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Probabilities of Reinforcement for R and R̸ as Parameters of Temporally Defined Schedules of Positive Reinforcement

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Faculty in Psychology in partial fulfillment of the requirements for the degree of
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Abstract

Probabilities of Reinforcement for R and $\not{R}$ as Parameters of Temporally Defined Schedules of Positive Reinforcement

by

Daniel M. Sussman

Adviser: Professor William N. Schoenfeld

Groups of subjects were exposed to various combinations of concurrent probabilities of reinforcement for lever-pressing and not-lever-pressing. At some probability values, the resultant schedules of reinforcement resembled those usually associated with "positive" reinforcement; at other values the schedules were those traditionally called "avoidance" schedules.

One major finding was that rates of lever-pressing declined as a function of increased frequency of reinforcement for not-lever-pressing, but that terminal rates were sufficiently high to produce "avoidance" behavior with "positive" reinforcement. Implications of these data for current theories of aversive control are discussed. Temporal patterning of lever-pressing within a repeating time cycle was examined, and the conditions necessary to establish cyclical behavioral patterns are considered.

CONTENTS

INTRODUCTION

A "schedule of reinforcement" is a rule which defines the temporal positions at which stimuli will be intruded into the behavior stream. Any such rule must make reference to two probabilities: first, the probability that an instance of the experimentally-specified response (R) will be followed by a stimulus, that is, a "reinforcer" presentation, notated $\underline{p}(S^R|R)$; and, second, the probability that the stimulus presentation will follow a specified interval in which no R occurs, notated $\underline{p}(S^R|\not{R})$. These probabilities may be independently varied, and the duration of the criterion period of non-responding ($\not{R}$, read "not-R") may take on any value. To date, only restricted portions of these probability continua have been studied.

In schedules of "positive" reinforcement, typically only $\underline{p}(S^R|R)$ is specified, it being understood that $\underline{p}(S^R|\not{R})$ will be zero. For example, in traditional interval or ratio schedules, the probability that a given response will be reinforced is either zero or one depending upon whether or not the response in question is, respectively, the first since the end of some time period, or the *n*th in a series of responses. Since $\underline{p}(S^R|\not{R})=0$, no reinforcers are delivered in the absence of R.

By contrast, those procedures which are traditionally identified as schedules of "aversive" stimulation have $\underline{p}(S^R|\not{R})$ take on some non-zero value. In most cases, $\underline{p}(S^R|\not{R})=1$, and $\underline{p}(S^R|R)=0$. Thus, the "aversive" stimulus never follows an R and always follows some pre-specified interval in which no R occurs.

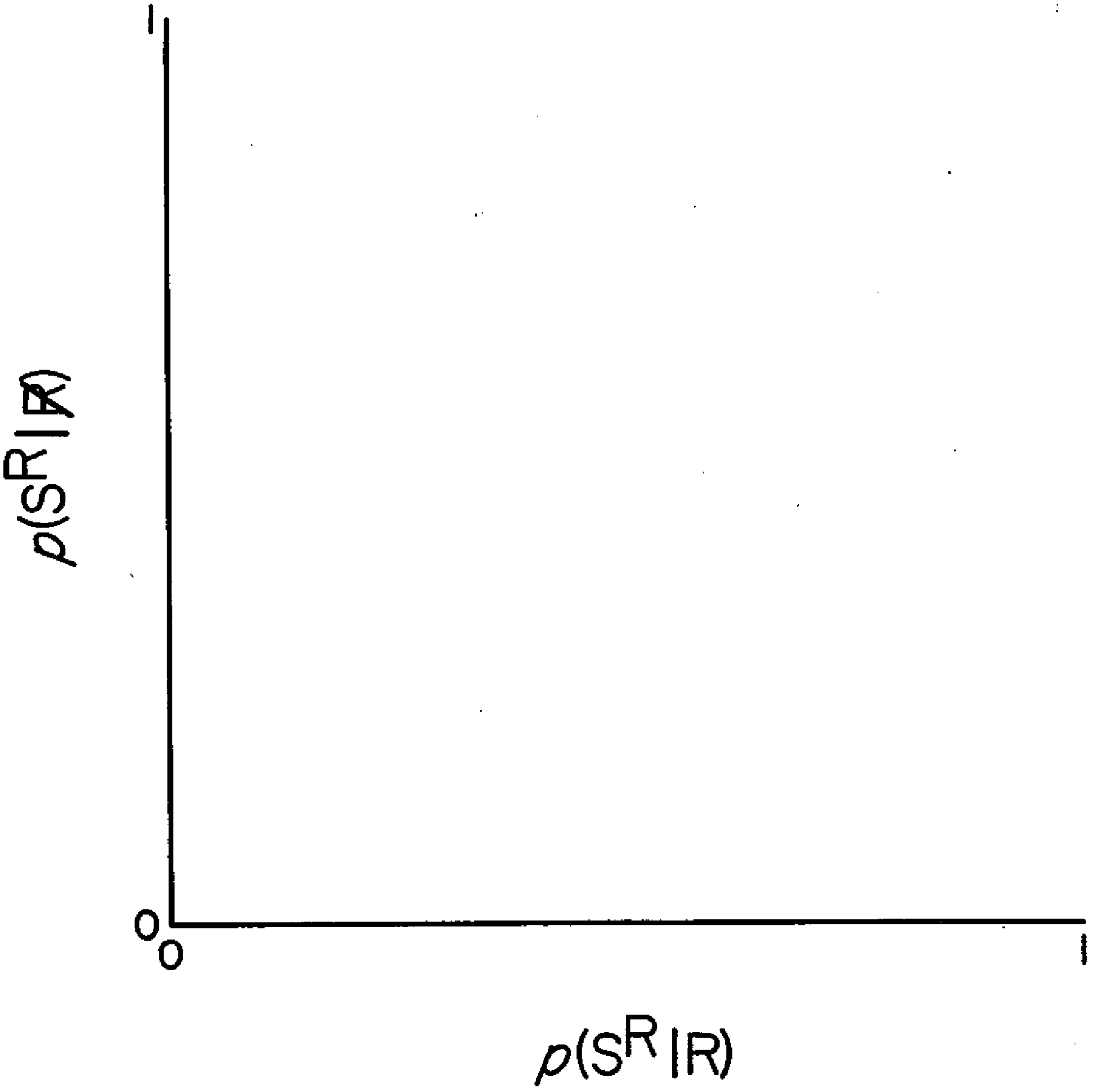
Whether with "positive" or "aversive" schedules, however, there is no reason why intermediate values of $\underline{p}(S^R)$ may not be employed. Figure 1 presents the two probabilities as the orthogonal abscissa and ordinate of an "experimental space" containimg all values of each probability, and all the combinations of the probability values. Several points in this space already bear customary labels and have been investigated in the laboratory. These include:

(a) The origin, at which no S^Rs are presented whether or not R occurs, identifies the procedure known as "extinction", or, before training, "operant level" determination.

(b) Where $\underline{p}(S^R|R)=1$ and $\underline{p}(S^R|\not{R})=0$, a schedule of either "positive" reinforcement or "punishment" is indicated depending upon whether the S^R used is "positive" or "negative". Since S^Rs are presented only following Rs, if every R is reinforced, the resultant schedule is that known as "regular" or "continuous" reinforcement (crf). If only those Rs which occur after the passage of some interval of time are reinforced, the traditional "fixed interval" (FI) schedules result.

(c) Where $\underline{p}(S^R|R)=0$ and $\underline{p}(S^R|\not{R})=1$, an "avoidance" schedule is indicated if S^R is "aversive". If S^R is

Figure 1: Schematic representation of an "experimental space" in which reinforcement or stimulus schedules are specified by $p(S^R|R)$ and $p(S^R|\not{R})$ as the independent variables.


1
$p(S^R|\bar{R})$
0
0
1
$p(S^R|R)$

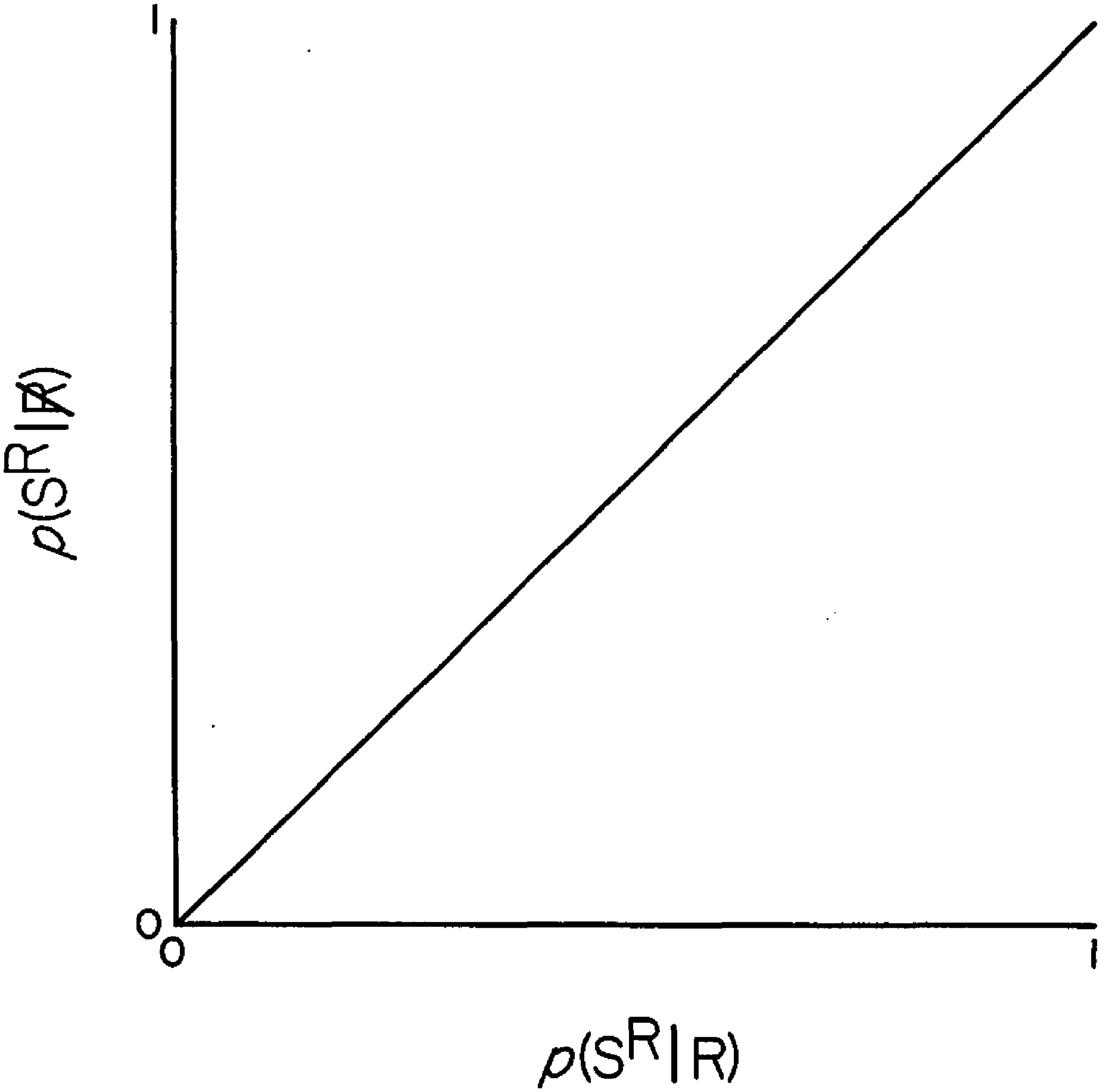
"positive", the resultant schedule has been called "differential reinforcement of other behavior" (DRO). To specify either schedule more precisely, a temporal parameter must be introduced, so that, for example, if S^Rs are presented only following ten seconds of not-R, "FI 10-sec avoidance" or "DRO 10-sec", results.

Figure 2 presents the same domain as that depicted in Figure 1 with the addition of the locus $\underline{p}(S^R|R)=\underline{p}(S^R|\not{R})$. In cases where there are an equal number of opportunities for reinforced Rs and $\not{R}$s to occur, the points on this line describe schedules in which responding or not-responding have no effect on overall S^R frequency. The number of S^Rs presented on any single schedule remains invariant regardless of the number of Rs and $\not{R}$s which occur.

It may be noted that these cases are similar to those procedures known as "non-contingent" or "response-independent" reinforcement schedules. The schedules described arise from clearly defined rules of contingency, but with the additional $\not{R}$ contingency statement, the schedules become difficult to distinguish from the "non-contingent" variety.

At the point where $\underline{p}(S^R|R)=\underline{p}(S^R|\not{R})=1$, S^Rs are delivered at every instance of S^R availability, whether for R or $\not{R}$. Thus, if only the first R in every 15-sec block of time qualifies for reinforcement, and if S^Rs are delivered at the end of the 15-sec block, and if $\not{R}$ is defined as 15-sec of non-responding, a situation closely resembling the classic "superstition" paradigm is generated.

Figure 2: The "experimental space" depicted in Figure 1 with the addition of the line $\underline{p}(S^R|R)=\underline{p}(S^R|\not{R})$.



1
0
0
1
$p(S^R|\not{R})$
$p(S^R|R)$

The line $\underline{p}(S^R|R)=\underline{p}(S^R|\not{R})$ divides the experimental space into two sub-areas each of which has been labeled and investigated, albeit in a discontinuous manner. The triangle bounded by the points (0,0), (0,1), (1,1) includes only the points, and all points, at which $\underline{p}(S^R|R) < \underline{p}(S^R|\not{R})$. These points define schedules in which responding produces S^R frequencies below those which would prevail if no Rs occured (and might, on that account, be called "avoidance" schedules). The triangle bounded by the points (0,0), (1,0), (1,1), conversely, includes only and all points at which $\underline{p}(S^R|R) > \underline{p}(S^R|\not{R})$. At these points, responding results in higher S^R frequencies than those which would result from not-R alone.

The synthetic value of the experimental space depicted in Figures 1 and 2 is now evident. Procedures which are usually viewed as unrelated (e.g., "superstition" and "avoidance") may rather be viewed as different points in the same domain. The integrative power of these continua becomes more complete when points between 0 and 1 on both the ordinate and abscissa are examined. In order to make complete specification of these areas possible, the temporal parameters mentioned earlier must be explored.

A temporal classification of schedules of reinforcement has been extant for some time (Schoenfeld, Cumming, and Hearst, 1956). It is within the framework of this system that the present investigation was conceived.

The basic element for a temporal classification of reinforcement schedules is a repeating time cycle, T, of pre-specified duration. For the purposes of the present discussion, only the first R in each cycle qualifies for reinforcement, which occurs immediately following such Rs with probability p. These two parameters, T and p, form the basis for the organization of reinforcement schedules to be presently discussed. Each of these parameters must be individually examined in order that their interactions may be appreciated.

Cycle length, T, may be varied from zero to infinity. When T takes on durations so brief that no more than one R can occur per cycle, every R must, by force, be the first in some cycle. Then, if $p=1$, every response is reinforced (i.e., crf results). As cycle length is increased so that more than one R can occur per cycle, an intermittent schedule is produced. So long as $p=1$, an FI schedule of value T is in effect.

Probability of reinforcement, p, may take on any value from zero to one. When $p=0$, regardless of the value of T, extinction is produced. When $p=1$, crf is produced when T is very brief, and FI is produced when T is sufficiently long to allow more than one R per T. Values of p between 0 and 1 produce schedules which require special attention. When T is very brief and $0 < p < 1$, responses are reinforced with equal probability since each R is the first in some cycle. If, for example, $p=0.1$, every tenth R, on the average, will be followed by S^R and the inter-reinforcement time (IS^RT) is determined by the rate of R alone. Since the number of Rs separating any two S^Rs is a random function, such schedules have been called "random ratio" (Brandauer, 1958).

As T is increased, some Rs (the first in cycles) are reinforced with a probability of p, and all other Rs do not qualify for reinforcement. Given a minimum of one R per cycle, T is the modulus for the computation of IS^RT. If, for example, p=0.1 and T=10 sec, an average of 10 cycles will elapse between S^Rs. Mean IS^RT is determined by the ratio of T to p, and the temporal distributions of S^Rs are random functions. Such schedules have been labeled "random interval" or RI (Farmer, 1963).

A more precise definition of the schedules which arise from the domain outlined in Figures 1 and 2 is now possible. Consideration will be given first to points along the abscissa and ordinate, and then to the area enclosed by the axes.

All points between 0 and 1 on the abscissa specify an intermittent schedule of some type. The precise import of the contingency statement for R at any given point depends upon how frequently Rs are eligible for S^R (i.e., the length of T). As was mentioned earlier, very brief T values produce random ratio schedules, while longer values produce random interval schedules. For any given value of T, an increase of $p(S^R|R)$ represents movement toward an FI of value T. Thus, for T=20 sec, p=0.1 produces RI 200 sec, but p=0.9 produces RI 22 sec; the difference between T and the value of the FI may be made as small as desired by increasing p (FI being the limiting case).

Similarly, all points between 0 and 1 on the ordinate define one or another type of intermittent schedule of reinforcement. Parameters which must be specified are p, T, and R̸ criterion length (i.e., how much time without R must elapse in order that the R̸ reinforcement contingency be met). If R̸ is to be briefer than the duration of T, similar restrictions to those placed on R will be in effect: only the first R̸ in a particular T will qualify for S^R. When $\not{R} < T$, and $0 < p < 1$, a random interval schedule with mean IS^RT specified by T/p is in effect. When $\not{R}=T$, the situation is analagous to that obtaining when T is so brief that no more than one R can occur during T; in the R̸ case, no more than one R̸ can occur during T when $\not{R}=T$. Random ratio schedules for R̸ may be generated in this manner. The analogy between schedules of reinforcement for R and R̸ becomes somewhat less strict at this point. In the random ratio case for R, IS^RT is determined solely by the rate of R. There are, in effect, no temporal restrictions placed upon IS^RT with very brief cycle lengths. In the case of random ratio schedules for R̸, however, temporal restrictions upon IS^RT arise from the fact that R̸ is itself temporally defined. Thus, the "ratio" in this instance is identical to "number of cycles", and the two cases converge upon "random interval".

In order to specify precisely those schedules defined by points at which both $p(S^R|R)$ and $p(S^R|\not{R})$ are greater than zero, the interactions of the above-mentioned parameters require attention. The cases cited for $p(S^R|R)=$

$\underline{p}(S^R|\not{R})$ illustrate some of these schedules, but they do not exhaust the possibilities. The schedules resulting from other combinations of probability values comprise a broad set for experimental study.

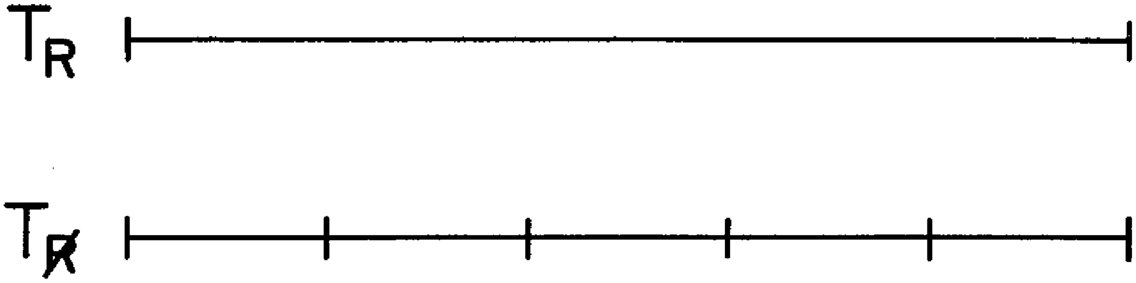
As mentioned earlier, specification of $\underline{p}(S^R|R)$ and $\underline{p}(S^R|\not{R})$ are not alone sufficient to identify the schedules associated with R and R̸. With the additional variables of T and R̸ duration, however, these schedules may be completely specified. There is no reason to limit such schedules to cases in which R and R̸ become eligible for S^R based upon synchronized and equal cycle lengths. With T of any considerable duration, moreover, the cases in which R and R̸ involve equal T values may be of little real interest. For example, if T=60 sec, and both $\underline{p}(S^R|R)$ and $\underline{p}(S^R|\not{R})$ are 1, and R̸=60 sec, an FI schedule is specified for both R and R̸. But the R̸ contingency will rarely be brought to bear on the behavior exhibited on FI 60 sec because rarely does an interval of 60 sec elapse without a single occurrence of R on such a schedule. Manipulation of parameters is indicated in order to insure that the R̸ contingency will indeed be met.

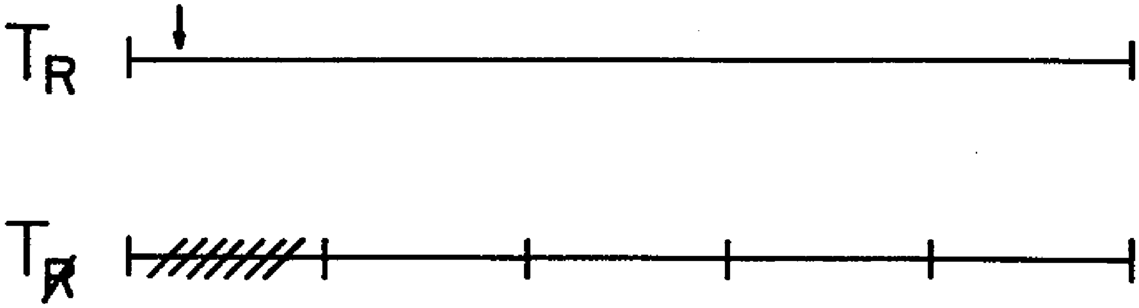
Such an effort may take several directions. If $\underline{p}(S^R|R)$ is to be 1, R̸ may be set at some value which assures that at least some of the post-reinforcement pauses (PS^RPs) meet the R̸ criterion. Alternatively, the distribution of inter-response times (IRTs) may be employed to select a value of R̸ such that R̸s occur between Rs with some considerable frequency. Both these approaches, however, suffer from the fact that a practical $\not{R}$ duration would arise from dependent variables such as PS^RP and distribution of IRT. A more straightforward approach results from an a priori consideration of the manner in which S^Rs are scheduled for R and $\not{R}$.

Figure 3 presents a scheme for scheduling S^Rs based upon R and $\not{R}$ which is derived from independent variables only. Two independent but synchronized time cycles are employed: one, T_R, for scheduling S^Rs for R; the second, $T_{\not{R}}$, for scheduling S^Rs for $\not{R}$. Only the first R in T_R is eligible for S^R, and the $\not{R}$ criterion is equal to $T_{\not{R}}$. The cycles begin at a common point in time, and one T_R is equal in duration to five $T_{\not{R}}$ cycles. The upper pair of lines in Figure 3 depicts the two concurrent cycles. The lower pair of lines illustrates the two effects of R upon S^R delivery. Given that an R occurs at the point indicated by the arrow, the T_R cycle has been sampled and, since the indicated R is the first in T_R, this R may be followed by S^R. At the same time, the first $T_{\not{R}}$ of the five indicated (this cycle is cross-hatched in Figure 3) has been disqualified for S^R. Subsequent Rs in this T_R cannot qualify for S^R; such Rs can, however, disqualify other $T_{\not{R}}$ cycles.

It should be noted that, in the given case, the $\not{R}$ contingency is defined by time alone, and that the $\not{R}$ "clock" is not reset by R. This is different from the usual DRO schedules. In the present case, a $\not{R}$ can occur

Figure 3: Schematic representation of two concurrent time cycles used to schedule S^Rs for R and $\not{R}$.


T_R
$T_{\not R}$

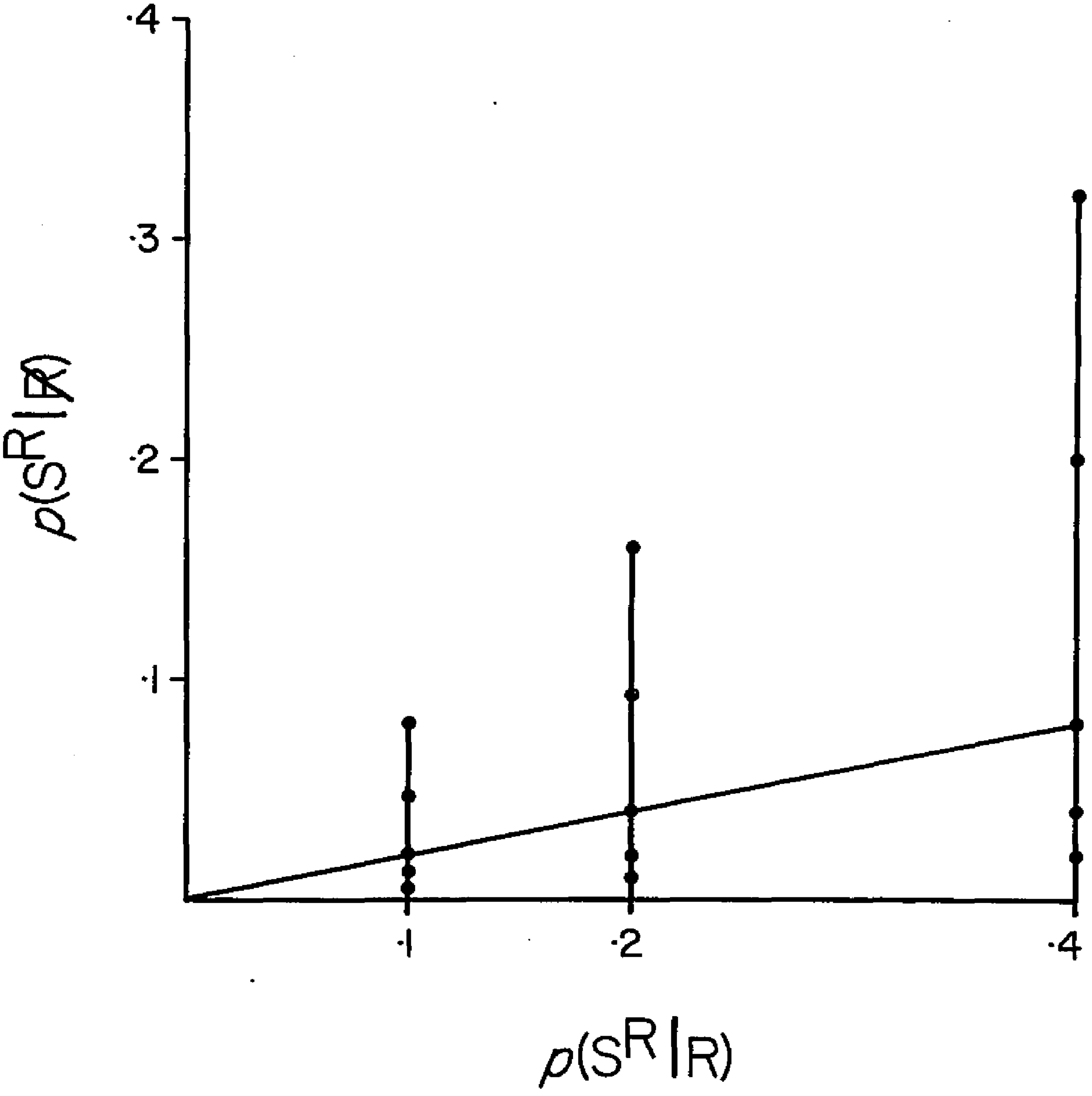

T_R
$T_{\not R}$

only in the "time windows" indicated in Figure 3. Thus, if another R should occur at the end of the second $T_{\not{R}}$, no $\not{R}$ would be recorded in spite of the fact that the interval between Rs was greater than $T_{\not{R}}$. The rationale for this $\not{R}$ definition will become clear from the design of the present experiment in Figure 4.

The ordinate and abscissa represent the two probability continua, and each of the vertical lines indicates the series of values to which a single group of subjects was exposed. For any group, then, $\underline{p}(S^R|R)$ remained constant at 0.1, 0.2, or 0.4. The line $\underline{p}(S^R|\not{R})=1/5\ \underline{p}(S^R|R)$ is analagous to the line of unit slope indicated in Figure 2. Since reinforced $\not{R}$s can occur five times as frequently as reinforced Rs, the line representing equal S^R frequencies has been adjusted in slope to one-fifth.

Discussion of the sequence of experimental procedures for one group of subjects will serve to clarify procedural considerations. The line $\underline{p}(S^R|R)=0.2$ illustrates the probability values to which this group was exposed. Values of $\underline{p}(S^R|\not{R})$ were employed in ascending order, so that the point closest to the abscissa presents the first set of parametric values used. At this point, $\underline{p}(S^R|\not{R})$ would produce fewer S^Rs in the absence of R than would $\underline{p}(S^R|R)$ if every T_R contained at least one R. The values of $\underline{p}(S^R|R)$ and $\underline{p}(S^R|\not{R})$ at this point are 0.2 and 0.01 respectively. The probability associated with $\not{R}$ is effectively 1/4 of that associated with R. The probability of

Figure 4: The combinations of probability values used in the present study.


·4
·3
·2
·1
$p(S^R|\not{R})$
·1
·2
·4
$p(S^R|R)$

reinforcement for $\not{R}$ is doubled at the next point and is thus effectively 1/2 the R probability. At the second set of values of $\underline{p}$ it is still true that R occurrences increase S^R frequency. Thus, the first two points describe schedules which have traditionally been called schedules of "positive" reinforcement when S^R is "positive". In the present study, S^R consisted of water and the subjects were water-deprived, so that the first two points describe random interval schedules of "positive" reinforcement for R and $\not{R}$. For both these points, the RI is of briefer mean duration for R than for $\not{R}$. The third point represents values of $\underline{p}(S^R|R)$ and $\underline{p}(S^R|\not{R})$ which are effectively equal. The overall frequency of S^R is not affected by the frequencies of R and $\not{R}$. At this point, the RI schedules specified for R and $\not{R}$ are of equal value.

The two remaining points indicate schedules in which $\underline{p}(S^R|\not{R})$ is effectively greater than $\underline{p}(S^R|R)$. At both these points, S^R frequency is greater in the absence of R than is the case when Rs occur; that is, the RI schedules for $\not{R}$ are of briefer mean duration than those for R. Accordingly, Rs decrease the overall frequency with which S^Rs occur. Reduction of S^R frequency by R has traditionally been labeled "avoidance" when S^R is "negative"; the case of reduction of S^R frequency when S^R is "positive" has received little experimental or taxonomic attention.

That little interest has been shown in such procedures seems natural when the basic principles which developed from the earliest investigations in operant conditioning are considered. The demonstration that the frequency of some pre-specified behavior could be increased by the judicious presentation of a stimulus was of primary importance. This orientation led directly to the classification of stimuli into at least two categories: those stimuli whose presentation results in an increase in the frequency of the behaviors which they follow, and those stimlui whose presentation does not have this effect. The former group included the "positive" reinforcers; the latter included the "negative" reinforcers and "neutral" stimuli. It is vital to note that the placement of a particular stimulus into one or another of these categories depended upon behavioral effects observed when the stimulus in question was intruded into some ongoing behavior. Thus, the "positive", "negative", or "neutral" value of a stimulus was determined by <u>behavioral</u> evidence; a shock is not inherently "negative" nor is a food pellet inherently "positive". The ascription of behavioral properties to stimulus events had practical value for the early investigators, but this categorization has led to uncomfortable situations for subsequent experimenters.

The conclusive evidence from continuing demonstrations of behavioral control obtainable with the use of the procedures set forth in the initial investigations has led to a shift in emphasis to schedule variables *per se*. Morse and Kelleher (1970) believe that schedule variables are often more crucial than the properties of the stimulus employed. This point of view is no doubt partially due to the "anomalies" which have been appearing with increasingly disturbing frequency as a result of recent experiments. The fact that these data have been viewed as anomalous is itself symptomatic of the need for a critical re-examination of the traditional systems for classifying stimuli and schedules of reinforcement.

There have been data in the literature for some time which indicate that the labels once used to identify the effects of stimulus presentations cannot be consistently applied if these labels are to remain consonant with the behavioral evidence now available. Kelleher, Riddle, and Cook (1963) demonstrated that behavior could be maintained by unavoidable shock, and that rates were highest in the presence of a stimulus which precedes such shocks. On earlier criteria for classifying stimuli, such behavior would argue for the inclusion of unavoidable shock in the class of stimuli known as "positive" reinforcers. First, the shocks maintain responding at levels well above operant level, and, secondly, a stimulus associated with these shocks acquires the types of stimulus control normally associated with discriminative stimuli which precede "positive" reinforcers. Kelleher and Morse (1968) strengthened the argument considerably with the demonstration that responding could be maintained under conditions in which responding produces shock. This demonstration has been amplified by McKearny (1969, 1970) and Byrd (1969). These data argue quite convincingly that, under some conditions, animals behave precisely as though shock were a "positive" reinforcer. Since the decision to label shock "aversive" was based strictly upon <u>behavioral</u> data available when the classification of stimuli was originally undertaken, these later experiments suggest that a review of stimulus categorization is in order.

The data indicating that long-held conceptions of the "aversiveness" of shock are in need of change have been in the literature for several years; only very recently, however, have there been attempts to re-examine the place of the "positive" reinforcers. Smith and Clark (1971) replaced shock with food in a traditional free operant (Sidman) avoidance schedule. Although this study failed to produce evidence of food "avoidance", the existence of such an experiment is instructive. It is not at all surprising that the labels which were appended to stimuli when only rudimentary knowledge of schedule parameters was available must now be amended.

The emphasis in the early investigations was upon the control of some response by stimulus presentations. This emphasis did not, however, obscure the fact that R accounted for a relatively small portion of the behavior stream. It was clear that any system which purported to produce control over behavior needed to demonstrate that other aspects of behavior, namely $\not{R}$, could also be brought under control. Skinner (1938), in his outline of the types of R-S^R contingencies which might be arranged, included a negative correlation between R and S^R. This type of contingency results in the reinforcement of $\not{R}$, and Skinner points out the interesting possibilities of conditioning an organism "not-to-respond". Skinner's negative R-S^R correlation was the forerunner of the procedure known now as DRO. Although DRO procedures are now relatively common, this procedure has been put to limited use. Almost exclusively it has been a means of eliminating Rs without the necessity of discontinuing S^R presentations. Reynolds (1961) used a DRO procedure to determine the conditions under which behavioral contrast takes place. Since the procedure involved the continuance of S^R presentations in the absence of R, it allowed the investigator to evaluate the relative importance of responding and reinforcement frequency in the production of behavioral contrast. Reinforcement of $\not{R}$ had been put to a somewhat different use by Dinsmoor (1950), who presented S^D only after 30 sec of $\not{R}$ in the presence of S^Δ. Once again, however, the primary purpose had been to reduce response rate. There have lately appeared a number of studies which focus upon the DRO procedures directly and, while these studies are limited in the range of parameters investigated, they do suggest that $\not{R}$ is now of interest as a behavioral measure.

Schoenfeld and Farmer (1970) originally suggested the investigation of $\not{R}$ for several reasons. Paramount among these was the fact that any pre-specified R must occur in some behavioral context and, as behavior is assumed to be continuous, the context in which Rs occur must form an important facet of the behavior stream. It is, in fact, the case that by defining $\not{R}$ by exclusion, $\not{R}$ comprises all behavior other than R. While this definition may seem so broad as to be virtually useless, it emerged only after other attempts at complete specification of the behavior stream had been found lacking in certain crucial aspects. One such attempt focussed upon a proliferation of responses selected for measurement. But no matter how many responses are specified and recorded, there always remains some residual time not included in the execution of any of the array of responses. The concept of $\not{R}$ as postulated by Schoenfeld and Farmer circumvents this shortcoming by dichotomizing the behavior stream; the categories which emerge are both mutually exclusive and exhaustive.

In theory, the R-$\not{R}$ categorization eliminated the residual time which other attempts at complete specification left unresolved. In practice, however, this problem reappears in a somewhat altered form. Since $\not{R}$ must be temporally defined, intervals which do not contain an instance of R but fall short of the $\not{R}$ criterion become analogous to the residual time of other classification schemes. In any system of "schedules of reinforcement", in which responses are viewed as binary events, the problem of partial Rs and $\not{R}$s remains unsolved. When $\not{R}$ is to be employed in the construction of reinforcement contingencies, binary decisions are called for. So long as this is the case, pauses in responding of insufficient duration to meet the $\not{R}$ criterion remain unaccounted for by this system. The R-R̸ conceptualization nonetheless offers a valuable technique for studying the behavioral context in which Rs occur.

It is the case that R̸ has been the subject of scrutiny for some time; a distribution of IRTs is, after all, a distribution of R̸. As was mentioned earlier, there are several studies available which concentrate upon the effects of reinforcing R̸. Nevin (1968) varied the frequency with which S^Rs were presented during a DRO component of a multiple schedule with a view toward determining the effects of such manipulation upon responding in another component in which only Rs were reinforced. Comparisons of the rate and permanence of the declines in responding produced by DRO, extinction, and/or punishment have been made by several experimenters (Uhl and Garcia, 1969; Uhl and Sherman, 1971; Zeiler, 1970; Zeiler, 1971). The general finding is that extinction produces more rapid declines in rate, but the DRO procedure results in more permanent effects. It should be noted that in all of the studies mentioned above, the probability of reinforcement for R̸ is always zero or one, and that R and R̸ are never eligible for reinforcement concurrently. It is in these two aspects that the present study differs in approach to the study of R̸.

There are a number of additional studies (some still in progress) which employ concurrent probabilities of reinforcement for R and R̸, and each begins with the experimental space presented in Figure 1. Rosenberg began with this experimental space and, through appropriate choices of parameter values, investigated the formation of "superstition". Studies by Kadden (1971), Kop, Blaustein, and Neffinger employed electric shock as S^R, and were designed to investigate the effects of various combinations of probability values upon shock "avoidance" behavior. These studies represent the first attempts to provide empirical investigations of the experimental space presented in the present study as well as by others (Catania, in press; Church, 1969; Gibbon, 1970; Seligman, Maier, and Solomon, 1971). Discussion of this area of investigation and its relevance to the present study will be deferred until evidence from the present experiment is presented in detail. Suffice it to say at this point that these studies call into question many of the theoretical notions currently held concerning "avoidance".

In summary, the present study is an attempt to examine the effects of various combinations of concurrent probabilities of reinforcement for R and $\not{R}$. These data will serve as the basis for a discussion of the classification of stimuli and the types of schedules usually associated with these stimuli.

METHOD

Subjects

Nine male Long-Evans hooded rats, 90-120 days old at the start of experimentation, served as subjects. The animals were housed in individual home cages where, for seven days following their arrival in the laboratory, they had continuous access to Purina lab chow and tap water. A watering rhythm was initiated on the eighth day: each animal was given access to water for ½ hour per day at the same hour on each of seven consecutive days (with Purina lab chow still available in the home cage). Following this acclimatization to the watering schedule (i.e., on the fifteenth day) operant level measures were begun.

Apparatus

A Lehigh Valley Electronics (LVE) model 1316 rat chamber enclosed in an LVE-1316c housing was used. General illumination was provided by a #304 miniature lamp (operated at 24VDC) mounted outside and behind the rat chamber. The right lever (LVE-1352), mounted 5.1 cm above the grid floor and 2.5 cm from the right side of the work panel, was the manipulandum (the left lever was present in the chamber, but was inoperative). The lever measured 2.5 by 2.5 by 1 cm and required a weight of approximately 22 gm for switch closure. An LVE-1351 dipper with a 0.02 cc cup was mounted in the center of the work panel, 2.5 cm above floor level.

