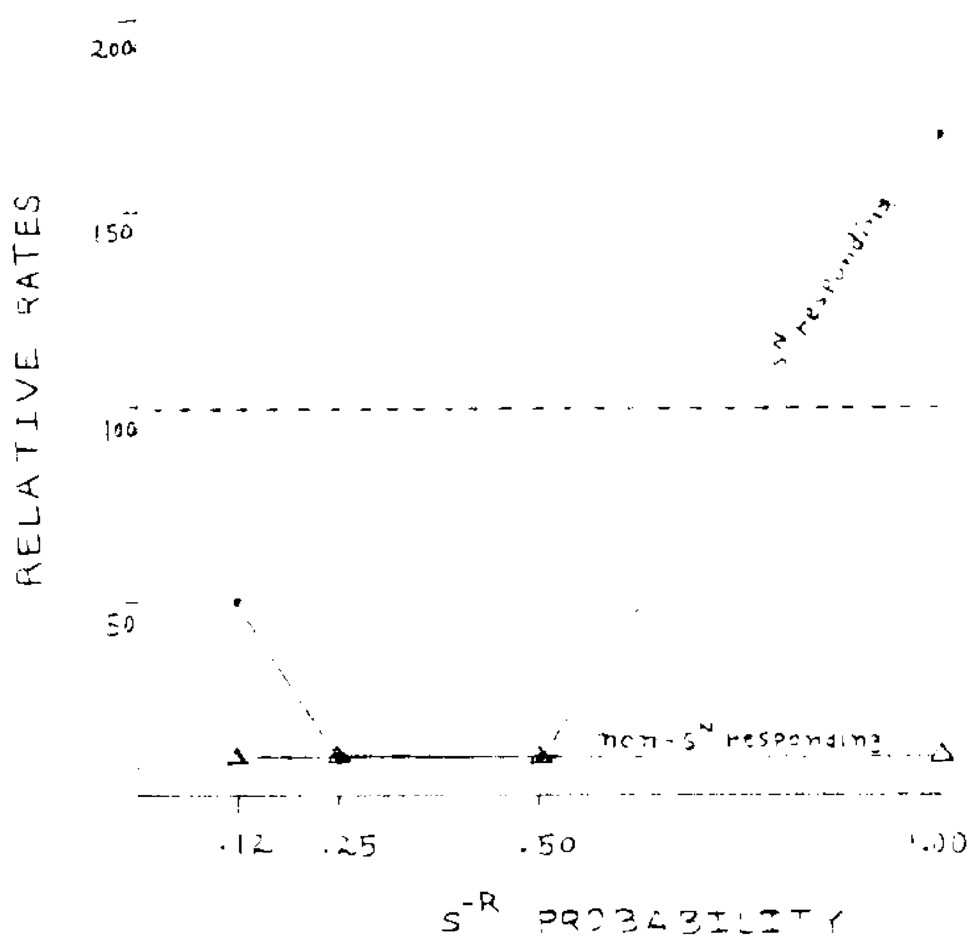
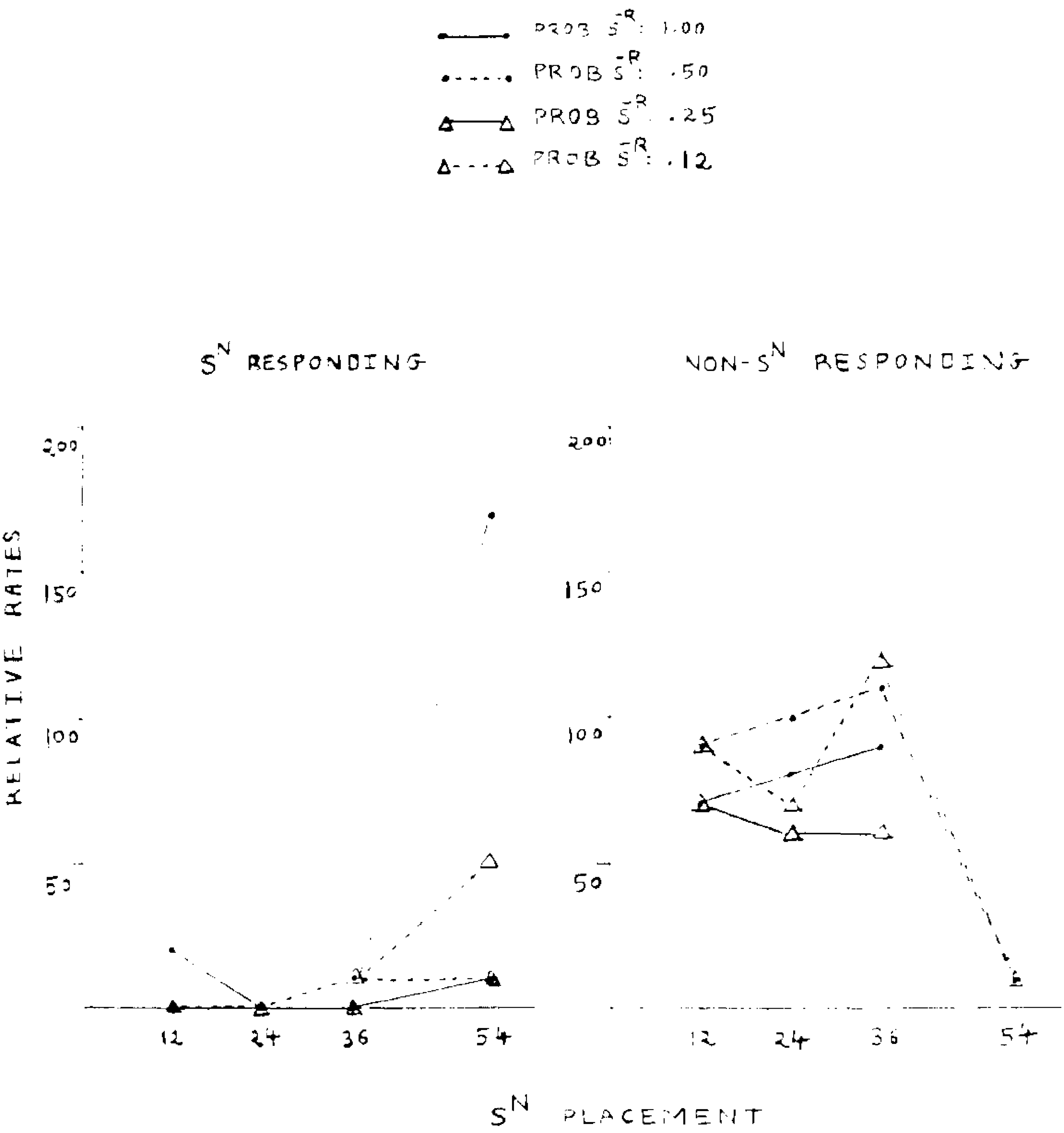

200
150
100
50
RELATIVE RATES
S^N responding
non-S^N responding
.12
.25
.50
1.00
S^{-R} PROBABILITY

figure 4

S^N responding and non-S^N responding as functions of S^N placement with S^{-R} probability as a parameter. All response rates are averaged over the four S^{-R} placements (at each S^N placement) and over the three subjects of each S^{-R} probability group. The response rates are plotted as relative rates (percents of response rates in the corresponding portions of the fixed interval in the preceding baselines).


PROB $\bar{S}^R$: 1.00
PROB $\bar{S}^R$: .50
PROB $\bar{S}^R$: .25
PROB $\bar{S}^R$: .12
S^N RESPONDING
NON-S^N RESPONDING
RELATIVE RATES
200
150
100
50
12
24
36
54
S^N PLACEMENT

was intruded in the terminal segment of the fixed interval but at the other three S^N placements (away from the terminal segment of the fixed interval) non-S^N responding rose to a level close to that under baseline for three out of four groups while for the group with S^{-R} probability =.25 non-S^N responding remained well below baseline through all S^N placements.

Change in the overall rates of responding as a result of intruding S^N and S^{-R} on the baseline behavior is shown in Figure 5. All data are averaged over all S^{-R} placements since S^{-R} placement was found not to produce any differential effects (see Figure 2). In order to take into account the differences in the preceding baseline rates, overall rates are expressed in relative form (mean percent baseline) on the ordinate. For all S^{-R} probability groups overall rates dropped to a level far below that under baseline when S^N was placed in the terminal 6 seconds of the 60-sec. cycle. Following the movement of S^N away from the end of the fixed interval, overall rates increased but never surpassed those prevailing under baseline. When different S^{-R} probability groups are compared with one another, the only trend seems to be that as a result of S^N and S^{-R} intrusion, overall rates remained lowest in the group with S^{-R} probability =.25.

The effects of removing S^{-R} and intruding S^N alone at various temporal placements are described in figure 6. The four left hand panels in figure 4 compare S^N responding under S^{-R} present condition with that under S^{-R} absent condition. The four right hand panels compare S^{-R} present and S^{-R} absent conditions with respect to non-S^N responding. Figure 6 shows a moderate rise in non-S^N responding following the removal of S^{-R}. Except when S^N appeared during the last 6 seconds of the fixed interval, removal of shock seems to have produced a similar rise in the

Figure 5

Overall response rates as a function of S^N placement (averaged over the four S^{-R} placements). At each S^N placement, the overall response rates are averaged over all S^{-R} placements and over the three subjects of each S^{-R} probability group. The rates are plotted as relative rates (percents of overall rates in the preceding baselines).

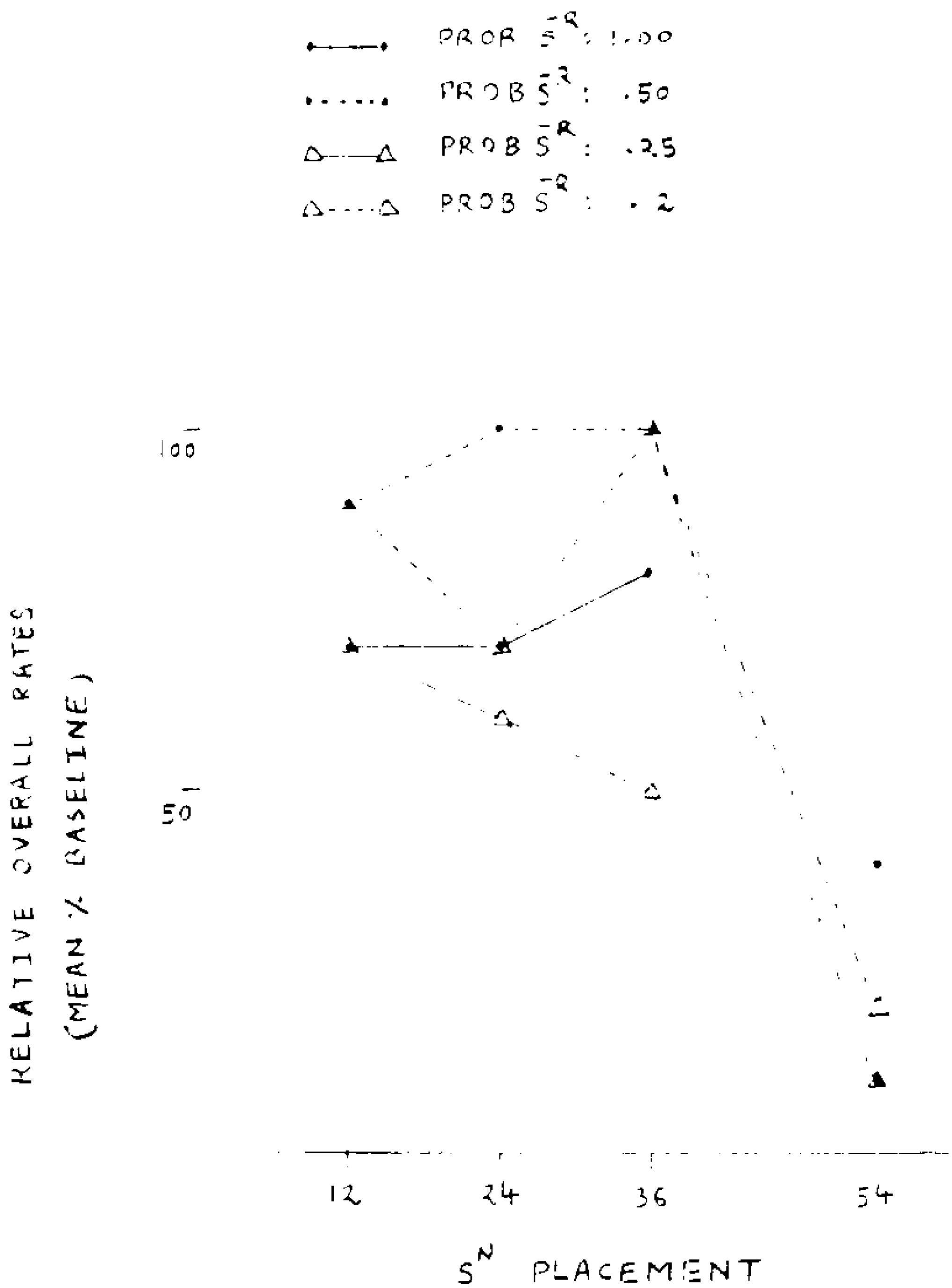
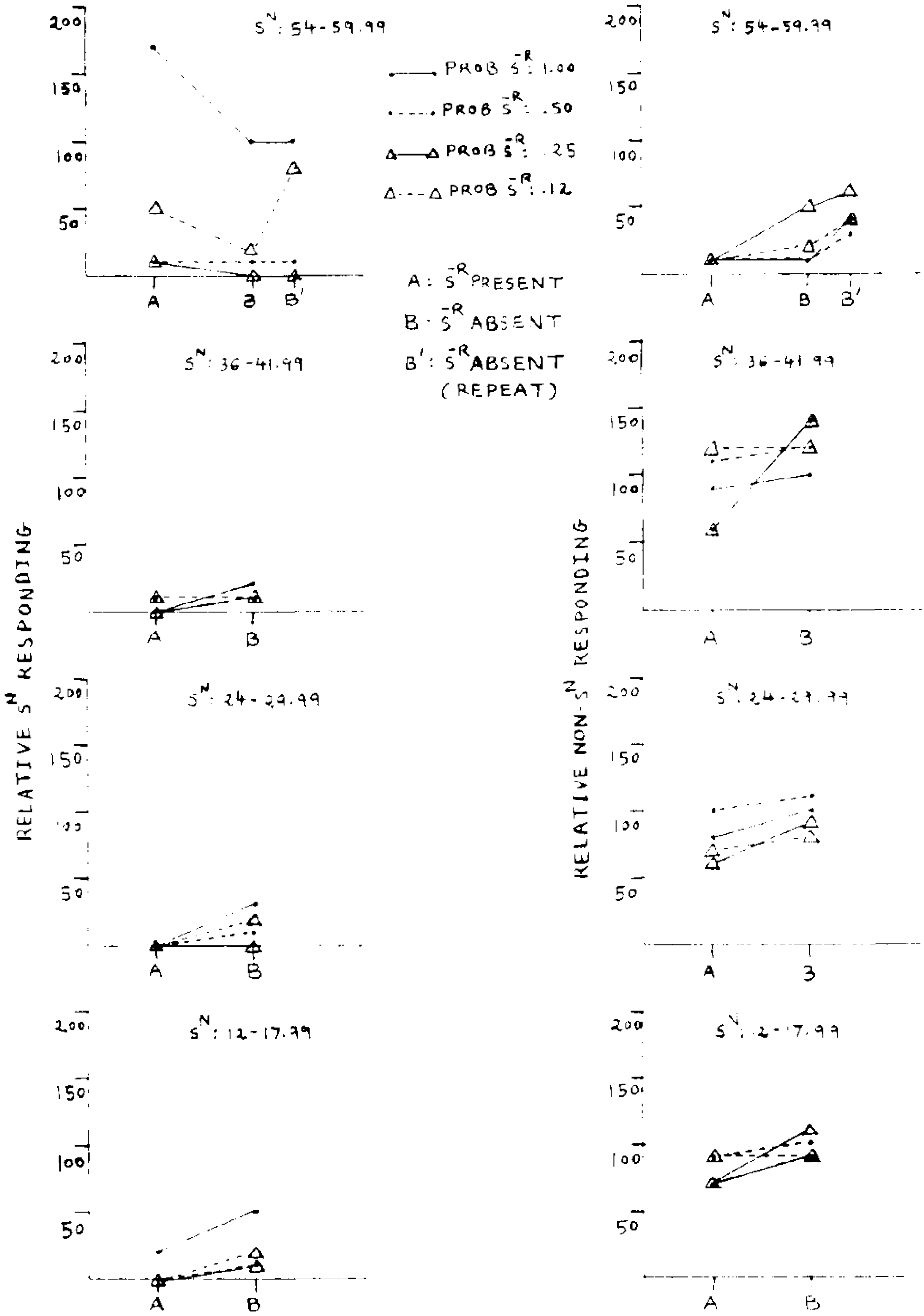

PROB $\bar{S}^R$: 1.00
PROB $\bar{S}^R$: .50
PROB $\bar{S}^R$: .25
PROB $\bar{S}^R$: .2
100
50
RELATIVE OVERALL RATES
(MEAN % BASELINE)
12
24
36
54
S^N PLACEMENT

Figure 6

Effects of the removal of S^{-R} on S^{N} responding and non-S^{N} responding at each S^{N} placement and for the four S^{-R} probability groups. The response rates, averaged over the four S^{-R} placements and over the three subjects of each group are plotted as relative rates (percents of baseline rates in the corresponding portions of the fixed interval in the preceding baselines).