Experimental conditions were programmed by BRS Electronics (Digi-Bit) logic modules, precision clocks, and probability generators. Data were recorded on Sodeco impulse counters, Sodeco printing counters, and a Gerbrands cumulative recorder.

Procedure

Operant level of bar-pressing was recorded on three successive days in 40-min daily sessions, following each of which each animal had 40-minutes' access to water.

Following these three days, all rats were trained to approach and drink from the dipper and the bar-pressing response was "shaped" over the course of three days. Training was continued until each animal had received approximately 300 reinforcers on a continuous reinforcement schedule (crf). During this phase, as during the remainder of the experiment, the dipper was normally out of the subjects' reach below floor level, and was raised only during reinforcement. Reinforcement duration was 2 sec.

When the requisite number of reinforcers had been delivered (in three sessions, each of which was terminated after approximately 100 reinforcers), the reinforcement schedule was changed to FI 20 sec. This was accomplished by setting T_R at 20 sec and $\underline{p}(S^R|R)$ at 1. This schedule was in effect for one session, following which $\underline{p}(S^R|R)$ was systematically decreased to 0.4 over three 40-min sessions. This value pf $\underline{p}(S^R|R)$ was reduced no further for three of the animals; of the remaining six, three were eventually exposed to $\underline{p}(S^R|R)=0.2$, and three to $\underline{p}(S^R|R)=0.1$. In this way, three different baseline schedules (RI50, RI100, RI200) were achieved. Three days were spent on acclimatization to the RI schedules. The following day was considered Day 1 of the first baseline exposure.

Animals were exposed to the baseline schedules for thirty days (sessions were conducted on successive days throughout the course of the experiment; the two exceptions to this rule are noted under Results). The first value of $\underline{p}(S^R|\not R)$ was introduced on Day 31, and this value was in effect for thirty days. A fifteen day baseline recovery period followed exposure to the first $\underline{p}(S^R|\not R)$ value. This pattern — thirty days per value of $\underline{p}(S^R|\not R)$ followed by fifteen days of exposure to the baseline schedule — was repeated until all five values of $\underline{p}(S^R|\not R)$ had been employed. Thirty days' exposure to the baseline schedules followed the final $\underline{p}(S^R|\not R)$ value. Table 1 presents the value of $\underline{p}(S^R|R)$ for each group of animals (this value remained unchanged throughout), the baseline schedule for each group, and the five values of $\underline{p}(S^R|\not R)$ to which each group was exposed.

Table 1

Values of $\underline{p}(S^R|R)$, baseline schedule, and values of $\underline{p}(S^R|\not{R})$ for each group.

Group	$\underline{p}(S^R\|R)$	Baseline Schedule	Values of $\underline{p}(S^R\|\not{R})$
1	0.1	RI 200 sec	0.005, 0.01, 0.02, 0.04, 0.08
2	0.2	RI 100 sec	0.01, 0.02, 0.04, 0.08, 0.16
3	0.4	RI 50 sec	0.02, 0.04, 0.08, 0.16, 0.32

Each daily session consisted of 120 T_R cycles (and therefore 600 $T_{\not{R}}$ cycles) and lasted approximately 40 minutes. All timing was disabled (but not reset) during S^R presentation, so that with each dipper presentation, two seconds were added to overall session length. Bar-pressing during S^R was not recorded, but if any occurred it had no effect upon the R and $\not{R}$ contingencies.

Since it was possible for two S^Rs to be presented without an intervening R (in the case where at least one S^R was presented based upon the $\not{R}$ contingency), the specification of the post-reinforcement pause (PS^RP) required special consideration. It was decided that PS^RP would be defined as the interval beginning with the termination of S^R and ending with the next R, regardless of whether or not another S^R (for $\not{R}$) had intervened. If a PS^RP timer was running when S^R was presented, it was interrupted with the onset of S^R and started again with S^R offset, thus cumulating the PS^RP. Given the following sequence of events — $R \rightarrow S^R_R \rightarrow S^R_{\not{R}} \rightarrow R$ — a certain part of this sequence would be counted in two tallies. The interval from S^R_R to the subsequent R would be considered the PS^RP for S^R_R, and the interval from $S^R_{\not{R}}$ to the same R would be counted as the PS^RP for $S^R_{\not{R}}$. The interval from $S^R_{\not{R}}$ to the succeeding R would therefore be included in both PS^RP measures. Such replication was monitored by a coincidence detector ("AND" gate). For the purposes of calculating response rates (see Results), one-half of the time detected by this AND gate was subtracted from total PS^RP time.

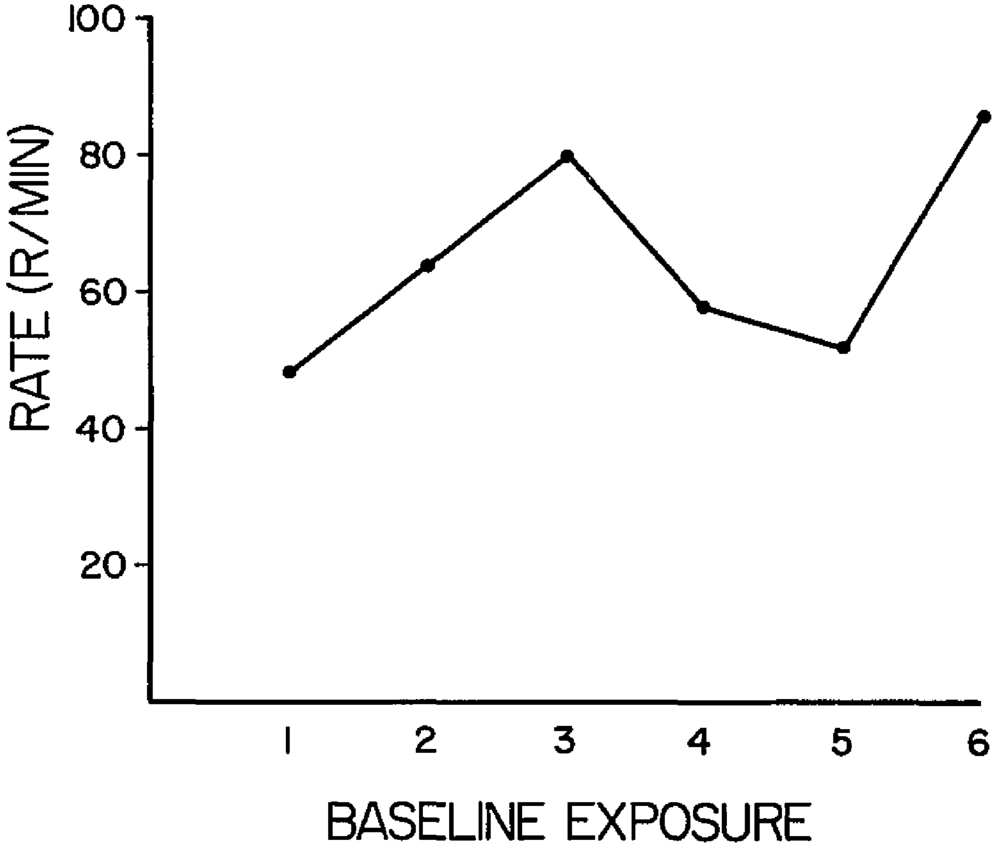
All calculations were based upon the last ten days of thirty-day exposures, and the last five days of fifteen-day exposures.

RESULTS AND DISCUSSION

For clarity, the results of the present study are presented separately for baseline exposures and experimental points. Several points should be borne in mind. Sessions were held on consecutive days throughout the course of the experiment, with the exception of one day during the fourth baseline exposure, and one day during the fifth experimental point. Neither of these one-day interruptions seemed to have a significant effect. All calculations were based upon the final ten sessions of each 30-day exposure (first and final baseline exposure and all experimental points), and upon the final five sessions of the remaining baseline exposures. Response rates were calculated by subtracting reinforcement time and total PS^RP from session length; such rates have been called "running" rates. The methods employed in the determination of PS^RPs for R and $\not{R}$ were discussed earlier (see Method). Other dependent variables will be discussed as the appropriate data are presented.

Figures 5 through 12 depict response rate and PS^RP functions for the six baseline exposures for each of the eight subjects. (One subject, Rat 6, was destroyed due to illness and no data for this subject are included.) It is clear that for the subjects in Groups 2 and 3 (RI 100 sec and RI 50 sec, respectively) baseline response rates changed considerably over successive exposures. Although Sidley

Figure 5: Mean response rate and $PS^{R}P$ for successive baseline exposures for Rat 1.


100
80
60
40
20
RATE (R/MIN)
1
2
3
4
5
6
BASELINE EXPOSURE

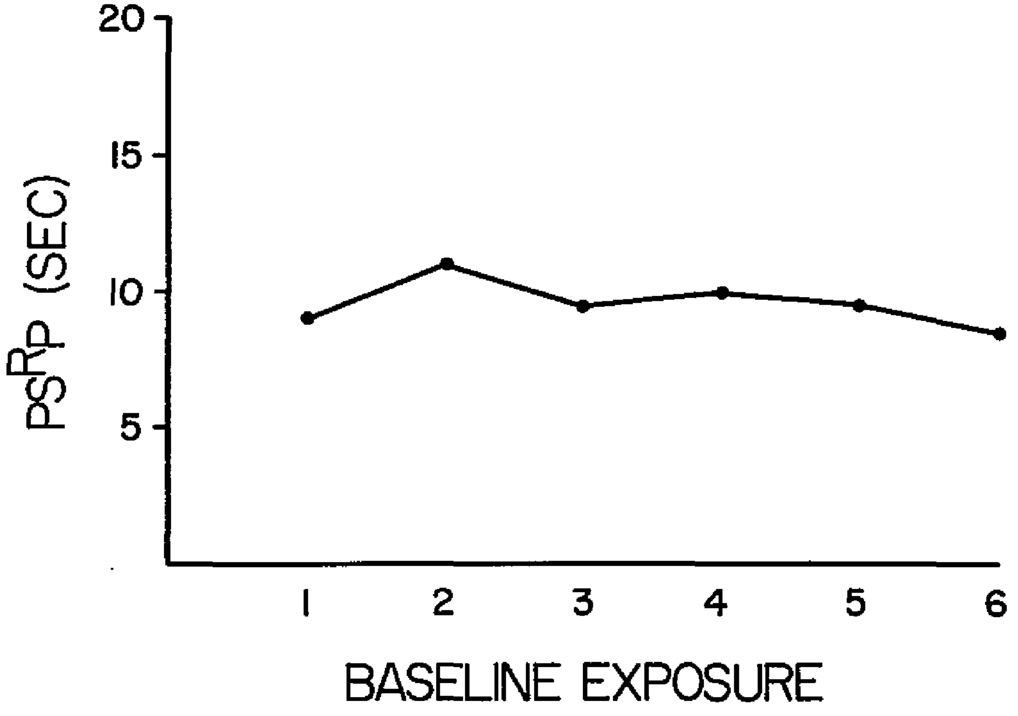
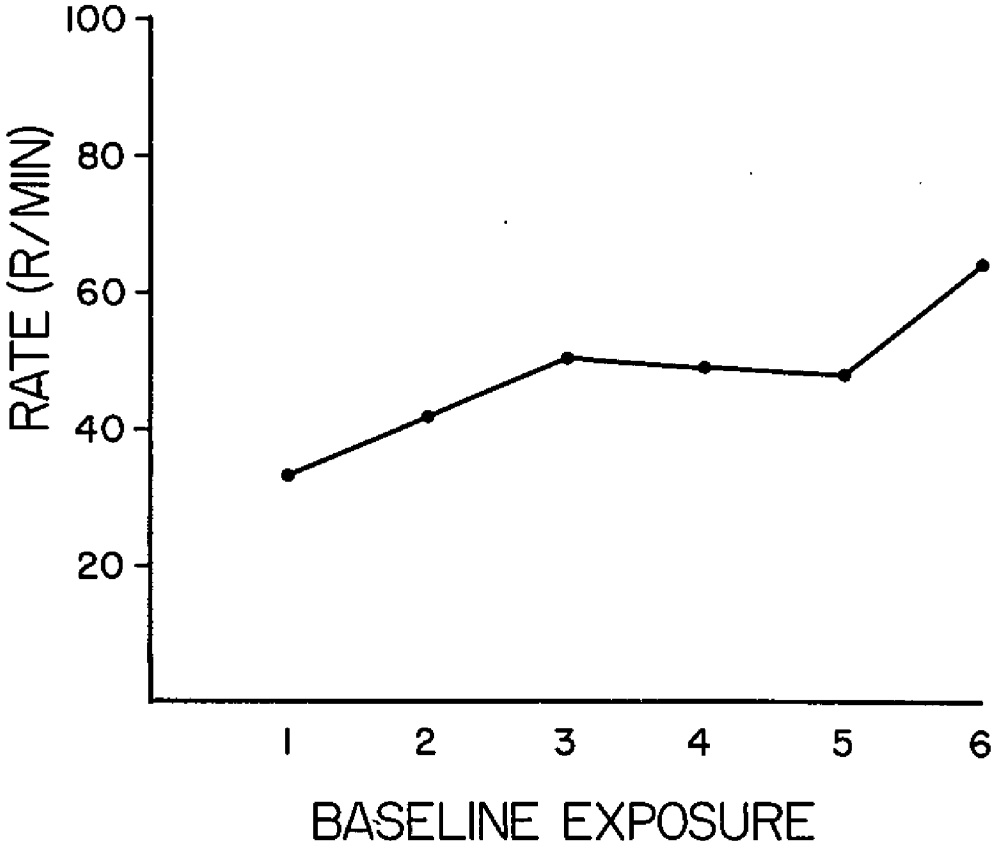

20
15
10
5
PS^RP (SEC)
1
2
3
4
5
6
BASELINE EXPOSURE

Figure 6: Mean respose rate and $PS^{R}P$ for successive baseline exposures for Rat 2.


RATE (R/MIN)
100
80
60
40
20
1
2
3
4
5
6
BASELINE EXPOSURE

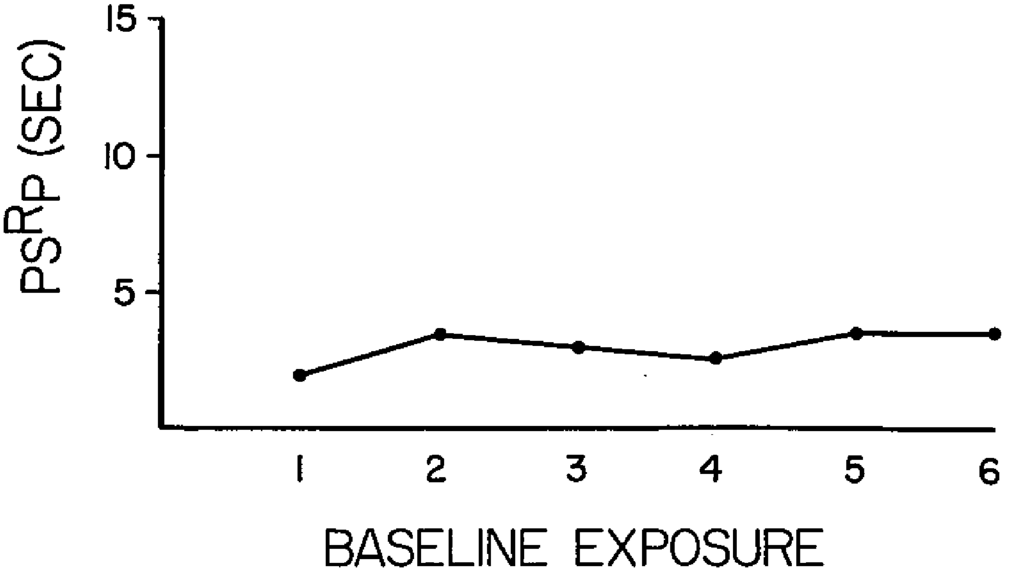
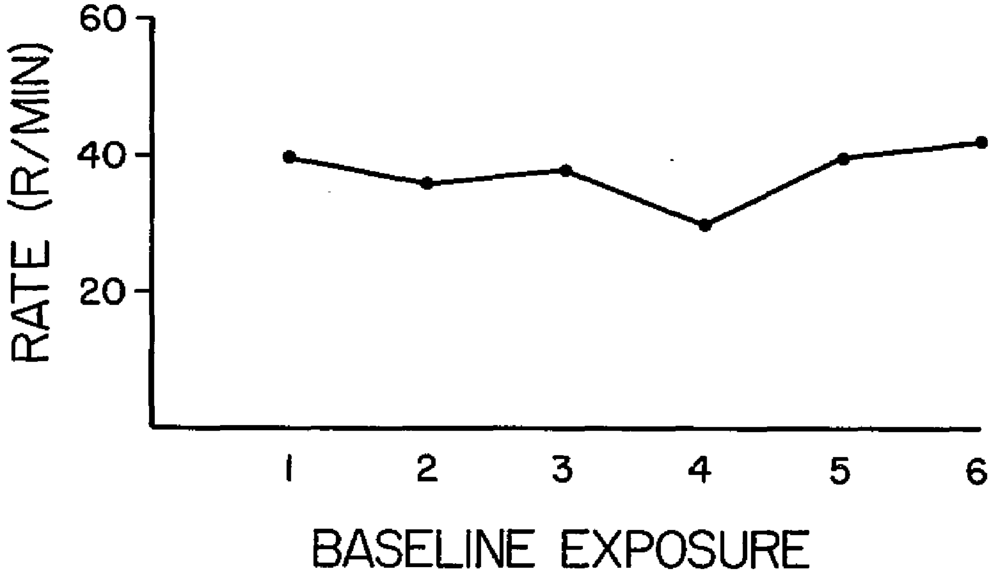

PS^RP (SEC)
15
10
5
1
2
3
4
5
6
BASELINE EXPOSURE

Figure 7: Mean response rate and $PS^{R}P$ for successive baseline exposures for Rat 3.


RATE (R/MIN)
60
40
20
1
2
3
4
5
6
BASELINE EXPOSURE

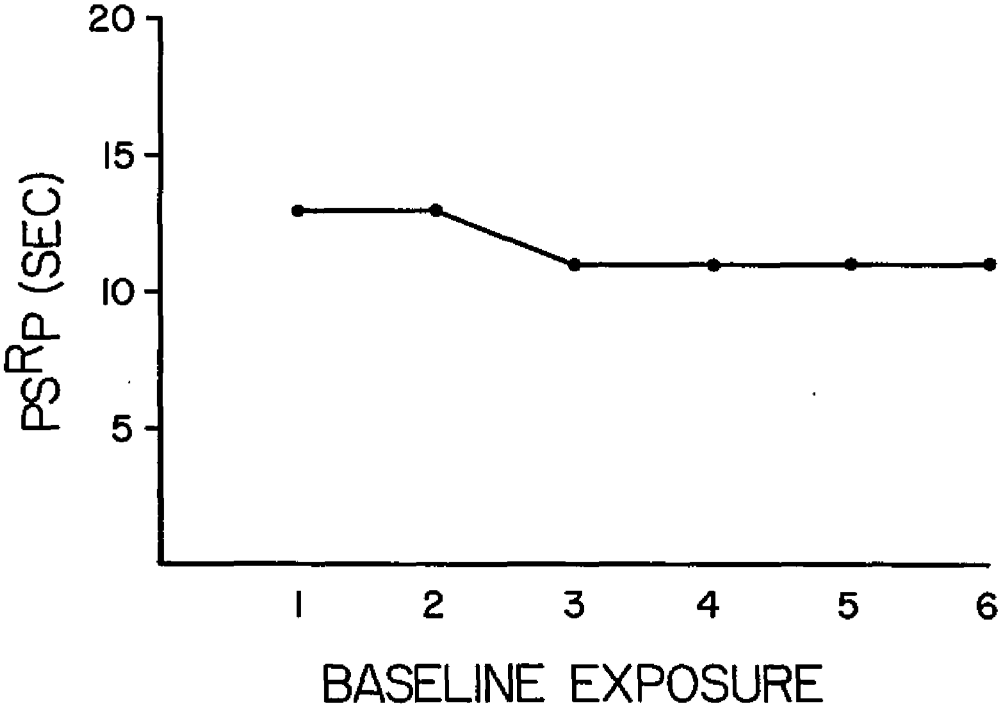
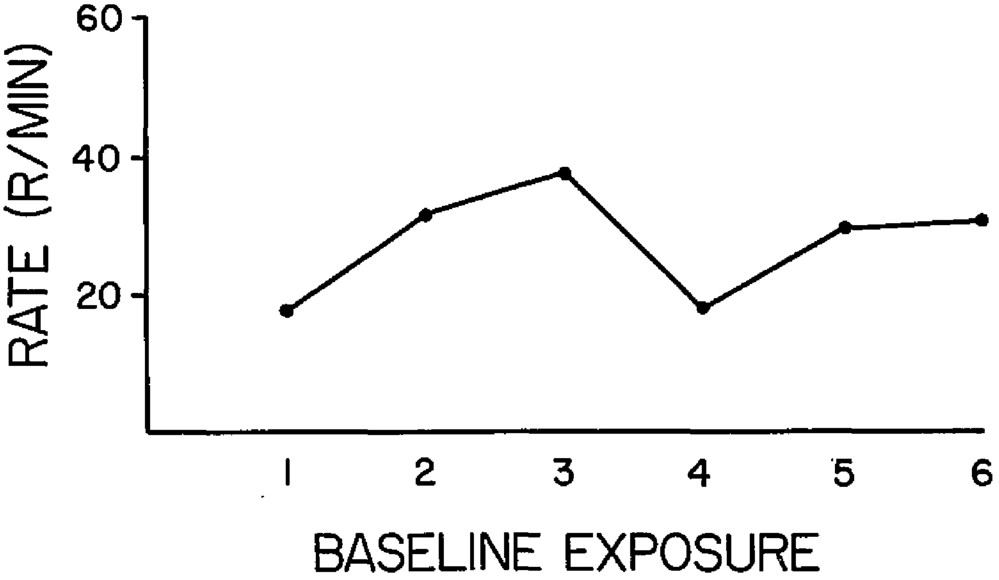

PSRP (SEC)
20
15
10
5
1
2
3
4
5
6
BASELINE EXPOSURE

Figure 8: Mean response rate and $PS^{R}P$ for successive baseline exposures for Rat 4.


RATE (R/MIN)
60
40
20
1
2
3
4
5
6
BASELINE EXPOSURE

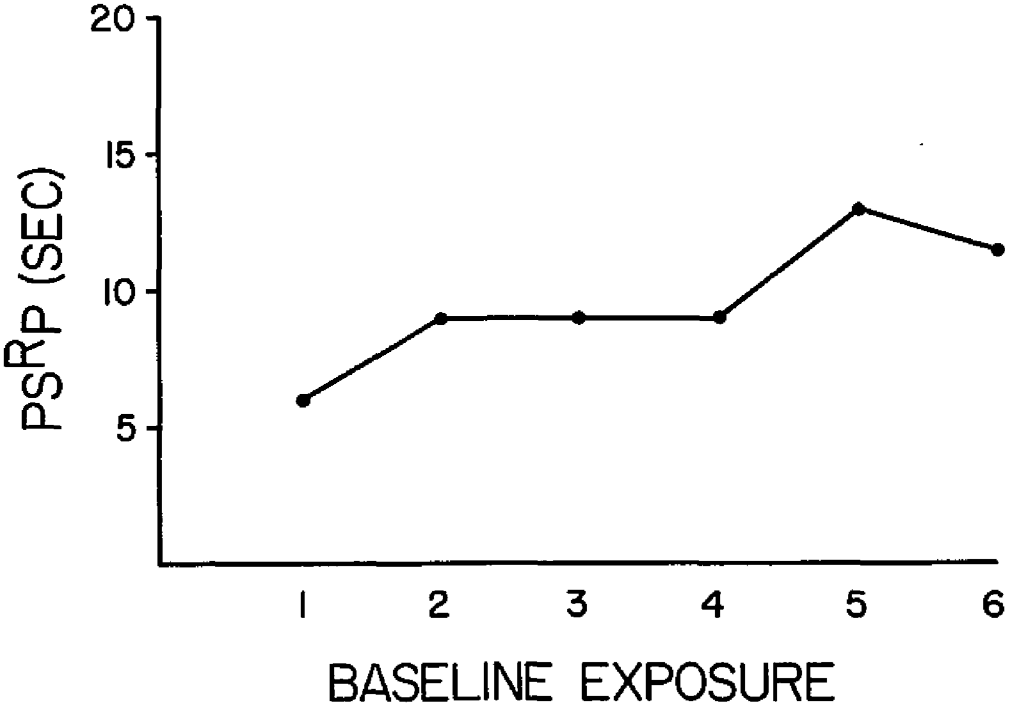
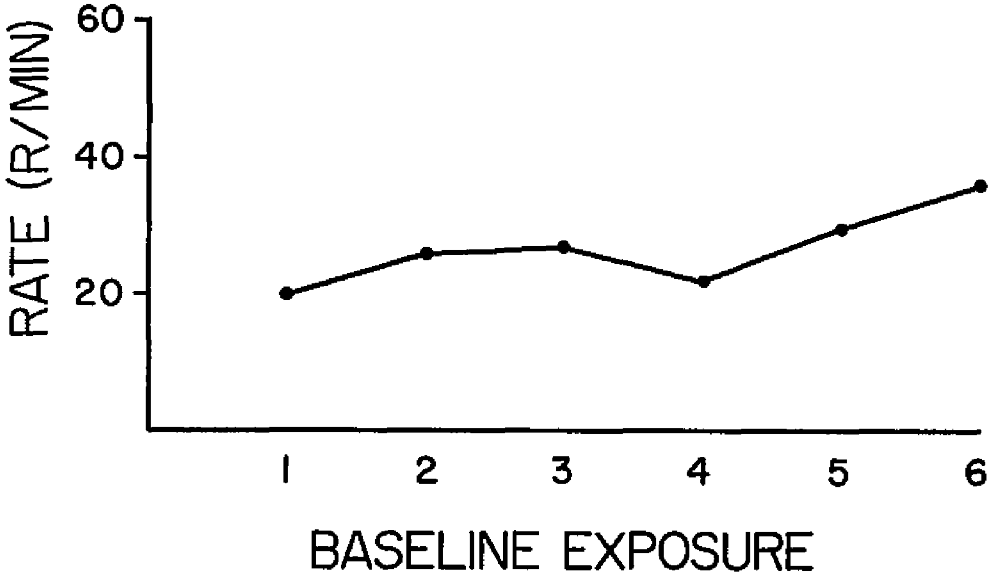

$PS^{R}P$ (SEC)
20
15
10
5
1
2
3
4
5
6
BASELINE EXPOSURE

Figure 9: Mean response rate and $PS^{R}P$ for successive baseline exposures for Rat 5.


RATE (R/MIN)
60
40
20
1
2
3
4
5
6
BASELINE EXPOSURE

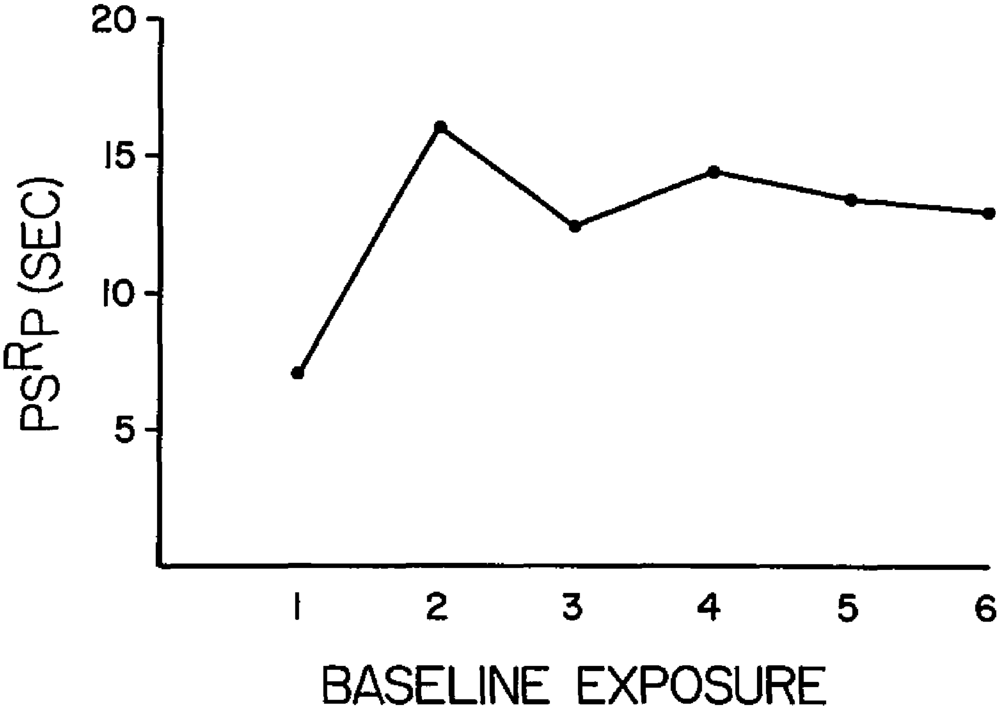
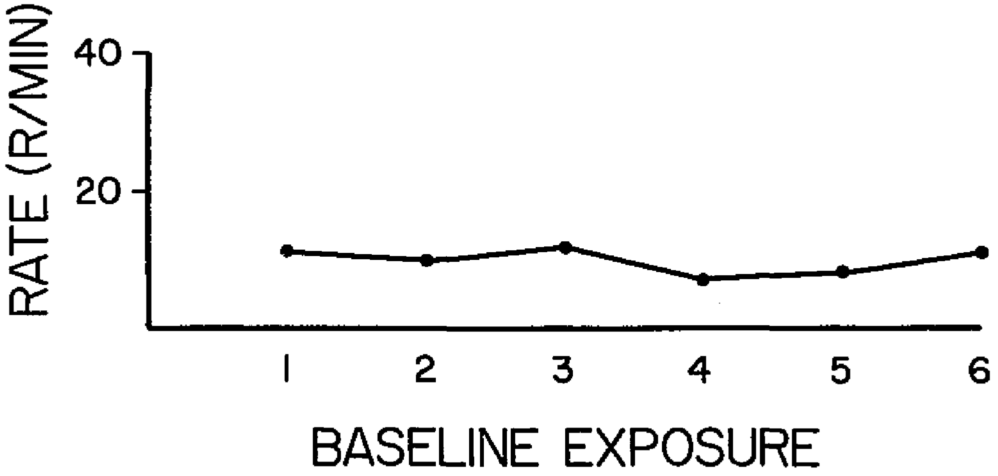

$PS^{R}P$ (SEC)
20
15
10
5
1
2
3
4
5
6
BASELINE EXPOSURE

Figure 10: Mean response rate and PS^RP for successive baseline exposures for Rat 7.


RATE (R/MIN)
40
20
1
2
3
4
5
6
BASELINE EXPOSURE

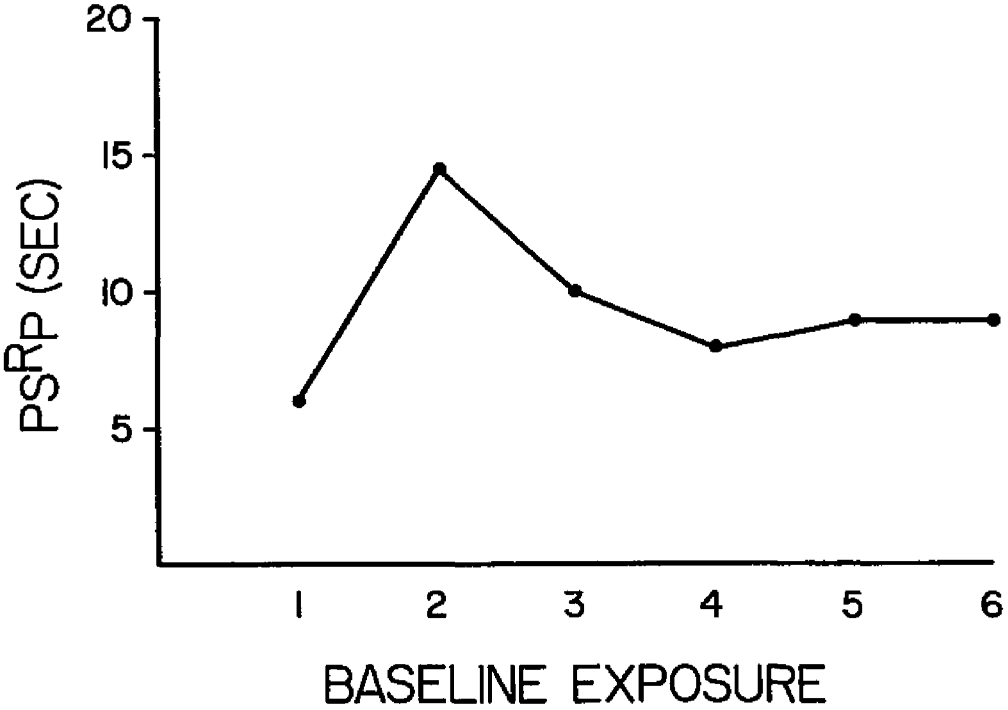
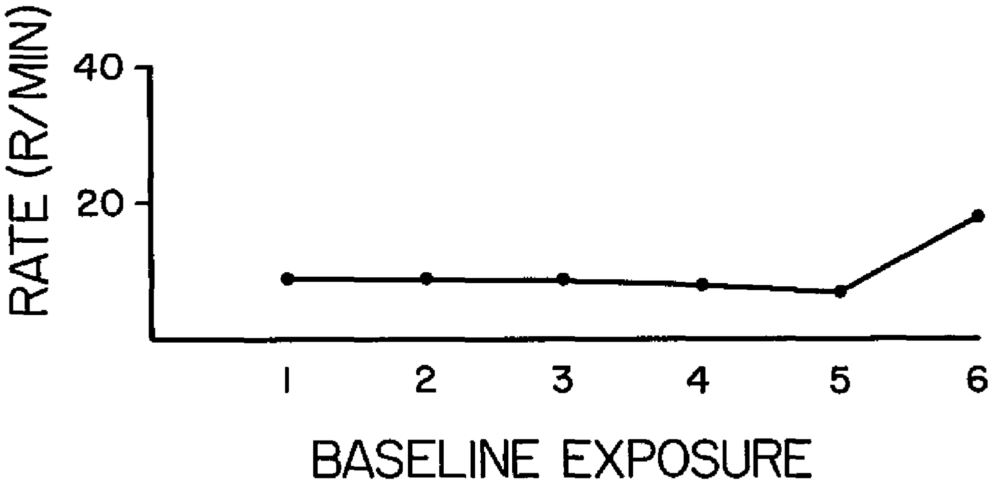

$PS^{R}P$ (SEC)
20
15
10
5
1
2
3
4
5
6
BASELINE EXPOSURE

Figure 11: Mean response rate and $PS^{R}P$ for successive baseline exposures for Rat 8.


RATE (R/MIN)
40
20
1
2
3
4
5
6
BASELINE EXPOSURE

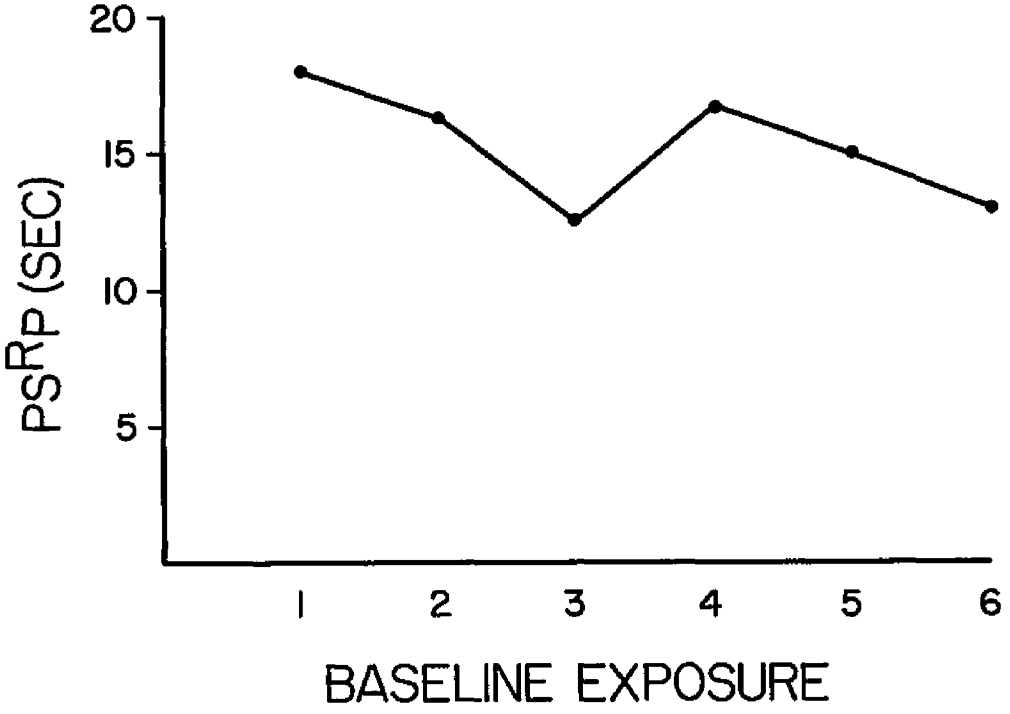
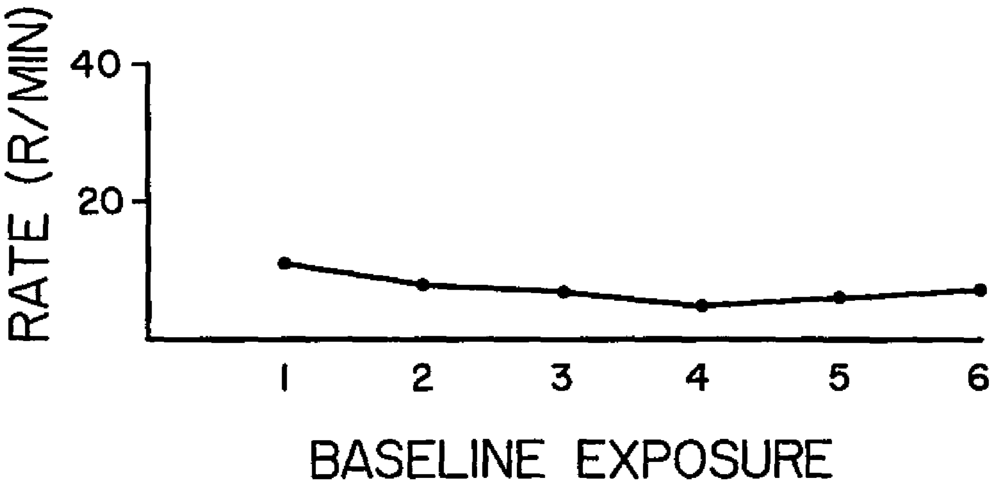
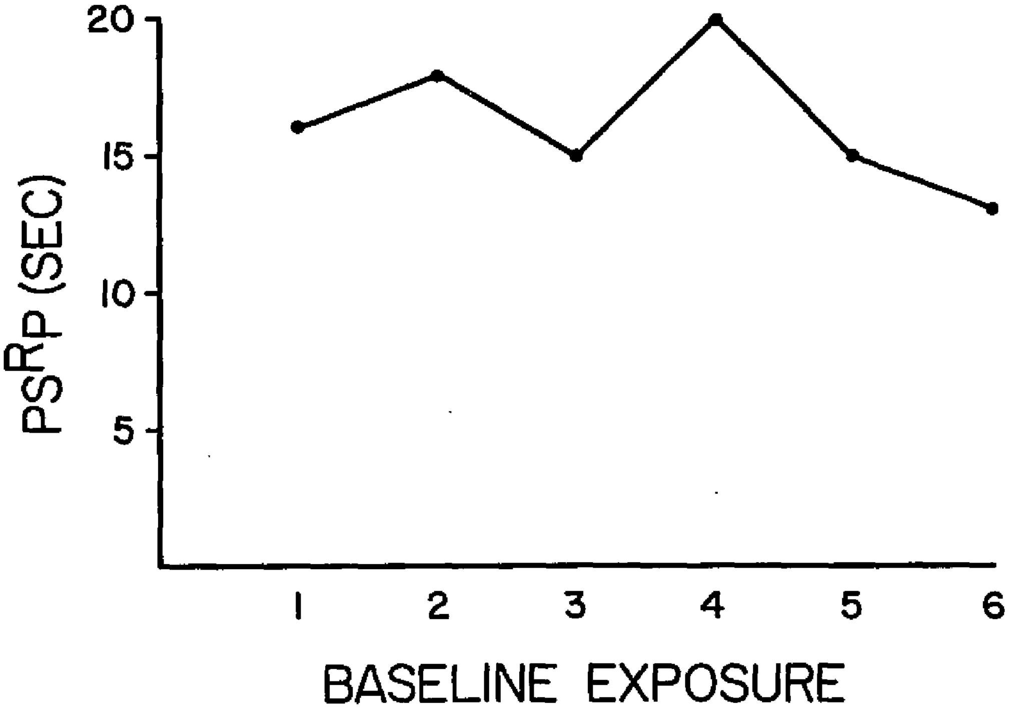

$PS^{R}P$ (SEC)
20
15
10
5
1
2
3
4
5
6
BASELINE EXPOSURE

Figure 12: Mean response rate and $PS^{R}P$ for successive baseline exposures for Rat 9.