RELATIVE S^N RESPONDING
RELATIVE NON-S^N RESPONDING
S^N: 54-59.99
S^N: 36-41.99
S^N: 24-29.99
S^N: 12-17.99
PROB S̄^R: 1.00
PROB S̄^R: .50
PROB S̄^R: .25
PROB S̄^R: .12
A: S̄^R PRESENT
B: S̄^R ABSENT
B': S̄^R ABSENT (REPEAT)
200
150
100
50
A
B
B'

level of S^N responding but the relative amount of increase in S^N responding was less than that in non-S^N responding. When S^N alone was intruded in the last 6 seconds of the 60-sec. interval, facilitation of responding in S^N in the group with S^{-R} probability = 1.00 returned to baseline value. However, there was no change in the level of S^N responding shown by the intermediate S^{-R} probability (.50 and .25) groups. Finally, in the group with S^{-R} probability = .12 the moderate suppression of S^N responding initially increased and then decreased when additional sessions were run with S^N alone (S^{-R} absent). For intermediate S^{-R} probability groups, suppression of responding in S^N (S^N placement: 54-59.99) was maintained even after 'S^{-R} absent' condition was repeated but the level of non-S^N responding was raised from its near zero level. This finding shows that S^N responding and non-S^N responding differed with respect to the time course for the recovery from the effects of S^{-R}. The effects of S^{-R} removal on different portions of the fixed interval were not always unidirectional. For the S^{-R} probability =1.00 group. When S^N was intruded, without S^{-R}, during the last 6 seconds of the fixed interval, S^N responding was reduced while non-S^N responding was increased during additional sessions with S^N alone.

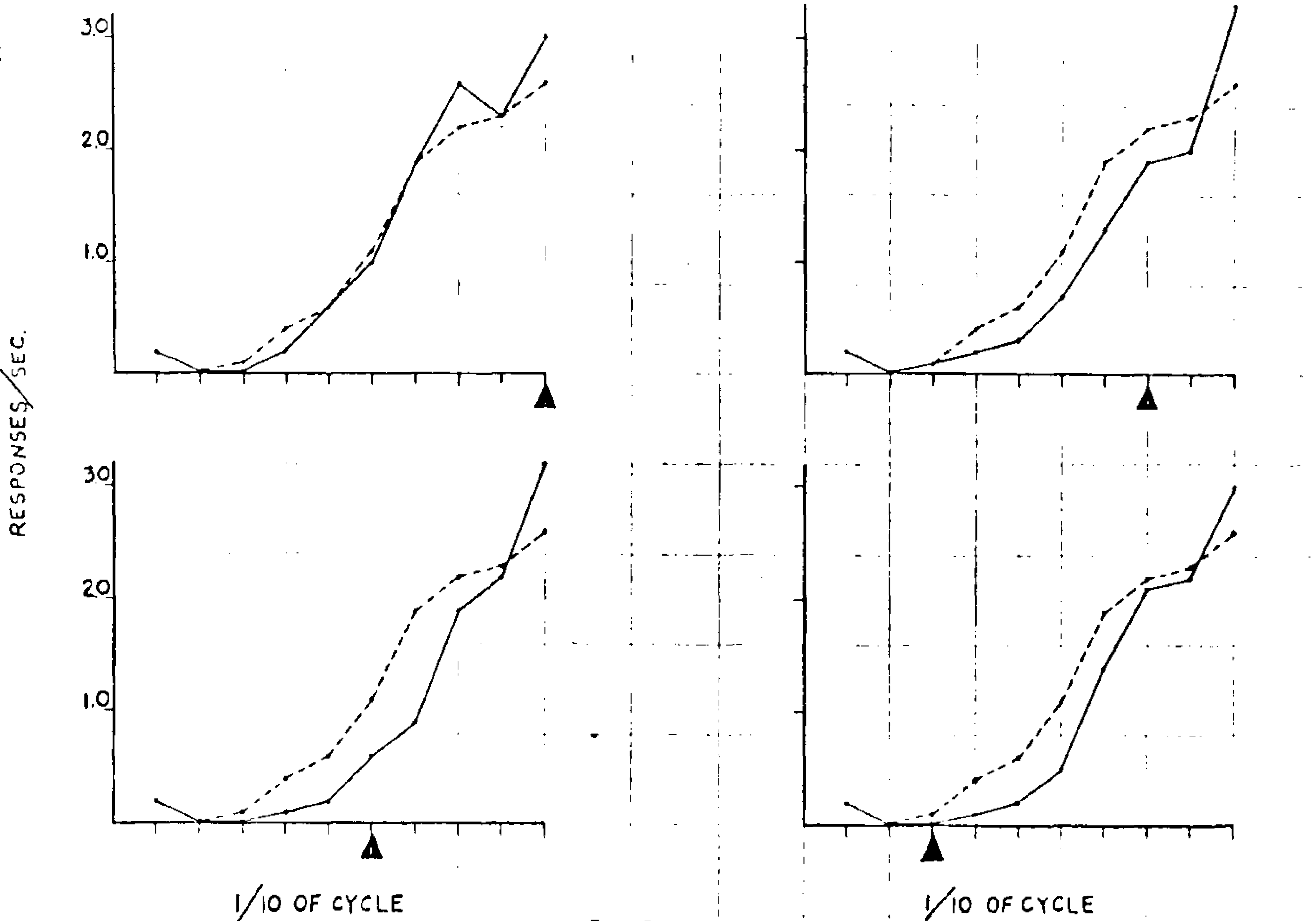
Individual functions for all subjects comparing the temporal distribution of responding within the fixed interval under S^{-R} present conditions with that under S^{-R} absent conditions are placed in Appendix B.

Part B

Figures 7 and 8 show the effects of intruding S^{-R} alone (without S^N) upon the fixed interval responding. Only birds #3 and #4 were used in this part of the experiment, with the respective S^{-R} probabilities of 1.00 and .50. The four panels in each figure represent the four

FIGURE 7

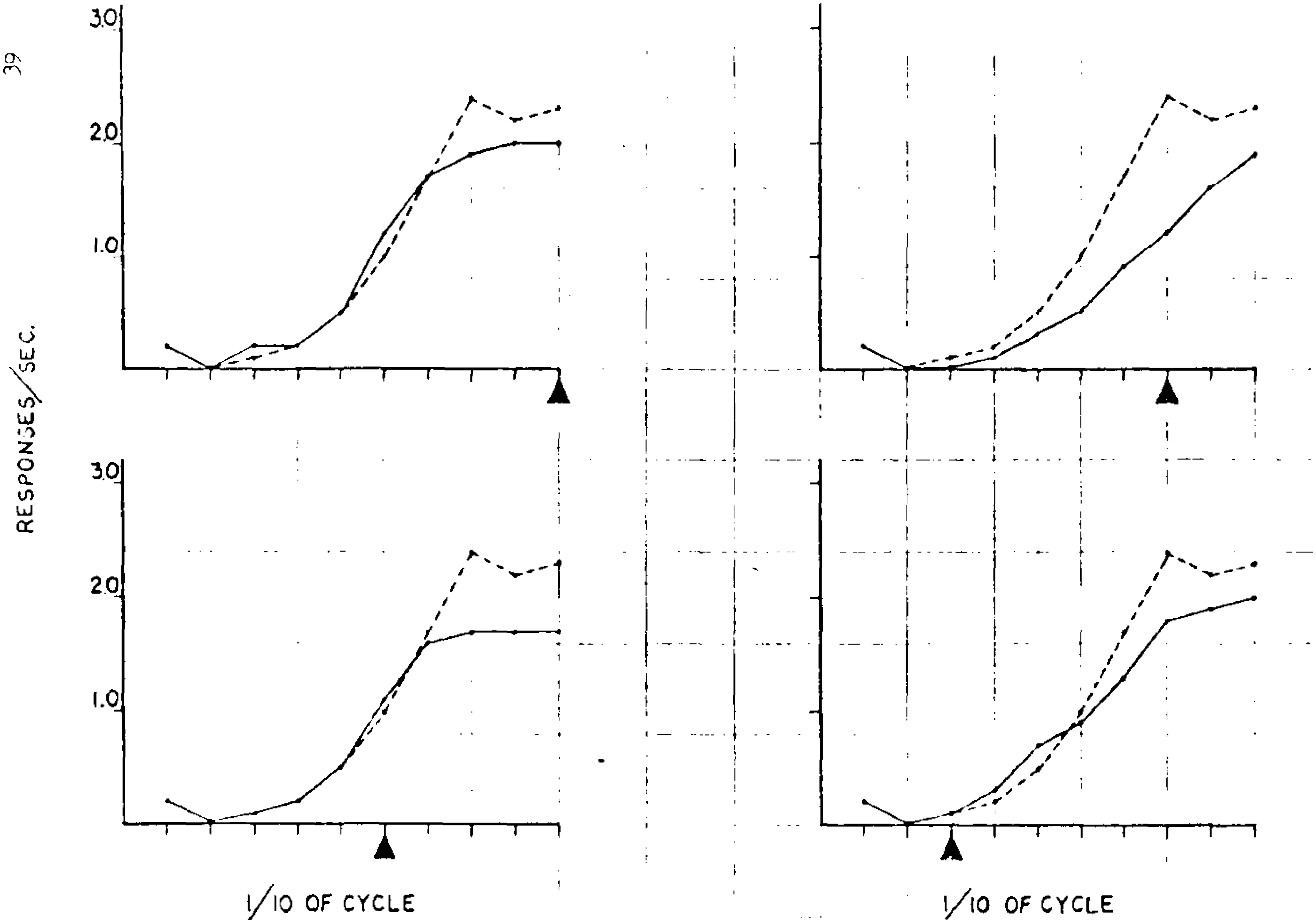
Performance of subject 3 under the condition of intruding S^{-R} alone. In each panel, the solid function represents the performance under the condition of S^{-R} intrustion (the filled triangle under the abscissa indicating the onset time of S^{-R}) and the dashed function represents the performance under the preceding baseline. The data points in all functions are the response rates in successive [illegible] sec. bins, averaged over [illegible]0 cycles (comprising the last 2 sessions at each experimental point).



BIRD NO. 3

FIGURE [illegible]

Performance of subject 4 under the condition of intruding S^{-} alone. In each panel, the solid function represents the performance under the condition of S^{-} intrusion (the filled triangle under the abscissa indicating the onset time of S^{-}) and the dashed function represents the performance under the preceding baseline. The data points in all functions are the response rates in successive 6 sec. bins, averaged over [illegible]0 cycles (comprising the last 2 sessions at each experimental point).



BIRD NO. 4

temporal locations at which S^{-R} was intruded. For comparison, the preceding baseline function has also been plotted in each panel.

Bird #3 (S^{-R} probability: 1.00) exhibited the following effects of intruding S^{-R} alone upon the fixed interval responding.

1. S^{-R} intrusion at the end of the interval facilitated the rate of responding in the last bin of the interval, and this effect was maintained even after S^{-R} location was shifted to the middle and earlier portions of the interval.

2. Shifting S^{-R} placement to the middle and earlier portion of the interval lowered the rate of responding in the middle portion of the interval (ranging from about the fourth to the eighth bin).

Bird #4 (S^{-R} probability: .50) exhibited the following effects of intruding S^{-R} alone upon the fixed interval responding:

1. S^{-R} intrusion at the end of the interval produced a slight suppression of responding in the last three bins of the interval.

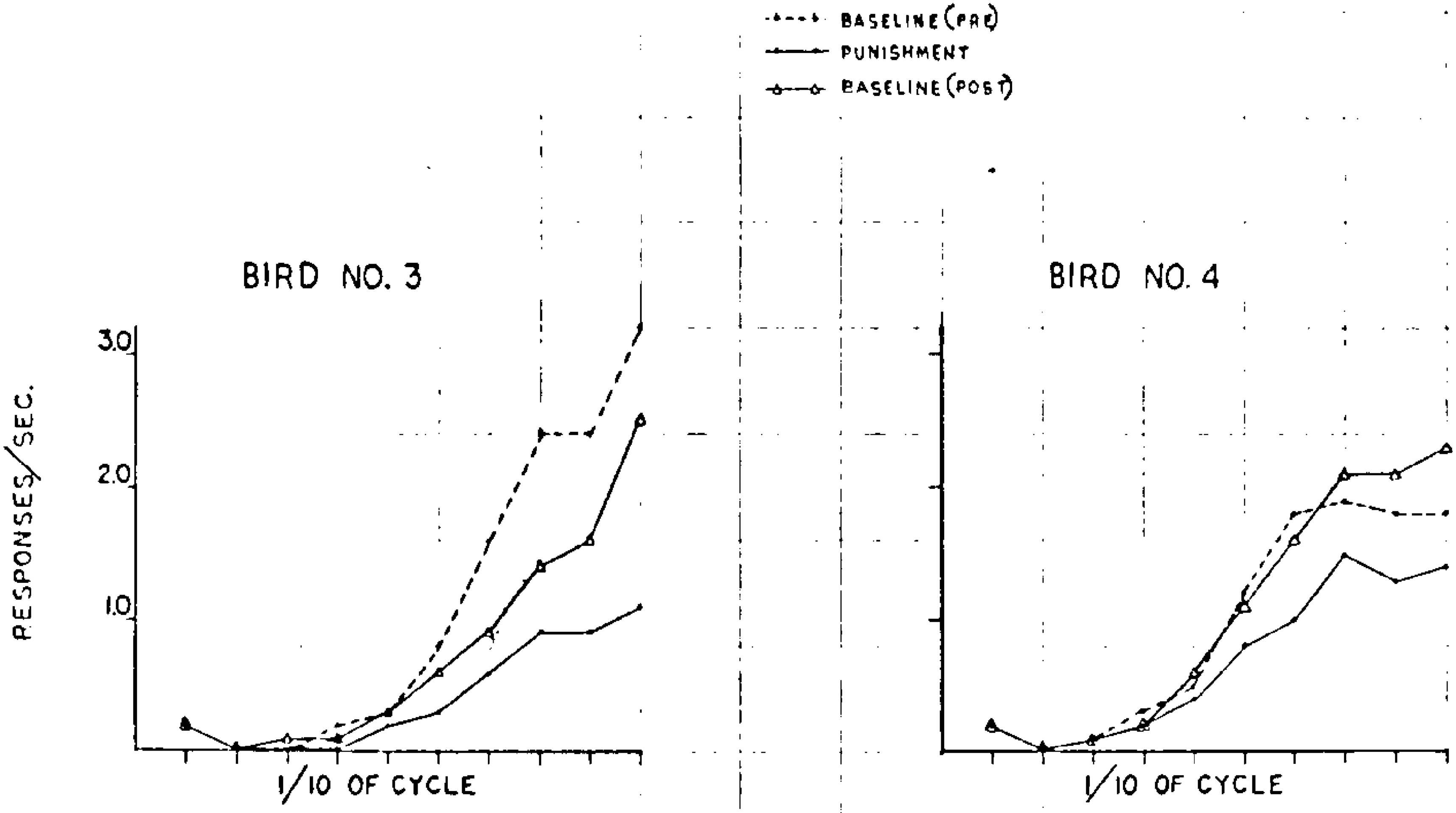
2. Shifting S^{-R} placement to the middle and earlier portion of the interval increased the degree of suppression in the last three bins of the interval. Also, at S^{-R} placement of 48 sec. the suppression effect spread to last five bins while at S^{-R} placement of 18 sec. it spread to last four bins of the interval. Thus, probability of S^{-R} was discovered to be an important parameter in determining the influence of intruding S^{-R} alone upon the fixed interval responding, S^{-R} probability of 1.00 producing facilitation of responding toward the end of the interval while S^{-R} probability of .50 producing suppression of responding toward the end of the interval.

Part C

Figure 9 shows how the fixed interval responding was affected when the (heretofore noncontingent) S^{-R} was delivered contingently upon each response. Again only birds #3 and #4 were used in this portion of the experiment. The left hand panel in figure 9 represents bird #3 and the right hand panel represents bird #4. In each case the preceding and the following baseline functions are also plotted for the sake of comparison. Examination of figure 9 clearly indicates that for both birds, 'punishment' suppressed the rate of responding throughout the interval and that when 'punishment' was discontinued, the response rates of both birds showed recovery.

FIGURE 9

Performances of subjects 3 and 4 under the condition of delivering S^{-R} contingently upon each response. The data points in all functions are the response rates in successive 6 sec. bins, averaged over 60 cycles (comprising the last 2 sessions at each experimental point).


BASELINE (PRE)
PUNISHMENT
BASELINE (POST)
BIRD NO. 3
BIRD NO. 4
RESPONSES/SEC.
3.0
2.0
1.0
1/10 OF CYCLE
1/10 OF CYCLE

DISCUSSION

One of the main findings of the present experiment was that the temporal relationship between S^N and S^R was found to have greater effects on baseline behavior than either the temporal relationship between S^N and S^{-R} or that between S^{-R} and S^R (see Figure 2 and 4). Notwithstanding the current demonstration of its importance the temporal relationship of S^N to S^R is often irregular or unspecified in much of the CER literature. Perhaps one reason for the lack of specification of this variable lies in the direction taken by the early investigators such as Kamin and his associates (Kamin, 1961; Annau & Kamin, 1961; Kamin & Schaub, 1963) who considered CER paradigm as a sensitive tool in understanding the classical conditioning principles and therefore concentrated on manipulating the temporal relation of the CS and US. One of the implications for future research using CER paradigm is the desirability of using a fixed interval schedule of baseline reinforcement instead of the variable interval schedule in order to facilitate experimental control over the temporal relationships of the intruded stimuli with the baseline reinforcer. If one thinks of using different values of S^N placement for different fixed interval cycles, what emerges is the distribution of S^N placements as a parameter. It is suggested that a systematic manipulation of this parameter (with specifiable and reclaimable values of S^N placements in different fixed interval cycles) has a potential of integrating some of the conflicting findings reported in the CER literature, for example, conditioned facilitation versus conditioned suppression (see page 11 of Introduction for illustrative studies).

The fact that S^N placement produced differential effects while S^{-R} placement did not has similarities with the overshadowing phenomenon found in Kamin's (1969) studies in which when a compound CS was paired with a US the stronger or more 'salient' element of the compound prevented the weaker element from being conditioned. In the present experiment the so called CS (S^N) seems to have an overshadowing effect upon the so called US (S^{-R}) itself in certain respects. It should be noted, however, that the presence or absence of an overshadowing (or any other) effect is a function of the physical parameters of the stimuli involved. Therefore the primary importance should be given to a detailed exploration of these parameters rather than to the phenomena encountered in a portion of the exploration.

The unusually short S^{-R} duration (25 milliseconds) employed in this experiment may be responsible for the fact that S^{-R} placement did not produce differential effects on behavior. Snapper, Kadden, Shimoff & Schoenfeld (1975) intruded a 15-sec. long S^{-R} upon a fixed interval baseline, and the manipulation of S^{-R} placement through different segments of the fixed interval was found to produce differential effects on the baseline behavior. Thus S^{-R} duration and S^{-R} intensity are suggested as other parameters useful in bridging the gap between the discrepant findings of the CER literature.