RATE (R/MIN)
40
20
1
2
3
4
5
6
BASELINE EXPOSURE


$PS^{R}P$ (SEC)
20
15
10
5
1
2
3
4
5
6
BASELINE EXPOSURE

and Schoenfeld (1964) have shown that rates continue to vary after extended exposure to an unchanging schedule of reinforcement, the changes in rate depicted here are too large to ascribe to extended exposure alone. Some interactions between behavior on the experimental points and on the baseline exposures are indicated. For Group 1 (RI 200 sec), rates are relatively stable across successive exposures to the baseline schedule. As rates on the experimental points for this group also show comparatively little variability, the stability of the baseline data do not argue against an interaction effect.

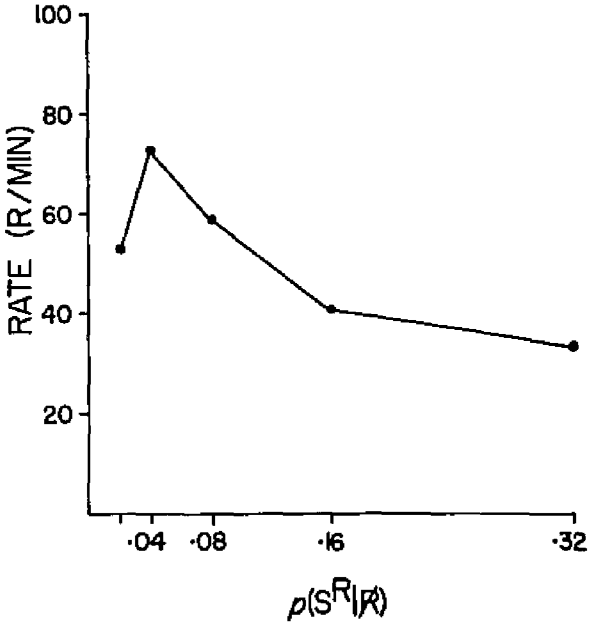
Comparisons across groups indicate that as $\underline{p}(S^R|R)$ is decreased, response rates show a concomitant decrease. These data are in agreement with Farmer (1963), who reported declines in rate as a function of increased IS^RT over the range of IS^RT employed in the present study.

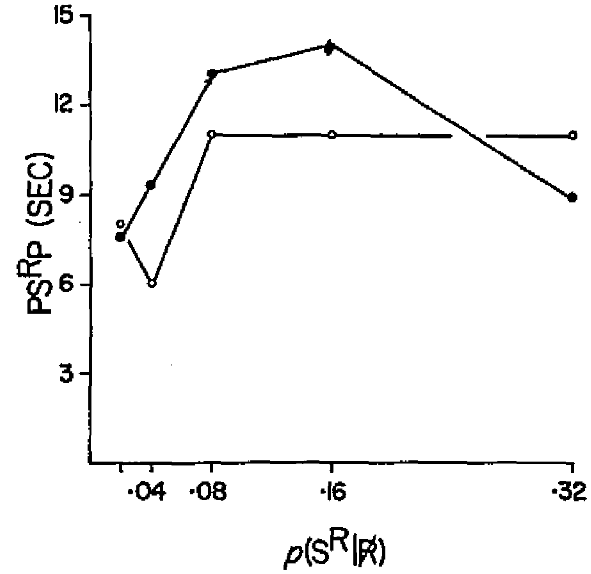
The data for PS^RP are also similar in form to those of Farmer (1963). As mean IS^RT is increased, PS^RP increases. It is also the case for a single subject that as rate decreases, PS^RP increases, and *vice versa*.

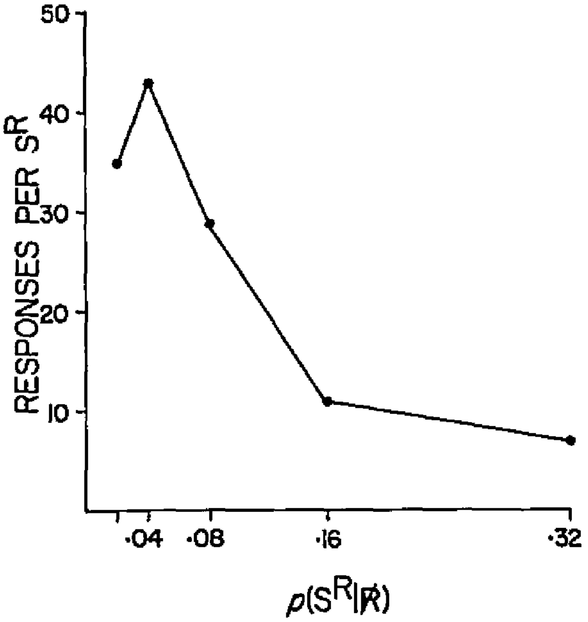
Data for the five experimental points are presented in Figures 13 through 20. Response rate, PS^RP for R and $\not{R}$, responses per S^R (R/S^R), and the number of $\not{R}$ cycles containing at least one R, are plotted as a function of $\underline{p}(S^R|\not{R})$.

The end result of an eightfold increase in $\underline{p}(S^R|\not{R})$ is clearly a decrease in the rate of R for subjects

Figure 13: Mean response rate, $PS^{R}P$, R/S^{R} and $\not{R}$ cycles sampled for the five experimental points for Rat 1.


RATE (R/MIN)
100
80
60
40
20
·04
·08
·16
·32
$p(S^R|\not{R})$


PS^RP (SEC)
15
12
9
6
3
·04
·08
·16
·32
$p(S^R|\not{R})$


RESPONSES PER S^R
50
40
30
20
10
·04
·08
·16
·32
$p(S^R|\not{R})$

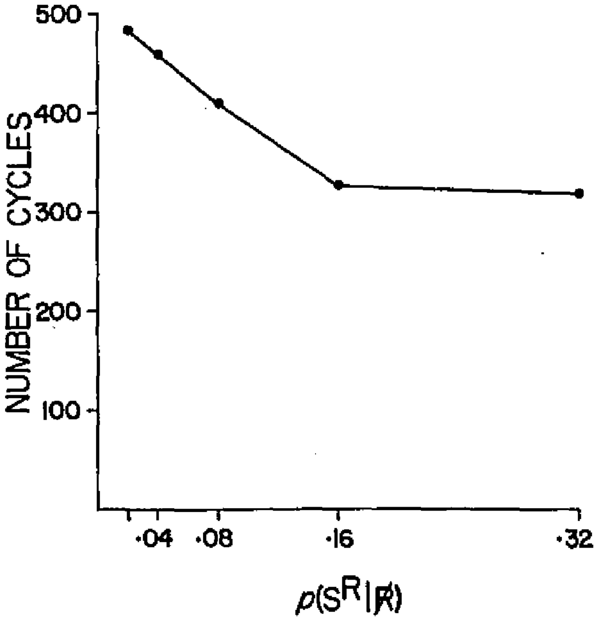
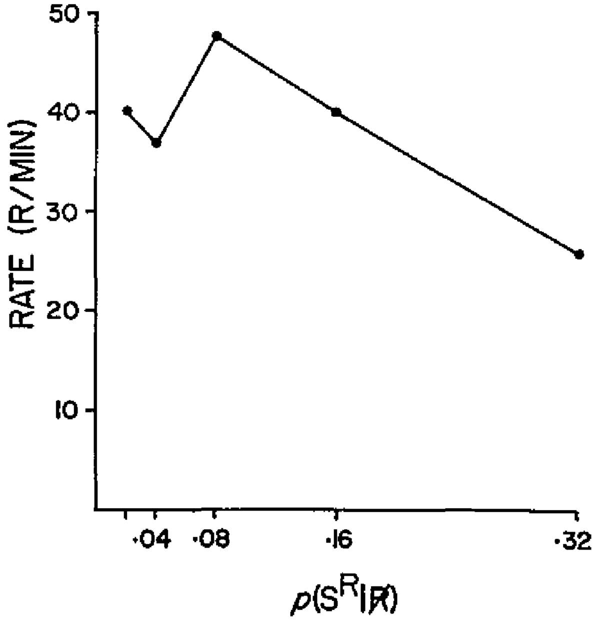
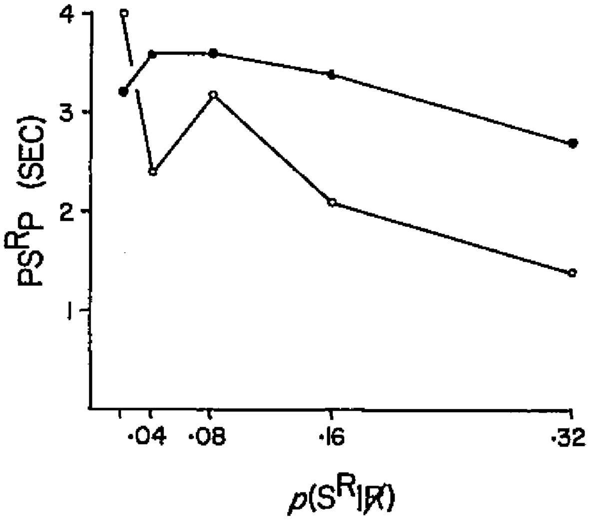
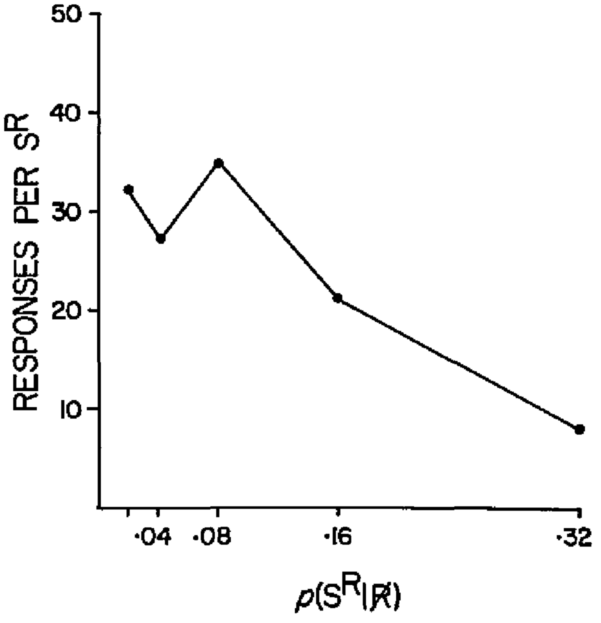

NUMBER OF CYCLES
500
400
300
200
100
·04
·08
·16
·32
$p(S^R|\not{R})$

Figure 14: Mean response rate, PS^RP, R/S^R and # cycles sampled for the five experimental points for Rat 2.


RATE (R/MIN)
50
40
30
20
10
·04
·08
·16
·32
$p(S^R|\not{R})$


PS^RP (SEC)
4
3
2
1
·04
·08
·16
·32
$p(S^R|\not{R})$


RESPONSES PER S^R
50
40
30
20
10
·04
·08
·16
·32
$p(S^R|\not{R})$

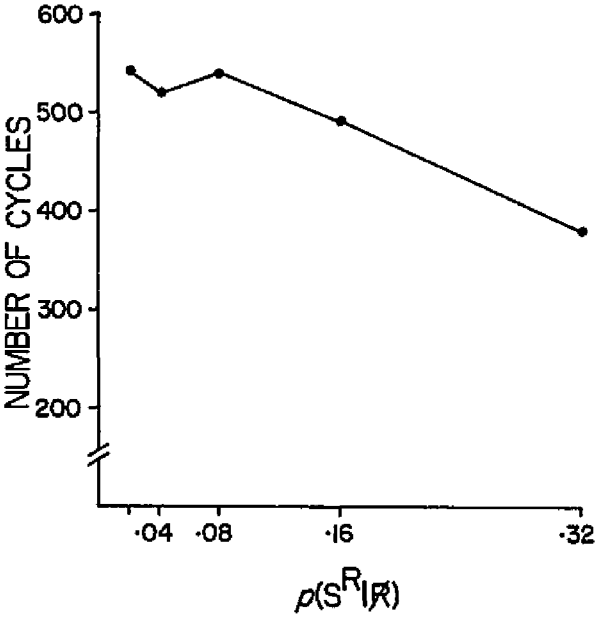
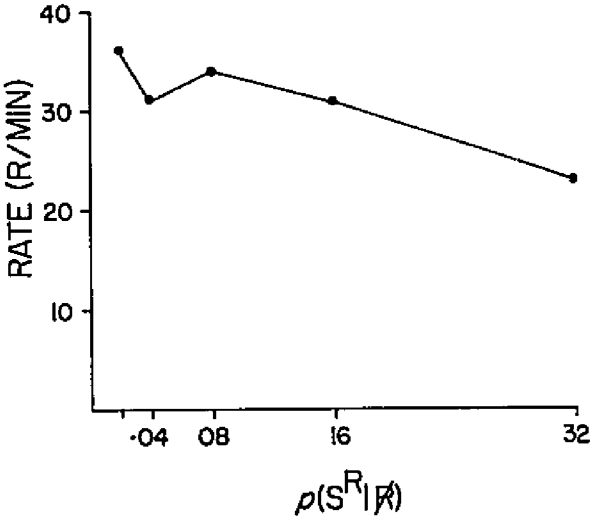
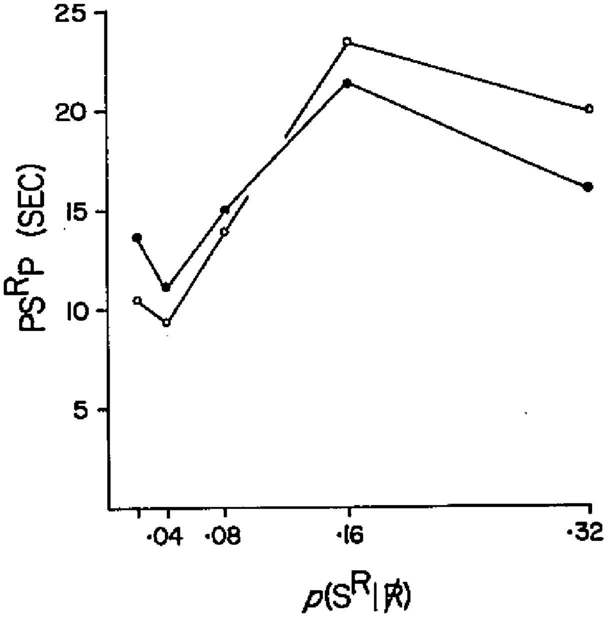
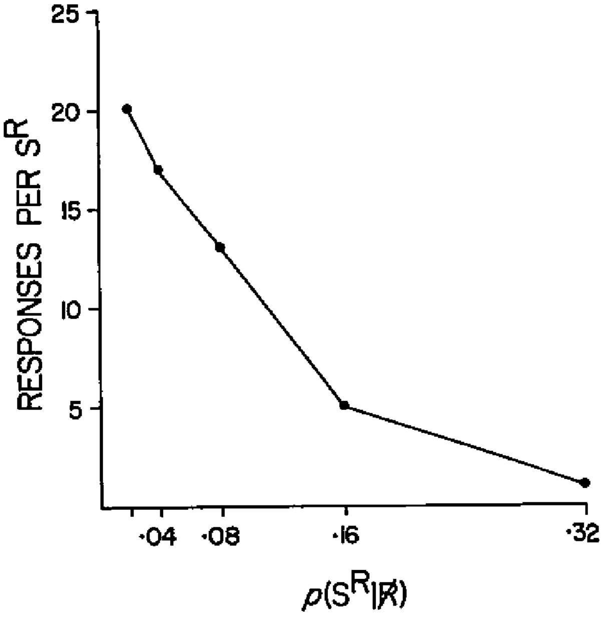

NUMBER OF CYCLES
600
500
400
300
200
·04
·08
·16
·32
$p(S^R|\not{R})$

Figure 15: Mean response rate, PS^RP, R/S^R and $\not{R}$ cycles sampled for the five experimental points for Rat 3.


RATE (R/MIN)
40
30
20
10
·04
08
16
32
$p(S^R|\not{R})$


PS^RP (SEC)
25
20
15
10
5
·04
·08
·16
·32
$p(S^R|\not{R})$


RESPONSES PER S^R
25
20
15
10
5
·04
·08
·16
·32
$p(S^R|\not{R})$

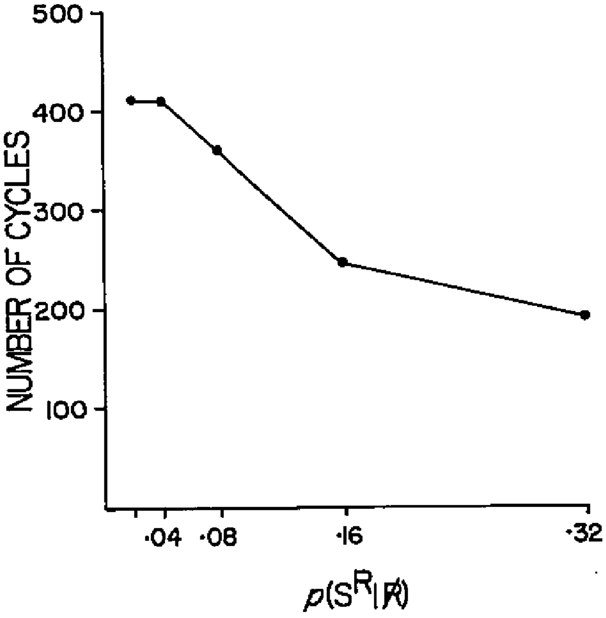
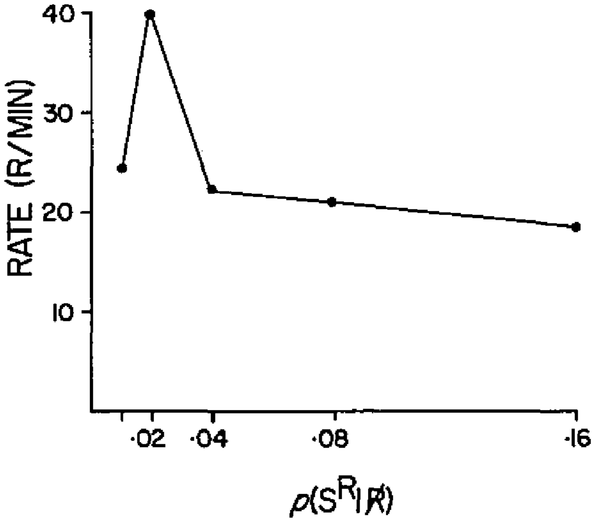
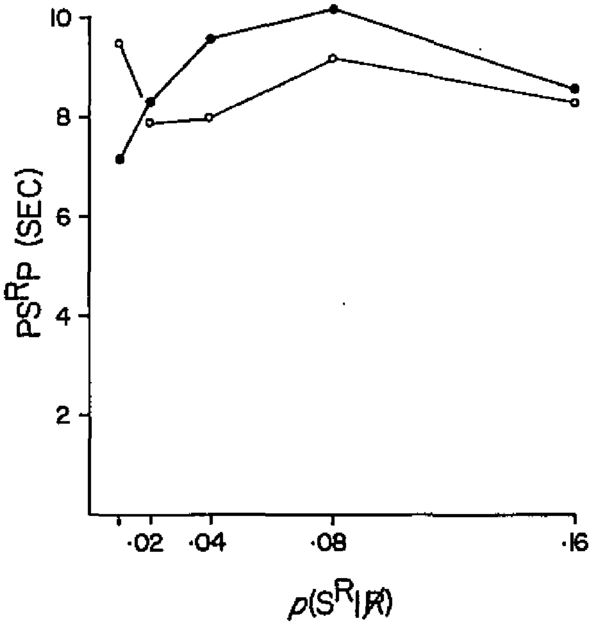
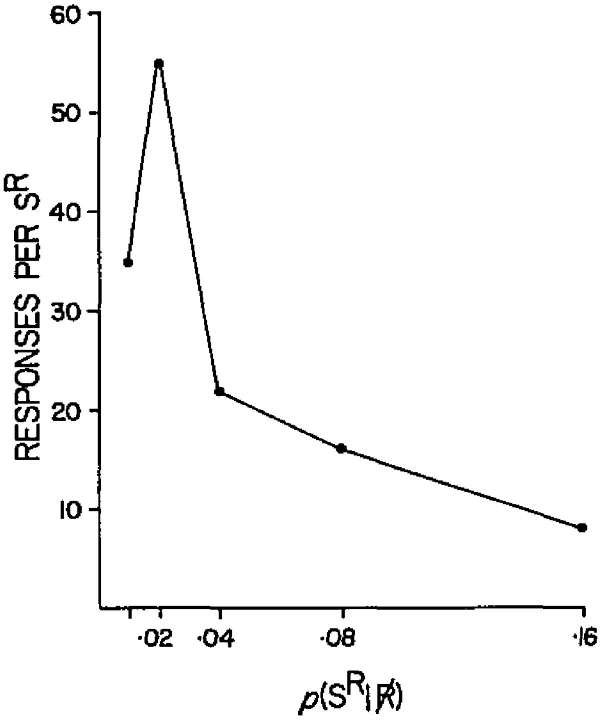

NUMBER OF CYCLES
500
400
300
200
100
·04
·08
·16
·32
$p(S^R|\not{R})$

Figure 16: Mean response rate, PS^RP, R/S^R and $\not{R}$ cycles sampled for the five experimental points for Rat 4.


RATE (R/MIN)
10
20
30
40
·02
·04
·08
·16
$p(S^R|\not{R})$


PS^RP (SEC)
2
4
6
8
10
·02
·04
·08
·16
$p(S^R|\not{R})$


RESPONSES PER S^R
10
20
30
40
50
60
·02
·04
·08
·16
$p(S^R|\not{R})$

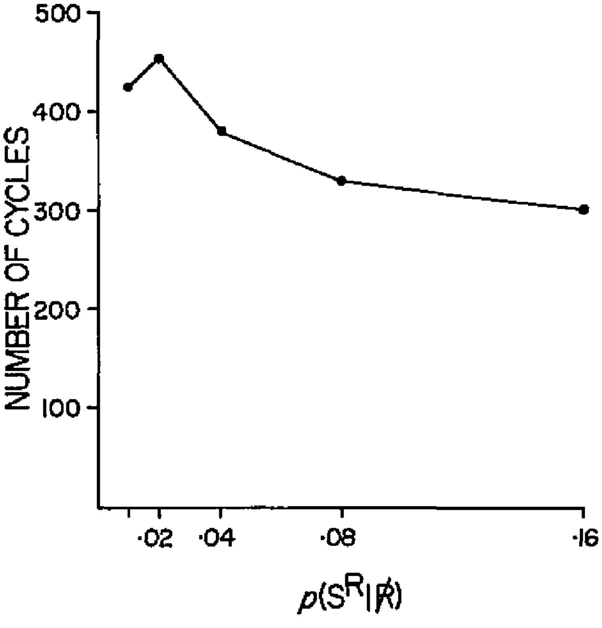

NUMBER OF CYCLES
100
200
300
400
500
·02
·04
·08
·16
$p(S^R|\not{R})$

Figure 17: Mean response rate, $PS^{R}P$, R/S^{R} and $\not{R}$ cycles sampled for the five experimental points for Rat 5.

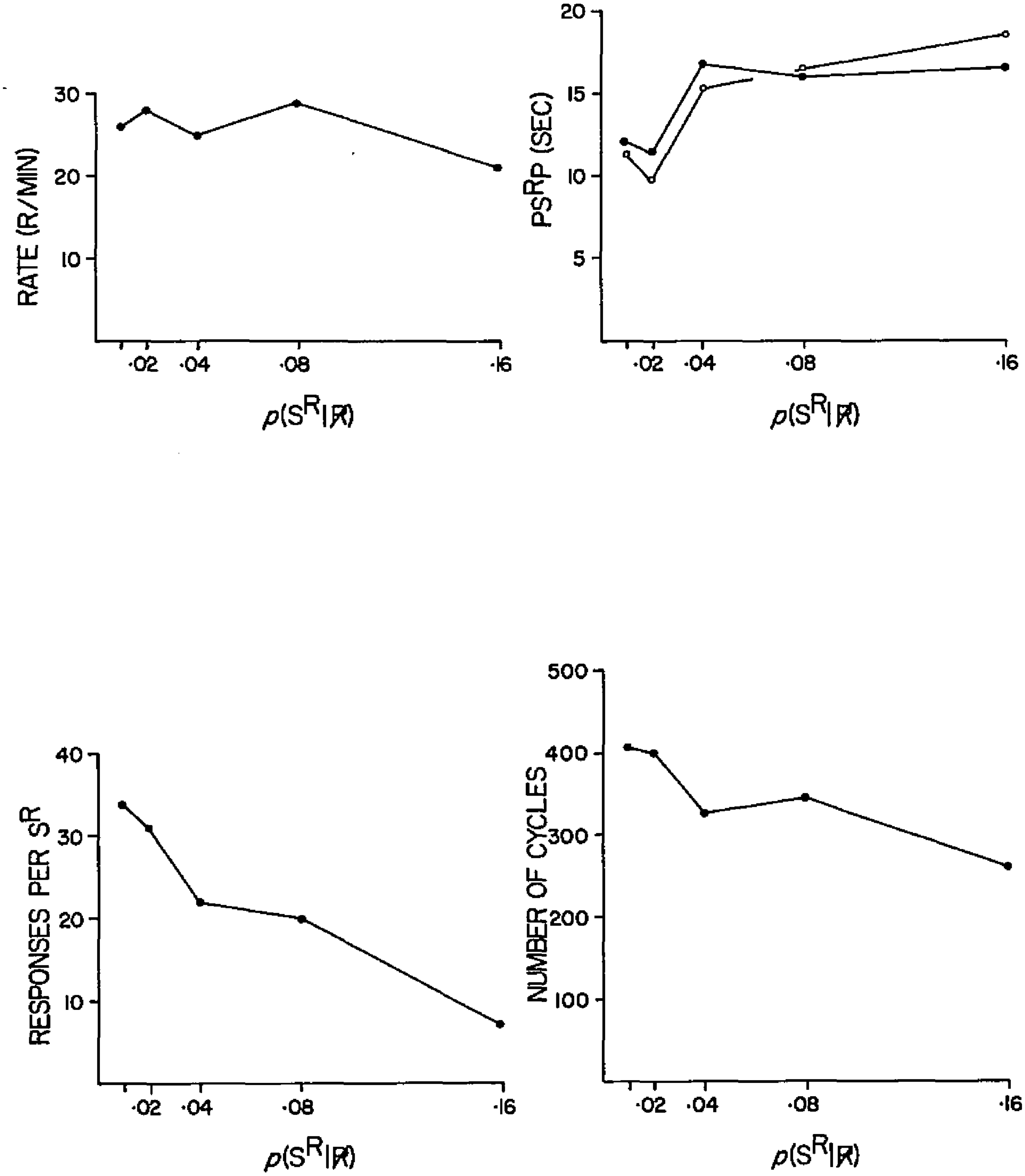

RATE (R/MIN)
30
20
10
PS^{R}P (SEC)
20
15
10
5
RESPONSES PER S^R
40
30
20
10
NUMBER OF CYCLES
500
400
300
200
100
·02
·04
·08
·16
$p(S^R|\bar{R})$

Figure 18: Mean response rate, PS^RP, R/S^R and $\not{R}$ cycles sampled for the five experimental points for Rat 7.

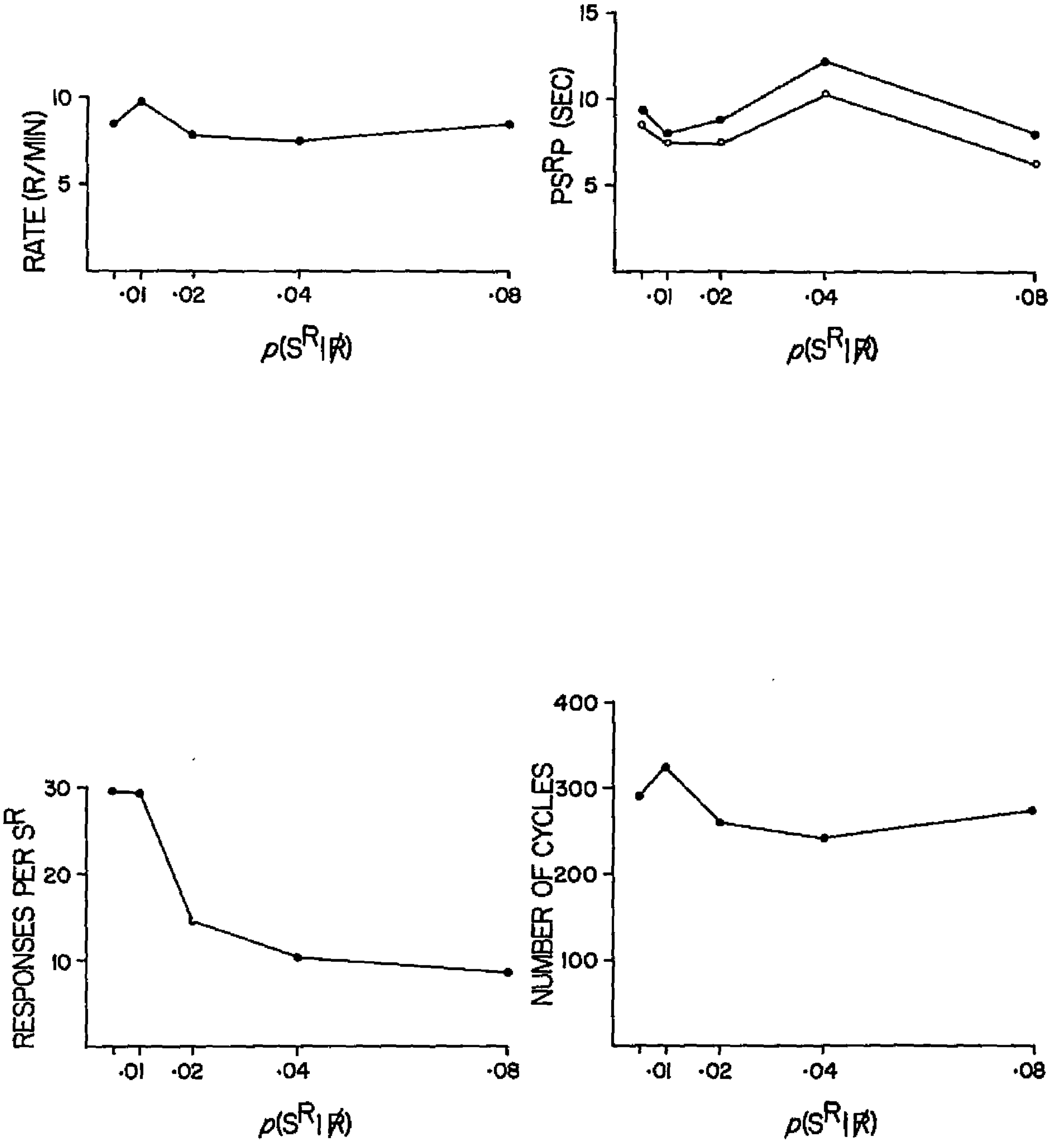

RATE (R/MIN)
10
5
·01
·02
·04
·08
p(S^R|R̸)
PS^RP (SEC)
15
10
5
·01
·02
·04
·08
p(S^R|R̸)
RESPONSES PER S^R
30
20
10
·01
·02
·04
·08
p(S^R|R̸)
NUMBER OF CYCLES
400
300
200
100
·01
·02
·04
·08
p(S^R|R̸)

Figure 19: Mean response rate, PS^RP, R/S^R and $\not{R}$ cycles sampled for the five experimental points for Rat 8.

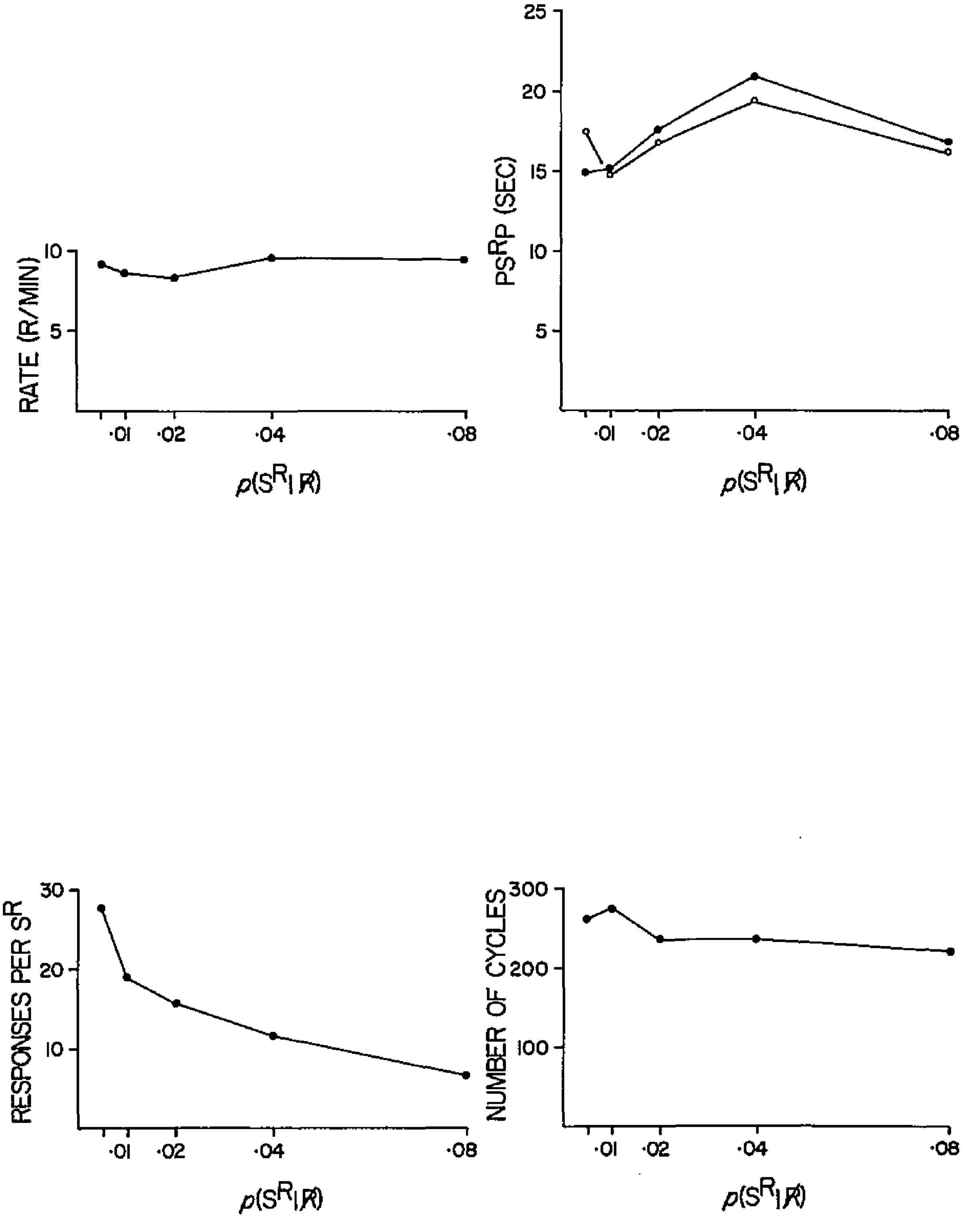
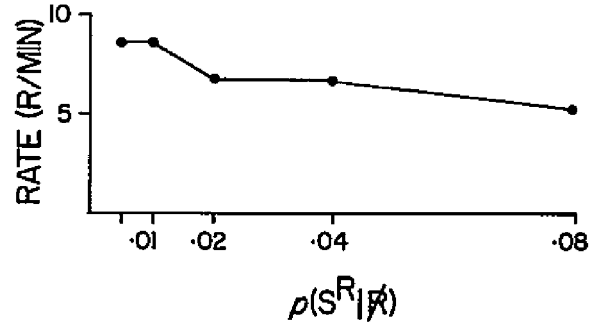
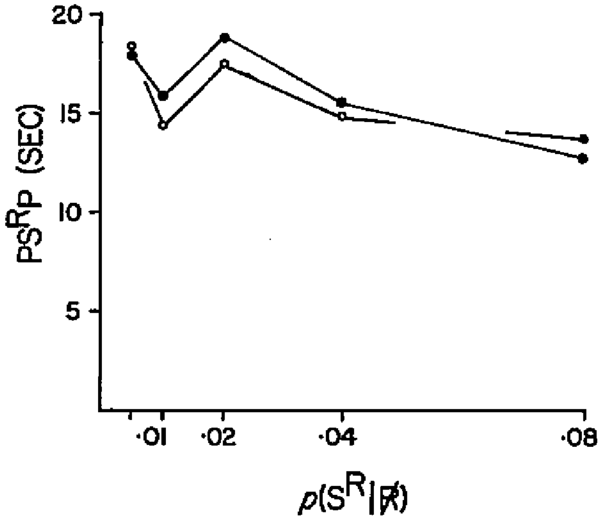
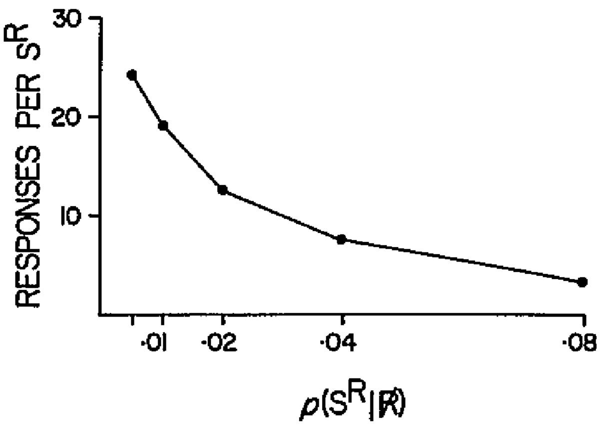
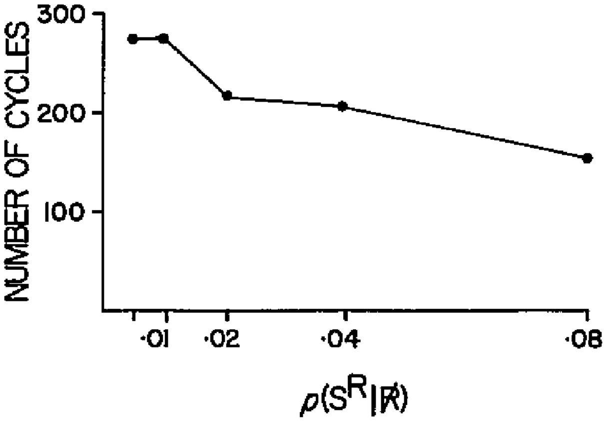

RATE (R/MIN)
10
5
PS^RP (SEC)
25
20
15
10
5
RESPONSES PER S^R
30
20
10
NUMBER OF CYCLES
300
200
100
·01
·02
·04
·08
p(S^R|R)

Figure 20: Mean response rate, $PS^{R}P$, R/S^{R} and % cycles sampled for the five experimental points for Rat 9.


RATE (R/MIN)
10
5
·01
·02
·04
·08
$p(S^R|\cancel{R})$


PS^RP (SEC)
20
15
10
5
·01
·02
·04
·08
$p(S^R|\cancel{R})$


RESPONSES PER S^R
30
20
10
·01
·02
·04
·08
$p(S^R|\cancel{R})$


NUMBER OF CYCLES
300
200
100
·01
·02
·04
·08
$p(S^R|\cancel{R})$

in Groups 2 and 3. (Two animals in Group 1 show this response decrement, one does not.) This decrease in R rate is probably related to the fact that as $\underline{p}(S^R|\not{R})$ is increased, $\not{R}$ is reinforced with increasing frequency. Since R and $\not{R}$ are mutually exclusive, if $\not{R}$ frequency increases as a result of increased S^R frequency, R frequency must decrease. It is well to reiterate at this point that $\underline{p}(S^R|R)$ remains constant throughout.

The response rate functions do, however, contain one feature which requires some attention. For all eight subjects, the decrease in response rate is not monotonic. There is at least one point in these functions for which there is a rise in rate over the previous value of $\underline{p}(S^R|\not{R})$. This transient increase in rate is reminiscent of the temporary rise in rate observed with some noncontingent reinforcement procedures, but this resemblance will not bear serious analysis. The increases observed in the present study do not necessarily occur at the initiation of the reinforcement of $\not{R}$, and frequently occur after considerable exposure to $\underline{p}(S^R|\not{R})$ values greater than zero. An explanation founded upon the discrimination of S^Rs delivered based upon the $\not{R}$ contingency from those delivered for R would be unsatisfactory for the same reasons.

The functions relating mean PS^RP for R (filled circles) and $\not{R}$ (open circles) to $\underline{p}(S^R|\not{R})$ are of interest for several reasons. For some animals, these functions covary (e.g., Rats 3, 5, 7, 8, 9) while for others the functions are independent. Also of interest is the fact that in most cases, PS^RP for $\not{R}$ is briefer than PS^RP for R. That is, subjects tend to return to the response lever more rapidly following reinforcement of four seconds' non-responding than following the immediate reinforcement of lever pressing. Once again, these data suggest comparisons with non-contingent reinforcement. Cole has observed shorter PS^RPs for non-contingent than for response-contingent S^Rs, but this phenomenon is transient and eventually gives way to a reveral of the relationship. The fact that the PS^RPs for $\not{R}$ remain briefer for a considerable time in the present study makes this comparison inapplicable.

Any comparison of these data to those observed under non-contingent procedures must suffer from at least one major point of non-congruence. In the present study, all S^Rs are, in fact, contingent upon either R or $\not{R}$. The apparent similarity of this arrangement to response-independent reinforcement arises from the observation that, in non-contingent procedures, response rate (R rate, in the present case) is decreased, and that incidences of R become more and more distant from S^R presentations. This change in the $R\text{-}S^R$ relationship is postulated to be the cause of the downward trend of response rate in response-independent procedures (Lachter, Cole, and Schoenfeld, 1971). This explanation is based upon the reinforcement of $\not{R}$, and is supported by the increasing $R\text{-}S^R$ intervals. But reinforcement contingencies are in no way related to $\not{R}$, and $\not{R}$ durations are tabulated as dependent variables. In the present case, $\not{R}$ duration is specified as an independent variable, and reinforcement contingencies are directly dependent upon $\not{R}$ occurrences. The fact that both these procedures produce a decrease in the rate of R is not alone sufficient to guarantee any further similarity.

The R/S^R function, generally speaking, decreases as $\underline{p}(S^R|\not{R})$ increases. If rate of R remained constant with increases in $\underline{p}(S^R|\not{R})$, this function would decrease due to the increasing number of S^Rs delivered based upon the $\not{R}$ contingency. Since R rate does, in fact, decrease, the R/S^R function decreases markedly. Only very large increases in response rate are sufficient to produce increases in the R/S^R ratio in the face of increased S^Rs for $\not{R}$. The increments in rate observed for Rats 1 and 2 are sufficient to produce such a change, but the smaller increase for Rat 3 is not. For the other groups of subjects, only Rat 4 shows an increase in the R/S^R function. For all other animals, the R/S^R data decrease monotonically.

The fourth set of functions presented in these figures are those relating the number of $\not{R}$ cycles containing at least one R to $\underline{p}(S^R|\not{R})$. Although it might be expected that these functions would vary directly with the rate of R, this need not be the case. It is possible for the number of Rs to change in any direction while the number of $\not{R}$ cycles sampled by R changes independently. Note, for example, the rate function for Rat 1. Although this function rises from $p(S^R|\not{R})=0.02$ to $p(S^R|\not{R})=0.04$, the number of $\not{R}$ cycles sampled decreases. This is indicative of the fact that the distribution of Rs with respect to the repeating R and $\not{R}$ cycles is changing. It is also possible for response rate to decline at the same time that the number of cycles sampled increases. This is the case for Rat 8; a change in $p(S^R|\not{R})$ from 0.005 to 0.01 brings about a decrease in response rate and an increase in the number of $\not{R}$ cycles sampled by R. The number of $\not{R}$ cycles which contain at least one R (and are thus disqualified for reinforcement for $\not{R}$) is crucial in the determination of the number of S^Rs obtained, and will be discussed further when the data concerning S^R frequency are reported.

Representative cumulative records for each baseline exposure and each experimental point are presented in Figures 21 through 28. Whenever possible, these records were drawn from the final session of a block, and were selected to closely represent the mean rates reported earlier. The number beneath each record represents the $p(S^R|\not{R})$ value in effect during the session from which that record was taken; records for baseline exposures are indicated by zeros. Further discussion of the most salient feature of these records, the obvious differences in the grain of the curves from group to group, will be deferred until more quantitative data may be brought to bear on this matter.

Inter-response time distributions were collected for the experimental points, and these distributions are depicted in Figures 29 through 36. The ordinate and abscissa are $p(S^R|\not{R})$ and inter-response time, respectively, and the relative frequency observed for a given IRT is represented by a vertical displacement. There is little evidence that the 4 sec $\not{R}$ criterion made contact via the differential reinforcement of 4 sec IRTs. There, is, however, substantial representation of the icreasing variability of the distribution brought about by increased $p(S^R|\not{R})$. For most cases, the increased range of the distribution is readily apparent. It is interesting to note that for Groups 2 and 3 the 0-1 sec IRT category remained modal throughout. This in spite of the fact that for these groups, 4 sec IRTs were reinforced with relatively high frequency. This observation has been made under other circumstances in which longer IRTs are reinforced, such as the differential reinforcement of low rates (DRL). The IRT functions obtained in the present study indicate that reduction in response rate was not achieved by a shift in the modes of these distributions, but rather through an increase in IRT variability. The distributions for Group 1 indicate a higher degree of overall variability, and likewise do not support the hypothesis that increased values of $p(S^R|\not{R})$ caused a significant rise in the frequency of 4 sec IRTs.

The PS^RP data reported earlier seemed to warrant further analysis. The finding that PS^RPs following S^Rs delivered following $\not{R}$ were, in general, briefer than those

Figure 21: Representative cumulative records for Rat 1.

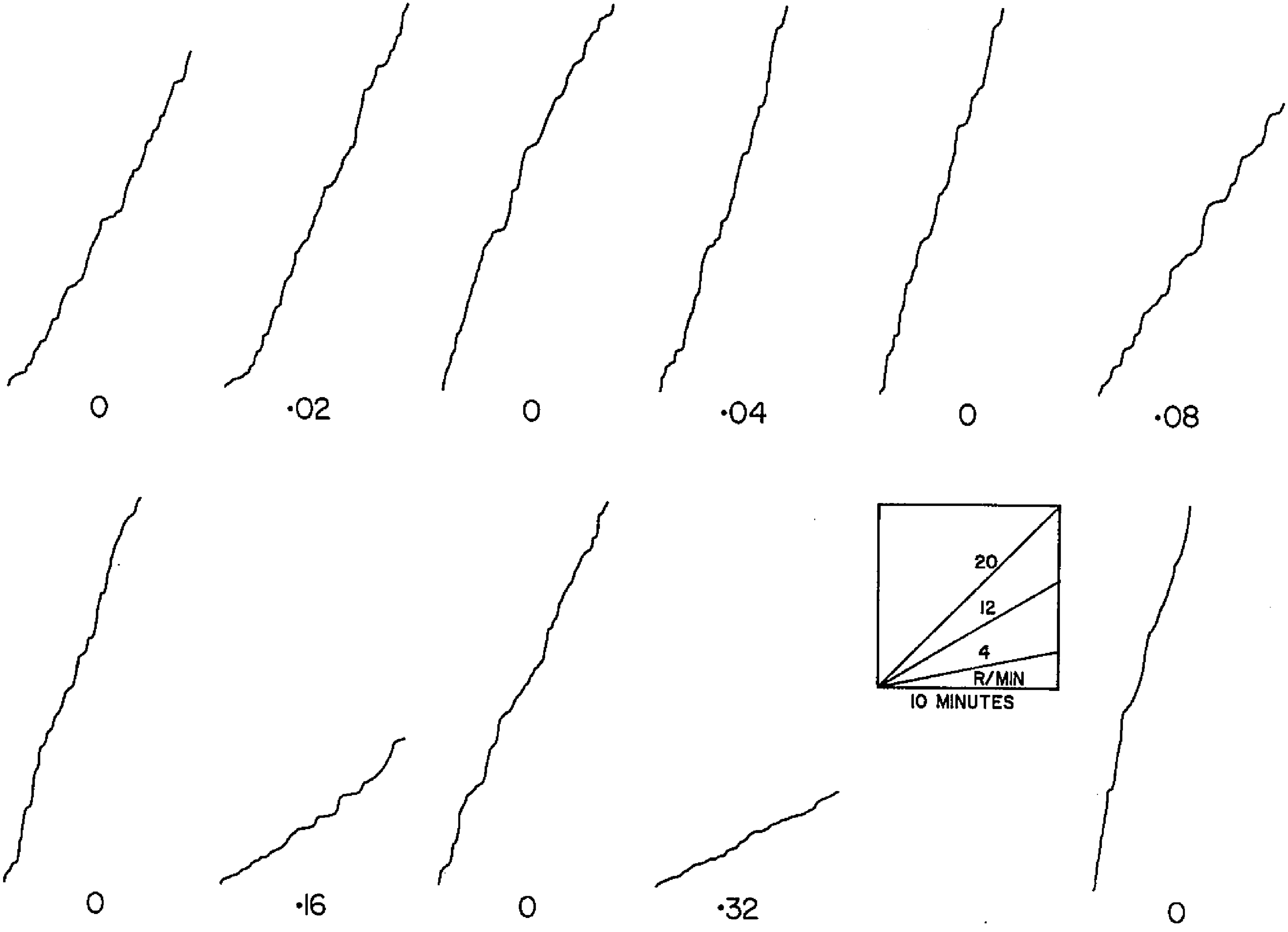
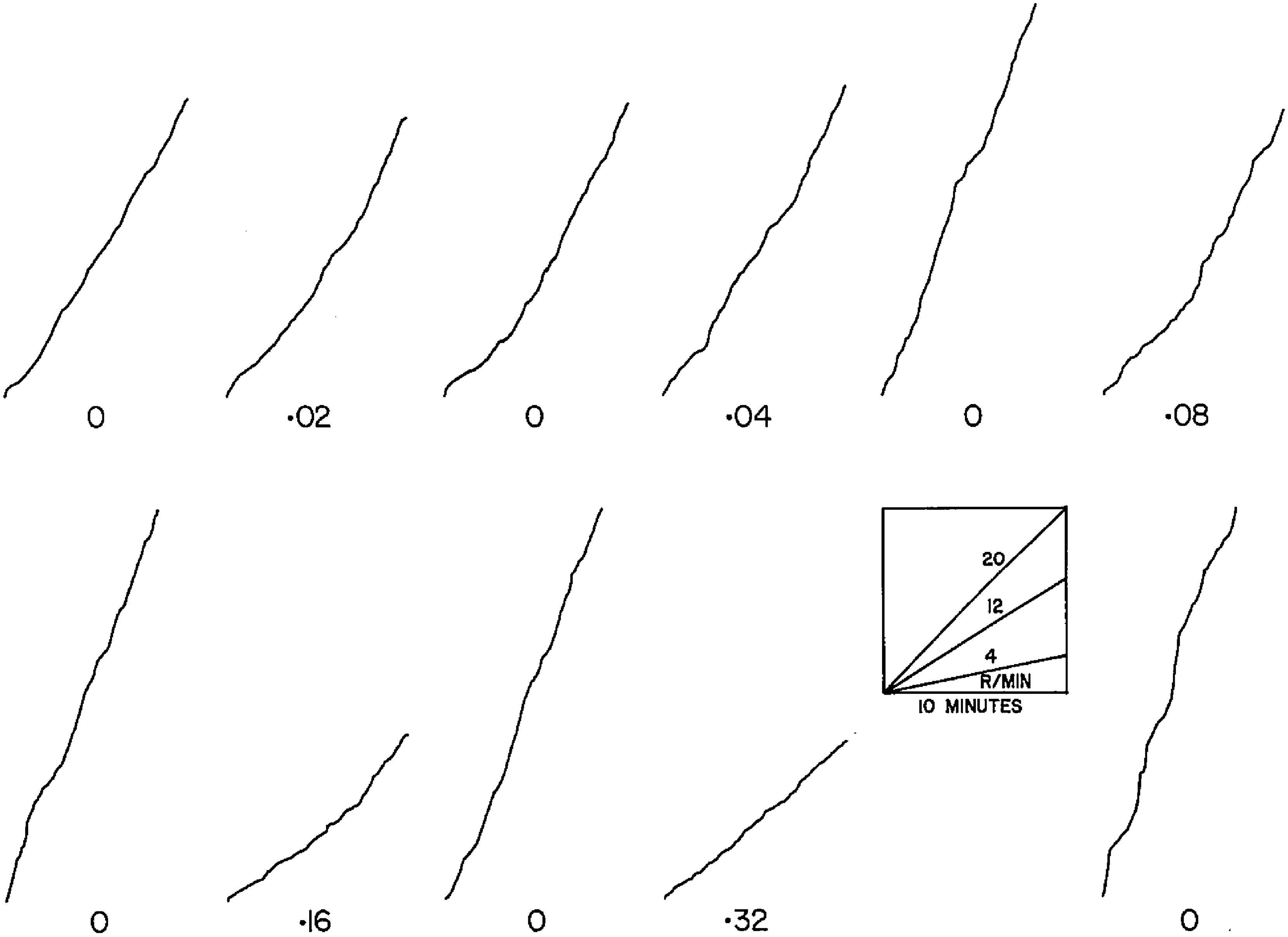

0
·02
0
·04
0
·08
0
·16
0
·32
0
20
12
4
R/MIN
10 MINUTES

Figure 22: Representative cumulative records for Rat 2.



0
·02
0
·04
0
·08
0
·16
0
·32
20
12
4
R/MIN
10 MINUTES
0

Figure 23: Representative cumulative records for Rat 3.

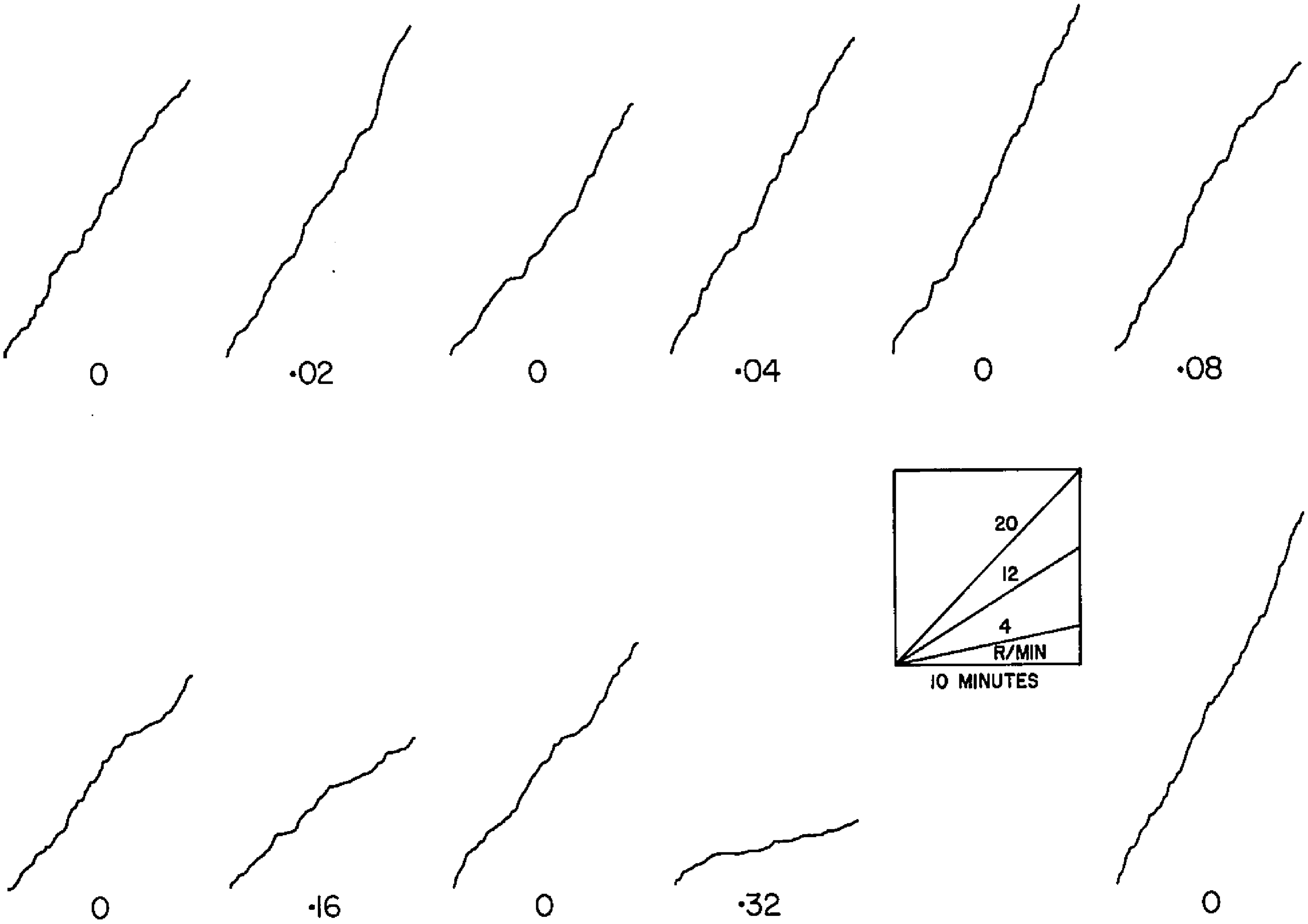

0
·02
0
·04
0
·08
20
12
4
R/MIN
10 MINUTES
0
·16
0
·32
0

Figure 24: Representative cumulative records for Rat 4.

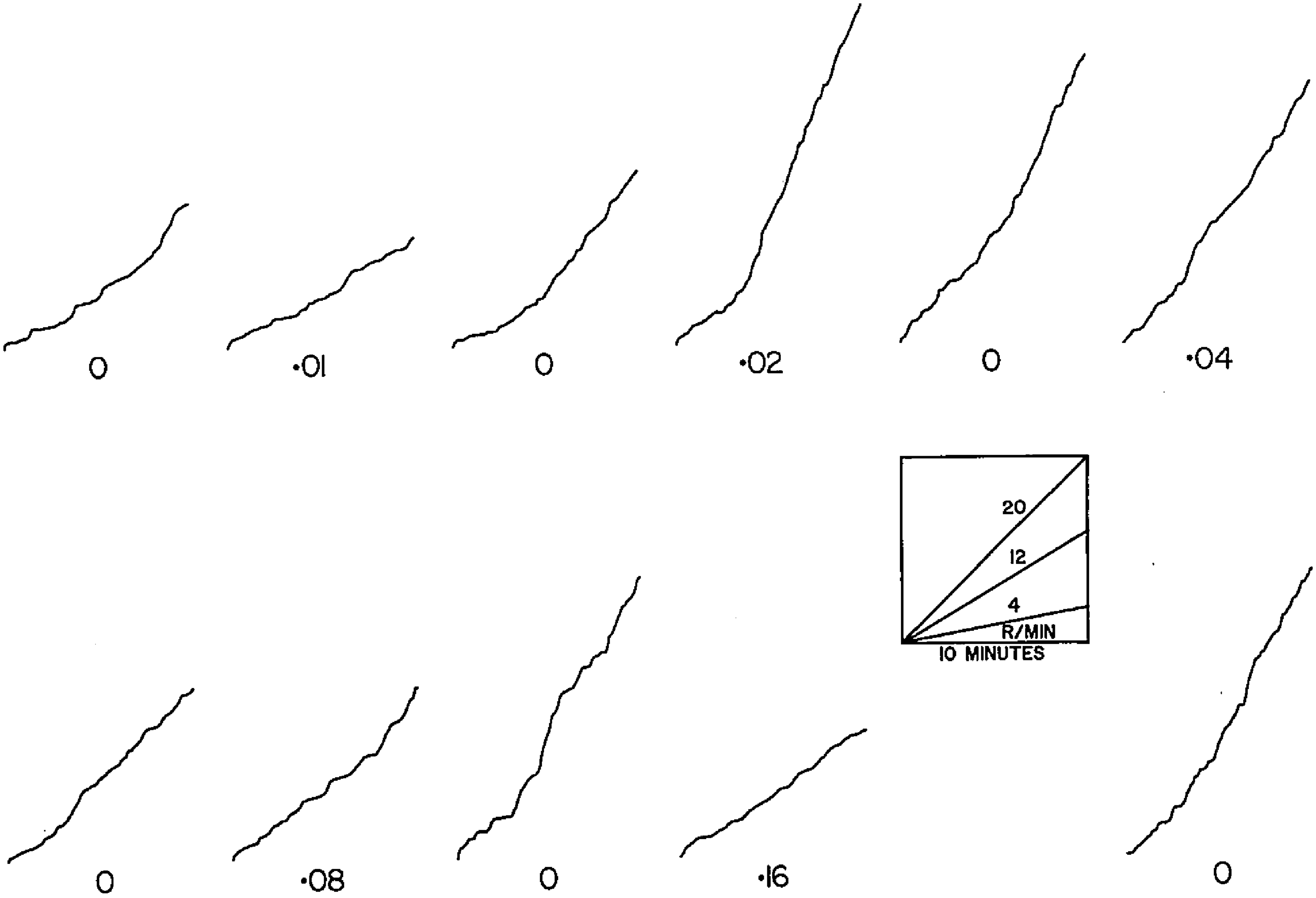

0
·01
0
·02
0
·04
20
12
4
R/MIN
10 MINUTES
0
·08
0
·16
0

Figure 25: Representative cumulative records for Rat 5.

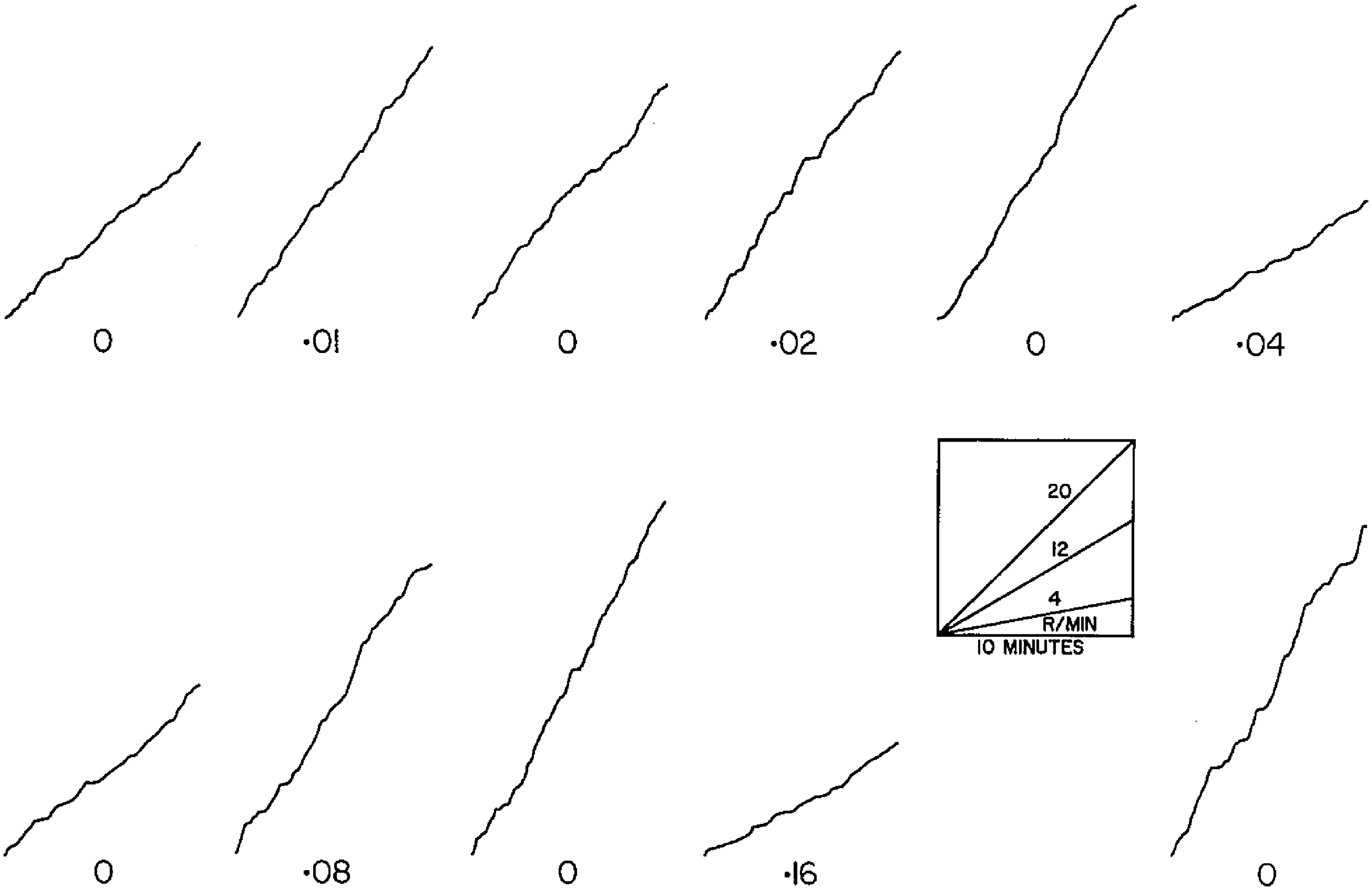

0
·01
0
·02
0
·04
20
12
4
R/MIN
10 MINUTES
0
·08
0
·16
0

Figure 26: Representative cumulative records for Rat 7.

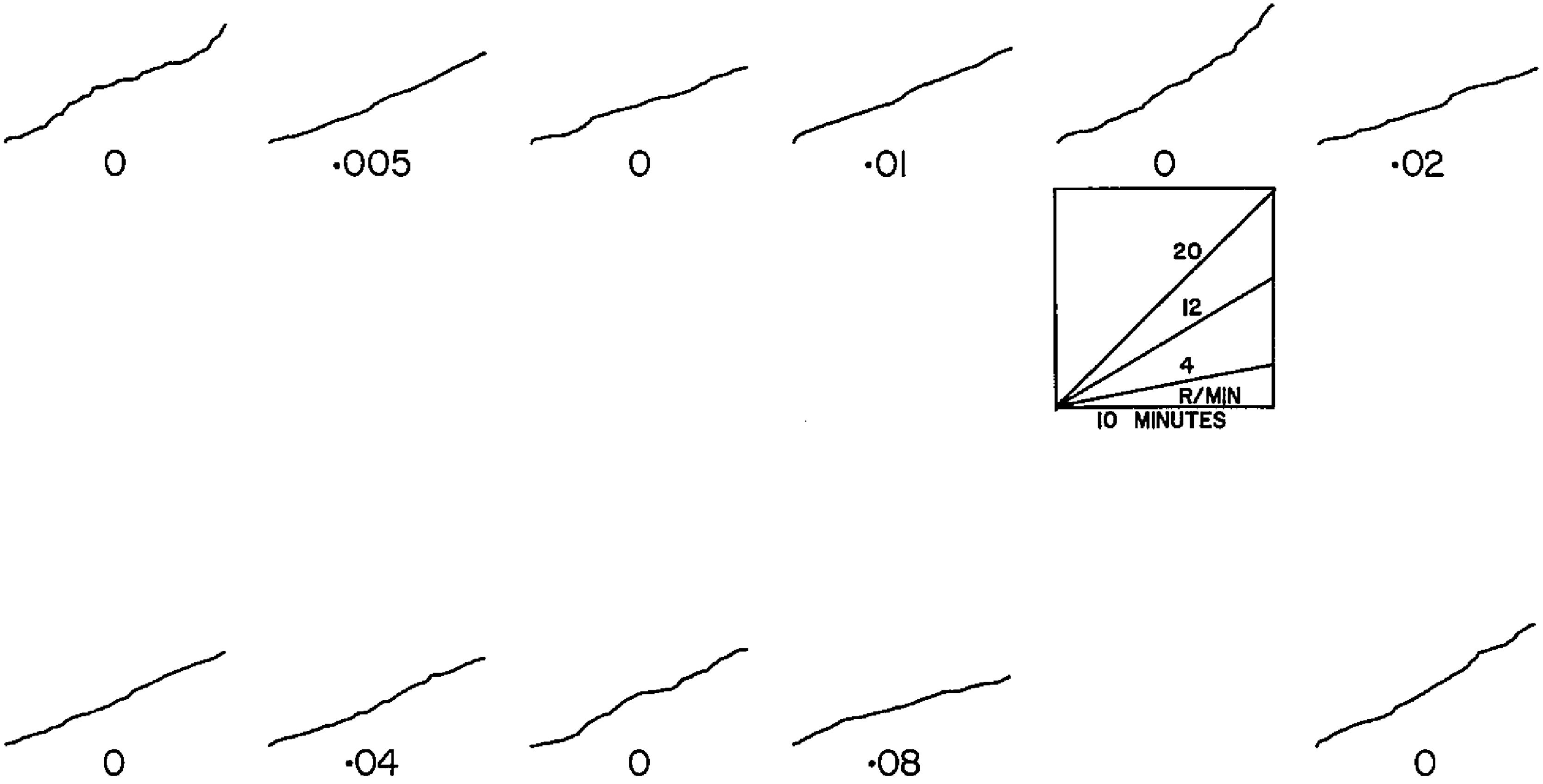

0
·005
0
·01
0
·02
20
12
4
R/MIN
10 MINUTES
0
·04
0
·08
0

Figure 27: Representative cumulative records for Rat 8.

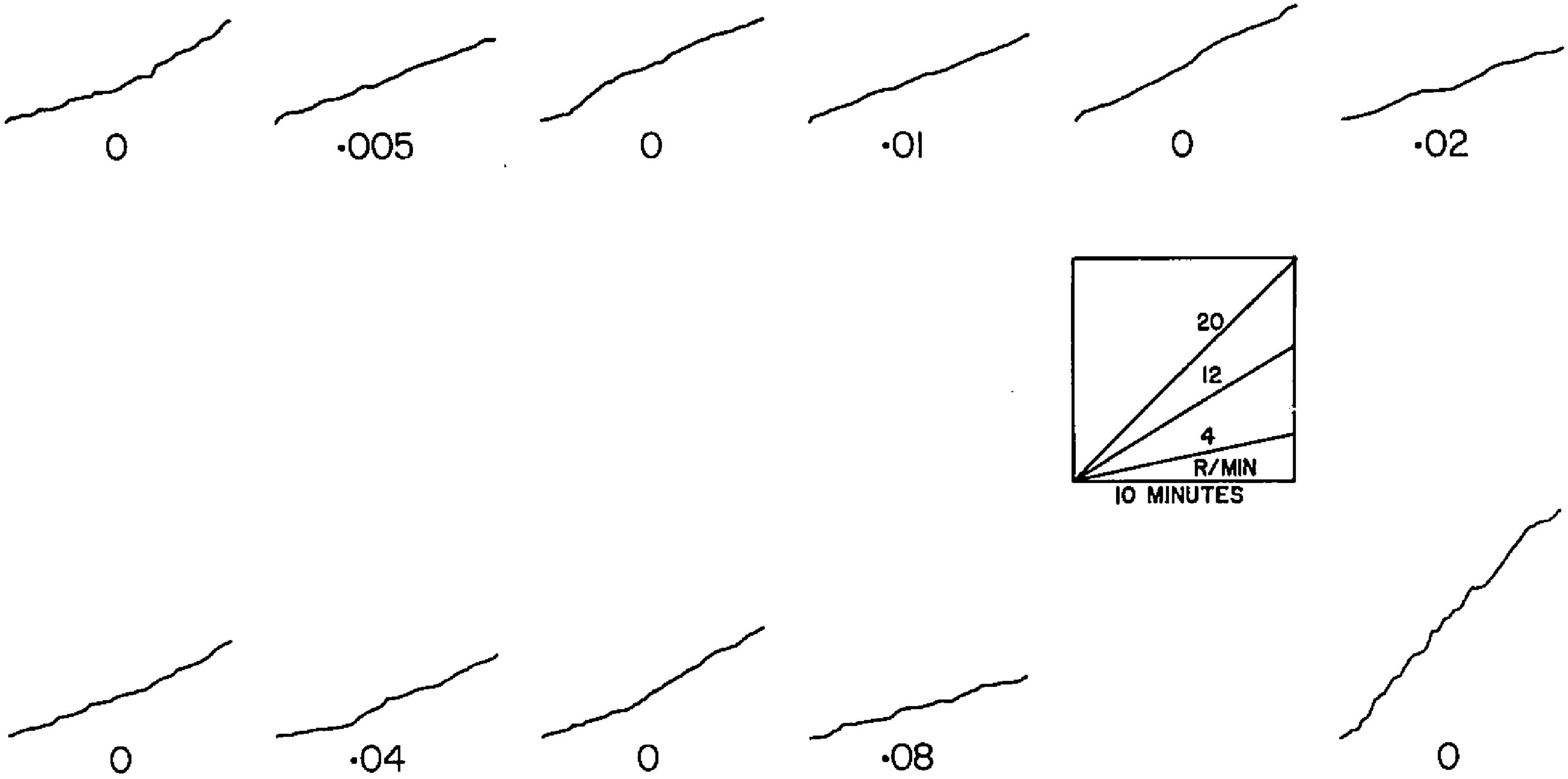

0
·005
0
·01
0
·02
20
12
4
R/MIN
10 MINUTES
0
·04
0
·08
0

Figure 28: Representative cumulative records for Rat 9.

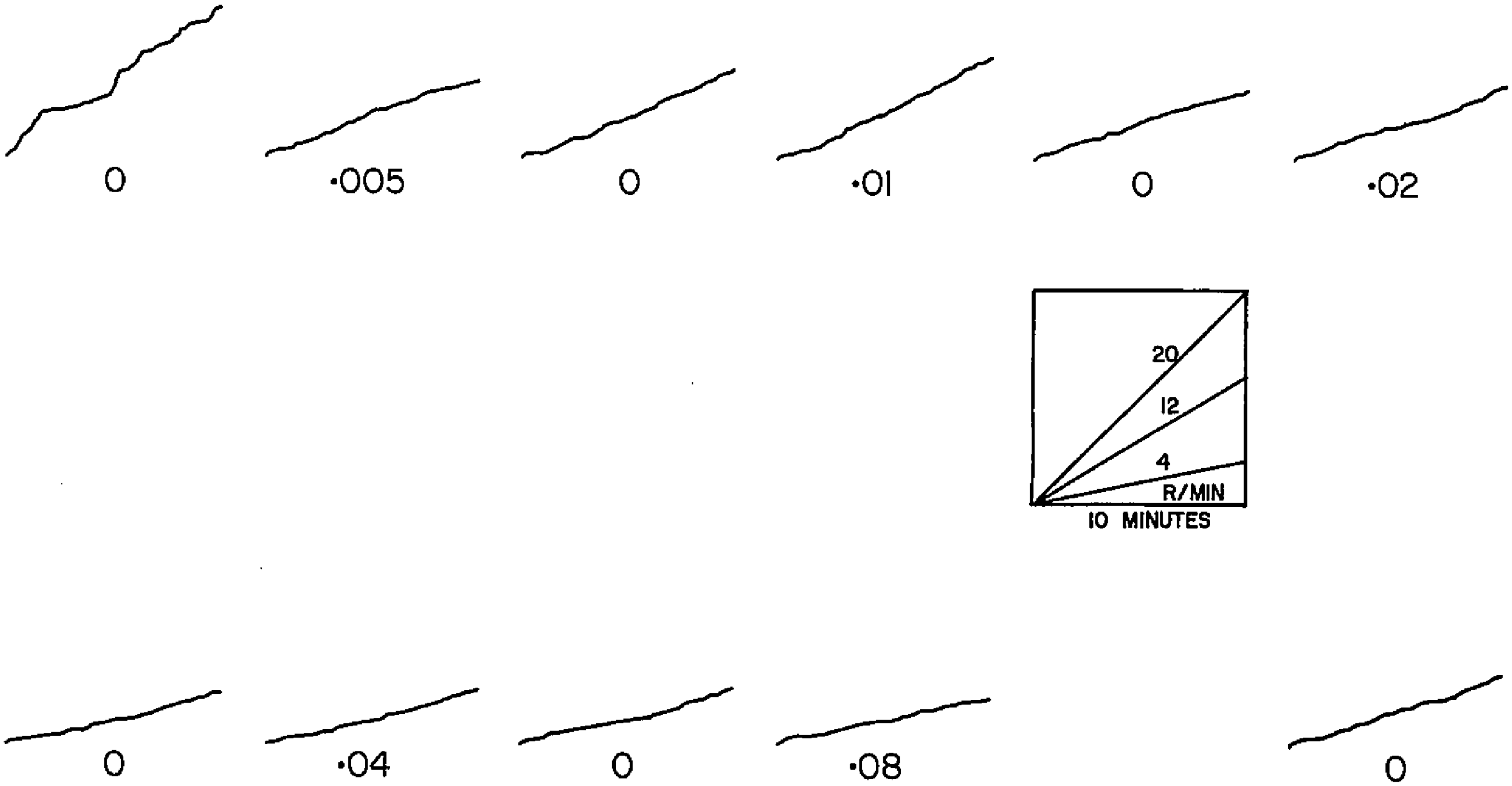

0
·005
0
·01
0
·02
20
12
4
R/MIN
10 MINUTES
0
·04
0
·08
0

Figure 29: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 1.