Another important finding of the present experiment was that the S^{-R} probability variable interacted with S^N placement with respect to its effects on S^N responding. At S^N placements away from the terminal segment of the fixed interval the S^{-R} probability variable did not produce any differential effect on S^N responding, i.e., S^N responding was equally suppressed for all S^{-R} probability groups, an effect quite similar to that obtained by Farmer & Schoenfild (1966) who intruded S^N alone at different temporal placements in a fixed interval. When S^N

was intruded in the last 6 seconds of the fixed interval change in responding during S^N was a nonmonotonic (J-shaped) function of S^{-R} probability (see figure 3). This finding is in contrast to that of Willis & Lundin (1966). They found a monotonic relationship between S^{-R} probability and conditioned suppression. They used three probability values, namely, .10, .50 and .90 and found that the greater the S^{-R} probability, the greater the conditioned suppression. The difference between the two findings may be attributable to the fact that while in Willis & Lundin study CS and US were intruded on a VI baseline (with no specified relationship prevailing between the intruded stimuli on the one hand and the baseline reinforcer - S^R - on the other), in the present study the stimuli were intruded on a fixed interval baseline; and the nonmonotonic function (between S^N responding and S^{-R} probability) developed only when S^N immediately preceded S^R. The J-shaped function found in the present study does not seem to support Rescorla's (1968) conclusion that the greater the probability of US given the prior occurrence of CS, the greater the amount of Pavlovian conditioning. It should be noted however that S^{-R} probability values used in Rescorla's study were different from those used in the present experiment. He used the probability values of .1, .2 and .4 while those used in the present experiment were .12, .25, .50 and 1.00. If one examines the first half of the function depicted in figure 3 (from .12 to .50 probability) it does seem to be in agreement with Rescorla's statement that the greater the S^{-R} probability, the greater the conditioned suppression. What the present finding does is to limit the generality of Rescorla's conclusion and to point to the complexity of the emerging function when the entire range of the S^{-R} probability variable is explored. The fact that S^{-R} probability variable produced differential effects on S^N responding only when S^N was placed at the end of the fixed interval further signifies the critical role played by the S^N - S^R relationship. Lyon & Millar (1968) found that when CS followed by US is intruded at the beginning or in the middle of the fixed interval, responding during CS is suppressed but such a suppression fails to appear when CS occupies the terminal segment of the fixed interval. An additional element is added to this relationship by the present finding that change in S^N (CS) responding is not only a function of S^N placement but also a function of S^{-R} (US) probability.

The finding that when S^N was intruded during the last 6 seconds of the fixed interval without any S^{-R}, the suppression of S^N responding in the case of the intermediate S^{-R} probability groups was maintained while the facilitation of S^N responding in the case of the S^{-R} probability = 1.00 group disappeared, (figure 6) is in conformity with the findings of Geller, Kailan, Stein & Brady (1957); Brimer & Dockrill (1966); and Willis & Lundin (1966) in terms of greater resistance to extinction on the part of the 'intermittent shock' groups compared to the 'regular shock' group. This finding extends the generality of the phenomenon of the partial reinforcement effect (widely confirmed in the operant conditioning literature using positive reinforcement) by demonstrating it in the context of the CER paradigm.

The finding that the removal of S^{-R} resulted in a moderate rise in non-S^N responding (see the four right hand panels in the figure 6) is consistent with the findings of Blackman (1968), Gottwald (1967), Orem-Johnson & Yarczower (1974), Geller (1963) and Scobie (1972) who have reported suppression of overall baseline rates (non-S^N rates) along with CS rates as a result of CS-US intrusion. This finding bears out the statement made by Davis, Malmott & Hurwitz (1976) that the systematic behavioral effects of experimental manipulations under the CER paradigm are not confined to changes in responding during CS (S^N).

Most CER studies have either considered the effects on non-CS responding as transient and insignificant or have adjusted for such effects by reporting a relative measure of the suppression of responding in the CS, called a 'suppression ratio', i.e., a ratio of the response rate in the CS to the response rate in the absence of CS. The use of suppression ratio as a measure of the dependent variable provides an incomplete information about the effects of the variables studied in any given experiment. It is suggested that influences of a given experimental variable on CS (S^N) responding should be described separately from its influences on non-CS (non-S^N) responding, in order to provide a complete description of the findings, as S^N responding as well as non-S^N responding have been found to be systematic functions of the experimental variables manipulated in this experiment. Of course, if one is interested, the additional analysis of results in terms of the relative measures of the dependent variables can still be carried out.

Reviewing all findings of the present experiment in light of the main experimental issue raised earlier (see Introduction), namely, determination of the necessary and sufficient conditions for the conditioned suppression (or any other) effects under the CER paradigm, the following conclusions may be derived:

1. Given the intensity and duration of S^N and S^{-R} employed in this experiment, the temporal location of S^N in relation to S^R is a critical variable in determining the pattern of responding within the fixed interval while manipulation of the temporal relationship between S^N and S^{-R} does not alter the initially developed pattern

of responding in the fixed interval. Thus for a given pattern of responding within the fixed interval a specific temporal placement of S^N is necessary condition but a specific temporal placement of S^{-R} is not.

2. When S^N appears at the intermediate locations within the fixed interval, S^N alone is sufficient to produce suppression of responding in S^N (Farmer & Schoenfeld 1966). The primary influence of the additional intrusion of S^{-R} seems to be a moderate degree of suppression of overall rate of responding in non-S^N portions of the interval.

3. Under the condition of S^N occupying the terminal segment of the fixed interval, S^{-R} probability is a critical parameter in determining whether responding in S^N will be facilitated or suppressed. S^{-R} probability of 1.00 (or close to 1.00) is a necessary condition to produce facilitation of responding in S^N, while in order to pro- suppression of responding in S^N it is necessary to intrude S^{-R} with a probability of less than 1.00. At what point on the continuum of S^{-R} probability the effect changes from facilitation of responding in S^N to suppression of responding in S^N cannot be exactly pinpointed on the basis of the present study but what can be stated is that the point of change lies somewhere between S^{-R} probability value of 1.00 and .50.

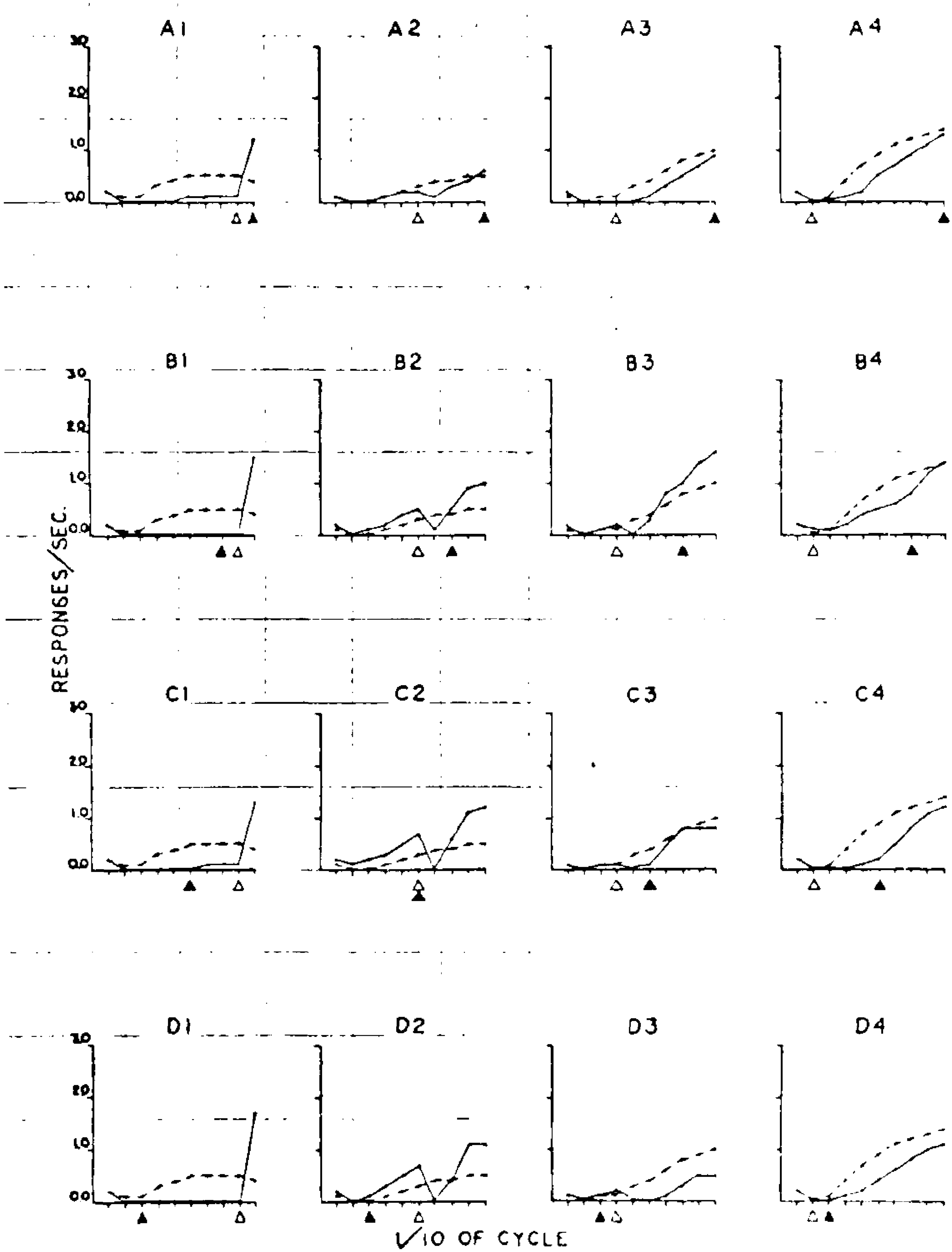
   Facilitation or suppression of responding toward the end of the interval can also be produced by intruding S^{-R} alone at the probability of 1.00 and .50 respectively (a sufficient condition), but in this case the effects are much smaller than those produced by intruding S^N as well as S^{-R}.

4. Intruding S^N and S^{-R} upon a fixed interval baseline not only has

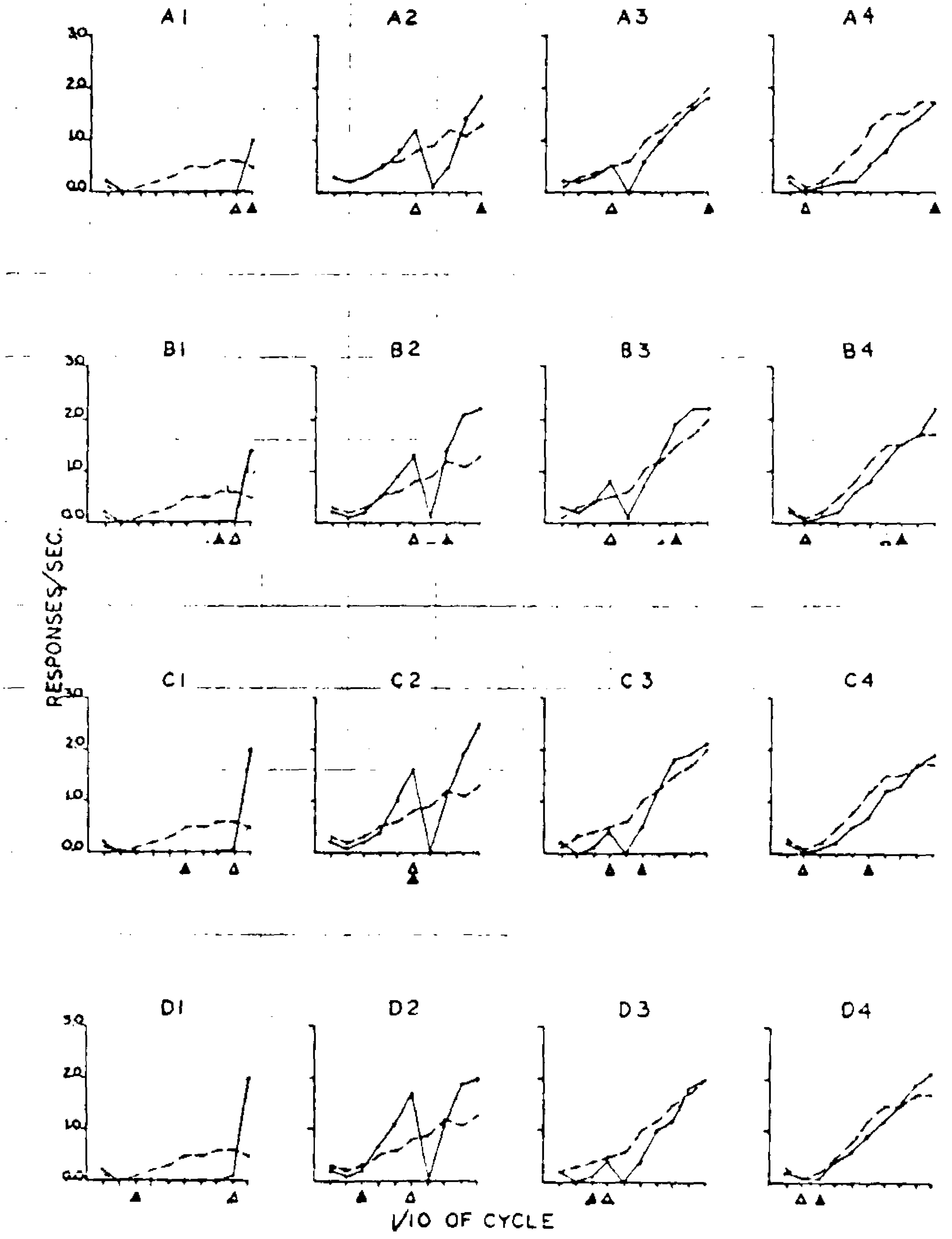
different effects on the S^N responding and the non-S^N responding but the time course for extinction of these effects is also different, suppression of S^N responding taking much longer to extinguish than the suppression of non-S^N responding. As far as just the effects on S^N responding are concerned the intermediate S^{-R} probability groups showed a greater resistance to extinction than the group with S^{-R} probability of 1.00.

APPENDIX A

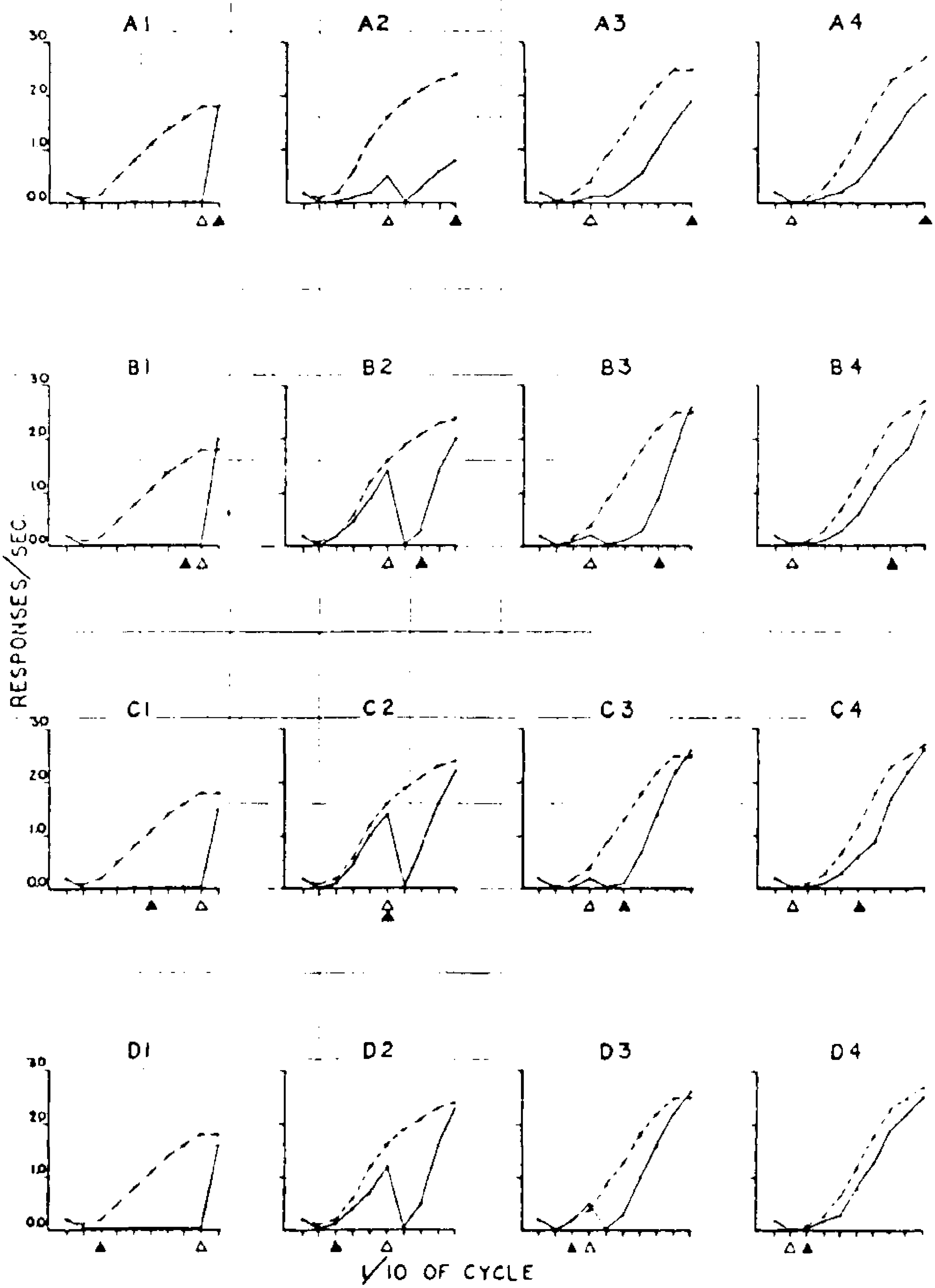
The following set of 12 figures represent individual functions for each of the 12 subjects, showing the distribution of responding in the fixed interval under different phases of S^N and S^{-R} intrusion. The solid function in each panel represents the performance under the condition of S^N and S^{-R} intrusion, the open triangle indicating the onset time of 6 sec. long S^N and the filled triangle indicating the onset time of 25 millisec. long S^{-R}. The dashed function in each panel represents the performance under the preceding baseline. The data points in all functions are the response rates in successive 6 sec. bins, averaged over 90 cycles (comprising the last 3 sessions at each experimental point). The letters A to D identify the four temporal placements of S^{-R} and the digits 1 to 4 identify the four S^N placements. S^R was contingent upon the first response occurring in the first 6 sec. bin. In most cases it was delivered during the first second of this bin.