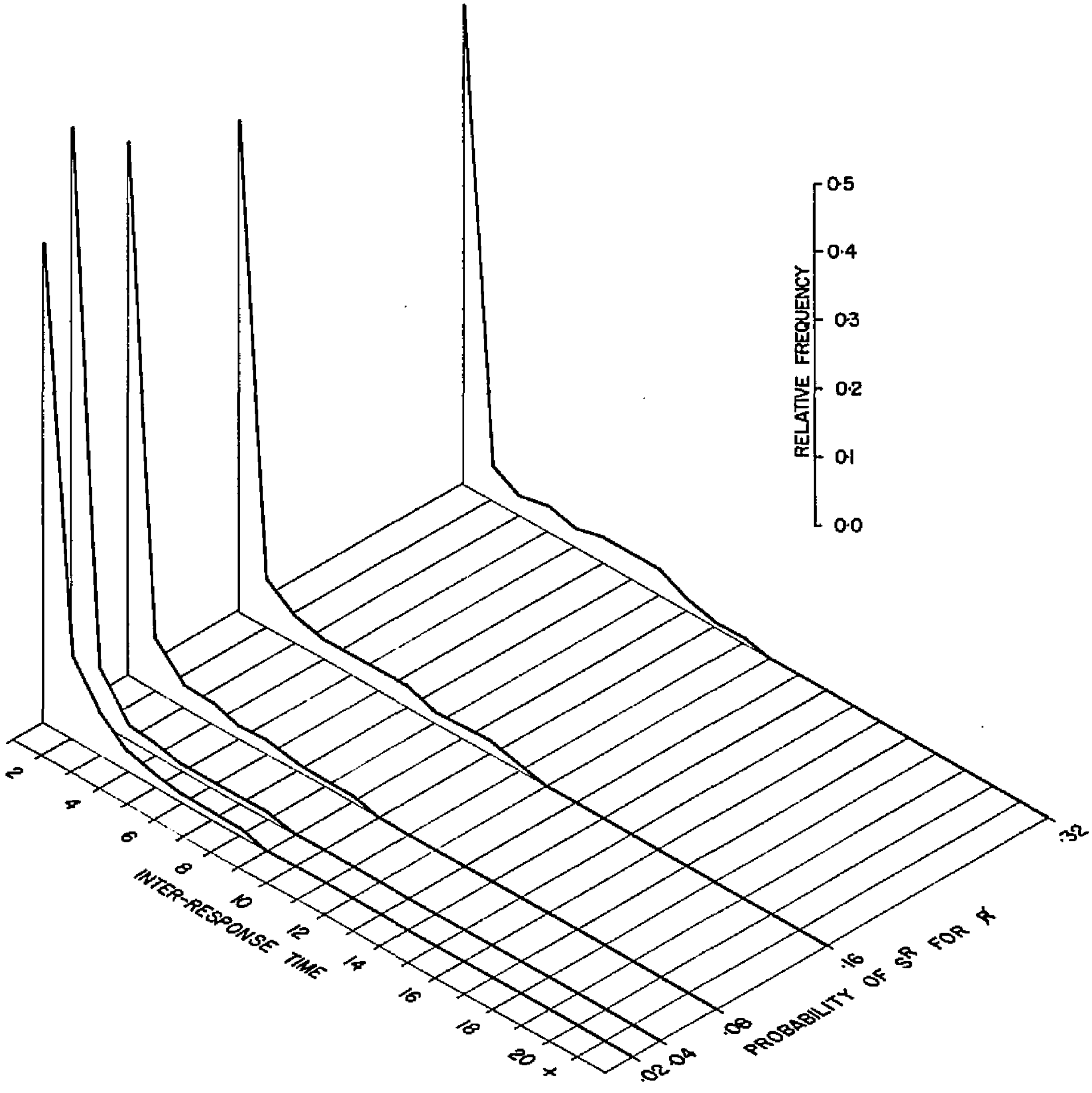

RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
2
4
6
8
10
12
14
16
18
20 +
INTER-RESPONSE TIME
·02
·04
·08
·16
·32
PROBABILITY OF SR FOR R

Figure 30: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 2.

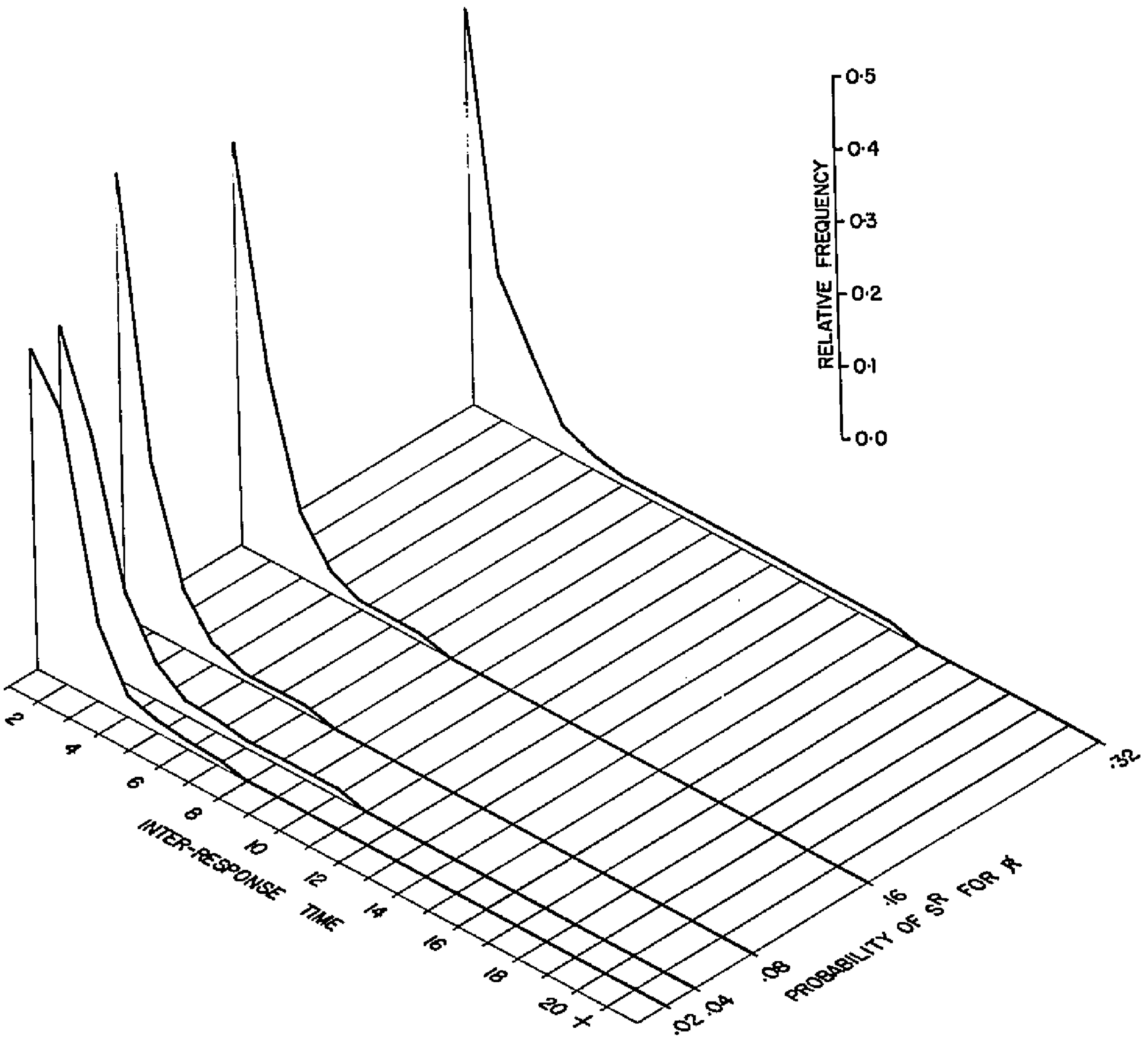

RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
INTER-RESPONSE TIME
2
4
6
8
10
12
14
16
18
20 +
PROBABILITY OF S^R FOR $\not{R}$
.02
.04
.08
.16
.32

Figure 31: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 3.

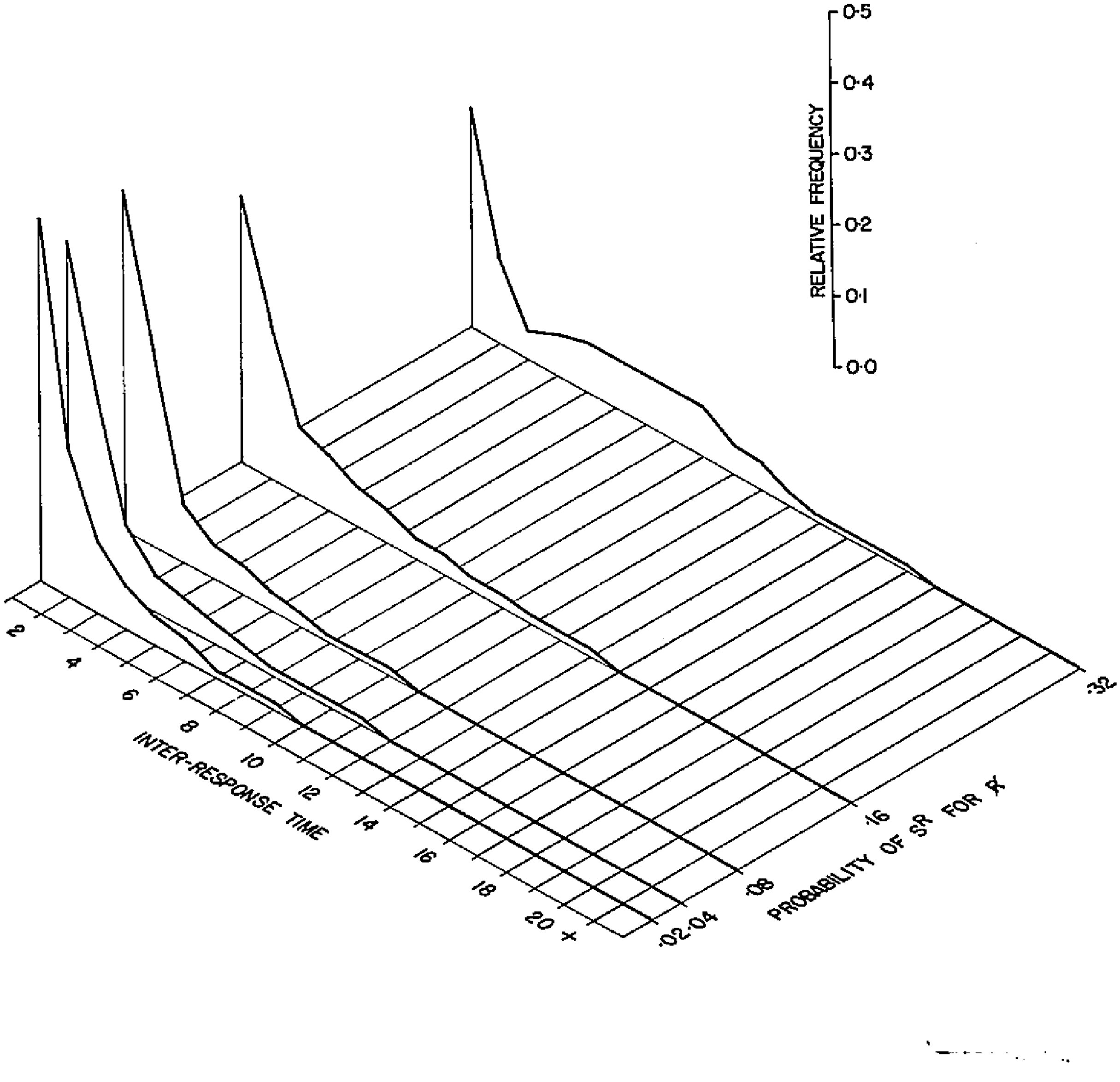

RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
INTER-RESPONSE TIME
2
4
6
8
10
12
14
16
18
20 +
·02·04
·08
·16
·32
PROBABILITY OF SR FOR R

Figure 32: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 4.

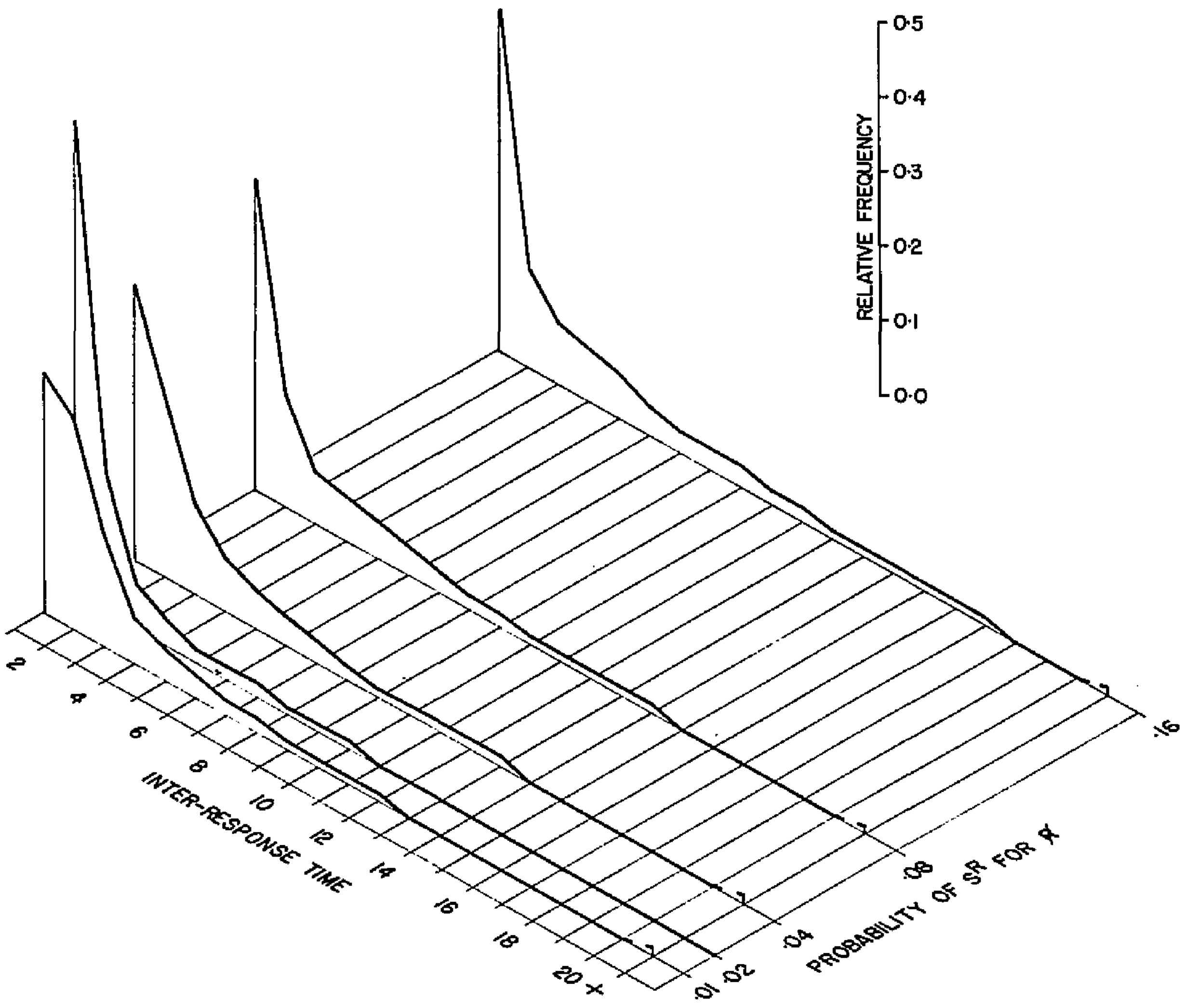

RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
2
4
6
8
10
12
14
16
18
20 +
INTER-RESPONSE TIME
·01
·02
·04
·08
·16
PROBABILITY OF S^R FOR $\not{R}$

Figure 33: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 5.

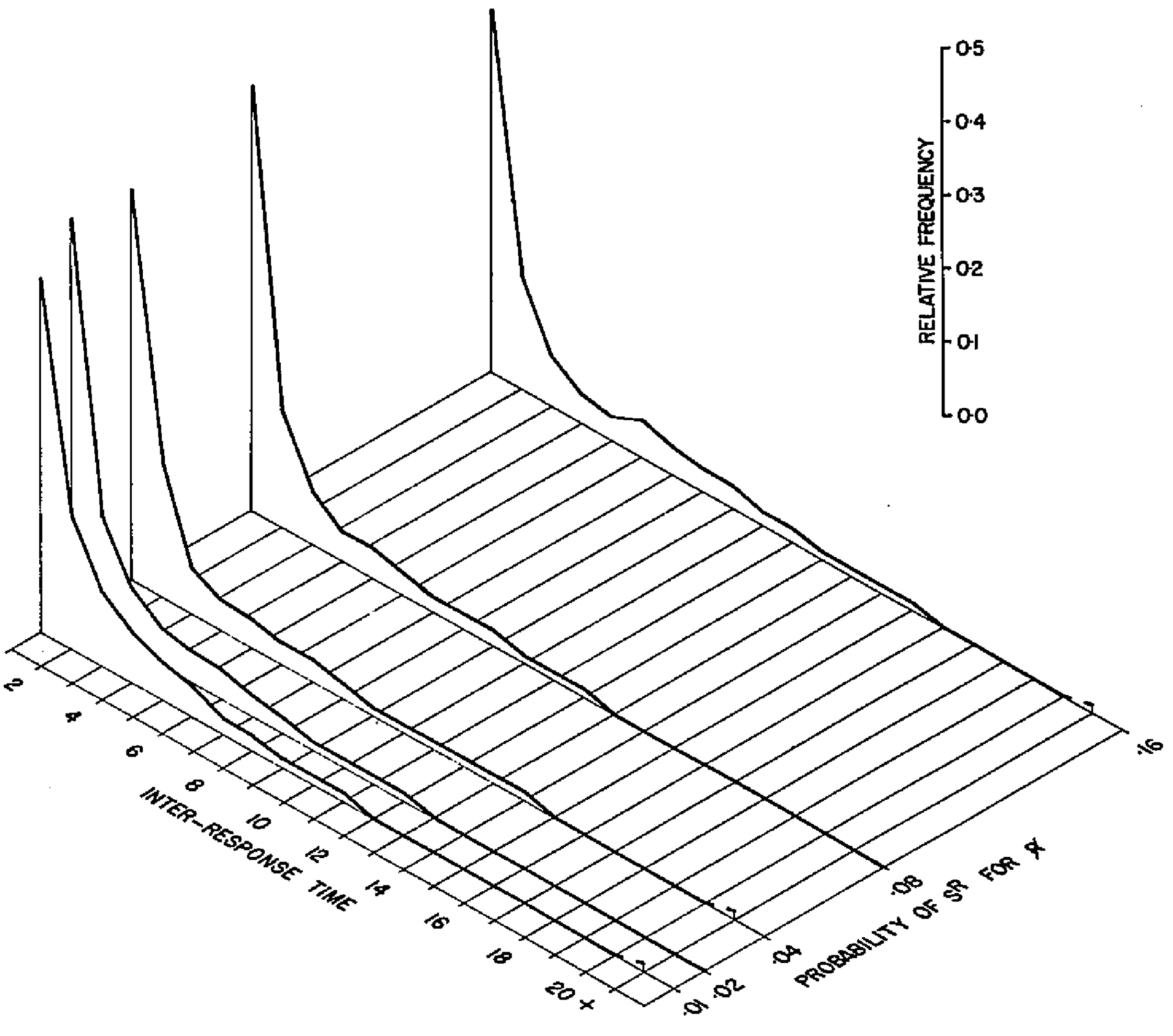

RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
2
4
6
8
10
12
14
16
18
20 +
INTER-RESPONSE TIME
·01
·02
·04
·08
·16
PROBABILITY OF SR FOR X

Figure 34: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 7.

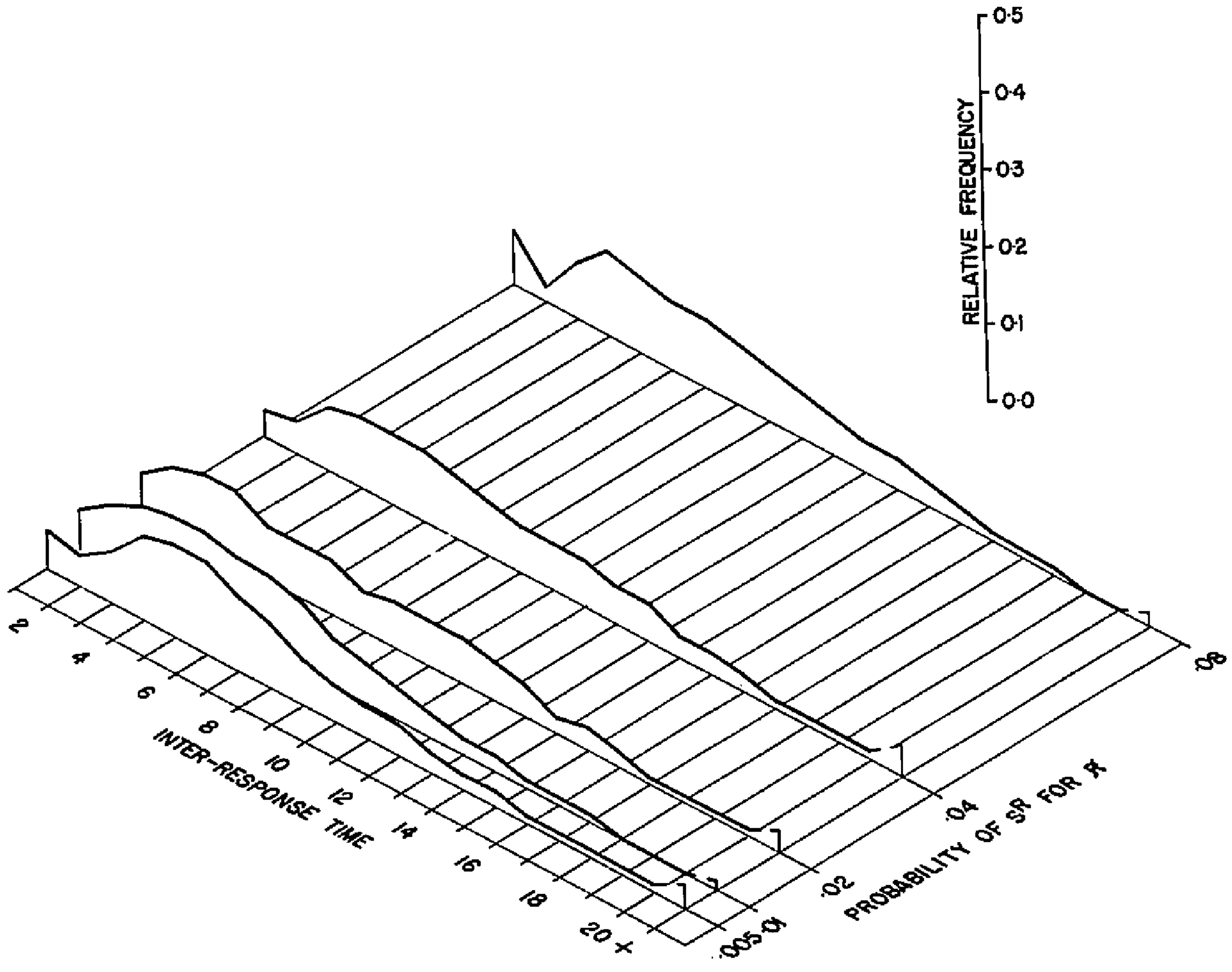

RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
INTER-RESPONSE TIME
2
4
6
8
10
12
14
16
18
20 +
PROBABILITY OF S^R FOR R
·005
·01
·02
·04
·08

Figure 35: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 8.

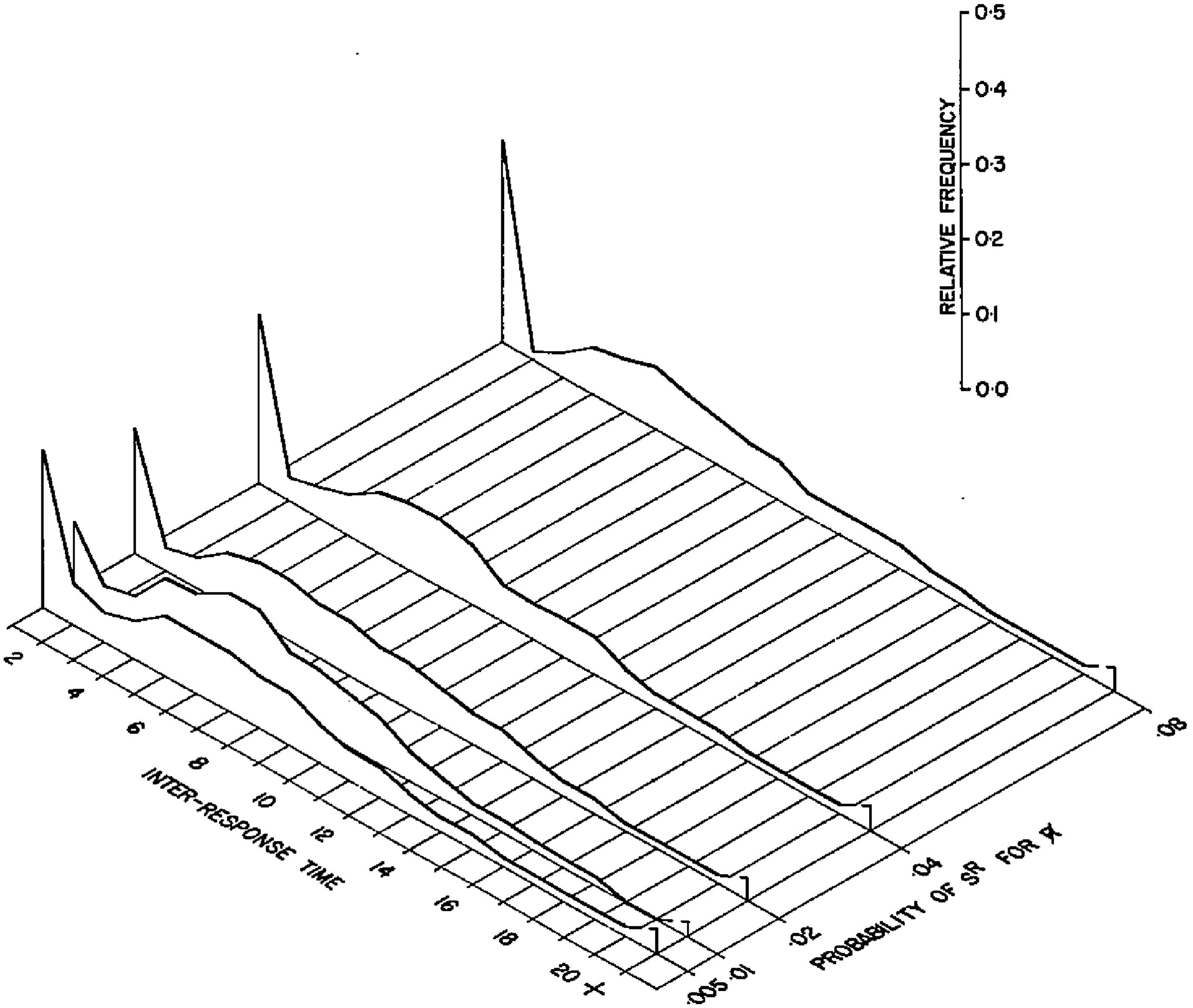
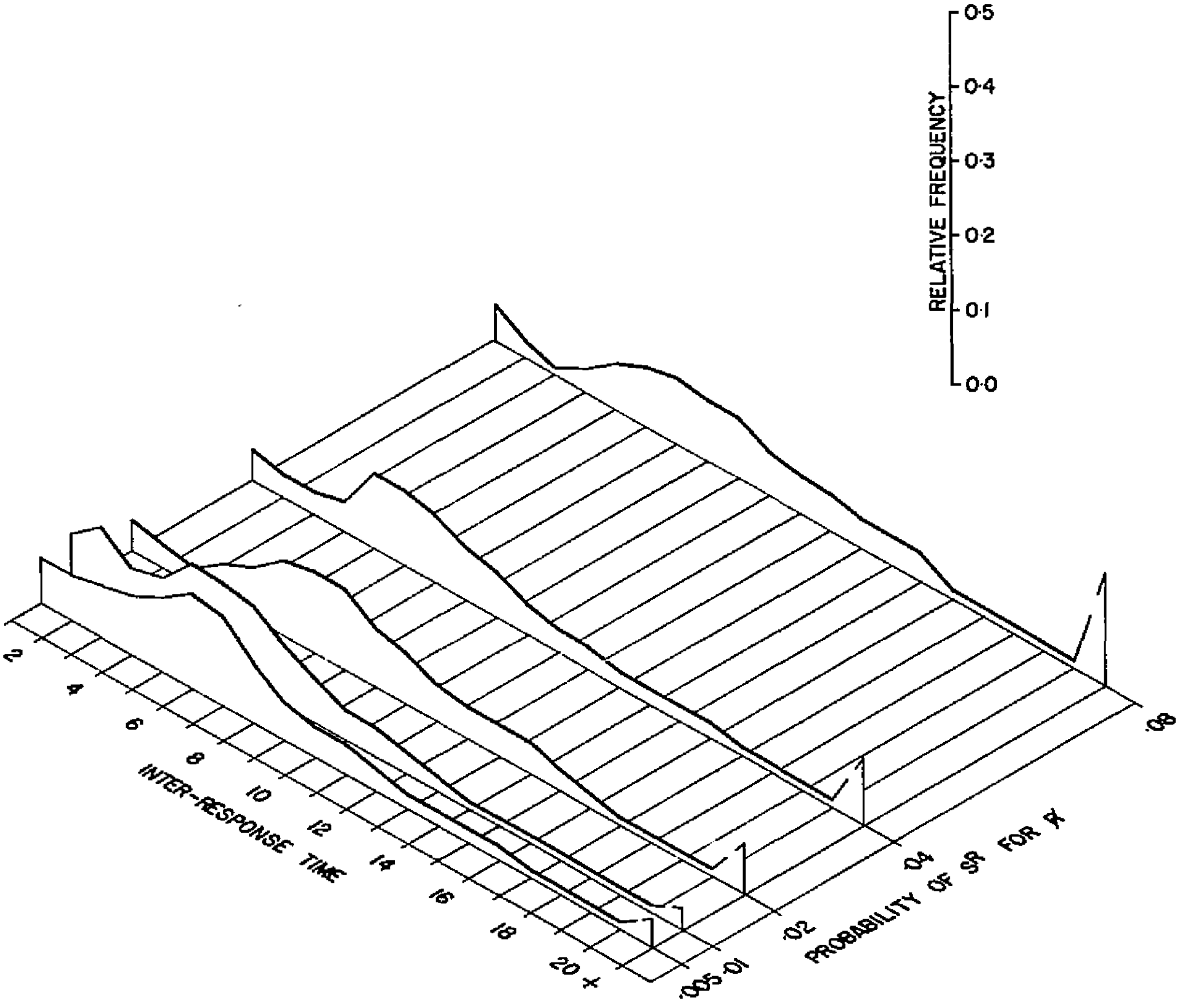

RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
INTER-RESPONSE TIME
2
4
6
8
10
12
14
16
18
20 +
PROBABILITY OF SR FOR X
·005
·01
·02
·04
·08

Figure 36: Distribution of IRTs as a function of $\underline{p}(S^R|\not{R})$ for Rat 9.


RELATIVE FREQUENCY
0·0
0·1
0·2
0·3
0·4
0·5
INTER-RESPONSE TIME
2
4
6
8
10
12
14
16
18
20 +
PROBABILITY OF SR FOR R̸
·005
·01
·02
·04
·08

delivered following R was sufficiently unexpected to merit closer scrutiny. Since the overall mean $PS^{R}P$ might possibly be non-representative of the distribution of $PS^{R}Ps$, a sequential analysis of these data was undertaken. The obtained sequential information is contained in Figures 37 through 44. Each data point represents the mean of five $PS^{R}Ps$ per session, with the first data point corresponding to the mean of the first five $PS^{R}Ps$ of each session pooled over ten sessions, the second data point the second five, etc. Filled circles represent $PS^{R}Ps$ following $S^{R}s$ based upon R, open circles those delivered following $\not{R}$. The numbers within each set of axes are the value of $\underline{p}(S^{R}|\not{R})$ in effect for the sessions over which a particular distribution was collected. The general finding was that sequential dependencies among $PS^{R}Ps$ were not significant. In few cases did $PS^{R}P$ change in a progressive fashion as a function of the ordinal position of the $PS^{R}P$ within sessions. The relationship between $PS^{R}Ps$ for R and those following $\not{R}$ cannot be attributed to any distortion due to averaging. It might also have been hypothesized that some within-session "learning curve" with respect to $PS^{R}P$ would emerge from a sequential analysis. No such function is evident from these data, even when the $PS^{R}Ps$ are pooled one at a time across sessions.

Figure 45 through 52 present data collected during baseline exposures. These functions relate relative frequency of R occurrences to 4 sec blocks of time within

Figure 37: Sequential PS^RPs for R (filled circles) and $\not{R}$ (open circles) for Rat 1.

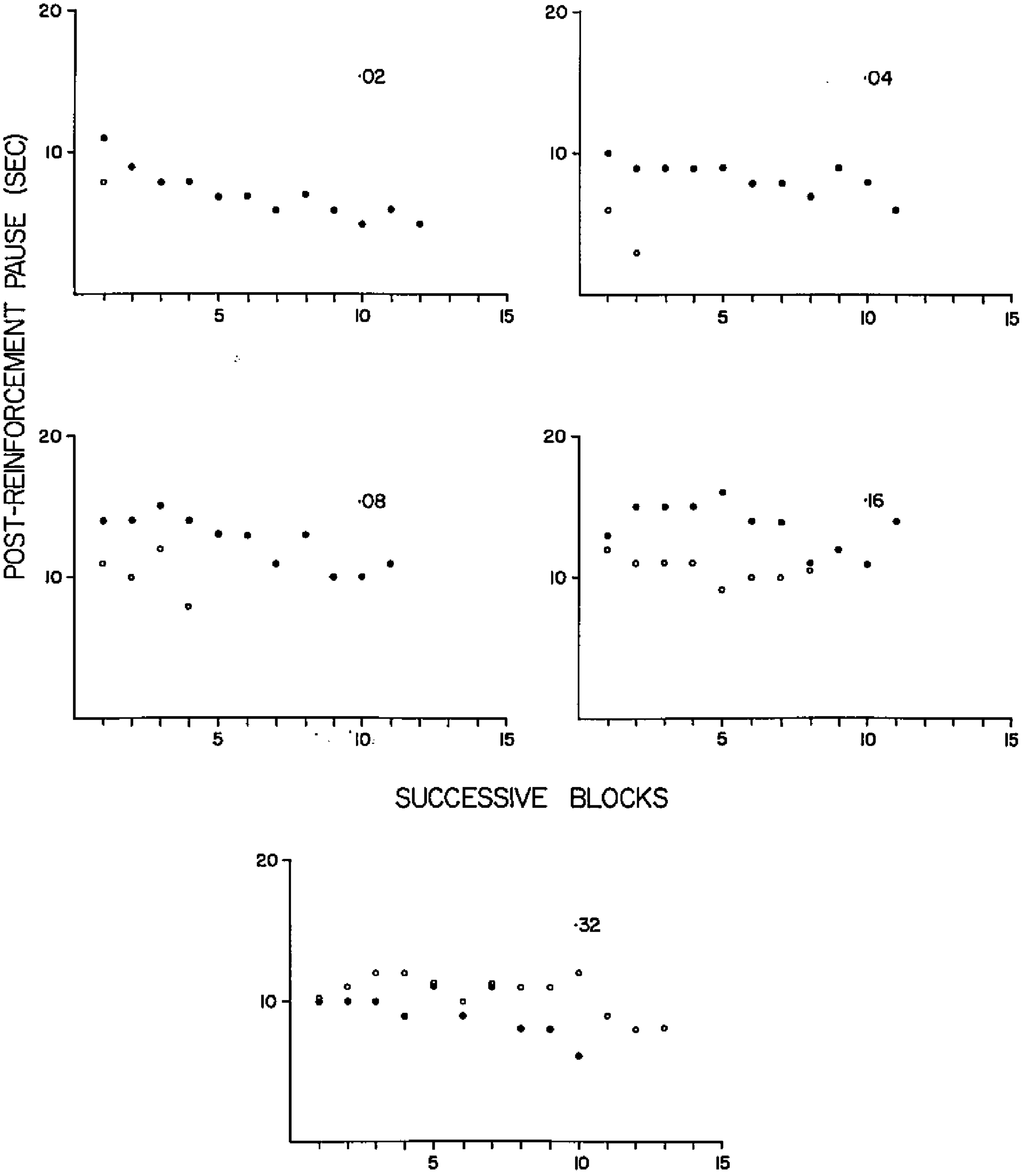

POST-REINFORCEMENT PAUSE (SEC)
SUCCESSIVE BLOCKS
·02
·04
·08
·16
·32
20
10
5
10
15

Figure 38: Sequential $\mathrm{PS}^{R}\mathrm{Ps}$ for R (filled circles) and $\not{R}$ (open circles) for Rat 2.

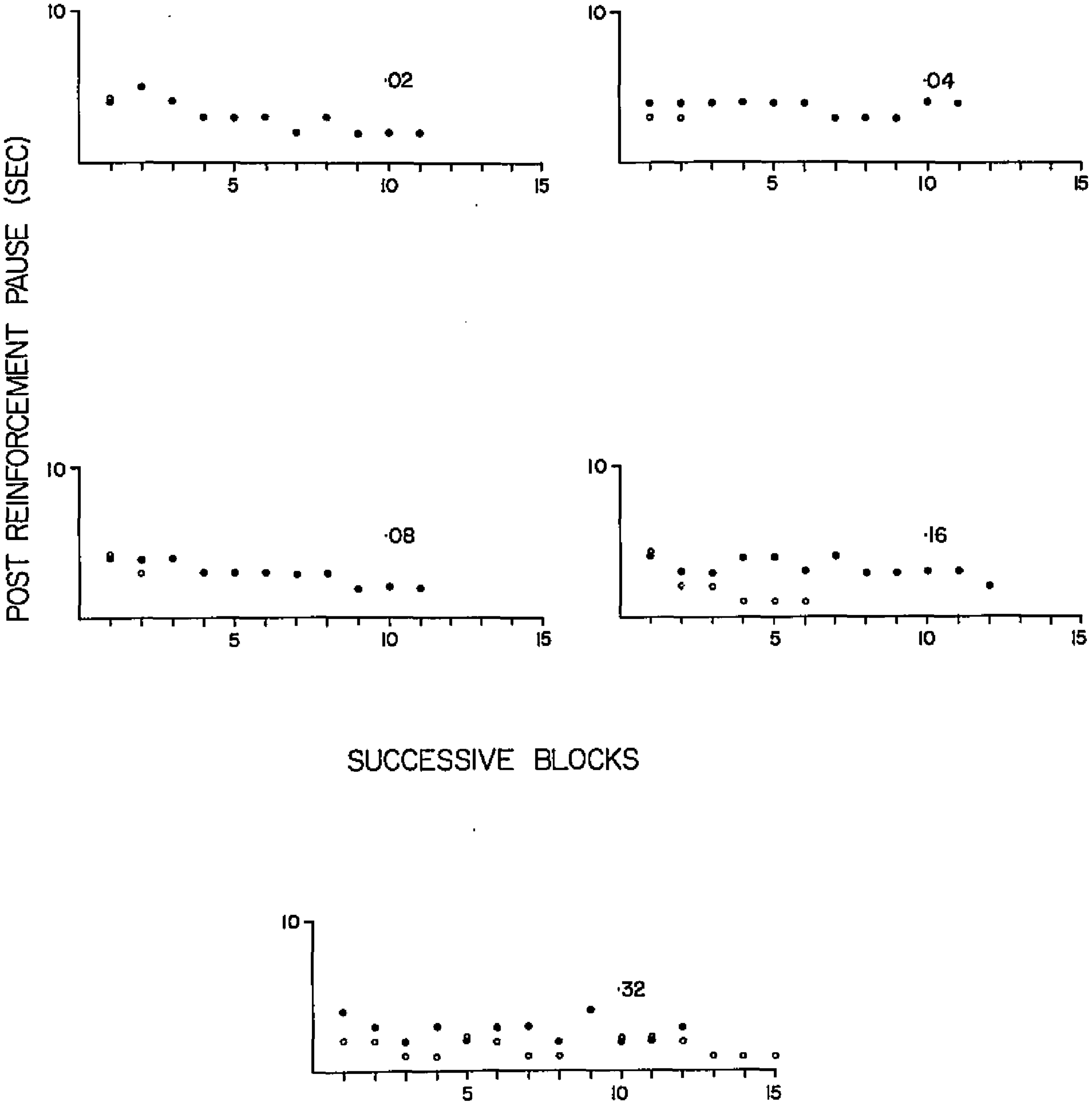

POST REINFORCEMENT PAUSE (SEC)
SUCCESSIVE BLOCKS
·02
·04
·08
·16
·32
10
5
10
15

Figure 39: Sequential PS^{R}Ps for R (filled circles) and $\not{R}$ (open circles) for Rat 3.

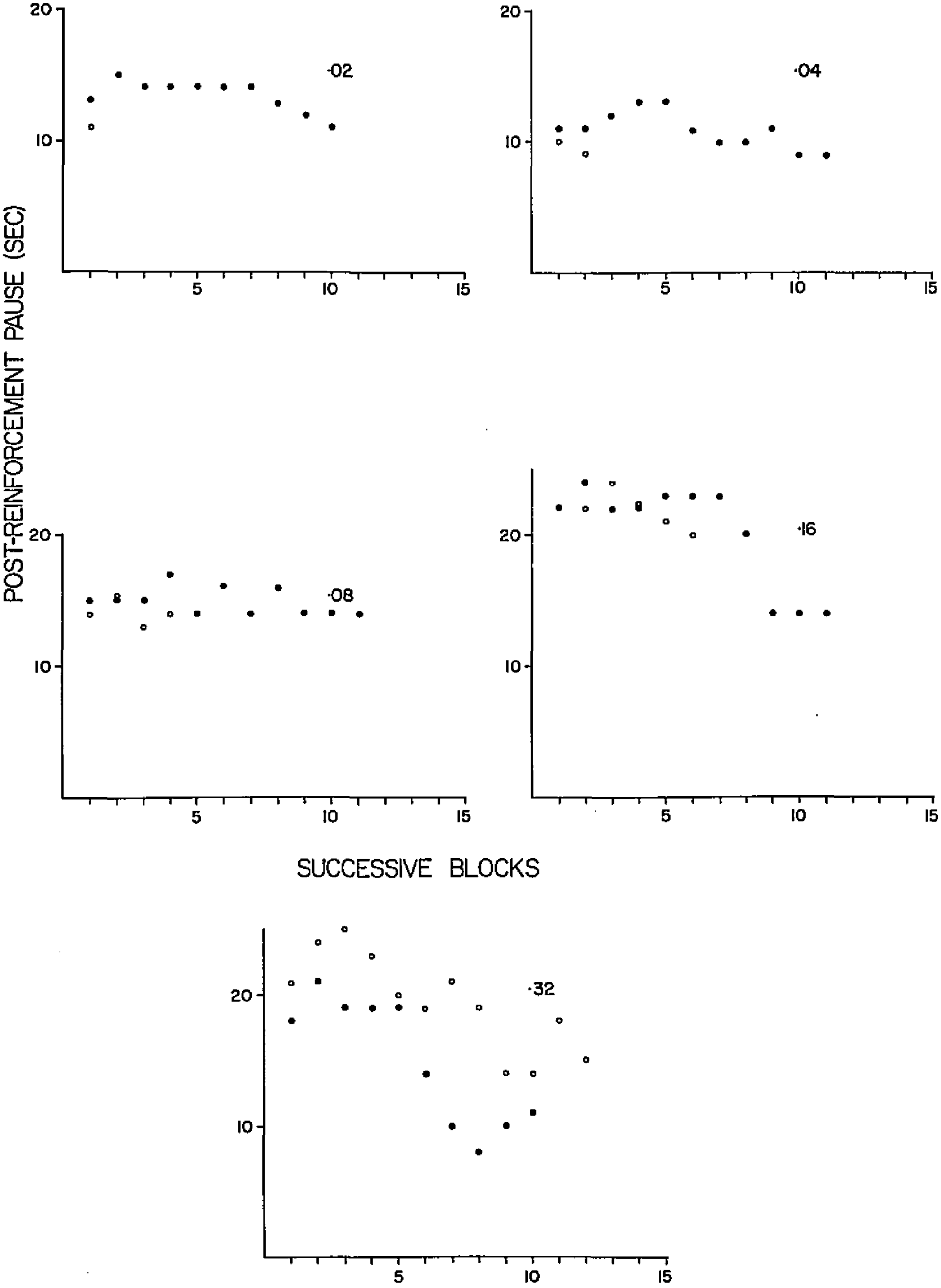

POST-REINFORCEMENT PAUSE (SEC)
SUCCESSIVE BLOCKS
·02
·04
·08
·16
·32
20
10
5
10
15

Figure 40: Sequential PS^RPs for R (filled circles) and $\not{R}$ (open circles) for Rat 4.

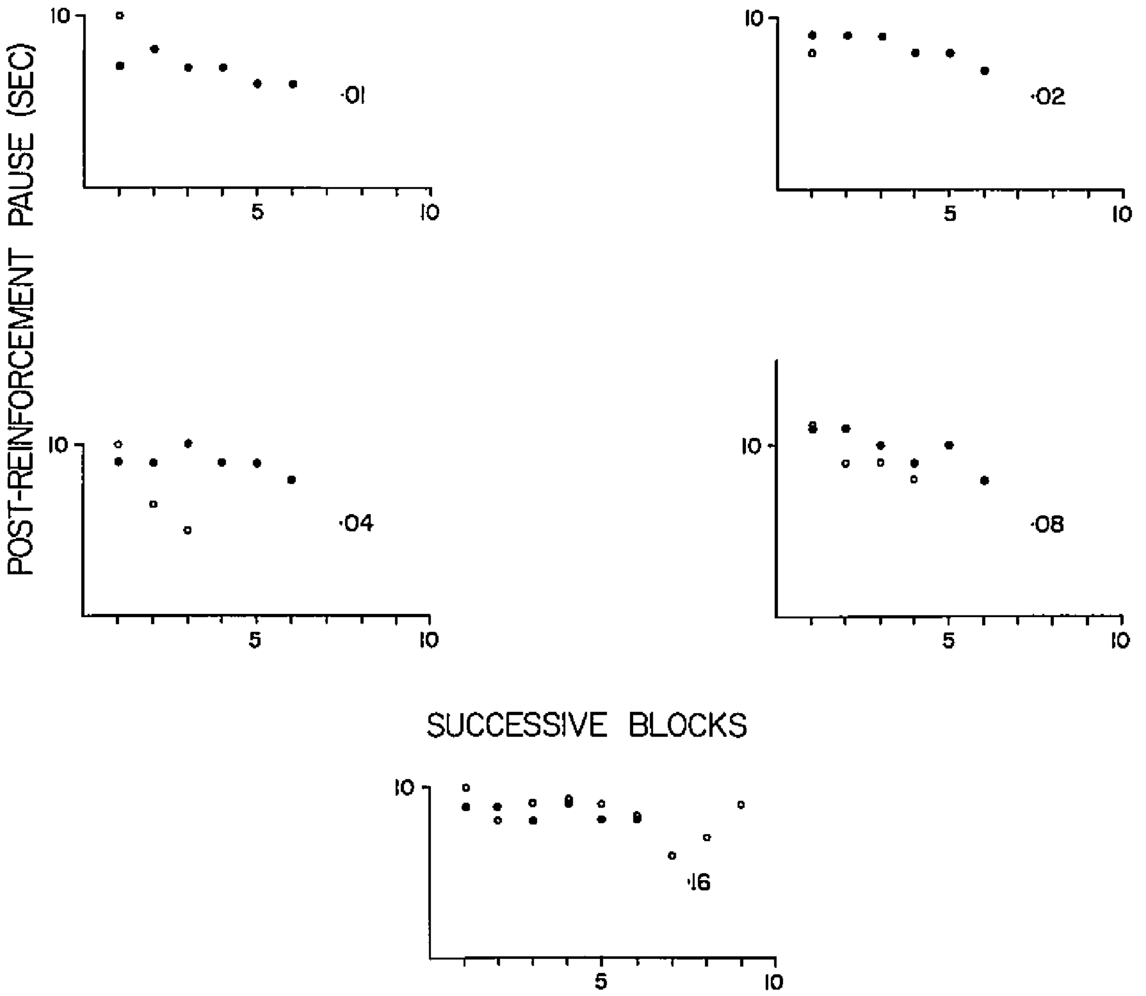

POST-REINFORCEMENT PAUSE (SEC)
SUCCESSIVE BLOCKS
10
5
10
·01
·02
·04
·08
·16

Figure 41: Sequential $PS^{R}Ps$ for R (filled circles) and $\not{R}$ (open circles) for Rat 5.

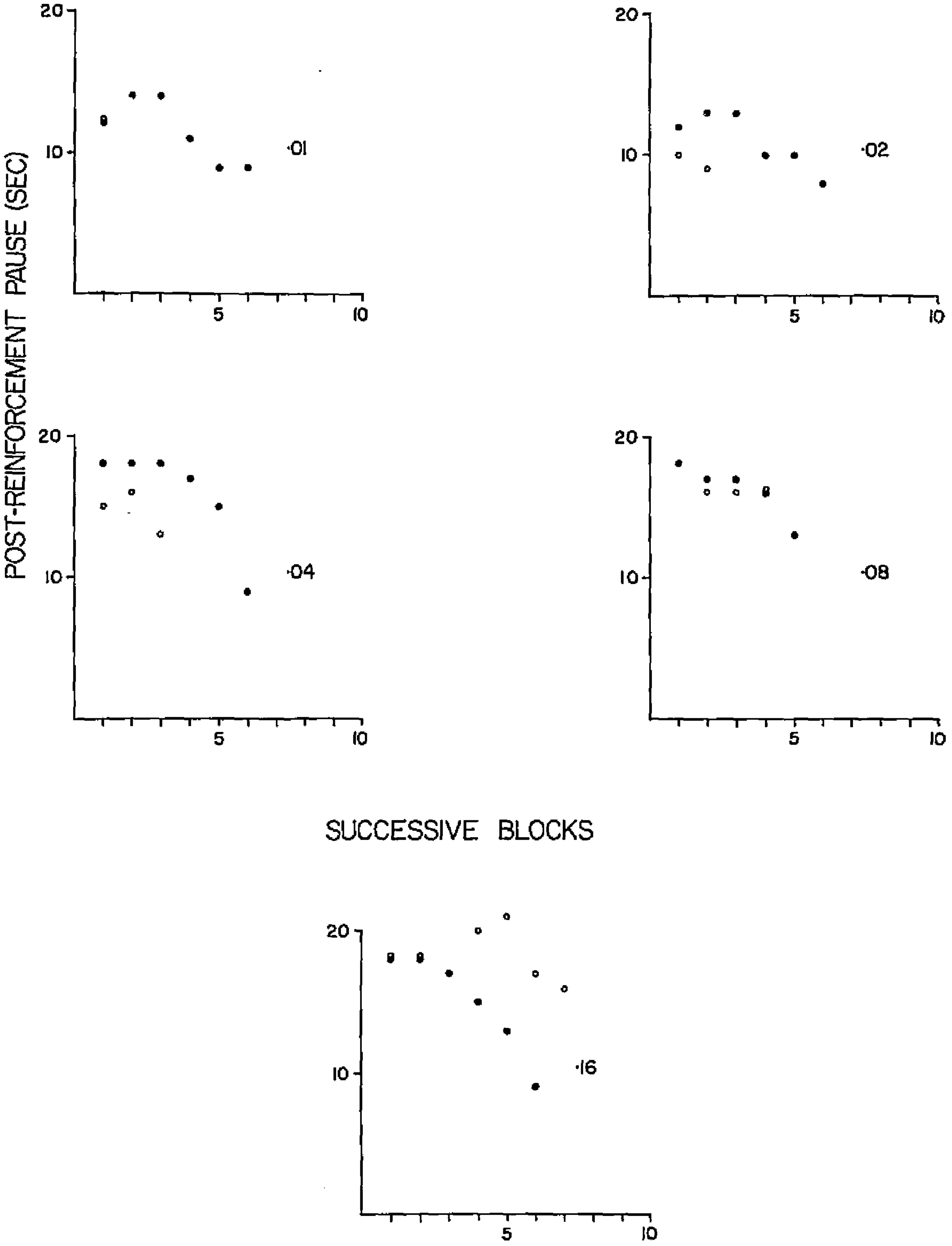

POST-REINFORCEMENT PAUSE (SEC)
20
10
5
10
·01
·02
·04
·08
·16
SUCCESSIVE BLOCKS

Figure 42: Sequential $PS^{R}Ps$ for R (filled circles) and $\not{R}$ (open circles) for Rat 7.

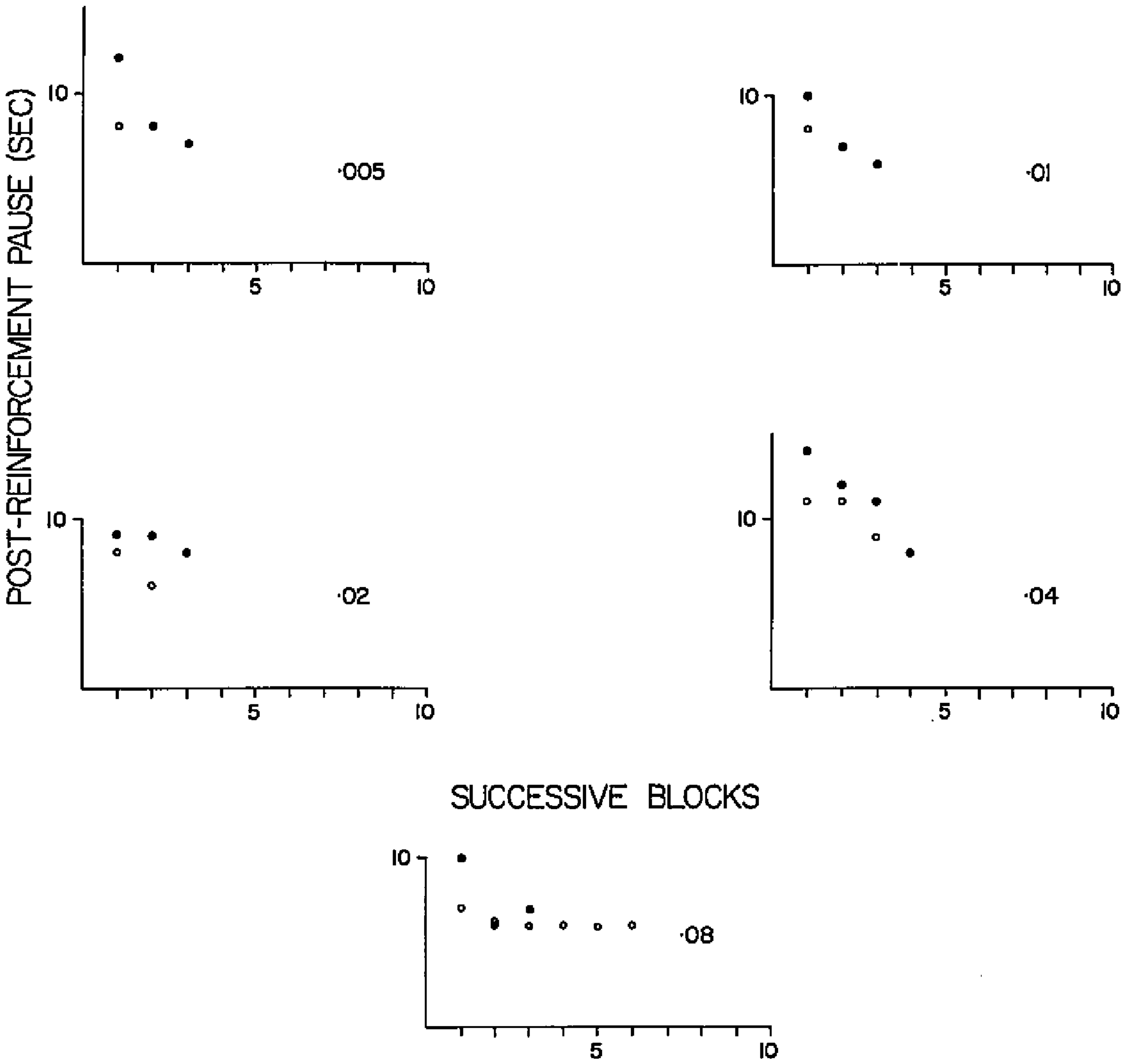

POST-REINFORCEMENT PAUSE (SEC)
10
5
10
·005
10
5
10
·01
10
5
10
·02
10
5
10
·04
SUCCESSIVE BLOCKS
10
5
10
·08

Figure 43: Sequential PS^{R}Ps for R (filled circles) and $\not{R}$ (open circles) for Rat 8.

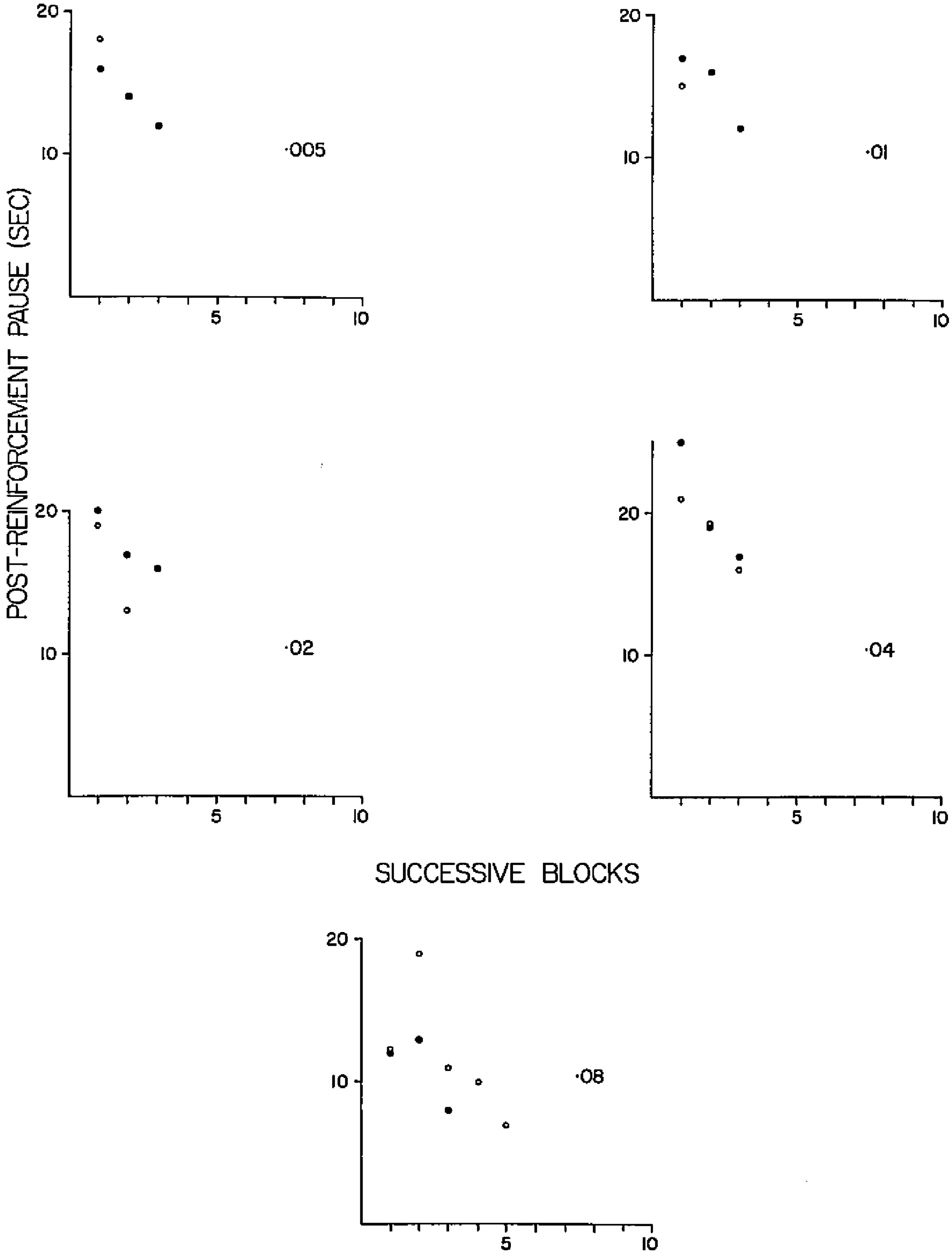

POST-REINFORCEMENT PAUSE (SEC)
20
10
5
10
·005
20
10
5
10
·01
20
10
5
10
·02
20
10
5
10
·04
SUCCESSIVE BLOCKS
20
10
5
10
·08

Figure 44: Sequential PS^{R}Ps for R (filled circles) and $\not{R}$ (open circles) for Rat 9.

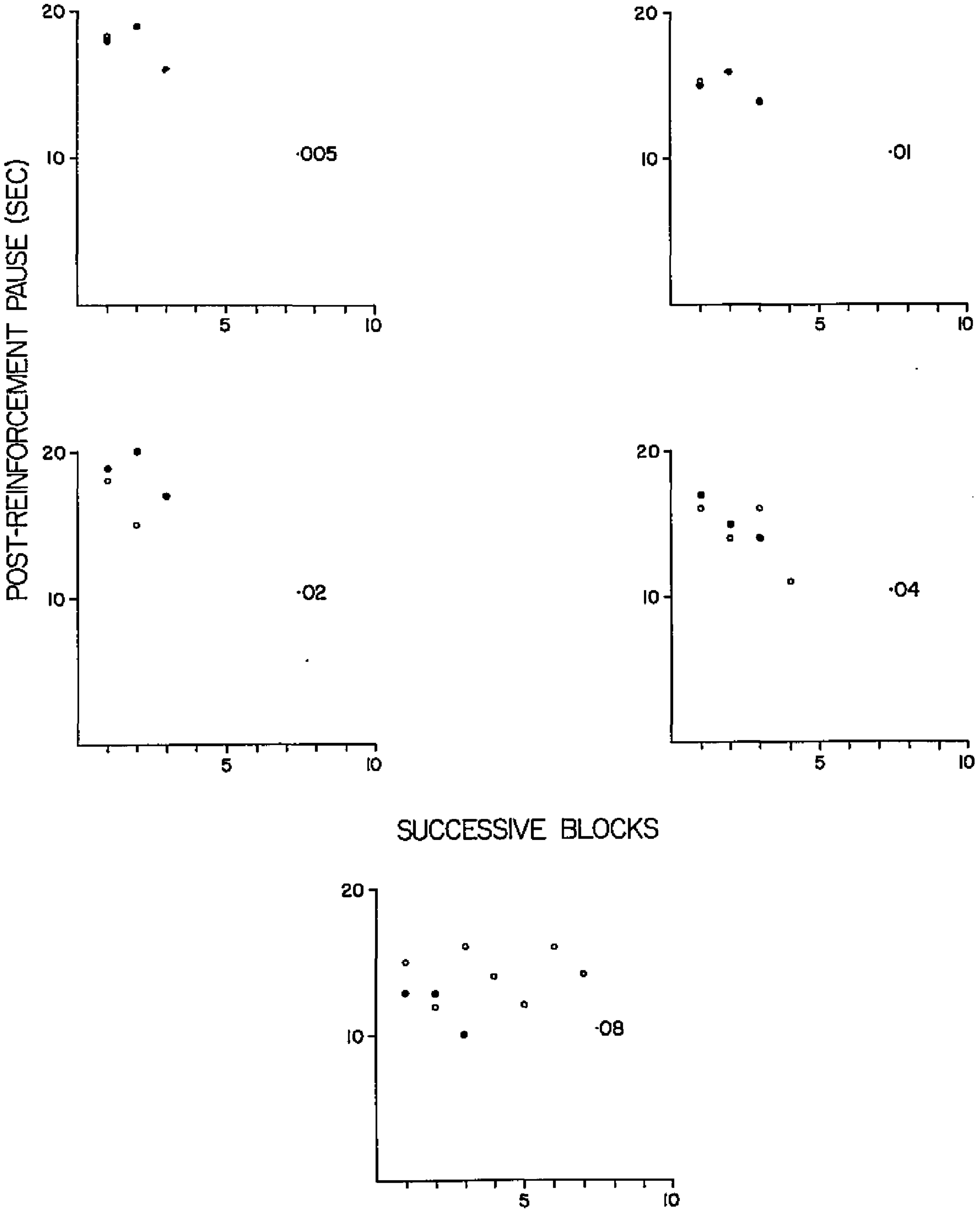

POST-REINFORCEMENT PAUSE (SEC)
SUCCESSIVE BLOCKS
20
10
5
10
·005
·01
·02
·04
·08

Figure 45: Relative frequency of Rs within T_R for the baseline exposures for Rat 1.

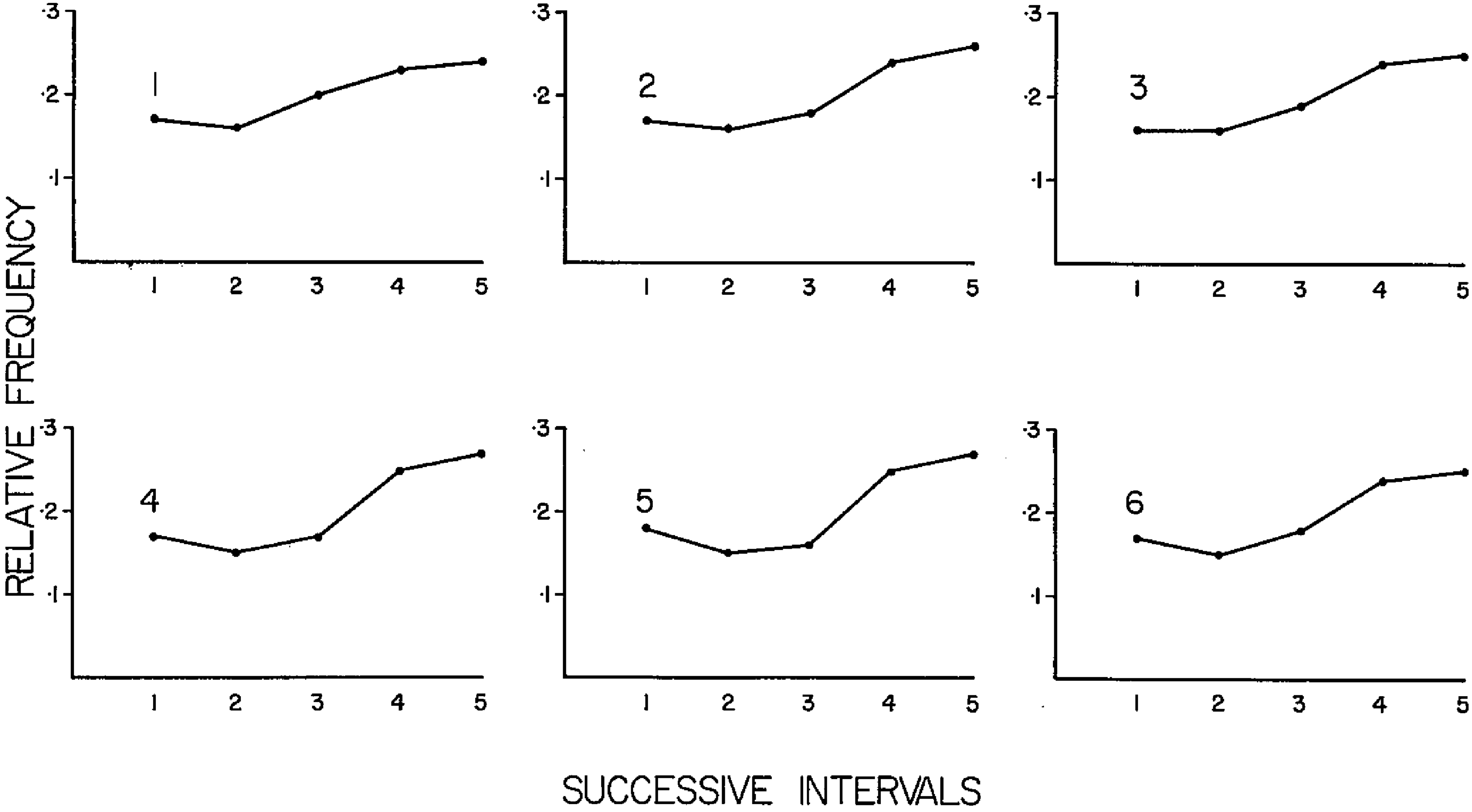

RELATIVE FREQUENCY
SUCCESSIVE INTERVALS
1
2
3
4
5
6
·3
·2
·1
1
2
3
4
5

Figure 46: Relative frequency of Rs within T_R for the baseline exposures for Rat 2.

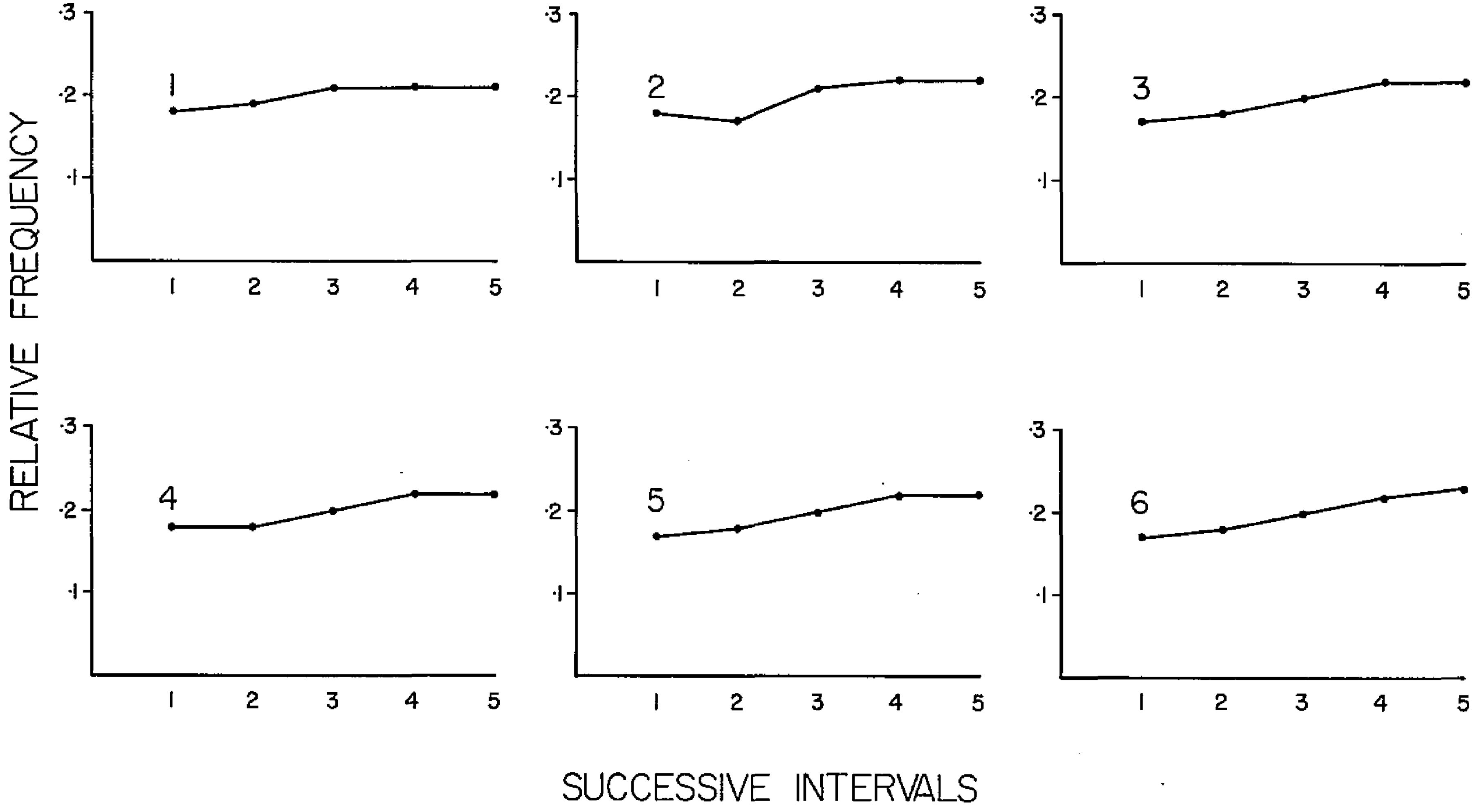

·3
·2
·1
1
2
3
4
5
6
RELATIVE FREQUENCY
SUCCESSIVE INTERVALS

Figure 47: Relative frequency of Rs within T_R for the baseline exposures for Rat 3.

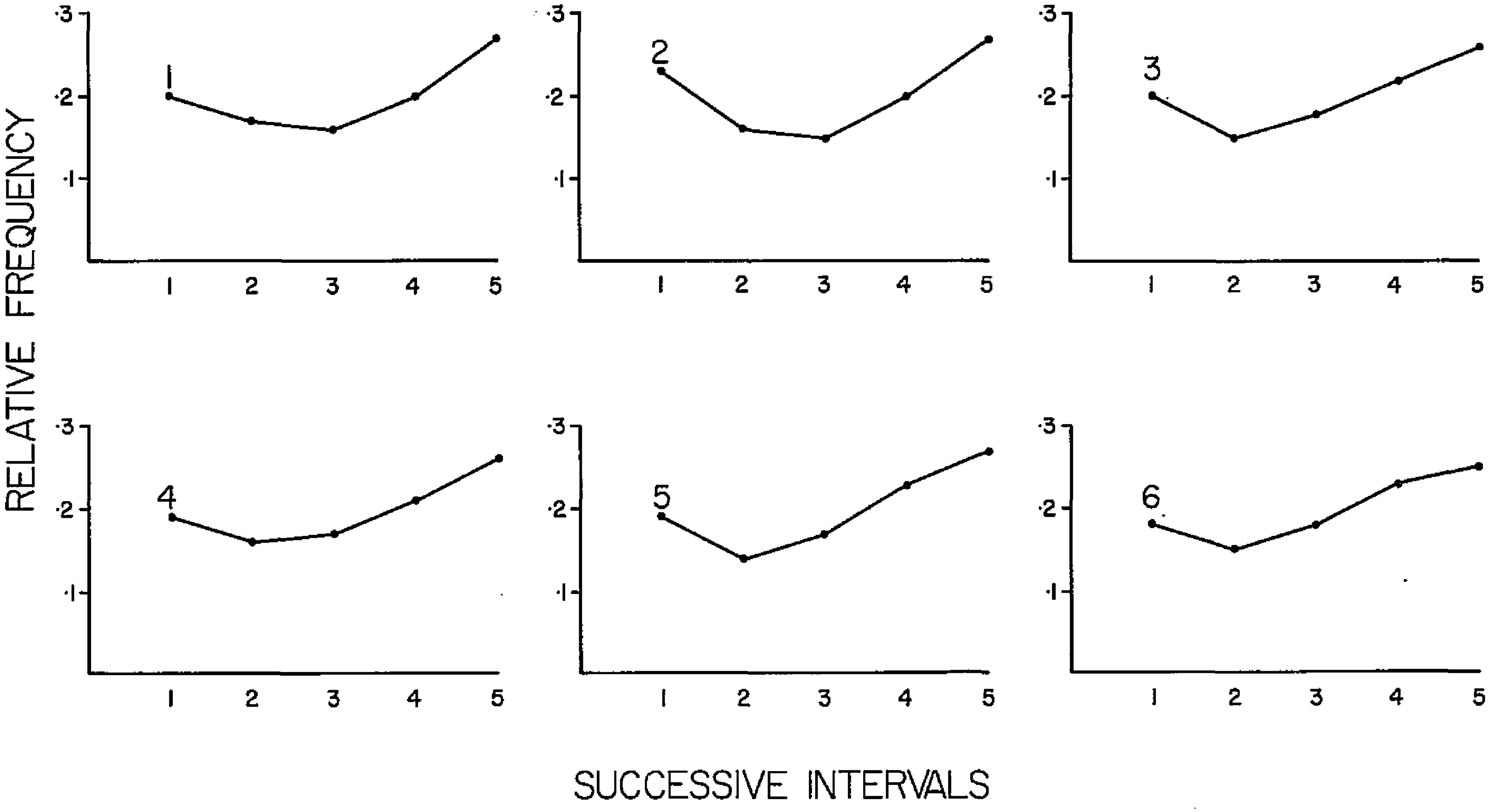

RELATIVE FREQUENCY
SUCCESSIVE INTERVALS
1
2
3
4
5
6
·1
·2
·3
1 2 3 4 5

Figure 48: Relative frequency of Rs within T_R for the baseline exposures for Rat 4.