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
RESPONSES/SEC.
0.0
1.0
2.0
3.0
√10 OF CYCLE

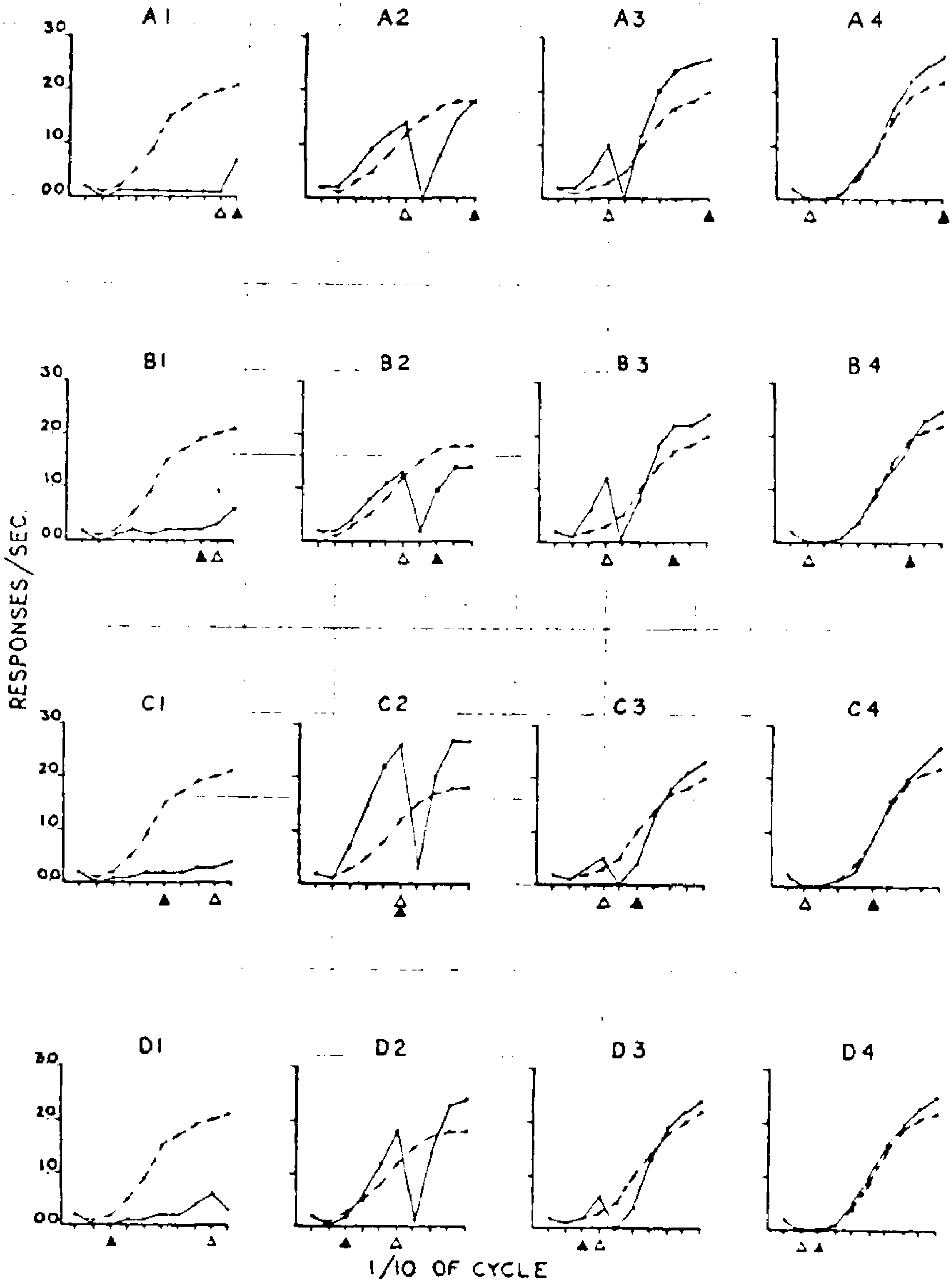
BIRD NO 1


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES/SEC.
1/10 OF CYCLE

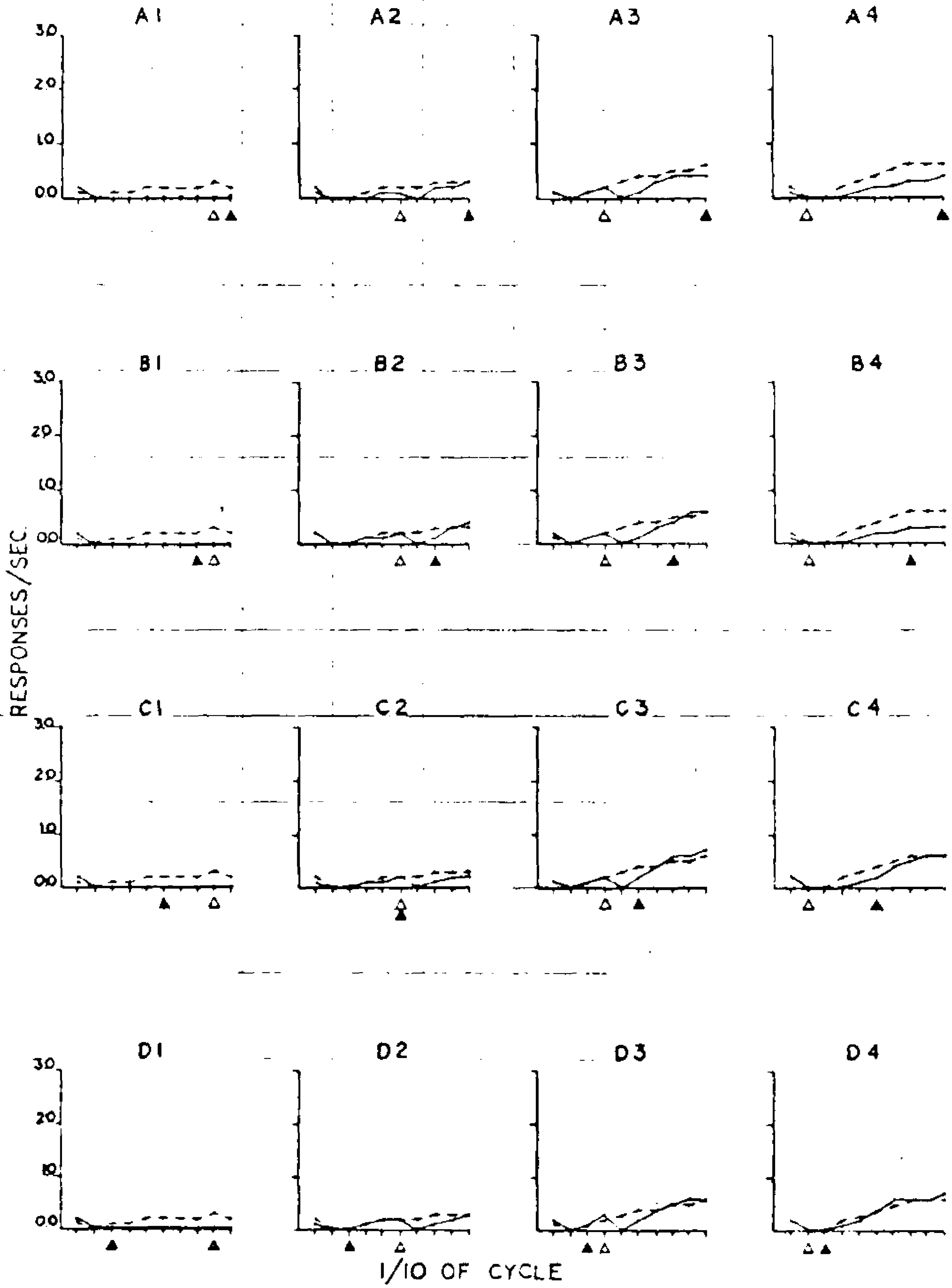
BIRD NO. 2


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
RESPONSES/SEC.
3.0
2.0
1.0
0.0
1/10 OF CYCLE

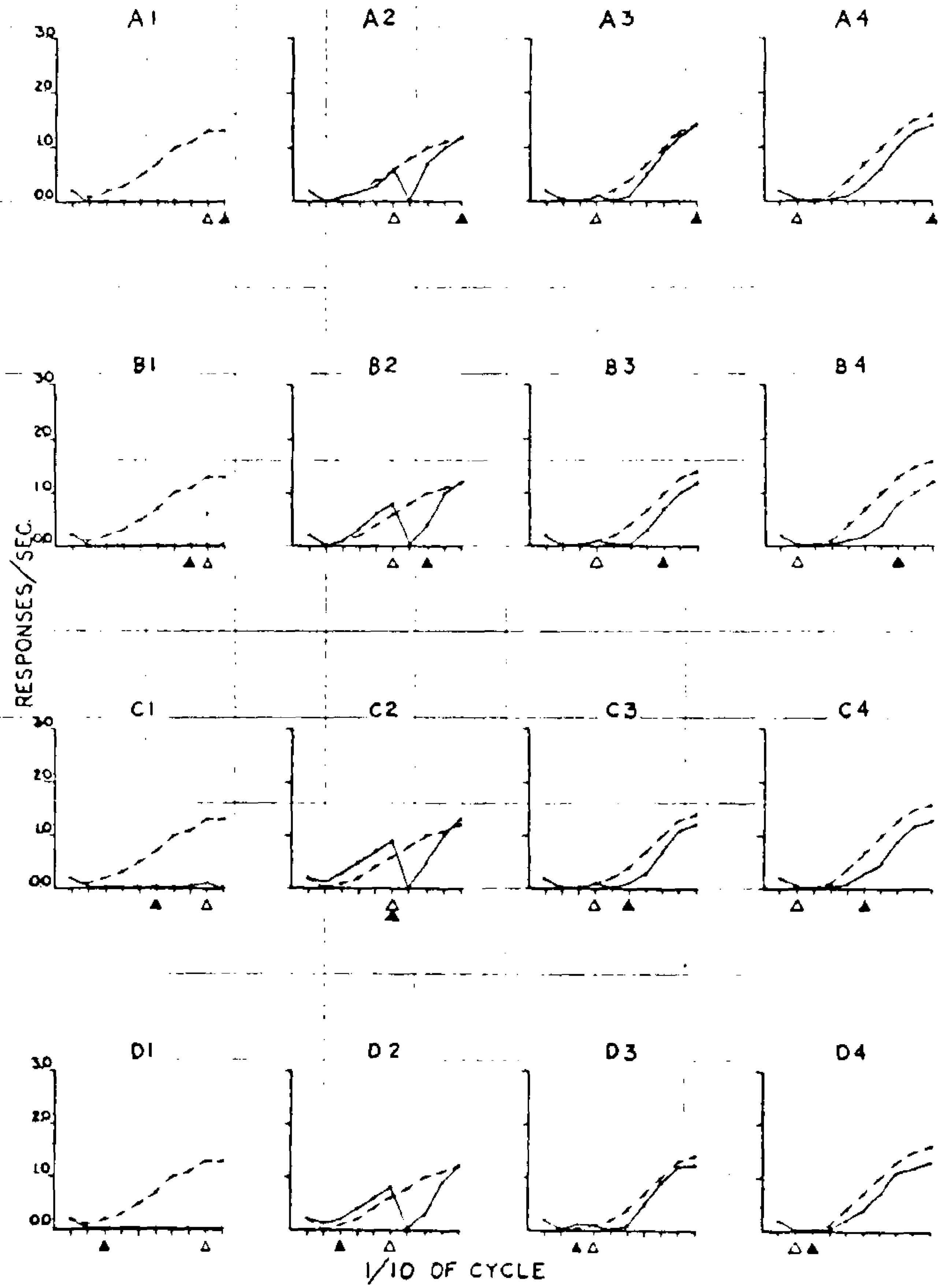
BIRD NO. 3


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
30
20
10
0.0
RESPONSES/SEC.
1/10 OF CYCLE

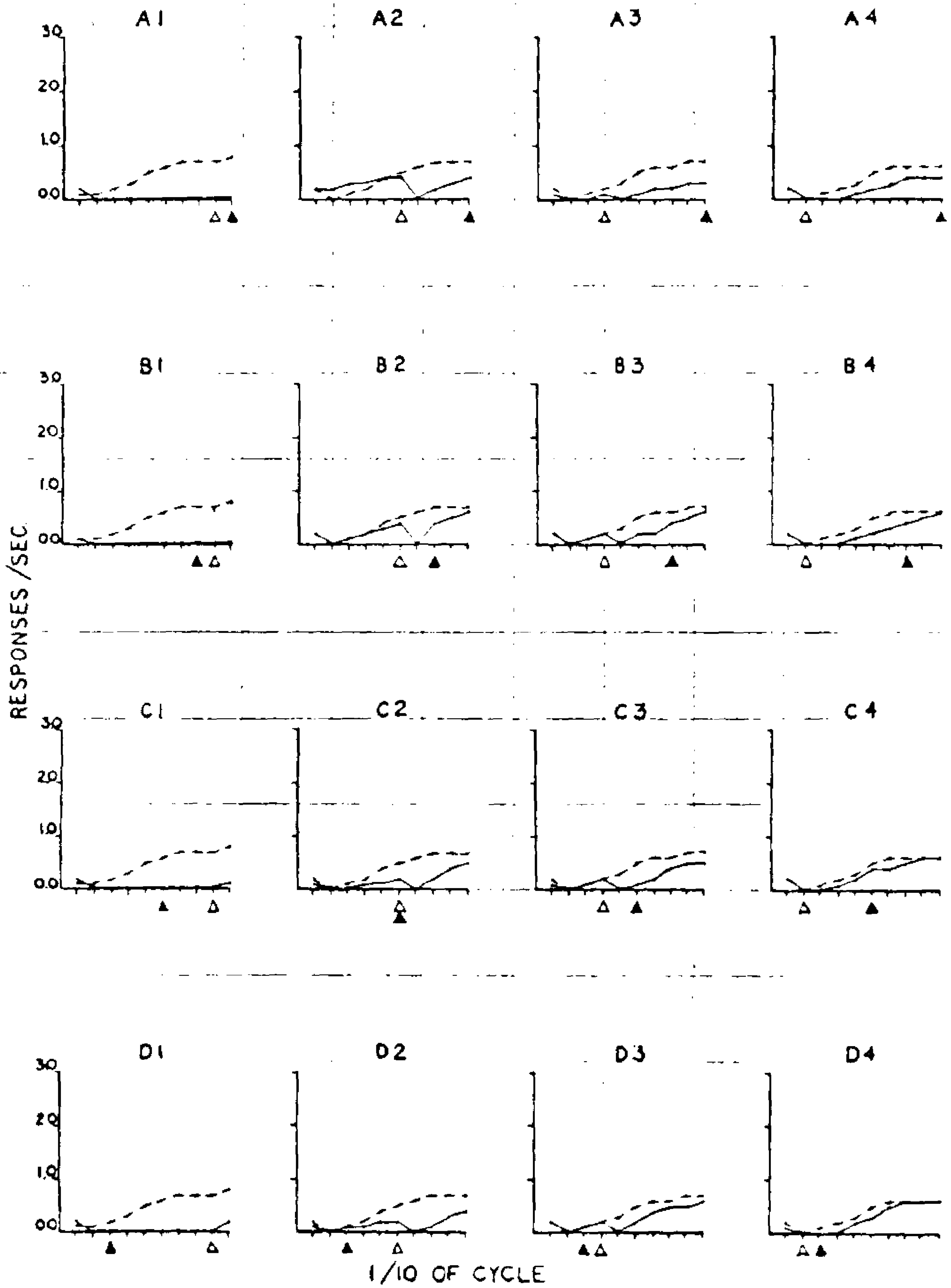
BIRD NO. 4


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES/SEC.
1/10 OF CYCLE

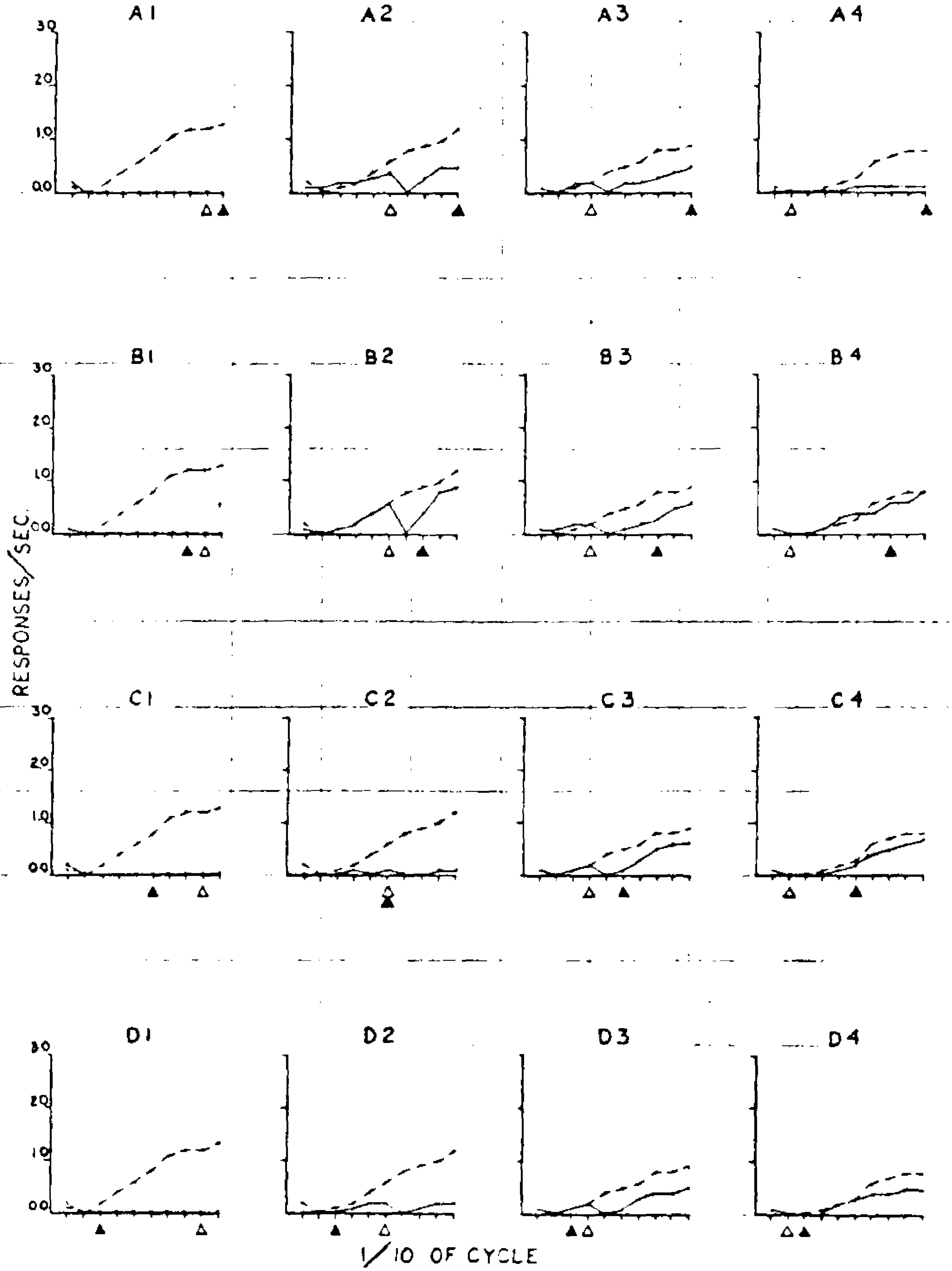
BIRD NO 5


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES/SEC.
1/10 OF CYCLE

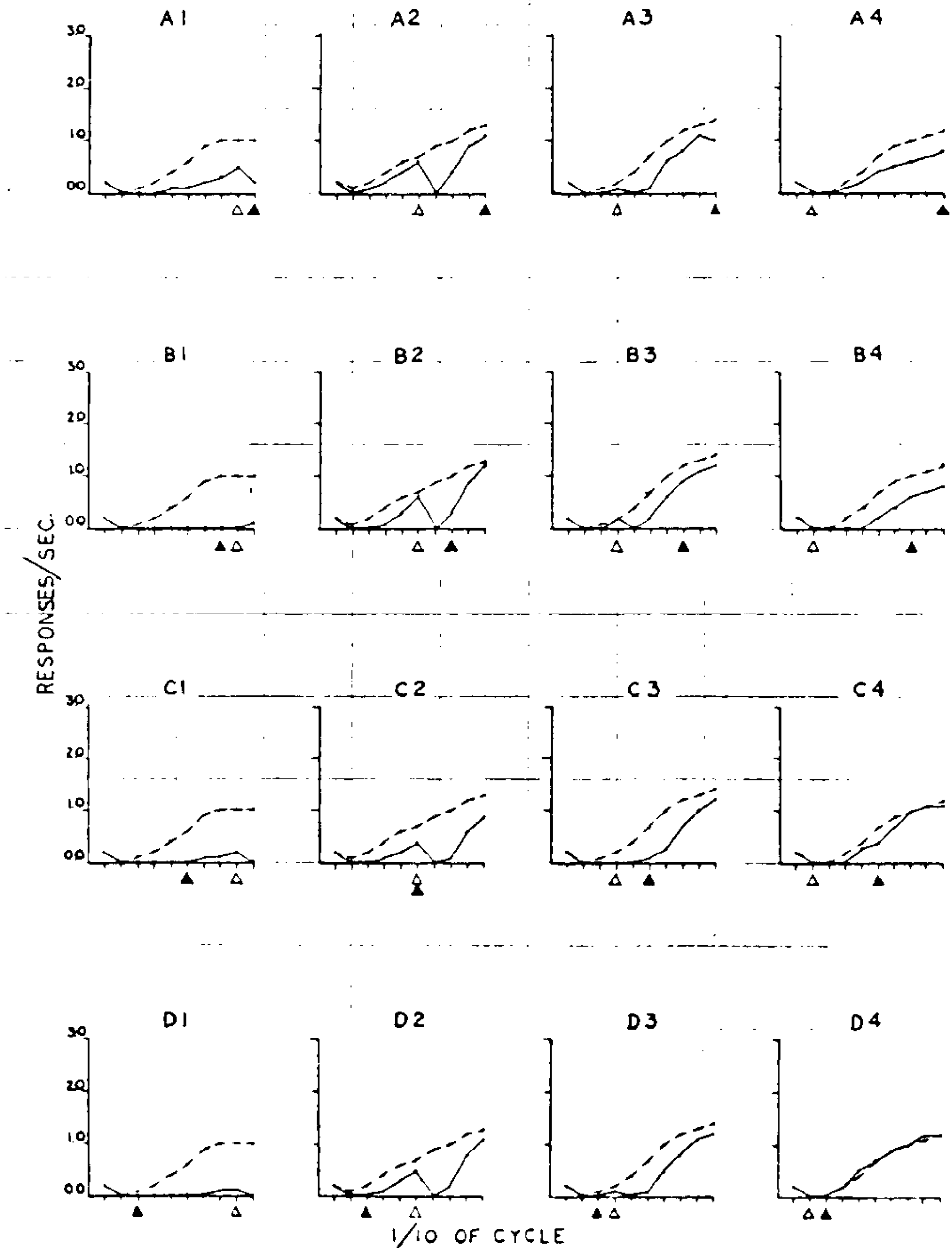
BIRD NO. 6


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES /SEC.
1/10 OF CYCLE

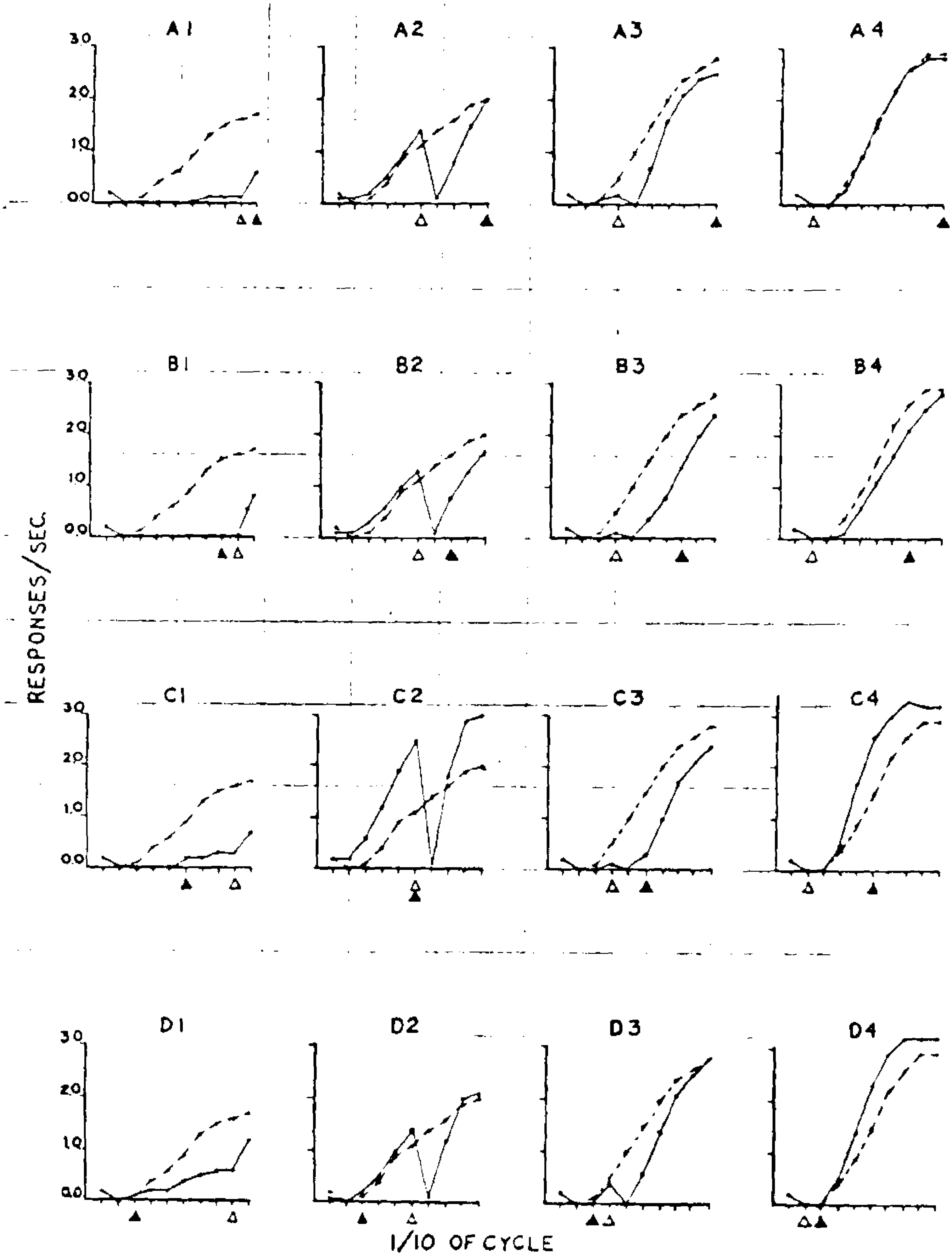
BIRD NO. 7


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES/SEC.
1/10 OF CYCLE

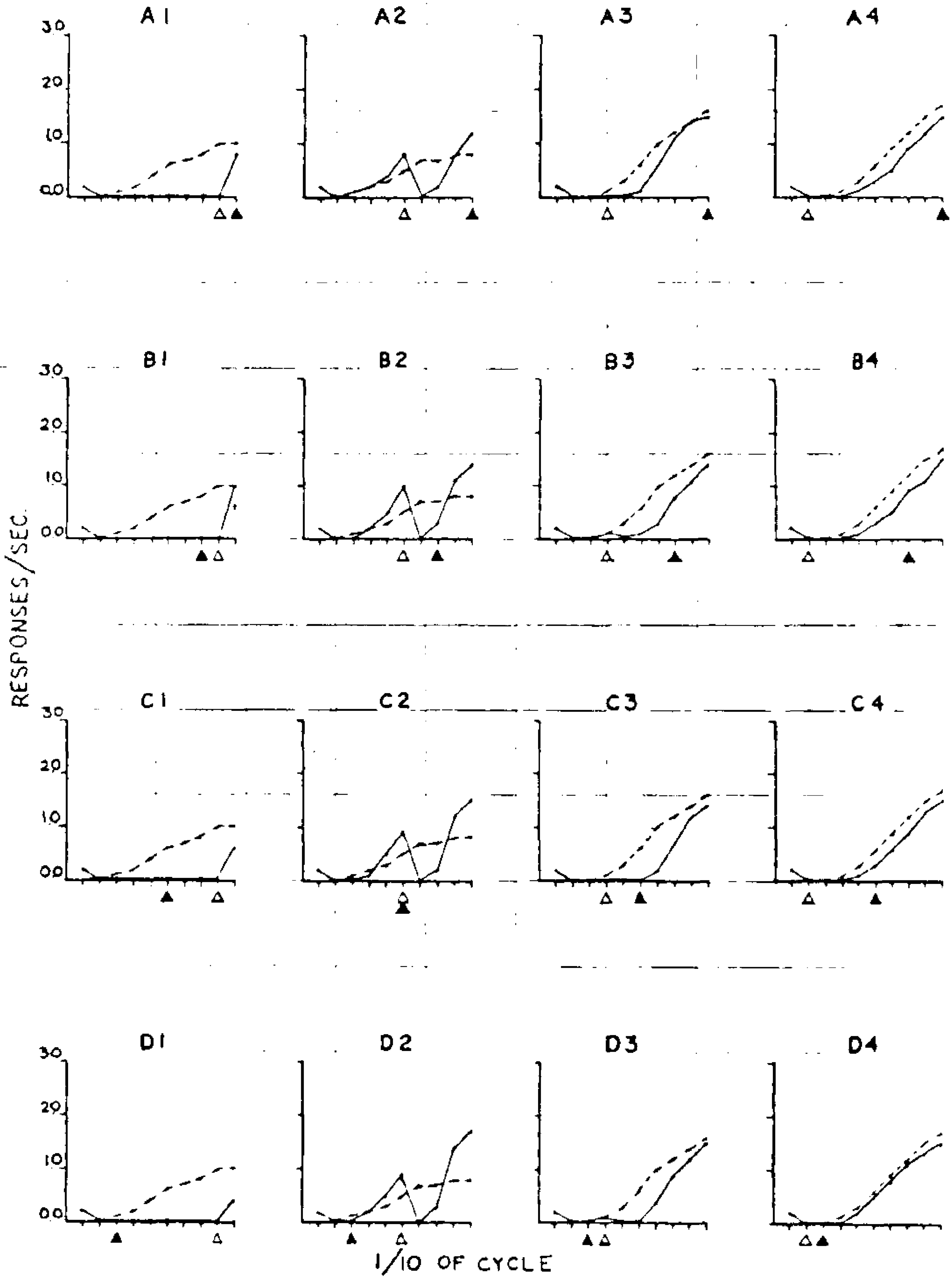
BIRD NO. 8


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES/SEC.
1/10 OF CYCLE

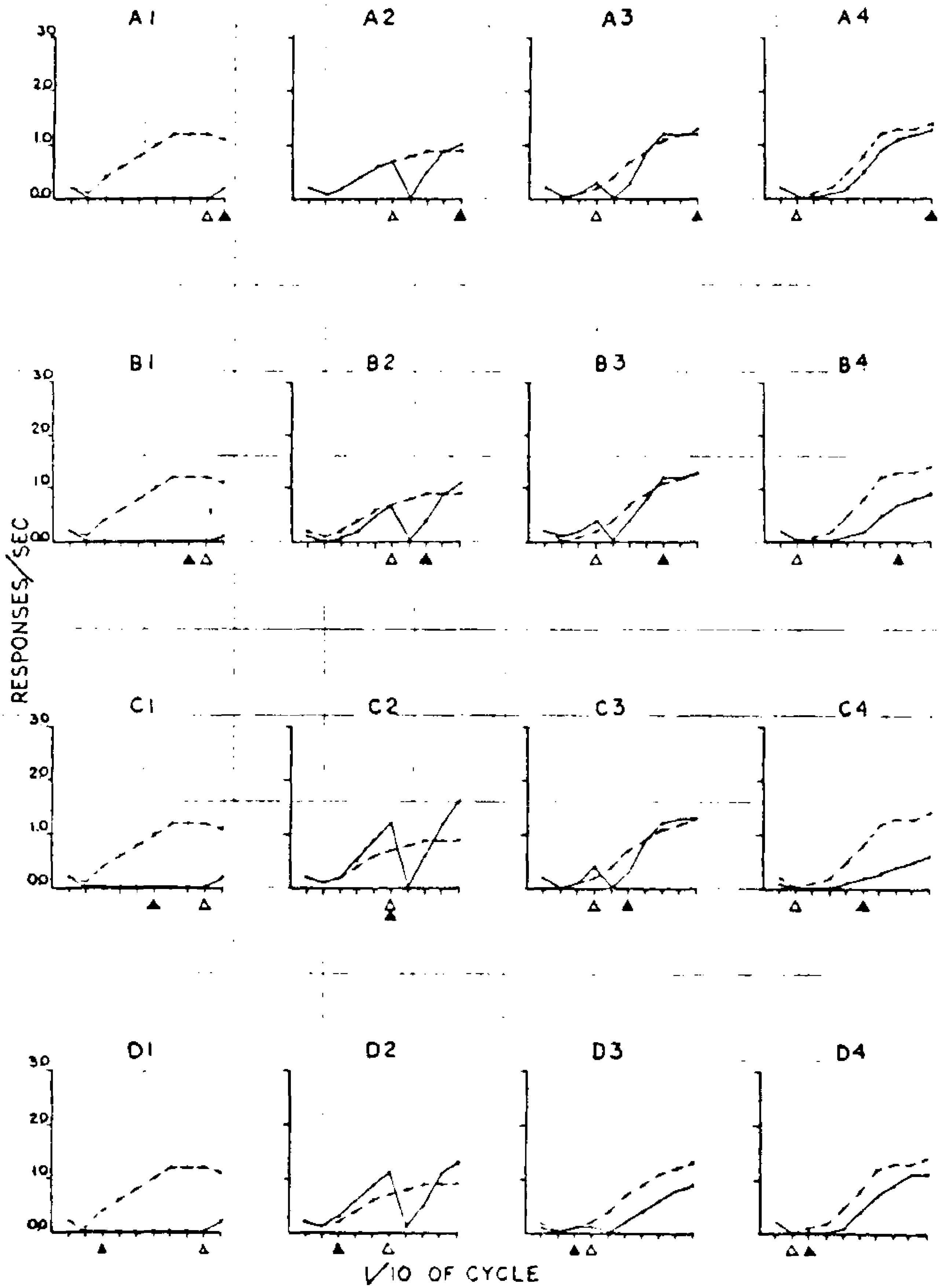
BIRD NO. 9


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES/SEC.
1/10 OF CYCLE

BIRD NO 10


A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
RESPONSES/SEC.
3.0
2.0
1.0
0.0
1/10 OF CYCLE