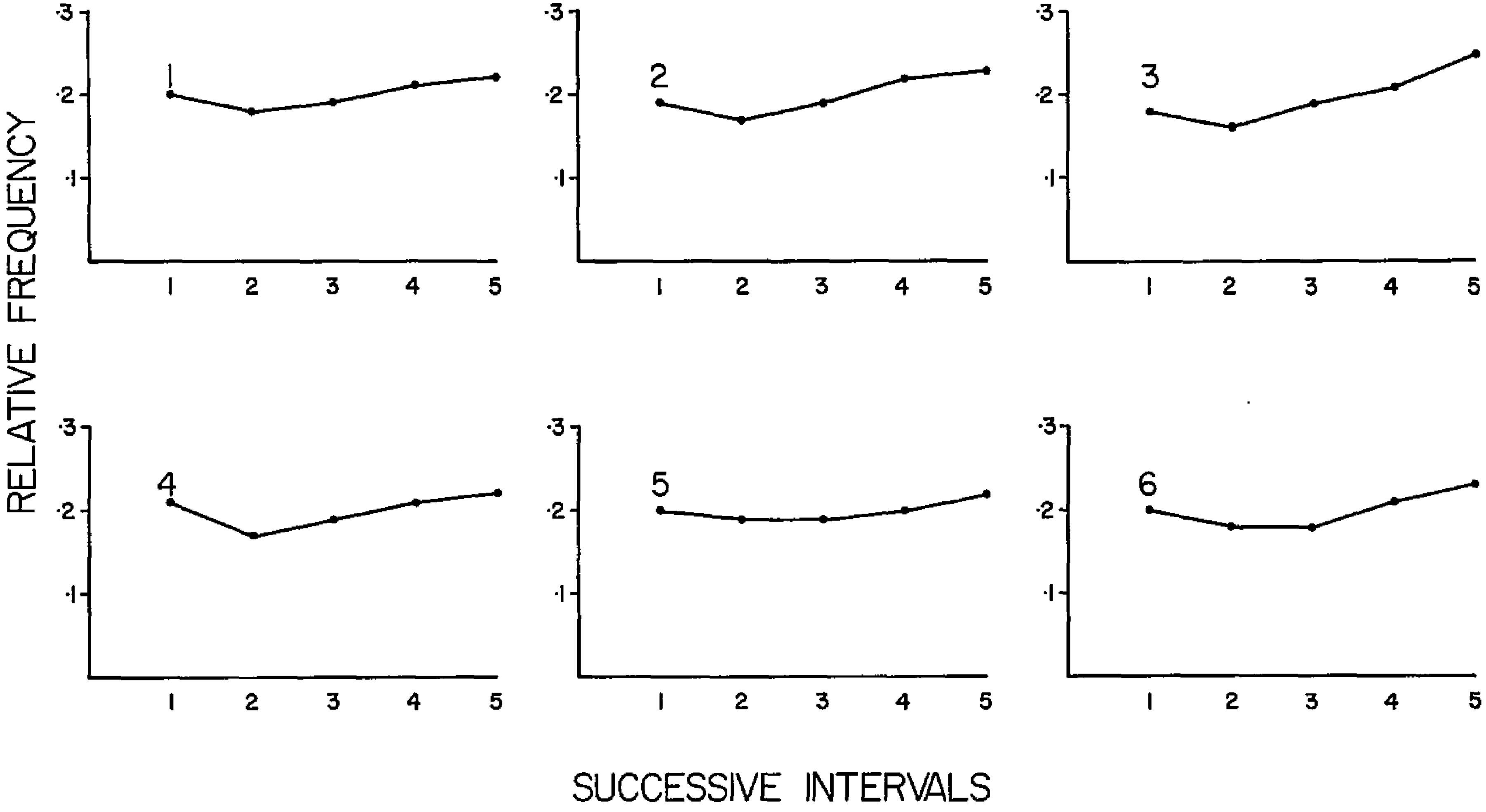

RELATIVE FREQUENCY
SUCCESSIVE INTERVALS
·3
·2
·1
1
2
3
4
5
6

Figure 49: Relative frequency of Rs within T_R for the baseline exposures for Rat 5.

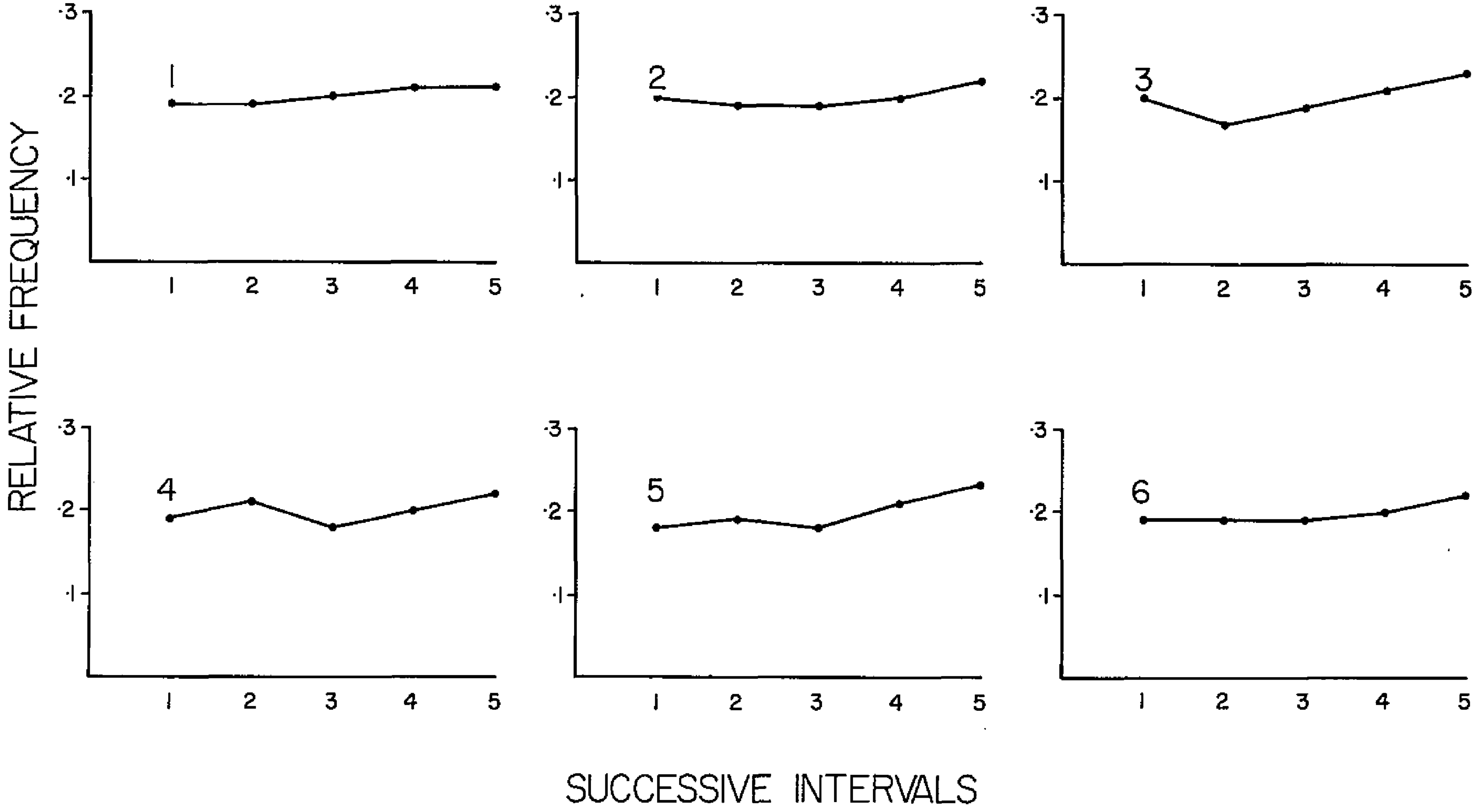

RELATIVE FREQUENCY
SUCCESSIVE INTERVALS
1
2
3
4
5
6
·3
·2
·1
1
2
3
4
5

Figure 50: Relative frequency of Rs within T_R for the baseline exposures for Rat 7.

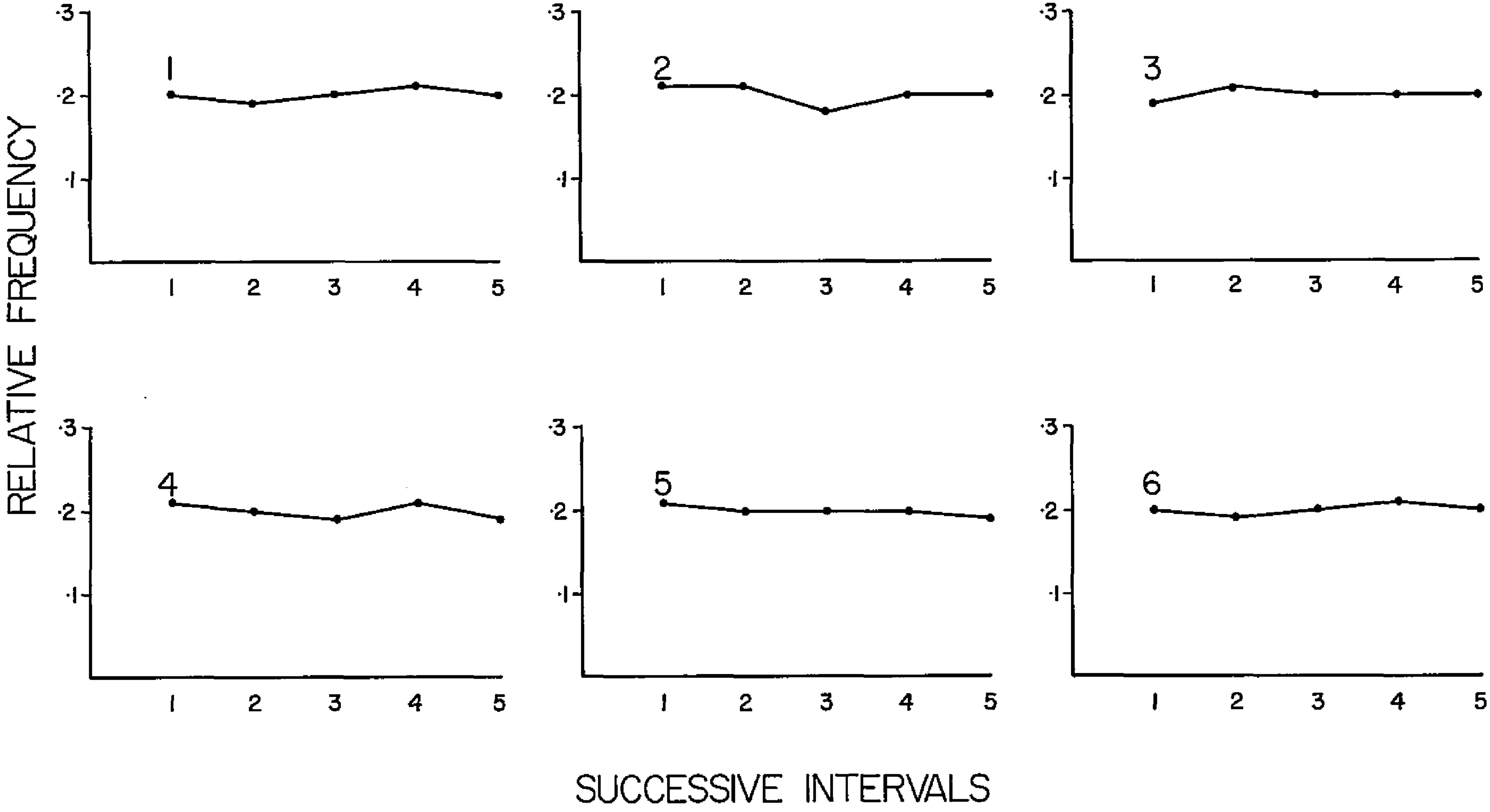

RELATIVE FREQUENCY
·3
·2
·1
1
2
3
4
5
6
SUCCESSIVE INTERVALS

Figure 51: Relative frequency of Rs within T_R for the baseline exposures for Rat 8.

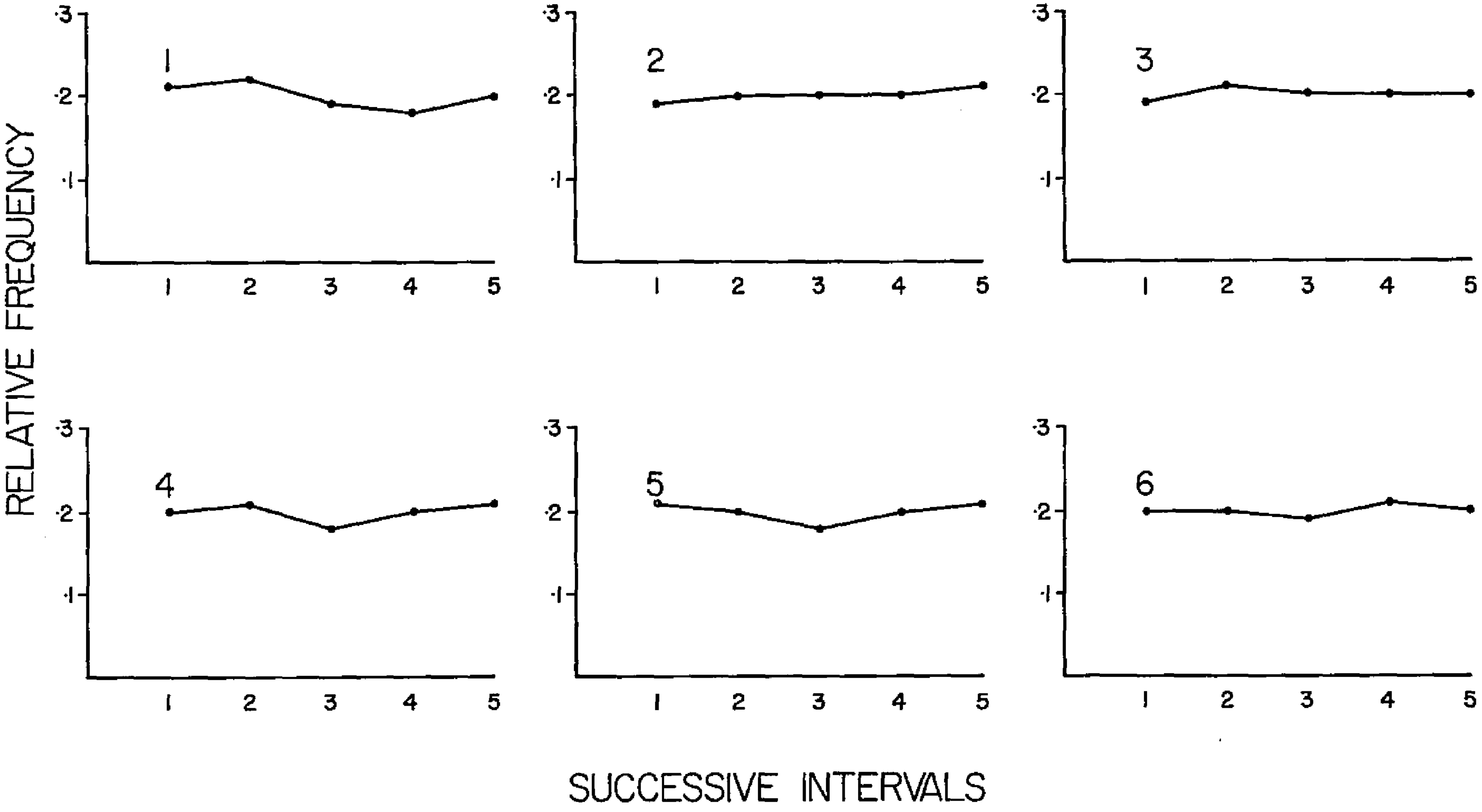
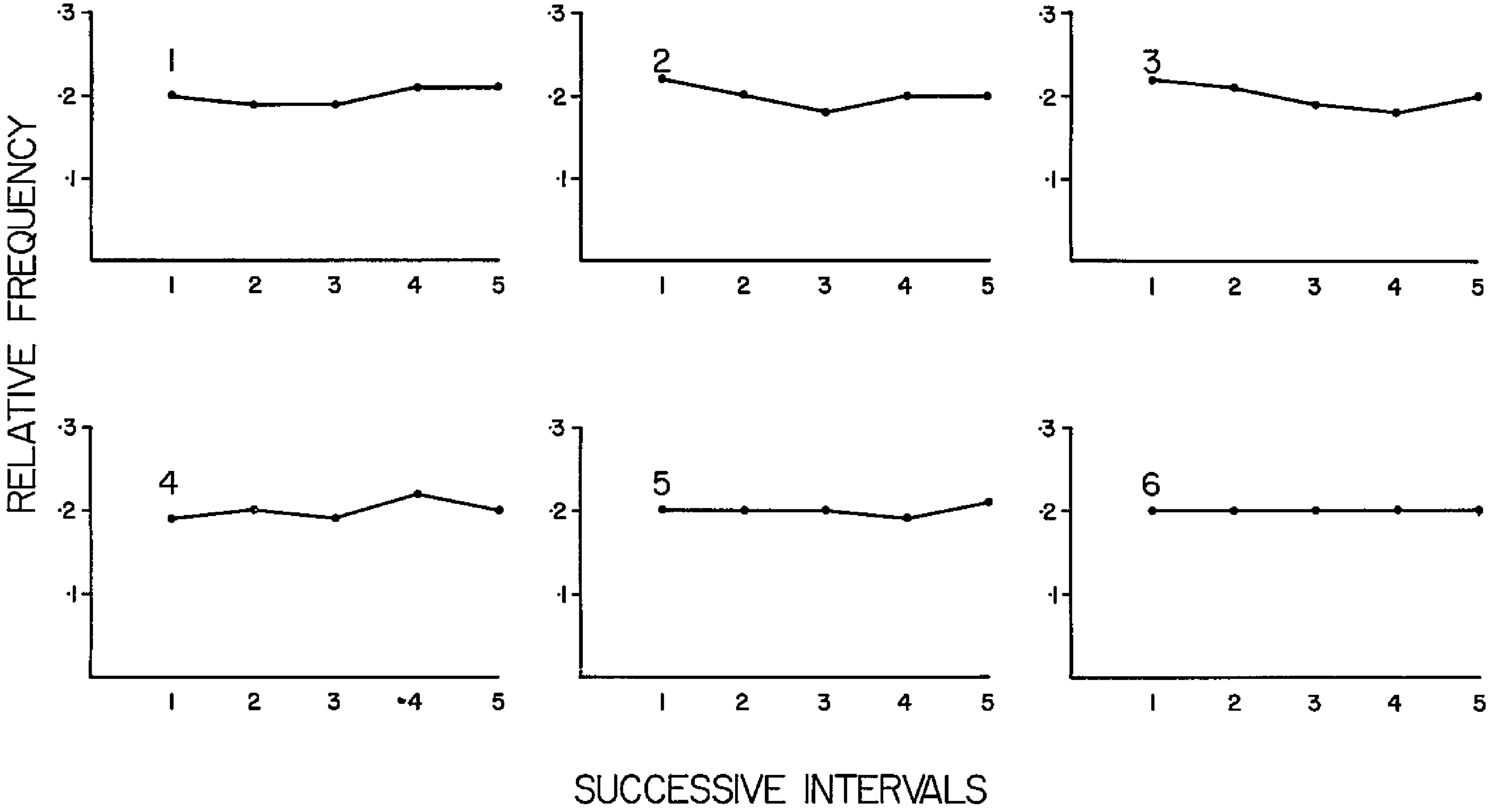

RELATIVE FREQUENCY
·3
·2
·1
1
2
3
4
5
6
1 2 3 4 5
SUCCESSIVE INTERVALS

Figure 52: Relative frequency of Rs within T_R for the baseline exposures for Rat 9.


RELATIVE FREQUENCY
SUCCESSIVE INTERVALS
1
2
3
4
5
6
·3
·2
·1
1
2
3
4
5

the 20 sec T_R. The number within each set of axes refers to the ordinal position of the baseline exposure to which a given function applies. The data indicate the relative frequency of Rs in a given 4 sec block of time pooled across cycles and across sessions. Thus, for Rat 1, the relative frequency of Rs during the first 4 sec of T_R (120 T_R cycles per session) over the last ten sessions of the first baseline exposure was 0.18. A brief digression may serve to further clarify this point. In the usual FI schedule of reinforcement, orderly temporal patterns of responding are observed if the interval is sub-divided and recycled with each S^R presentation. For a given interval, this function has been called the "FI scallop", and this pattern would most certainly survive cumulation over intervals. In the present case, not every interval (T_R) ends with S^R presentation, and the cumulation process is recycled with the termination of T_R rather than with S^R. The cycles over which such cumulation is imposed will, for the baseline schedules, be of only two varieties: those which contain an S^R, and those which contain no S^R. No distinction is made between these two types of cycles in the cumulation process.

As was noted earlier (see Introduction) increases in $\underline{p}(S^R|R)$ with fixed T produce closer and closer approximations to an FI schedule of value T. It should then be expected that as $\underline{p}(S^R|R)$ is increased, the observed behavior should resemble FI behavior more and more closely. That this is in fact the case may be observed in Figures 45 through 52. Subjects exposed to the highest value of $\underline{p}(S^R|R)$ (i.e., Rats 1, 2, and 3) produced temporal patterning of responding within cycles which bears resemblance to the "scallop". Subjects exposed to the lowest value of $\underline{p}(S^R|R)$ (i.e. Rats 7, 8, and 9) show no such patterning. For these animals, responding is evenly distributed during T_R. Animals exposed to an intermediate value of the probability display behavior which lies between these extremes.

Other investigators have demonstrated that temporal pattern similar to those maintained by FI schedules persist when not every interval ends with S^R presentation (Byrd and Marr, 1969; de Lorge, 1967; Kelleher, 1966; Marr, 1969; Stubbs, 1969; Zeiler, 1972). In these studies, some other event such as blackout occurred in place of some percentage of S^Rs, and, in most cases, the typical FI pattern of responding was maintained. In the present investigation, no stimulus signalled the termination of T_R but cyclic temporal patterning was maintained nonetheless.

The temporal patterning observed in Rats 1, 2, and 3 should be viewed in the context of the random interval schedule. For these subjects, $\underline{p}(S^R|R)$ was 0.4; on the average, 2.5 T_R cycles elapsed between S^Rs, and the distribution of IS^RTs follows a geometric distribution. There is certainly no "periodicity" of IS^RT in the traditional sense of "periodic" reinforcement schedules. Yet, observation of the behavior exhibited under an "aperiodic" schedule indicates that some periodicity is present in the temporal distribution of responses in T_R. These temporal patterns were, moreover, the most persistent and most "recoverable" aspect of the behavior exhibited during baseline exposures. A possible foundation upon which the observed periodicity may be constructed will be discussed following the presentation of the appropriate functions for the experimental points.

Data similar to those shown above for the baseline exposures are depicted in Figures 53 through 60. These functions apply to the experimental points, and the number contained within each set of axes refers to the value of $\underline{p}(S^R|\not{R})$ in effect for each function. These data indicate that one effect of increases in $\underline{p}(S^R|\not{R})$ was the flattening of the distribution of Rs within T_R. Given this finding, a possible explanation for the recurring patterns observed for the baseline exposures at the highest $\underline{p}(S^R|R)$ value may be offered. At this value of $\underline{p}(S^R|R)$, rates were relatively high and it was almost always the case that the first R in T_R (the only R eligible for S^R) occurred very shortly after T_R began. This being the case, the preponderance of S^R deliveries occurred in the early part of T_R. This regularity of the position of S^R within T_R may be viewed as an alternate form of "periodicity". For lower values of $\underline{p}(S^R|R)$, such regularity was reduced by lower response rates.

Such an analysis gains strength from the observation that increasing the frequency of S^Rs for $\not{R}$ has

Figure 53: Relative frequency of Rs within T_R for the experimental points for Rat 1.

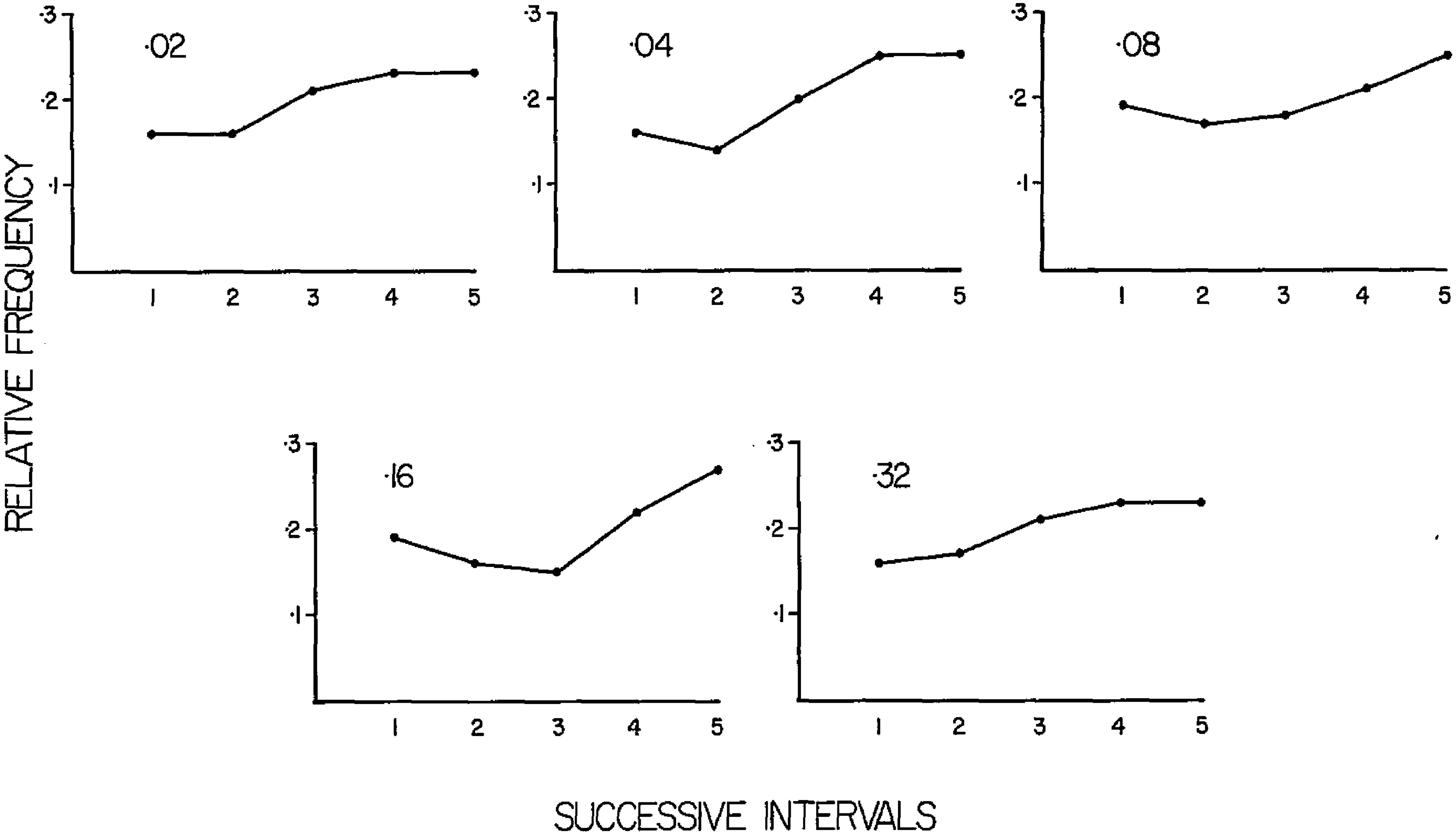

RELATIVE FREQUENCY
·02
·04
·08
·16
·32
·3
·2
·1
1
2
3
4
5
SUCCESSIVE INTERVALS

Figure 54: Relative frequency of Rs within T_R for the experimental points for Rat 2.

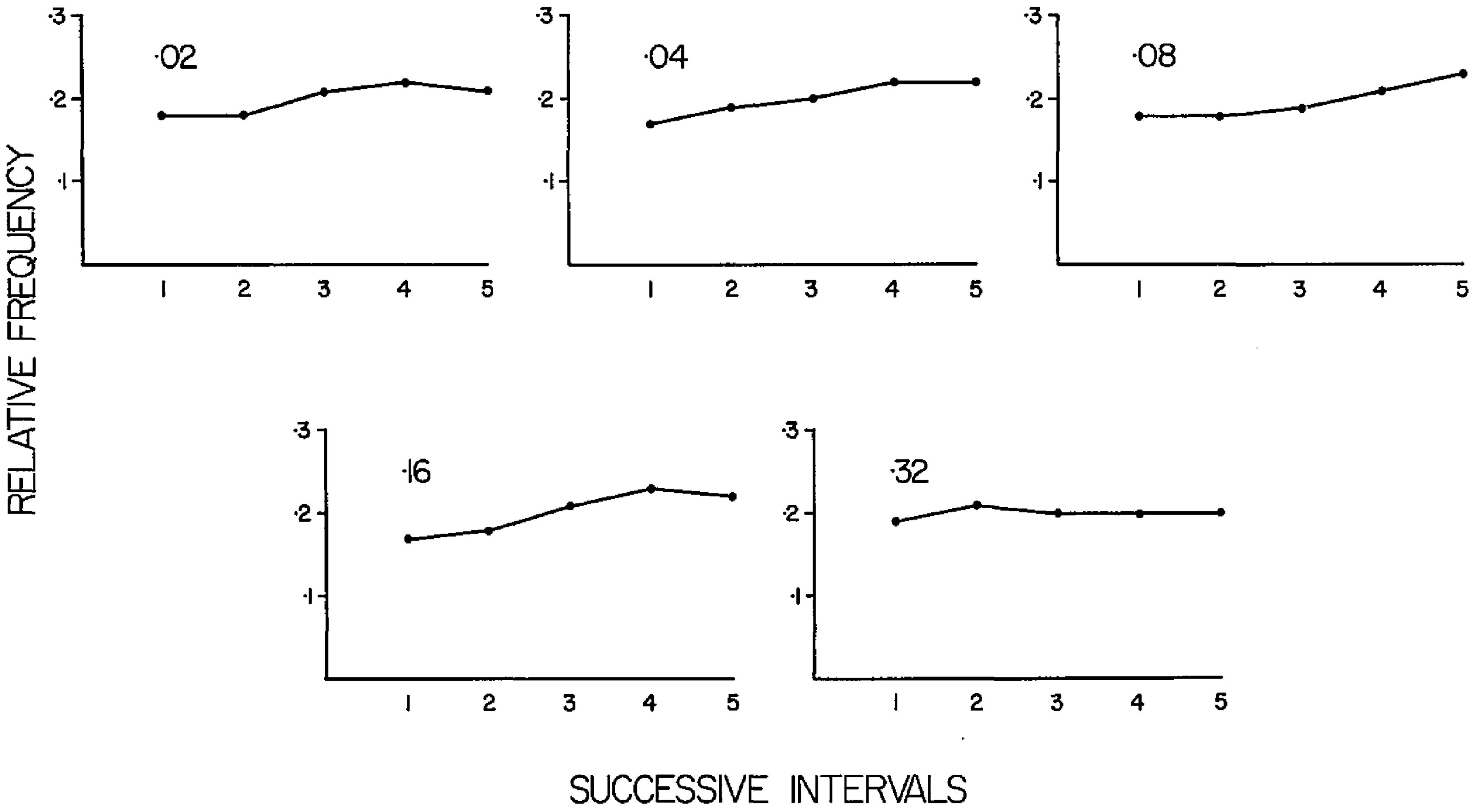

·02
·04
·08
·16
·32
·3
·2
·1
1
2
3
4
5
RELATIVE FREQUENCY
SUCCESSIVE INTERVALS

Figure 55: Relative frequency of Rs within T_R for the experimental points for Rat 3.

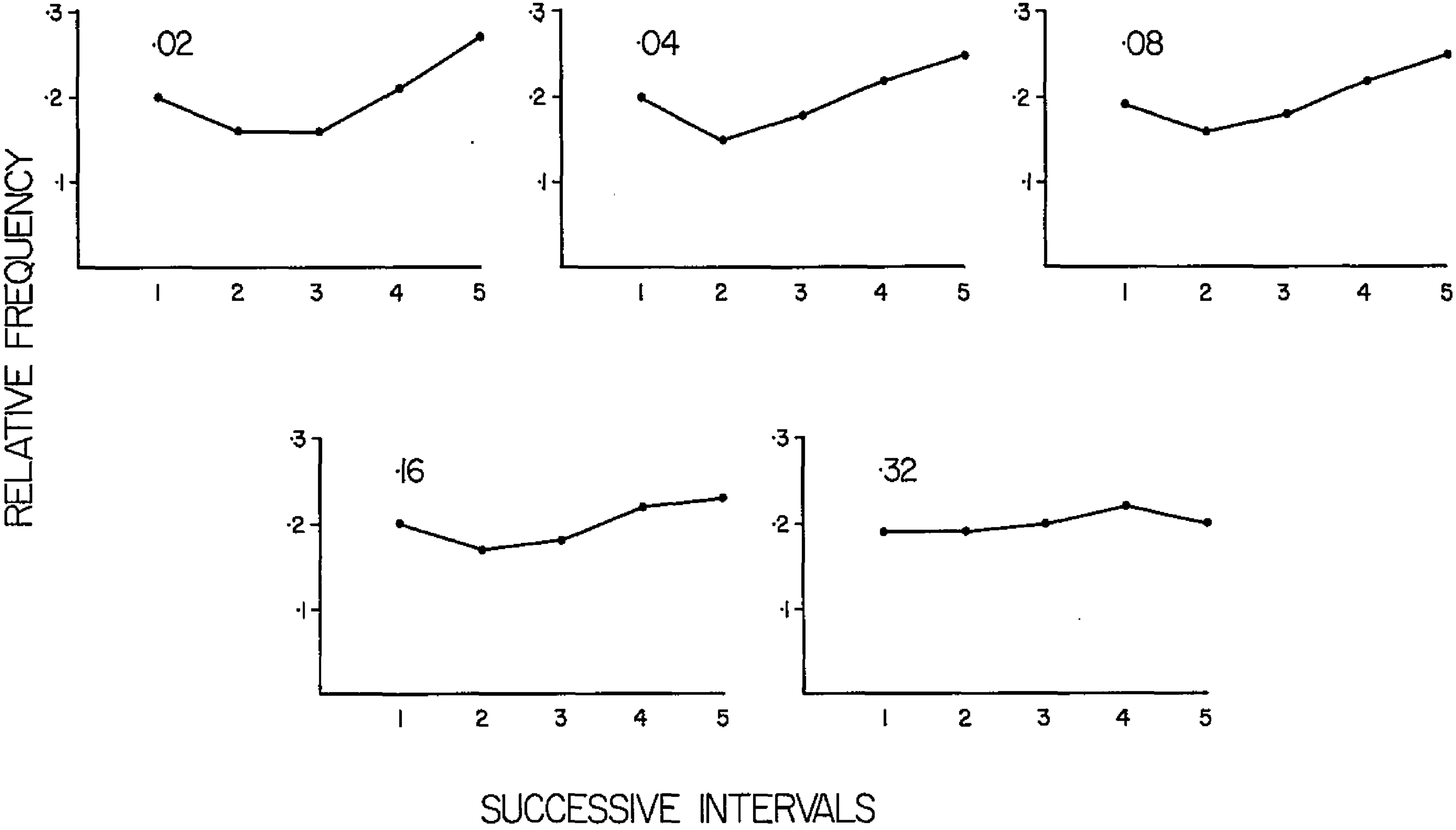

·02
·04
·08
·16
·32
·3
·2
·1
1
2
3
4
5
RELATIVE FREQUENCY
SUCCESSIVE INTERVALS

Figure 56: Relative frequency of Rs within T_R for the experimental points for Rat 4.

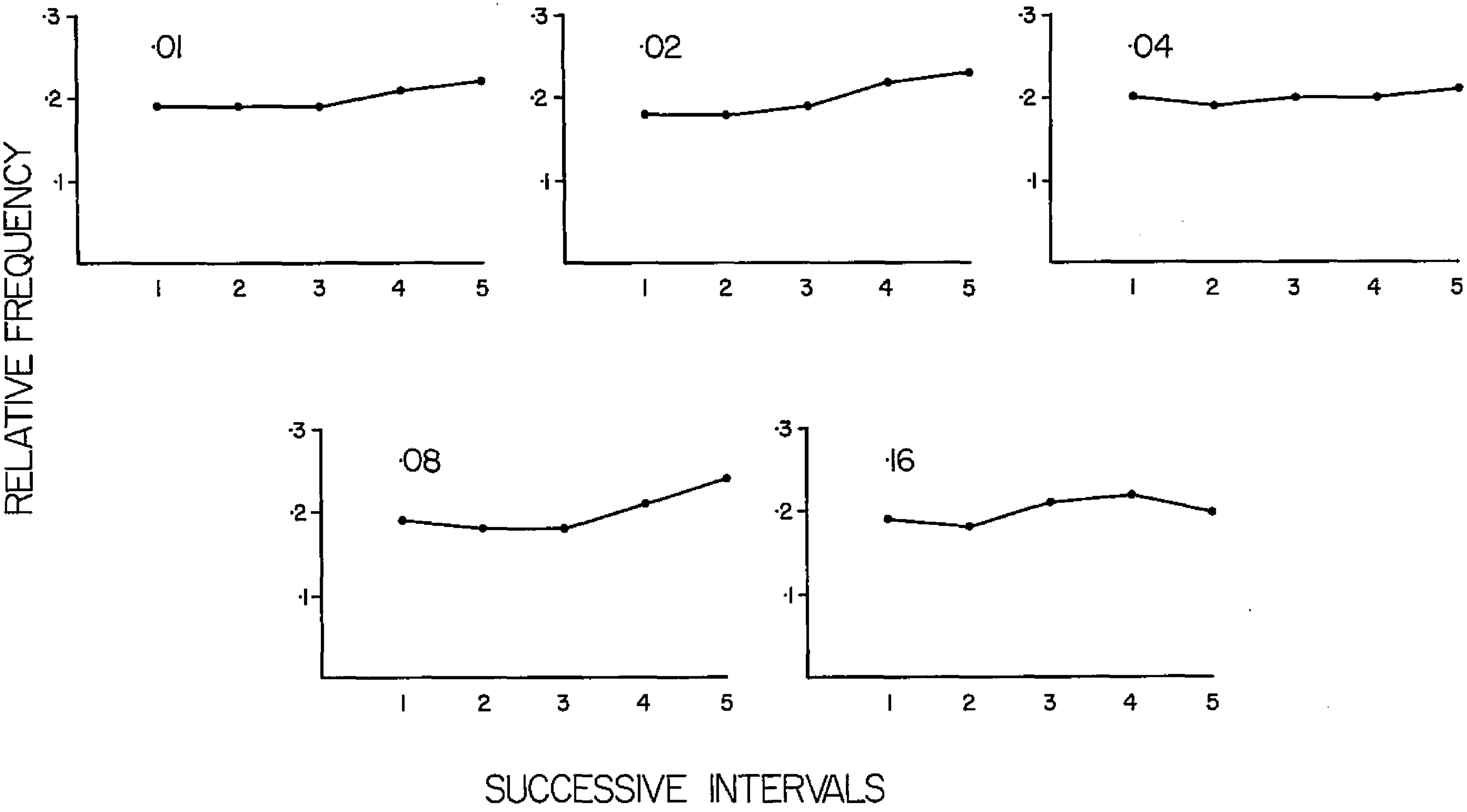

·01
·02
·04
·08
·16
·3
·2
·1
1
2
3
4
5
RELATIVE FREQUENCY
SUCCESSIVE INTERVALS

Figure 57: Relative frequency of Rs within T_R for the experimental points for Rat 5.