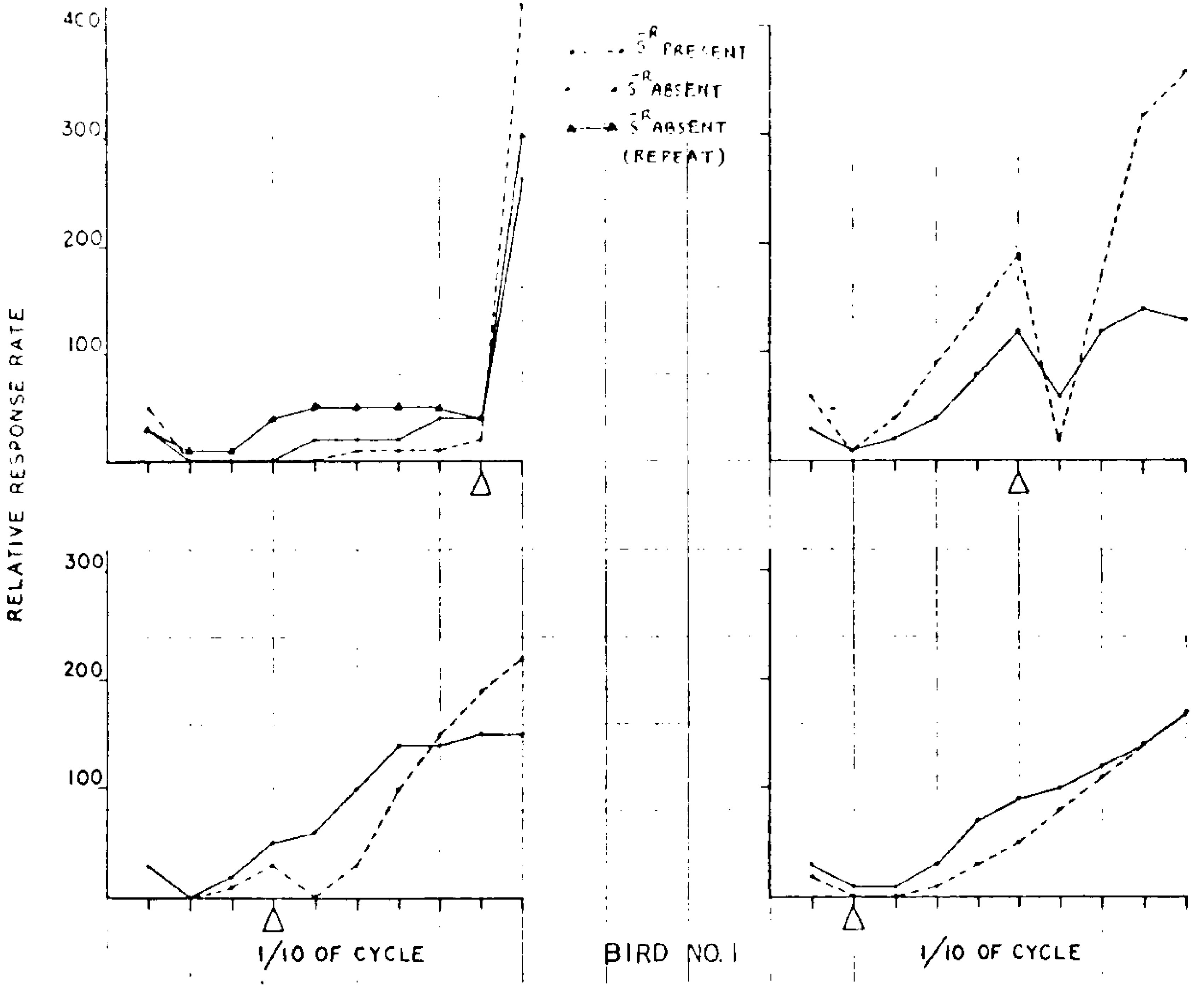
BIRD NO. 11

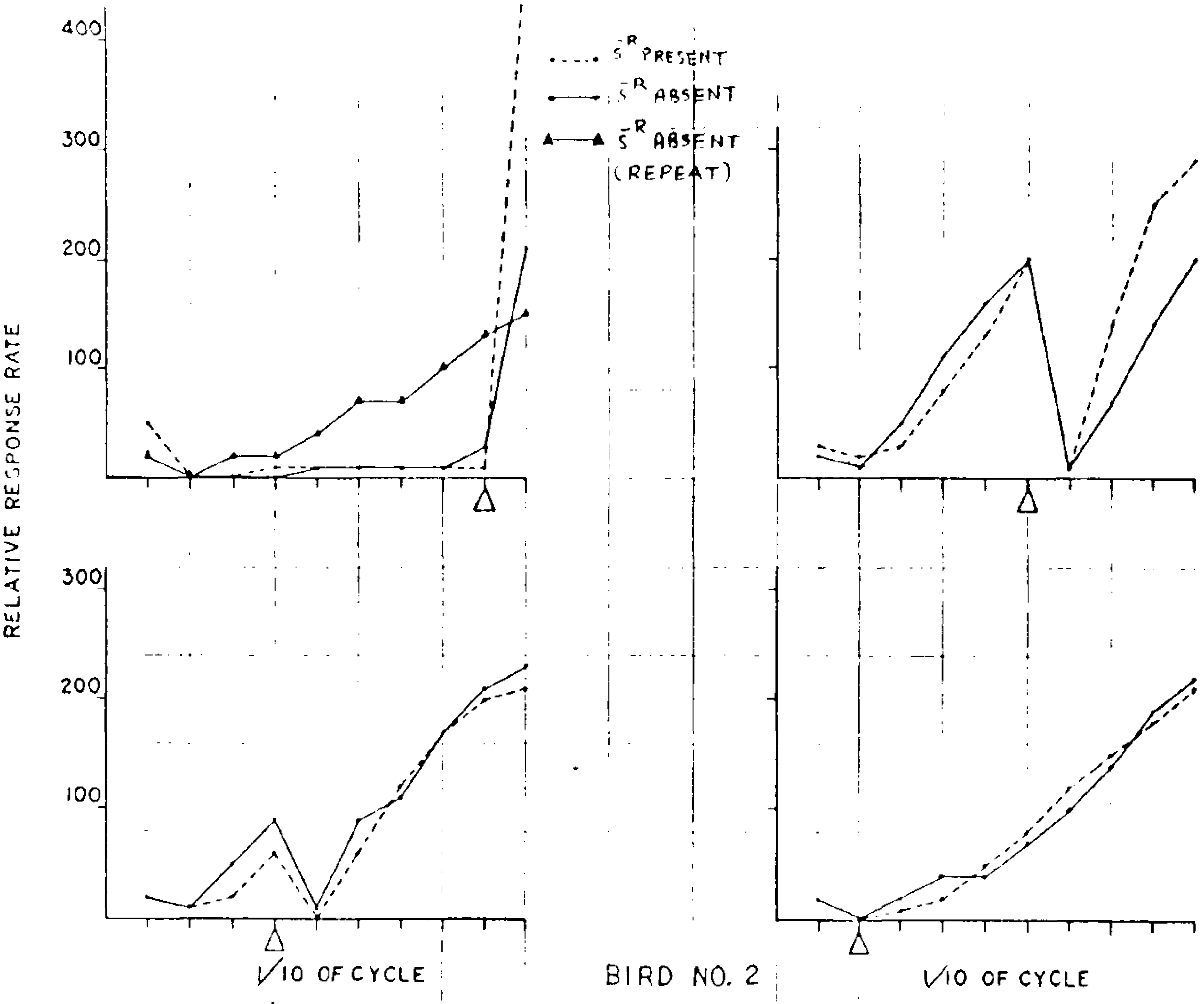

A1
A2
A3
A4
B1
B2
B3
B4
C1
C2
C3
C4
D1
D2
D3
D4
3.0
2.0
1.0
0.0
RESPONSES/SEC
1/10 OF CYCLE

BIRD NO. 12

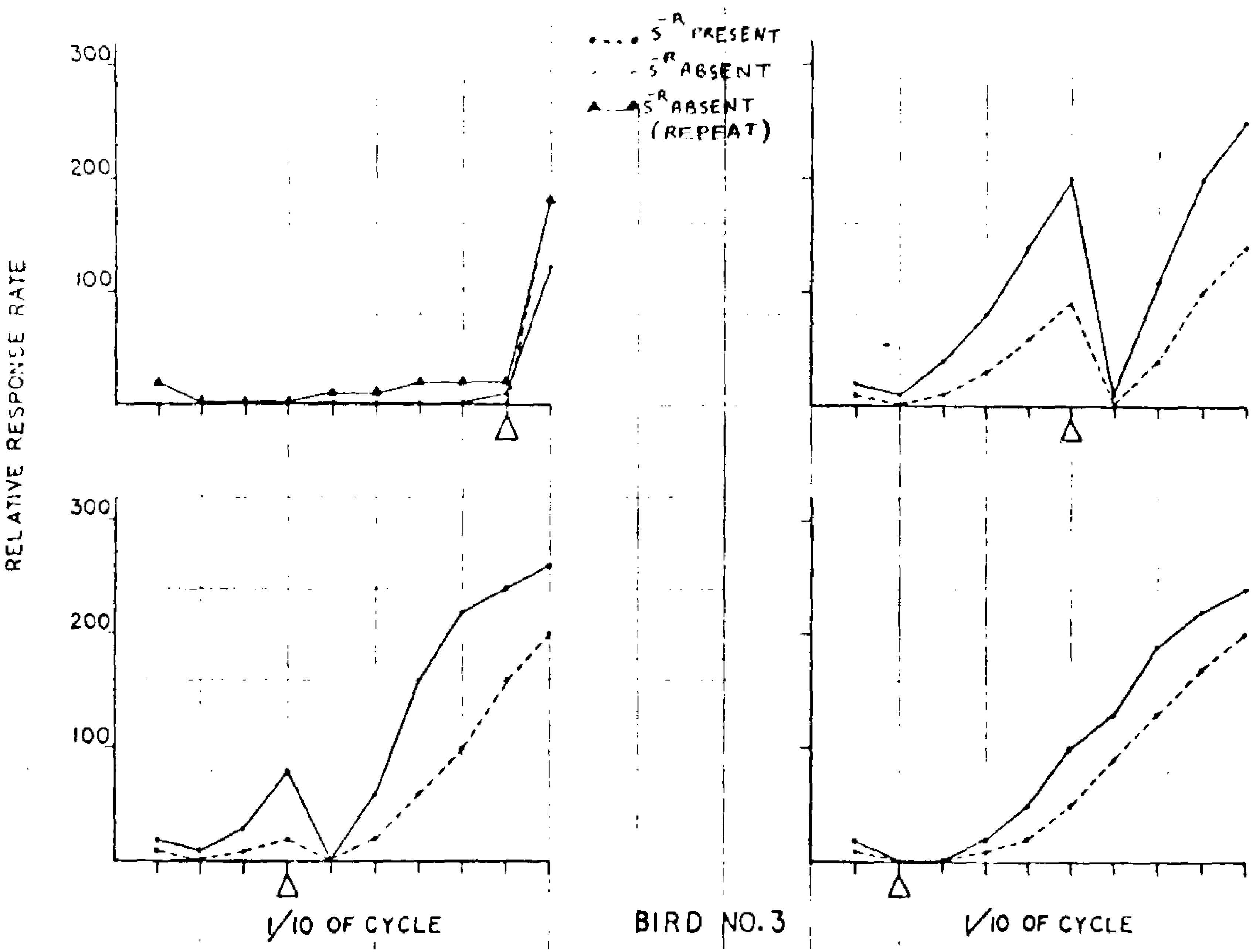
APPENDIX B

The following set of 12 figures represent for the 12 subjects individuals functions comparing their performances under S^{-R} present and S^{-R} absent conditions at each S^N location. The open triangle under each panel indicates the onset time of S^N. The data points in all functions are relative response rates during successive 6 sec. bins of the repeating time cycle. The response rates are reported as percentages of overall rates during the preceding baselines and reflect averaging over 90 cycles (comprising the last 3 sessions at each experimental point). Each S^{-R} present function is based on further averaging over the four experimental points across which S^{-R} location was varied but S^N location was kept constant.

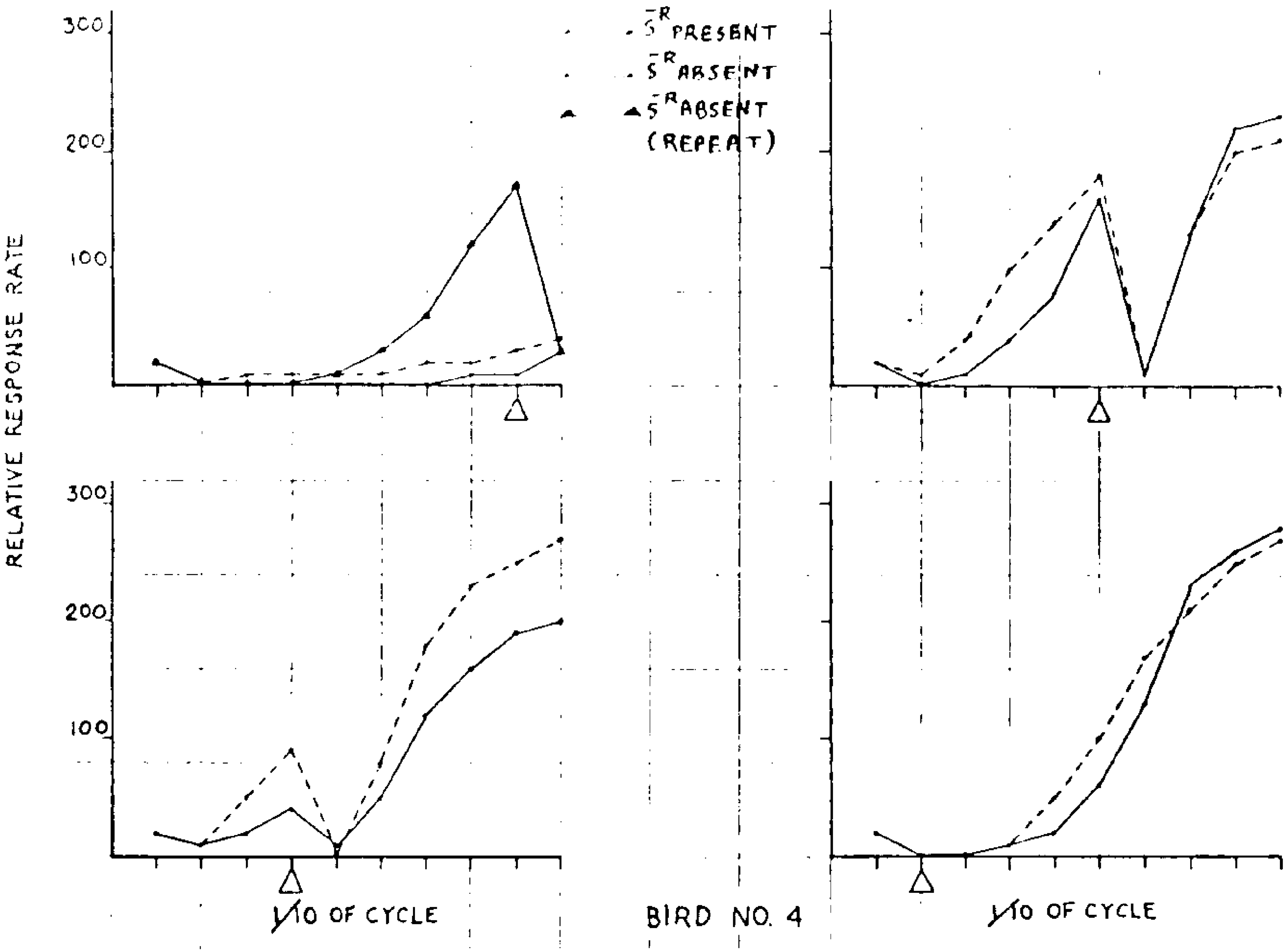

$\bar{S}^R$ PRESENT
$\bar{S}^R$ ABSENT
$\bar{S}^R$ ABSENT (REPEAT)
RELATIVE RESPONSE RATE
400
300
200
100
300
200
100
1/10 OF CYCLE
BIRD NO. 1
1/10 OF CYCLE

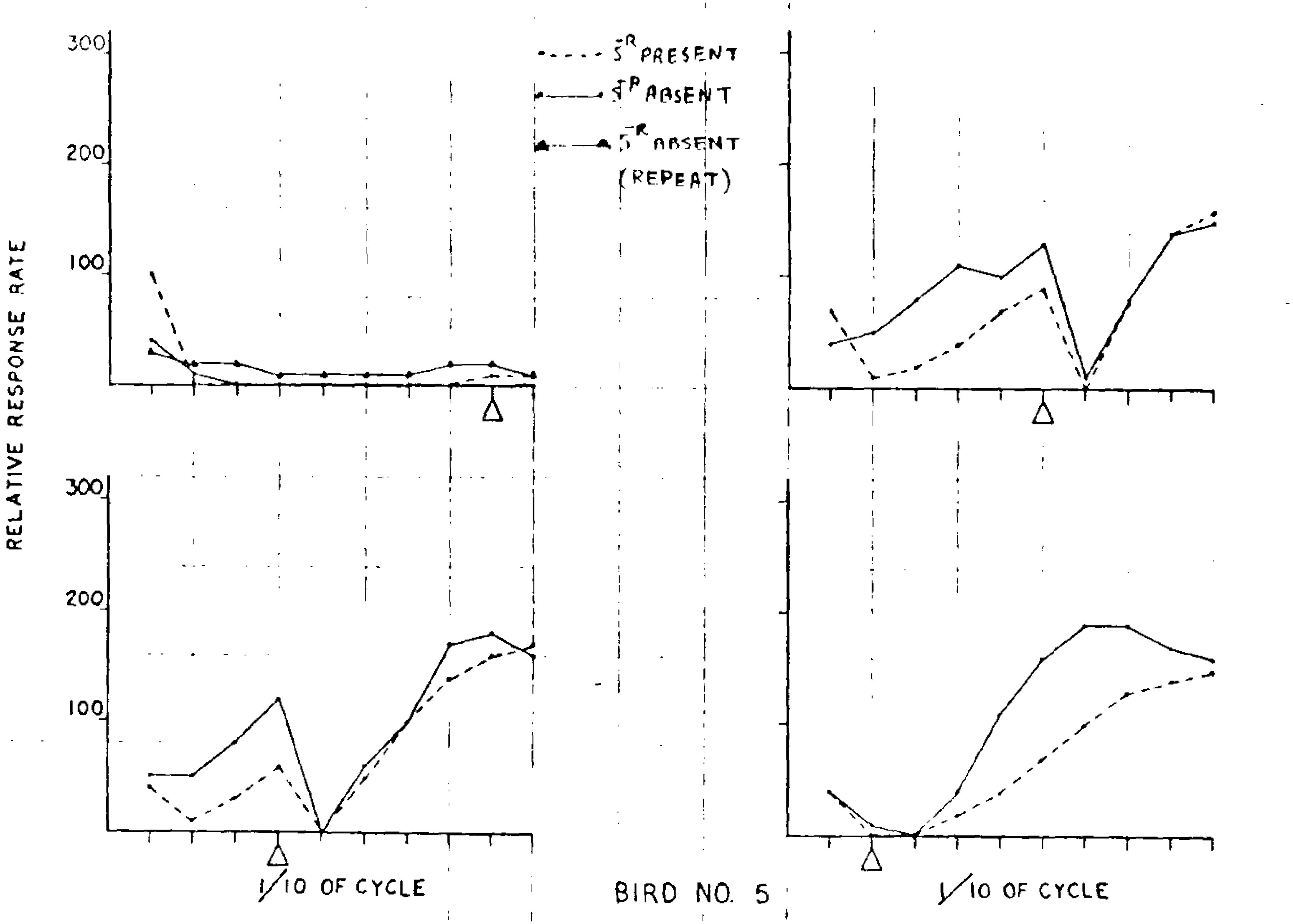


400
300
200
100
RELATIVE RESPONSE RATE
S^R PRESENT
$\bar{S}^R$ ABSENT
$\bar{S}^R$ ABSENT (REPEAT)
1/10 OF CYCLE
BIRD NO. 2
1/10 OF CYCLE

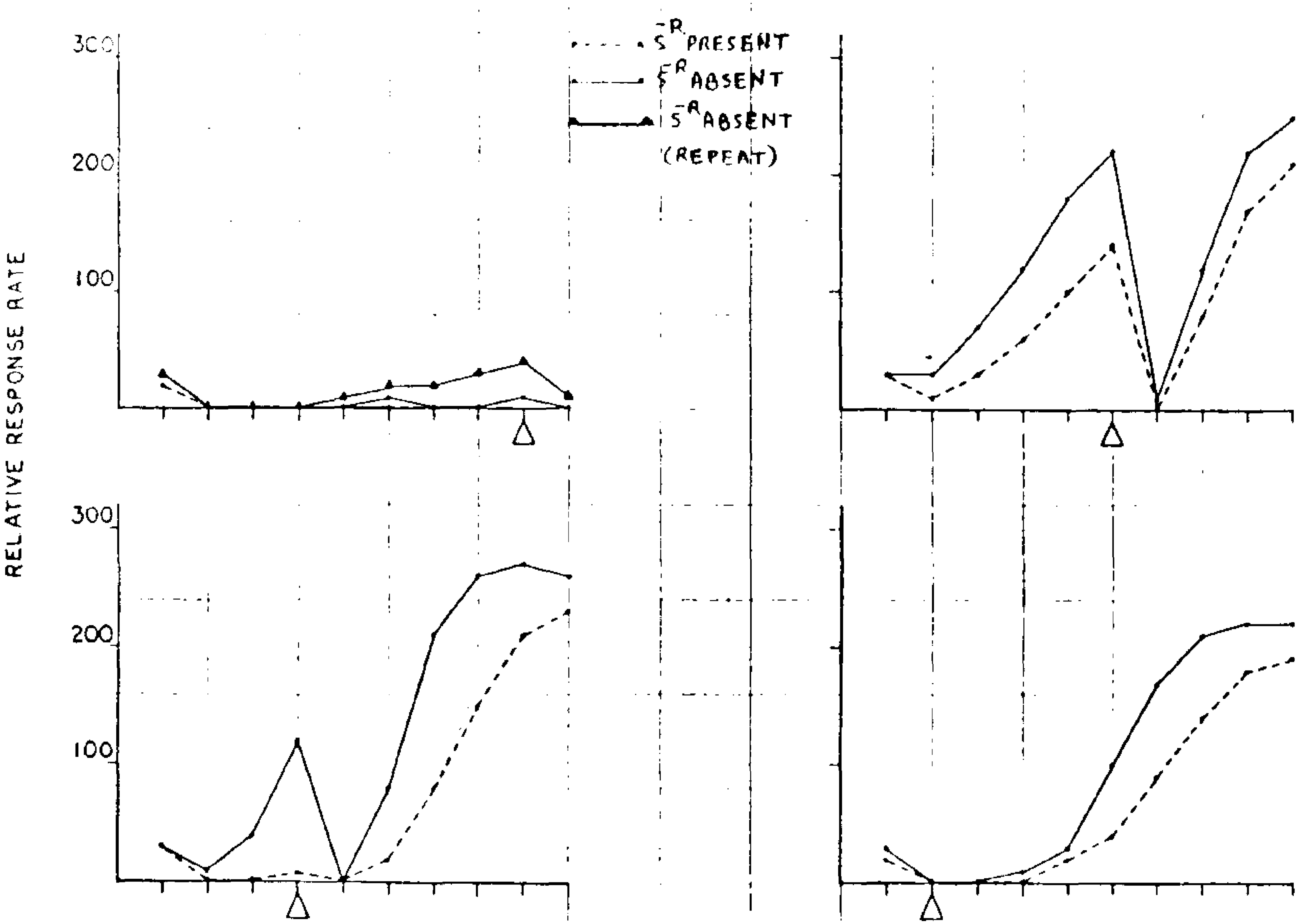


S^R PRESENT
S^R ABSENT
S^R ABSENT (REPEAT)
RELATIVE RESPONSE RATE
300
200
100
1/10 OF CYCLE
BIRD NO. 3
1/10 OF CYCLE

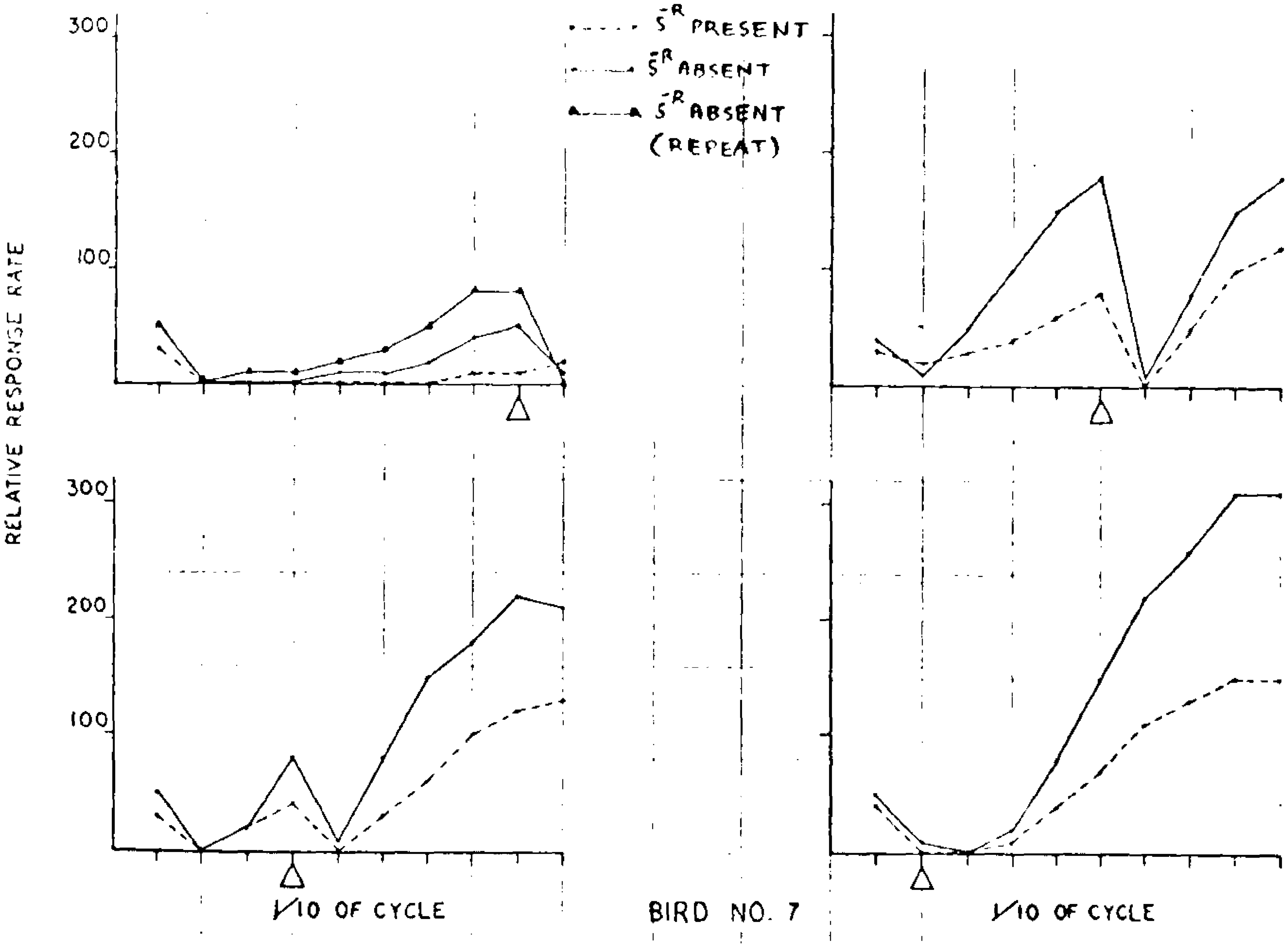

S^{-R} PRESENT
S^{-R} ABSENT
S^{-R} ABSENT (REPEAT)
RELATIVE RESPONSE RATE
300
200
100
1/10 OF CYCLE
BIRD NO. 4


RELATIVE RESPONSE RATE
300
200
100
S̄^R PRESENT
S̄^R ABSENT
S̄^R ABSENT (REPEAT)
1/10 OF CYCLE
1/10 OF CYCLE

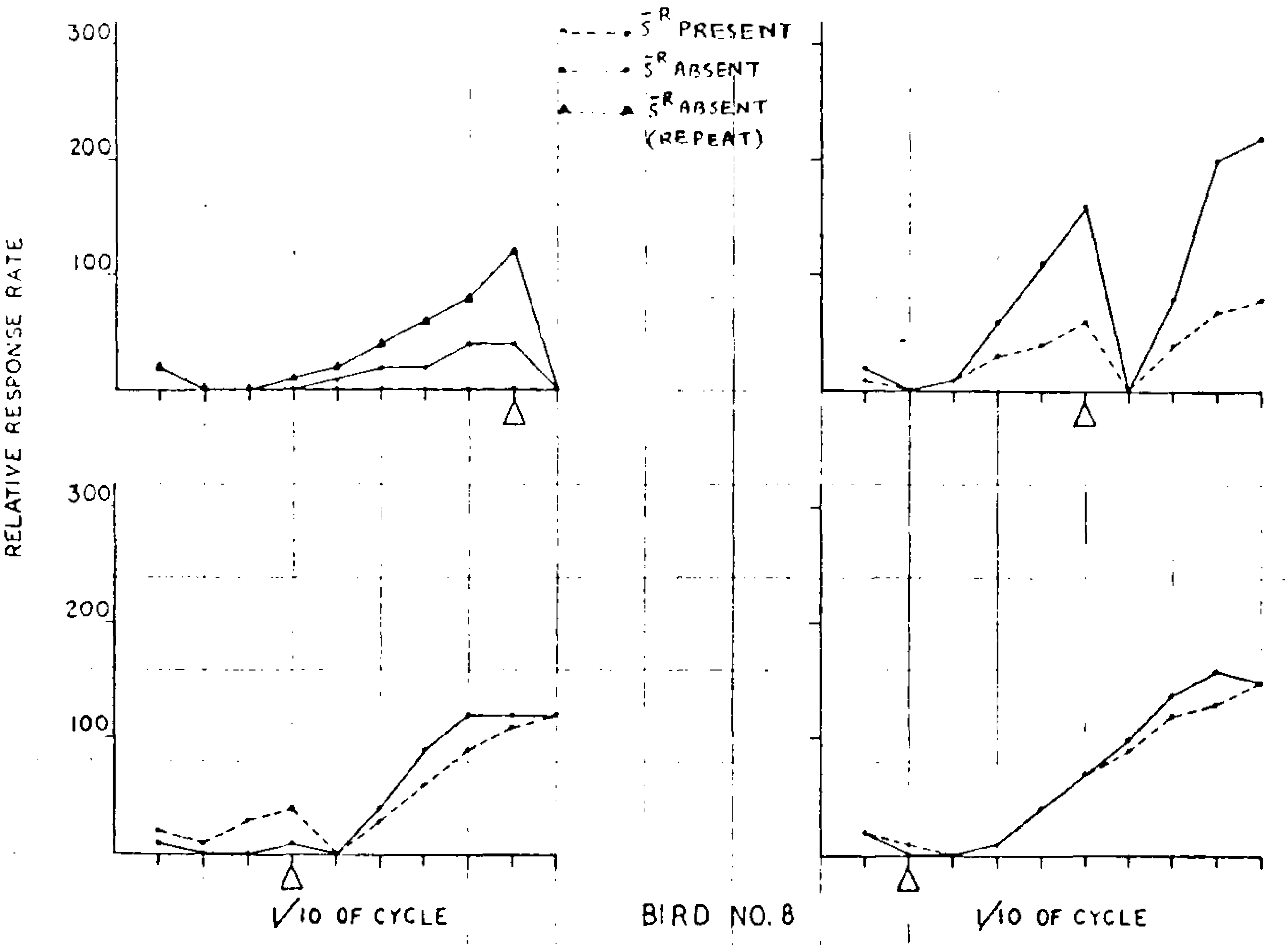
BIRD NO. 5


RELATIVE RESPONSE RATE
300
200
100
$\bar{S}^R$ PRESENT
S^R ABSENT
$\bar{S}^R$ ABSENT (REPEAT)
1/10 OF CYCLE
1/10 OF CYCLE

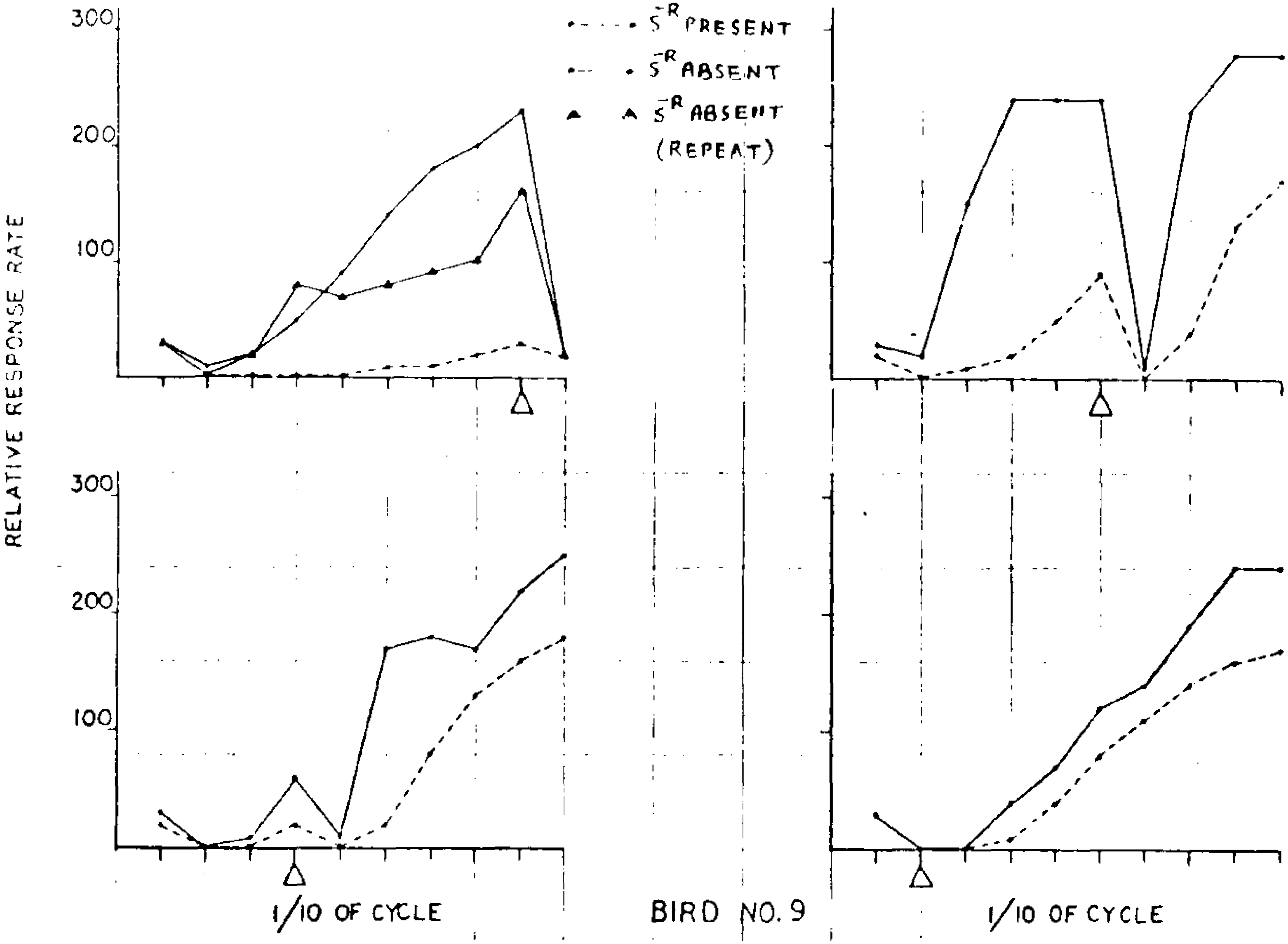
BIRD NO. 6

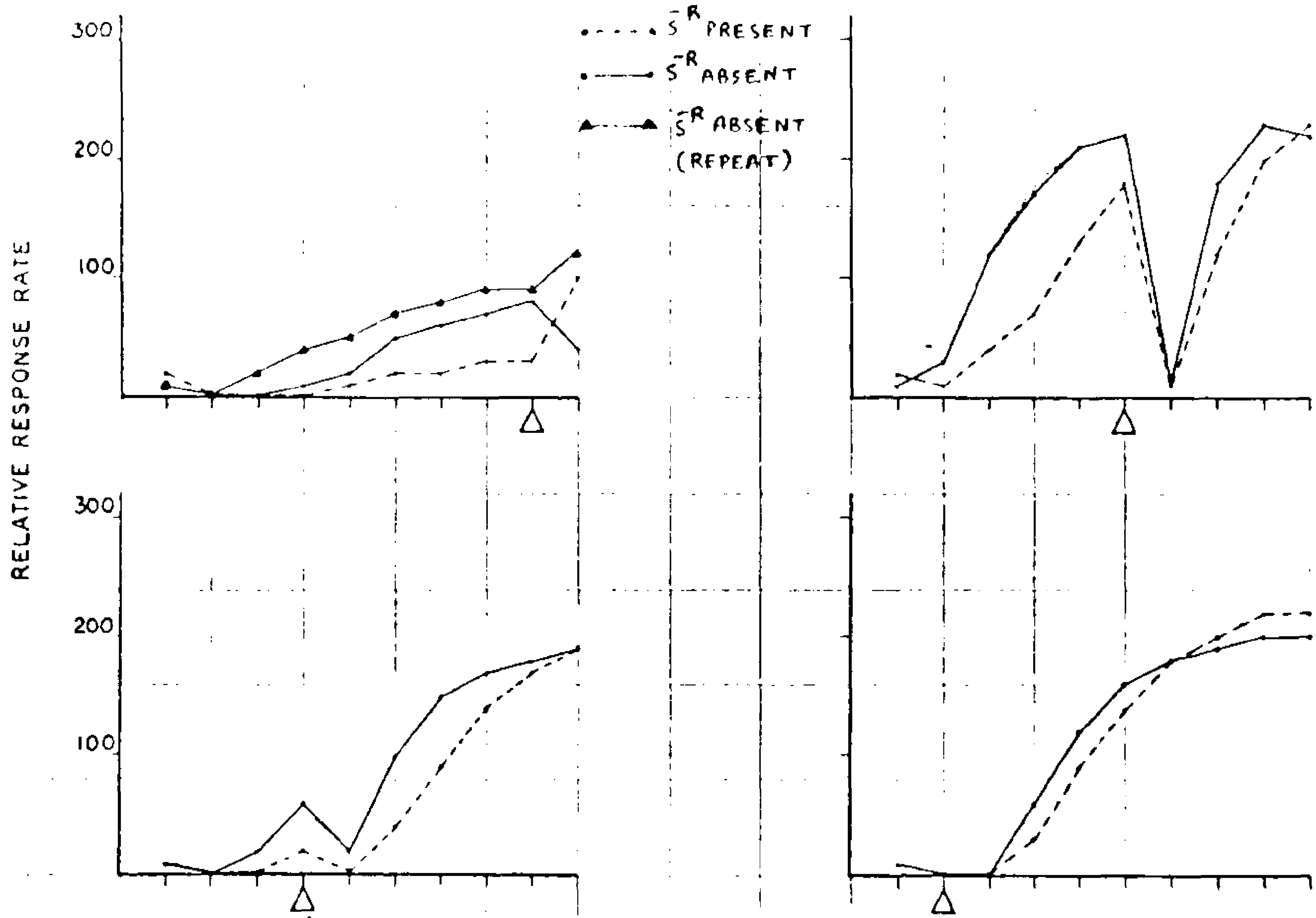


$\bar{S}^R$ PRESENT
$\bar{S}^R$ ABSENT
$\bar{S}^R$ ABSENT (REPEAT)
RELATIVE RESPONSE RATE
300
200
100
300
200
100
1/10 OF CYCLE
BIRD NO. 7
1/10 OF CYCLE

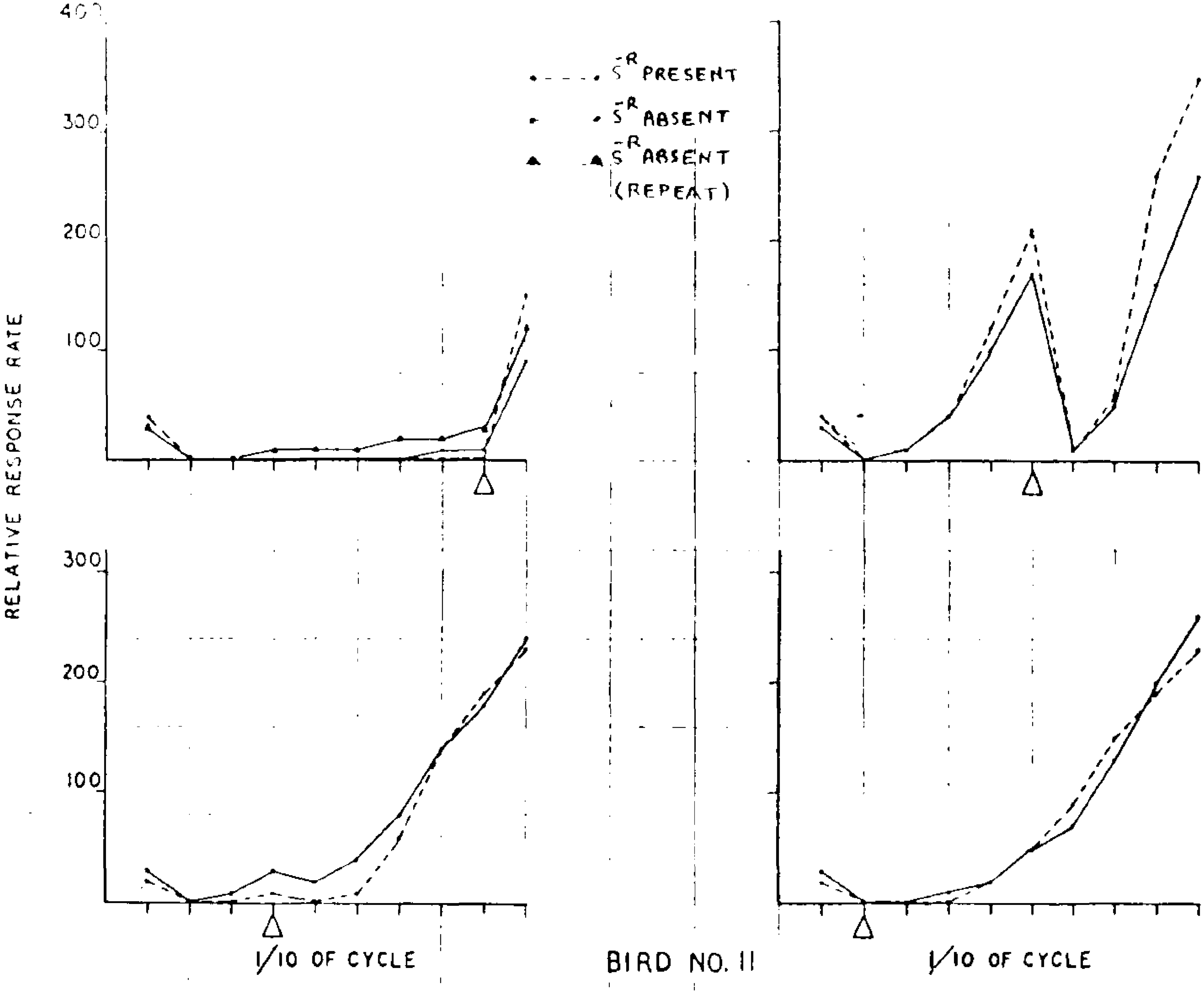


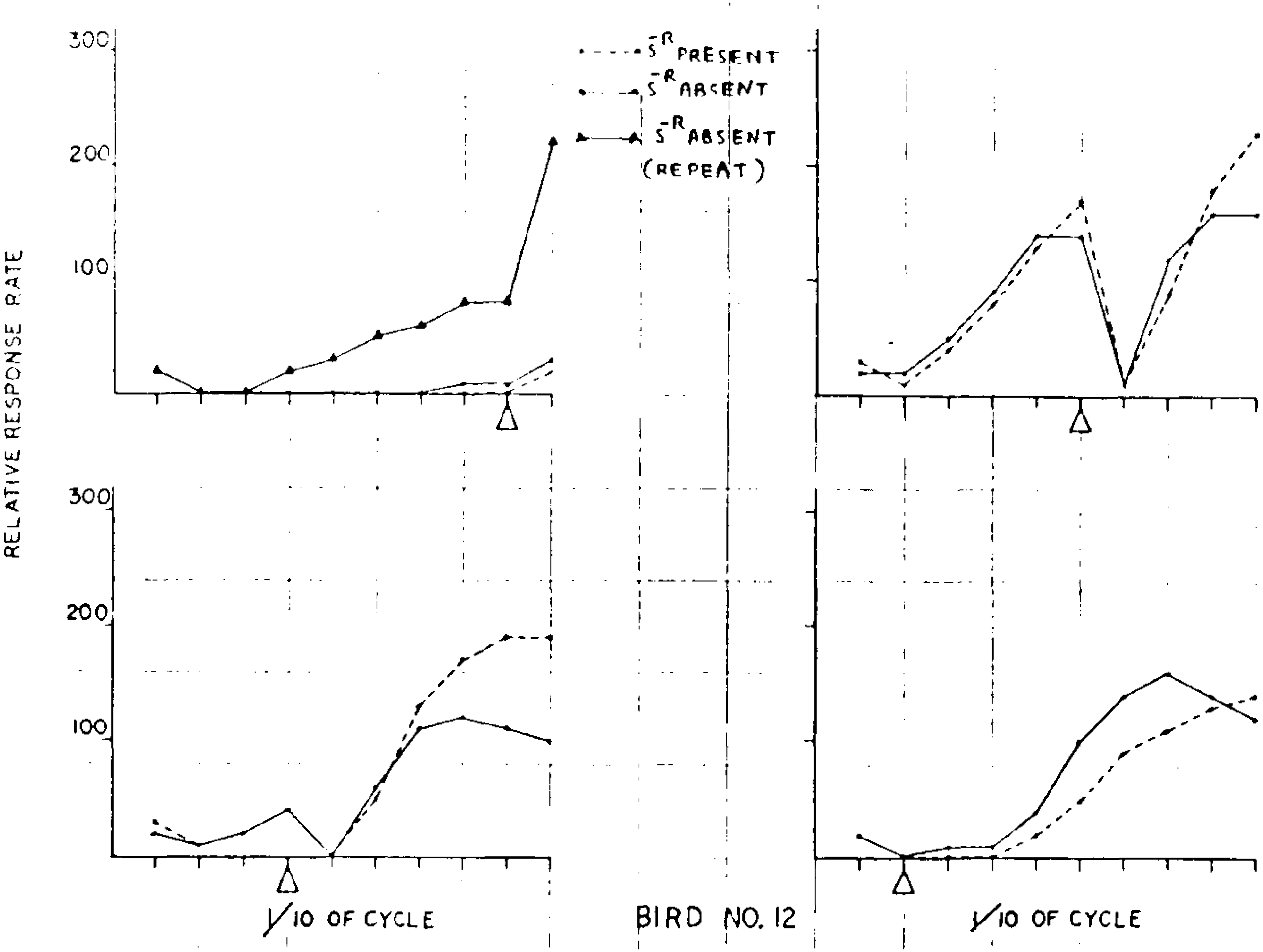
$\bar{S}^R$ PRESENT
$\bar{S}^R$ ABSENT
$\bar{S}^R$ ABSENT (REPEAT)
RELATIVE RESPONSE RATE
300
200
100
300
200
100
1/10 OF CYCLE
BIRD NO. 8
1/10 OF CYCLE


300
200
100
RELATIVE RESPONSE RATE
S̄R PRESENT
S̄R ABSENT
S̄R ABSENT (REPEAT)
1/10 OF CYCLE
BIRD NO. 9
1/10 OF CYCLE


RELATIVE RESPONSE RATE
300
200
100
$\bar{S}^R$ PRESENT
$\bar{S}^R$ ABSENT
$\bar{S}^R$ ABSENT (REPEAT)
1/10 OF CYCLE
1/10 OF CYCLE

BIRD NO. 10


RELATIVE RESPONSE RATE
400
300
200
100
$\bar{S}^R$ PRESENT
$\bar{S}^R$ ABSENT
$\bar{S}^R$ ABSENT (REPEAT)
1/10 OF CYCLE
BIRD NO. 11
1/10 OF CYCLE


RELATIVE RESPONSE RATE
300
200
100
S̄R PRESENT
S̄R ABSENT
S̄R ABSENT (REPEAT)
1/10 OF CYCLE
BIRD NO. 12
1/10 OF CYCLE

REFERENCES

Annau, Z., & Kamin, L.J. The conditioned emotional response as a function of intensity of the U.S. Journal of Comparative and Physiological Psychology, 1961, 54, 428-432.

Azrin, N.H., & 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

Bennassi, V.A. Effects of temporally related schedules of contingent and noncontingent reinforcement. Doctoral dissertation, City University of New York, 1975.

Blackman, D.E. Response rate and conditioned suppression. Psychological Reports, 1966, 19, 687-693.

Blackman, D.E. Effects of response pacing on conditioned suppression. Quarterly Journal of Experimental Psychology, 1967, 19, 170-174.

Blackman, D.E. Conditioned suppression or acceleration as a function of the behavioral baseline. Journal of the Experimental Analysis of Behavior, 1968, 11, 53-61. (a)

Blackman, D.E. Response rate, reinforcement frequency and conditioned suppression. Journal of the Experimental Analysis of Behavior, 1968, 11, 503-516. (b)

Blackman, D.E. Conditioned suppression and the effects classical conditioning on operant behavior. In W.K. Honig & J.E.R. Staddon (Ed.) Handbook of operant behavior. Englewood Cliffs, New Jersey: Prentice-Hall, 1977.

Brady, J.V. The extinction of a conditioned 'fear' response as a function of reinforcement schedule for competing behavior. Journal of Psychology, 1955, 40, 25-34.

Brady, J.V. & Contrad, D.G. Some effects of limbic system self stimulation upon conditioned emotional behavior. Journal of Comparative and Physiological Psychology, 1960, 53, 12 -137.

Brady, J.V., & Hunt, H.F. An experimental approach to the analysis of emotional behavior. Journal of Psychology, 1955, 40, 313-324.

Brimer, C.J., & Dockrill, F.J. Partial reinforcement and the CER. Psychonomic Science, 196 , 5, 1 5-1 .

Davis, H., Memmott, J., & Hurwitz, H.M.B. Effects of signals preceding and following shock on baseline responding during a conditioned suppression procedure. Journal of the Experimental Analysis of Behavior, 197 , 25, 2 3-277.

Estes, W.K., & Skinner, B.F. Some quantitative properties of anxiety. Journal of Experimental Psychology, 1941, 29, 390-400.

Farmer, J., & Schoenfeld, W.N. Varying temporal placement of an added stimulus in a fixed-interval schedule. Journal of the Experimental Analysis of Behavior, 19 , 9, -375.

Geller, I. Conditioned 'anxiety' and punishment effects on operant behavior in goldfish (carrassius auratus). Science, 19 3, 141, 351-353.

Geller, I., Kaplan, M., Stein, L., & Brady, J.V. Acquisition and extinction of conditioned 'fear' as a function of partial shock reinforcement. Paper presented at the meeting of the Eastern Psychological Association, New York, April 1957.

Gottwald, P. The role of punishment in the development of conditioned suppression. Physiology & Behavior, 19 , 2, 2 3-2 .

Heth, C.D. & Rescorla, R.A. Fear conditioning in the rat. Journal of Comparative and Physiological Psychology, 1973, 82, 434-443.

Hoffman, H.S., Fleshler, M. & Jensen, P.K. Stimulus aspects of aversive controls: the retention of conditioned suppression. Journal of the Experimental Analysis of Behavior, 1963, [illegible], 575-583.

Kamin, L.J. Trace conditioning of the conditioned emotional response. Journal of Comparative and Physiological Psychology, 1961, 54, 149-153.

Kamin, L.J. Backward conditioning and the conditioned emotional response. Journal of Comparative and Physiological Psychology, 1963, 5[illegible], 517-519.

Kamin, L.J. "Attention-like" processes in classical conditioning. In M.R. Jones (Ed.), Miami Symposium on the prediction of behavior: aversive stimulation Miami: University of Miami Press, 1968, 9-31.

Kamin, L.J. Predictability, surprise, attention and conditioning. In B. Church & B. Campbell (Ed.) Punishment and aversive behavior. New York: Appleton-Century-Crofts, 1969 279-296.

Kamin, L.J., & Schaub, R.E. Effects on conditioned stimulus intensity on the conditioned emotional response. Journal of Comparative and Physiological Psychology, 1963, 56, 502-507.

Kremer, E.F. & Kamin, L.J. The truly random control procedure: Associative or nonassociative effects in rats. Journal of Comparative and Physiological Psychology, 1971, 74, 203-210.

Libby, A. Two variables in the acquisition of depressant properties of a stimulus. Journal of Experimental Psychology, 1951, 42, 100-107.

Lyon, D.O. Frequency of reinforcement as a parameter of conditioned suppression. Journal of the Experimental Analysis of Behavior, 1963, 6, 95-9 .

Lyon, D.O. Some notes on conditioned suppression and reinforcement schedules. Journal of the Experimental Analysis of Behavior. 1964, 7, 2 9-291.

Lyon, D.O. & Millar, R.D. Conditioned suppression on a fixed interval schedule of reinforcement. Psychonomic Science, 1969, 17, 31-32.

Meltzer, D., & 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.

Orme-Johnson, D.W., & Yarczower, M. Conditioned suppression, punishment and aversion. Journal of the Experimental Analysis of Behavior, 1974, 21, 57-74.

Rescorla, R.A. Pavlovian conditioning and its proper control procedures. Psychological Review, 1967, 74, 71- 0.

Rescorla, R.A. Probability of shock in the presence and absence of CS in fear conditioning. Journal of Comparative and Physiological Psychology, 19 . 66, 1-5.

Schoenfeld, W.N., & Cole, B.K. Stimulus schedules: the t-τ systems. New York: Harper & Row, 1972.

Scobie, S.R. Interaction of an aversive Pavlovian conditioned stimulus with aversively and appetitively motivated operants in rats. Journal of Comparative and Physiological Psychology, 1972, 79, 171-1 .

Sidman, M., Herrnstein, R.J. & Conrad, D.G. Maintenance of avoidance behavior by unavoidable shocks. Journal of Comparative and Physiological Psychology, 1957, 50, 553-557.

Snapper, A.G., Kadden, R.M., Shimoff, E.H., & Schoenfeld, W.N. Stimulus intrusion on fixed-interval responding in the rat: the effects of electric shock intensity, temporal location and response contingency. Learning and Motivation, 1975, 6, 367-384.

Willis, R.D., & Lundin, R.W. Conditioned suppression in the rat as a function of shock reinforcement schedule. Psychonomic Schience, 1966, 6, 107-10 .