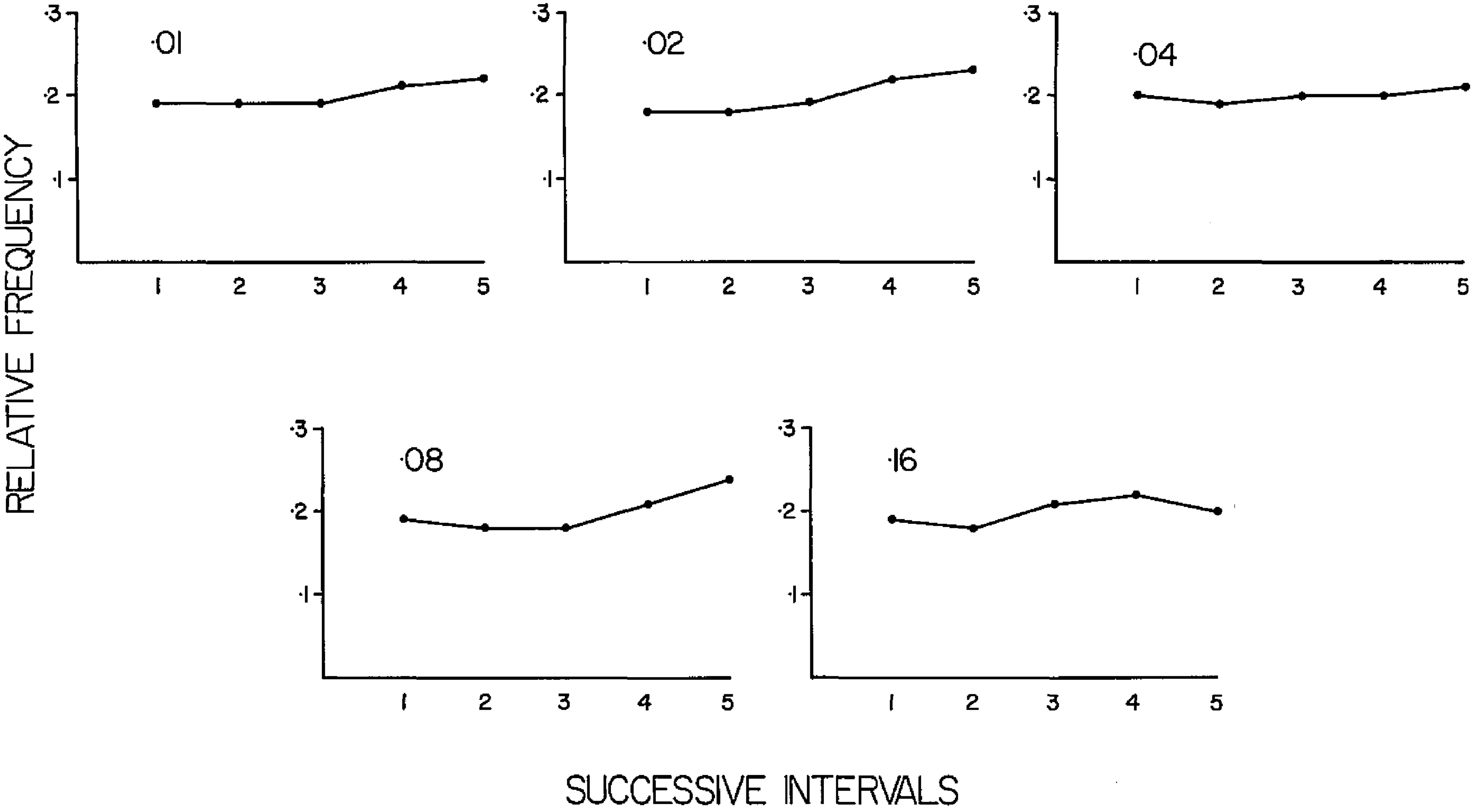

RELATIVE FREQUENCY
·3
·2
·1
·01
·02
·04
·08
·16
1
2
3
4
5
SUCCESSIVE INTERVALS

Figure 58: Relative frequency of Rs within T_R for the experimental points for Rat 7.

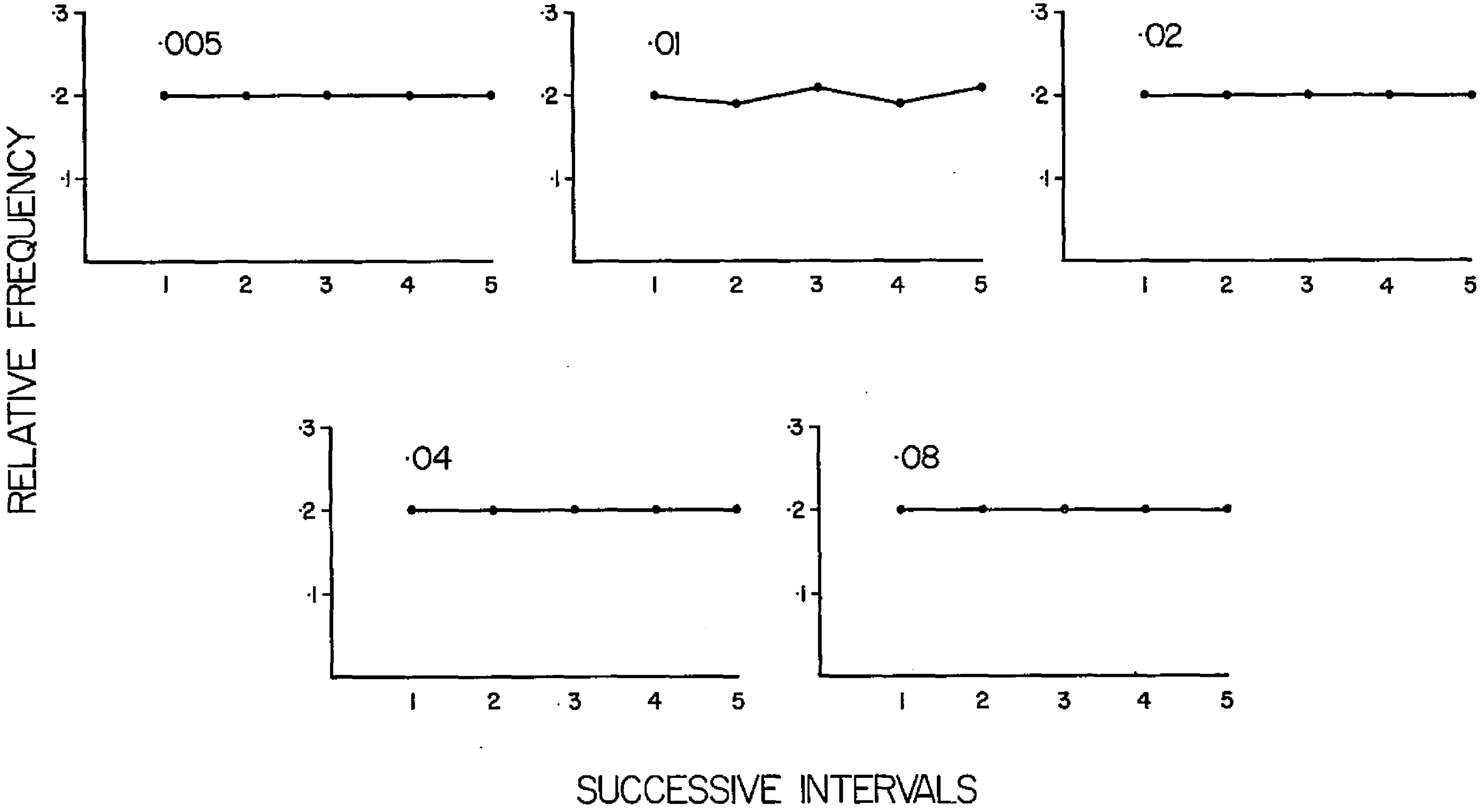

·005
·01
·02
·04
·08
·3
·2
·1
1
2
3
4
5
RELATIVE FREQUENCY
SUCCESSIVE INTERVALS

Figure 59: Relative frequency of Rs within T_R for the experimental points for Rat 8.

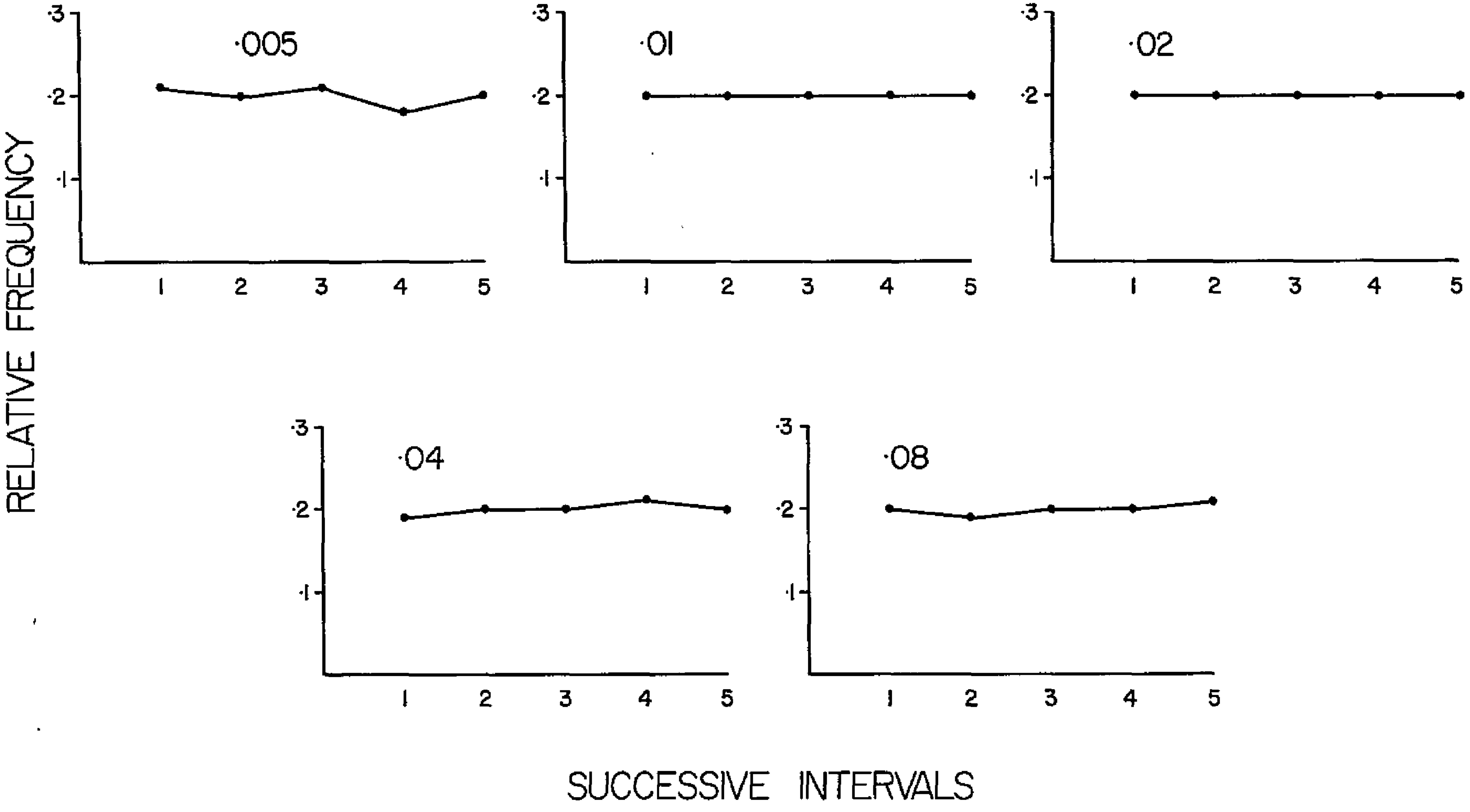
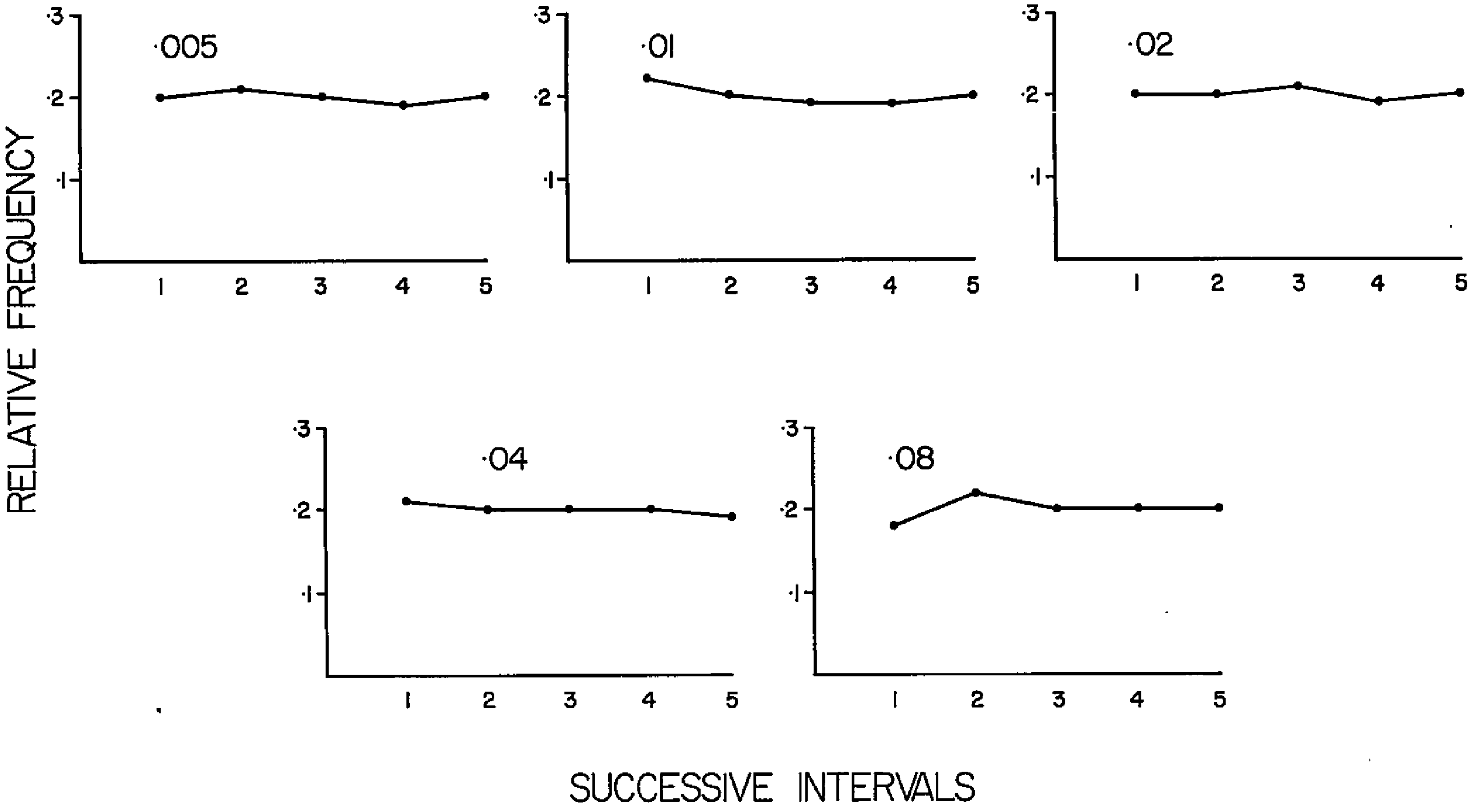

RELATIVE FREQUENCY
SUCCESSIVE INTERVALS
·005
·01
·02
·04
·08
·3
·2
·1
1
2
3
4
5

Figure 60: Relative frequency of Rs within T_R for the experimental points for Rat 9.


·005
·01
·02
·04
·08
·3
·2
·1
1
2
3
4
5
RELATIVE FREQUENCY
SUCCESSIVE INTERVALS

the effect of eliminating the temporal gradients established under $\underline{p}(S^R|R)$ alone. As $\underline{p}(S^R|\not{R})$ is increased, S^Rs occur with increased frequency given that a $\not{R}$ has occurred. Since response rates are high early in T_R, $\not{R}$s are unlikely to occur early in T_R. Initially, then, S^Rs for $\not{R}$ must have occurred most often toward the middle of T_R, when R rates are comparatively low. The effect of such S^Rs is twofold: their presentation alone is sufficient to disturb the within-cycle regularity described earlier, and their effect upon response rate causes further deterioration of this regularity. Additional research upon the influences of the variability in the temporal position of S^R in T_R is presently being planned.

The functions depicted in Figures 61 through 68 present the data which are most directly relevant to a discussion of what Schoenfeld (1969) has called the "avoidance problem". The referent for this term is the issue of the determination of the stimuli which are responsible for the maintenance of "avoidance" behavior. Although there is general agreement that the appeal to the non-occurrence of environmental events was unsatisfactory, there has been little agreement on a substitute for such an approach. Some have argued that the reduction of the frequency with which "noxious" stimuli occur is the reinforcer for "avoidance" behavior (e.g. Herrnstein and Hineline, 1966; Sidman, 1962). Although this approach seems to represent some progress over formulations which attribu-

Figure 61: Number of S^Rs available for $\not{R}$ (open circles) and total number obtained for both R and $\not{R}$ (filled circles) as a function of $\underline{p}(S^R|\not{R})$ for Rat 1.

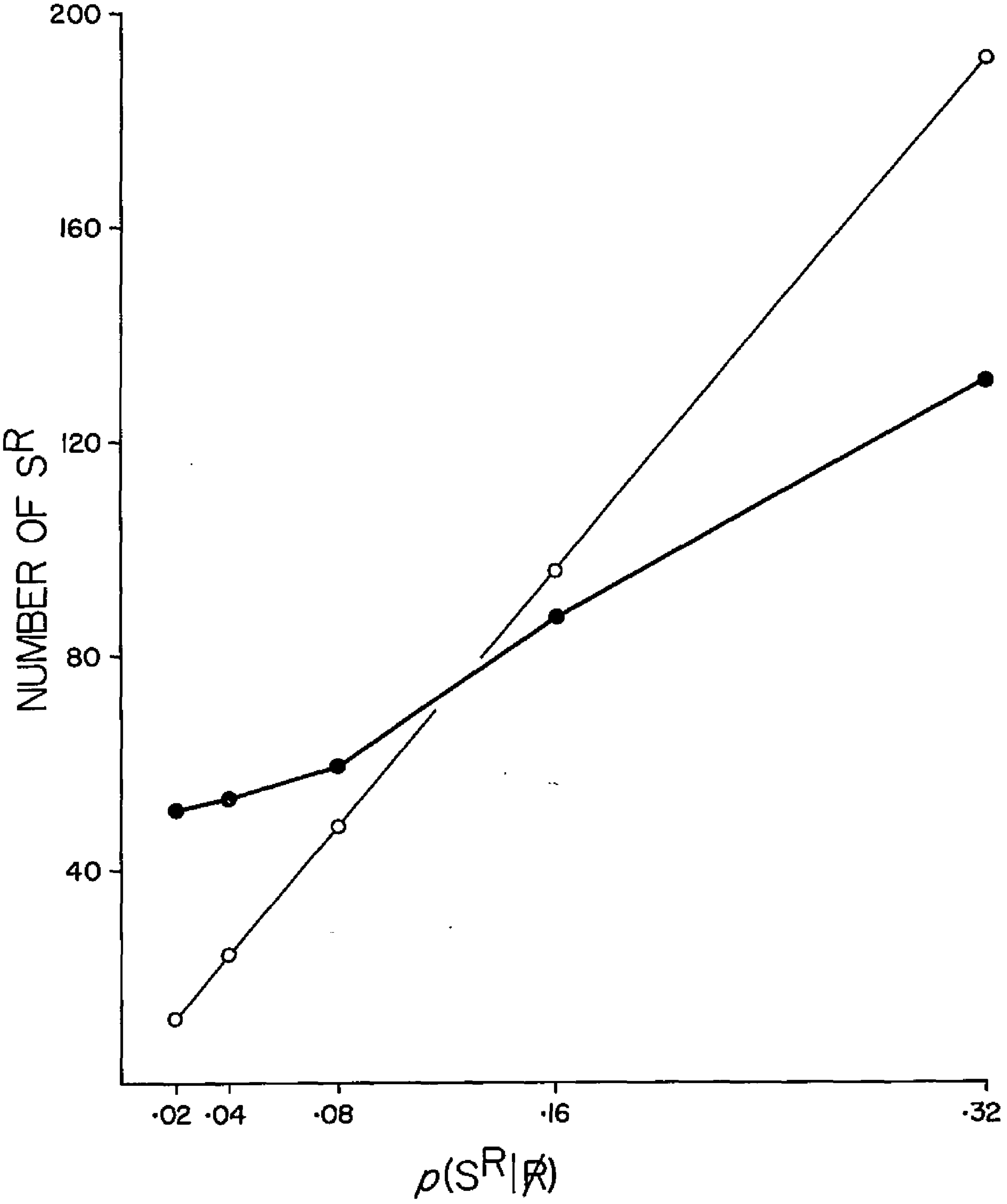

200
160
120
80
40
NUMBER OF S^R
·02
·04
·08
·16
·32
$p(S^R|\not R)$

Figure 62: Number of S^Rs available for $\not{R}$ (open circles) and total number obtained for both R and $\not{R}$ (filled circles) as a function of $\underline{p}(S^R|\not{R})$ for Rat 2.

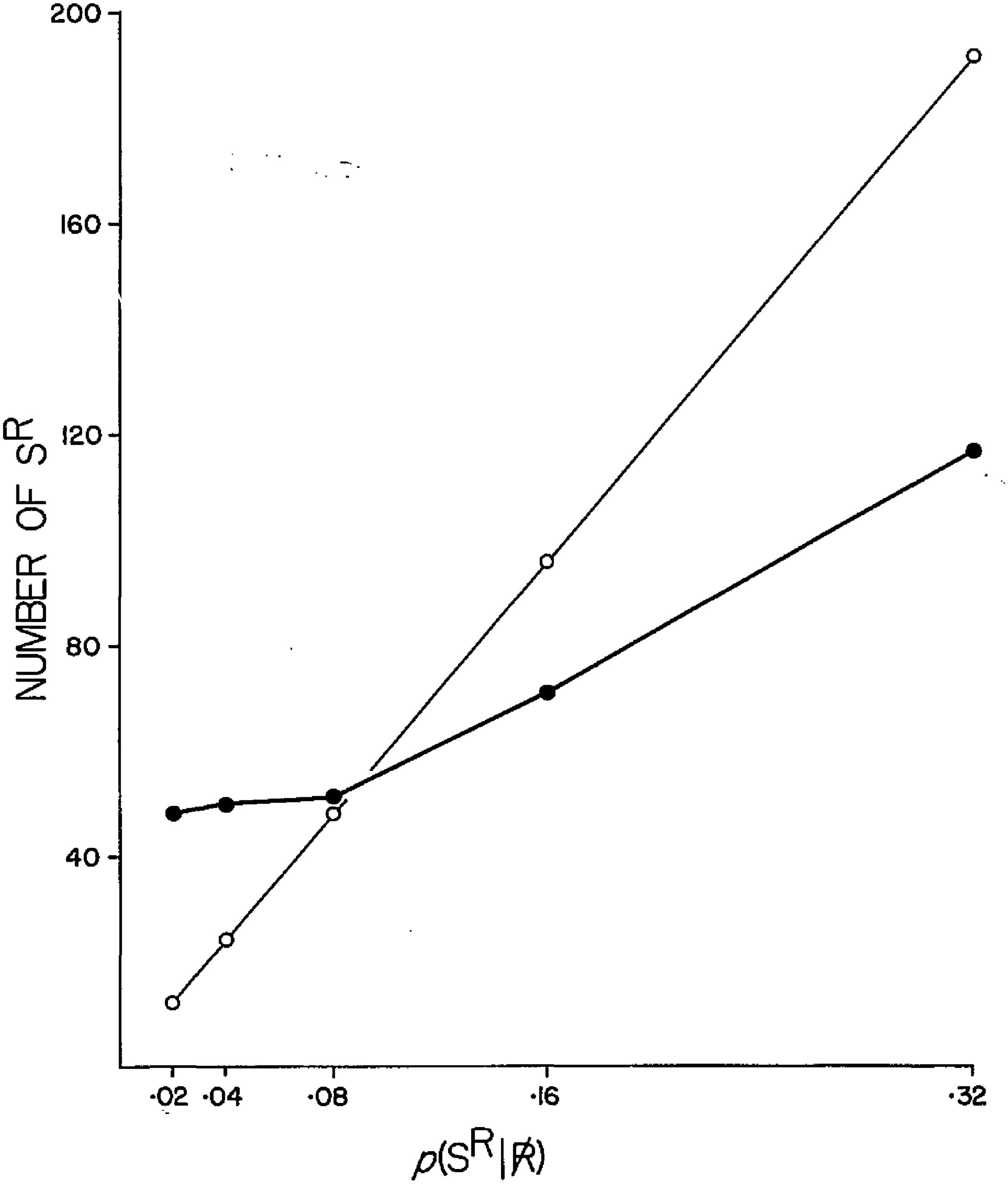
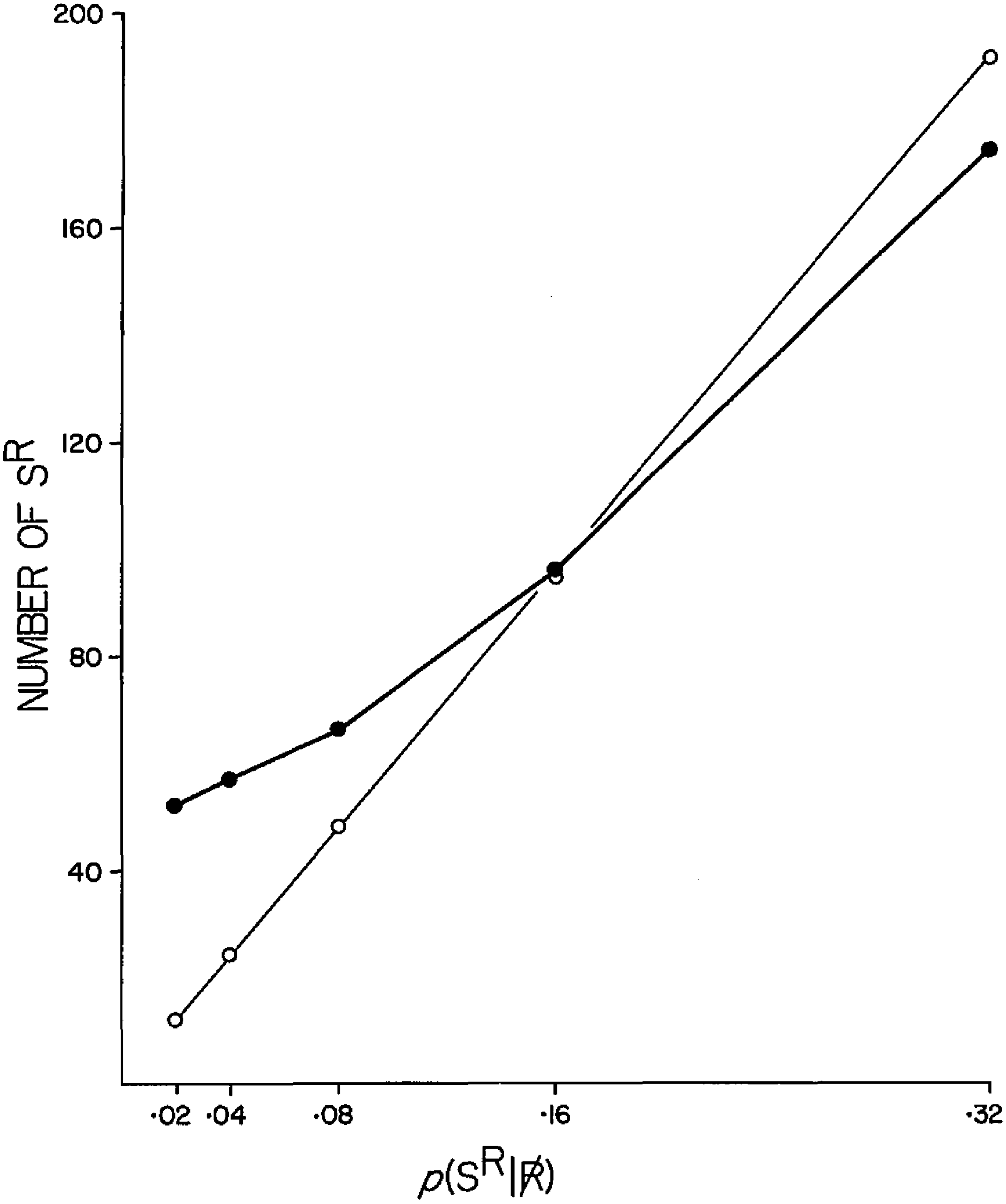

200
160
120
80
40
NUMBER OF S^R
·02
·04
·08
·16
·32
$p(S^R|\not R)$

Figure 63: Number of S^Rs available for $\not{R}$ (open circles) and total number obtained for both R and $\not{R}$ (filled circles) as a function of *p*($S^R|\not{R}$) for Rat 3.



200
160
120
80
40
NUMBER OF S^R
·02
·04
·08
·16
·32
$p(S^R|\not{R})$

Figure 64: Number of S^Rs available for $\not{R}$ (open circles) and total number obtained for both R and $\not{R}$ (filled circles) as a function of $\underline{p}(S^R|\not{R})$ for Rat 4.

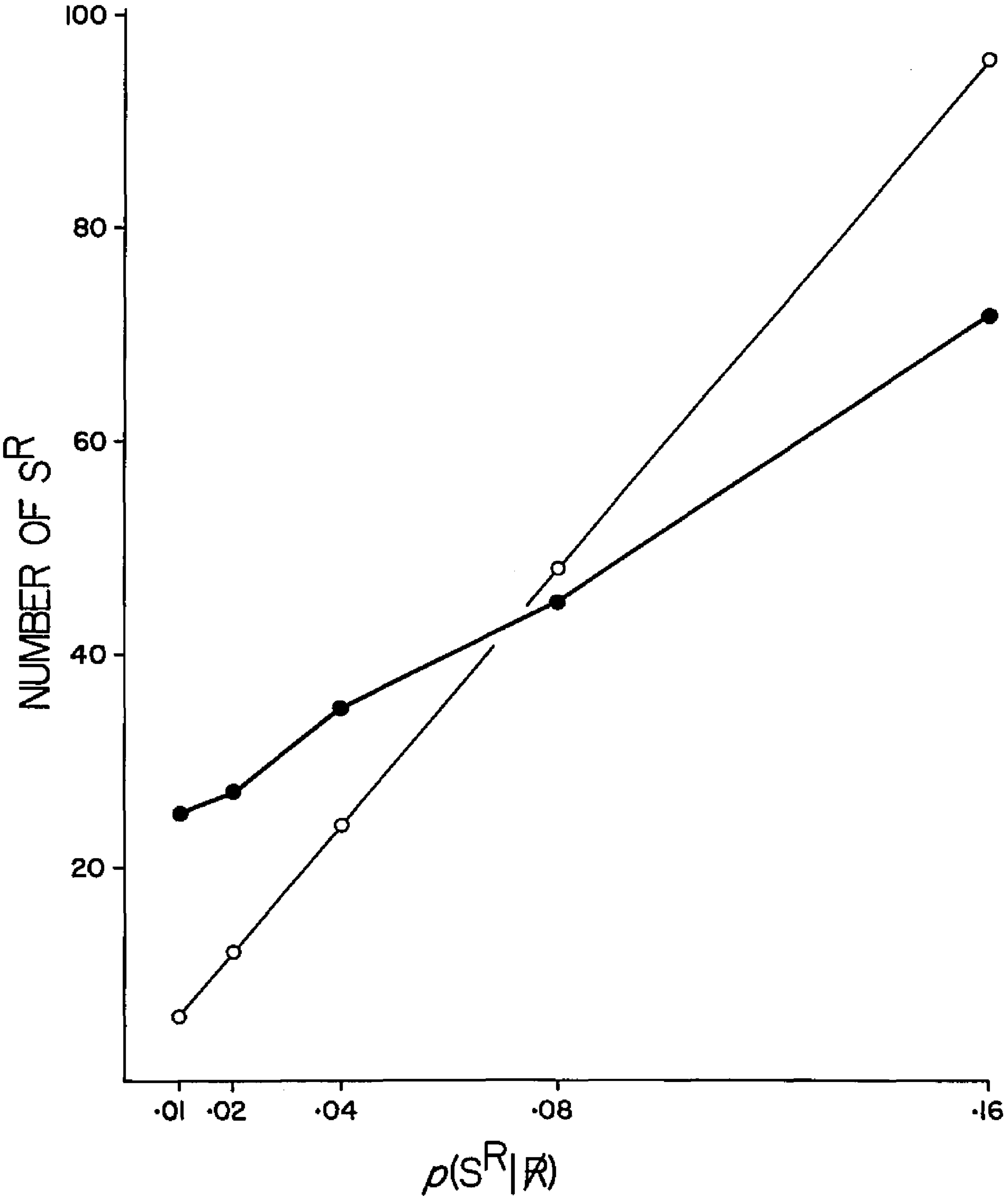

100
80
60
40
20
NUMBER OF S^R
·01
·02
·04
·08
·16
$p(S^R|\not{R})$

Figure 65: Number of S^Rs available for $\not R$ (open circles) and total number obtained for both R and $\not R$ (filled circles) as a function of $\underline{p}(S^R|\not R)$ for Rat 5.

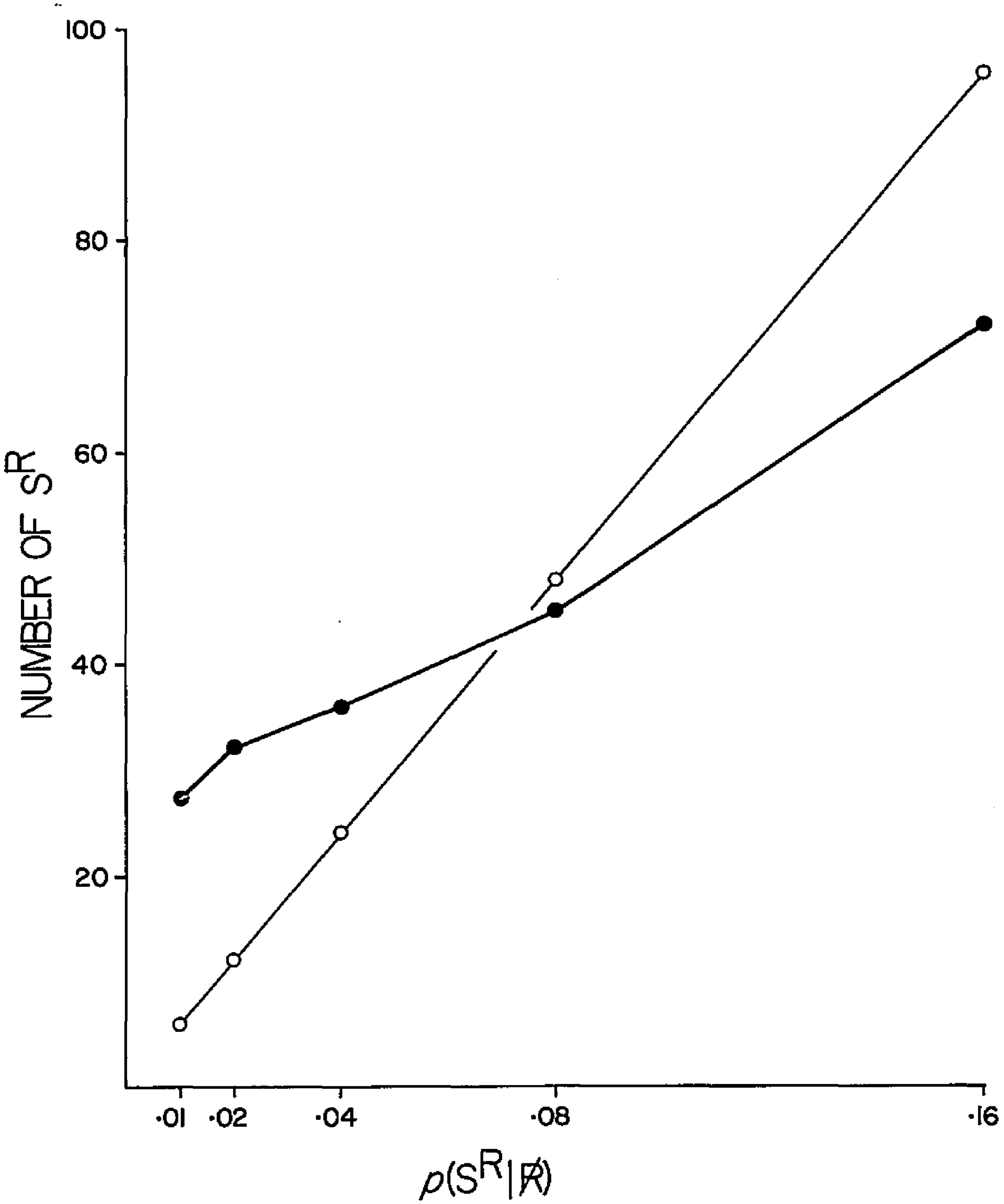

100
80
60
40
20
NUMBER OF S^R
·01
·02
·04
·08
·16
$p(S^R|\not{R})$

Figure 66: Number of S^Rs available for $\not{R}$ (open circles) and total number obtained for both R and $\not{R}$ (filled circles) as a function of $\underline{p}(S^R|\not{R})$ for Rat 7.

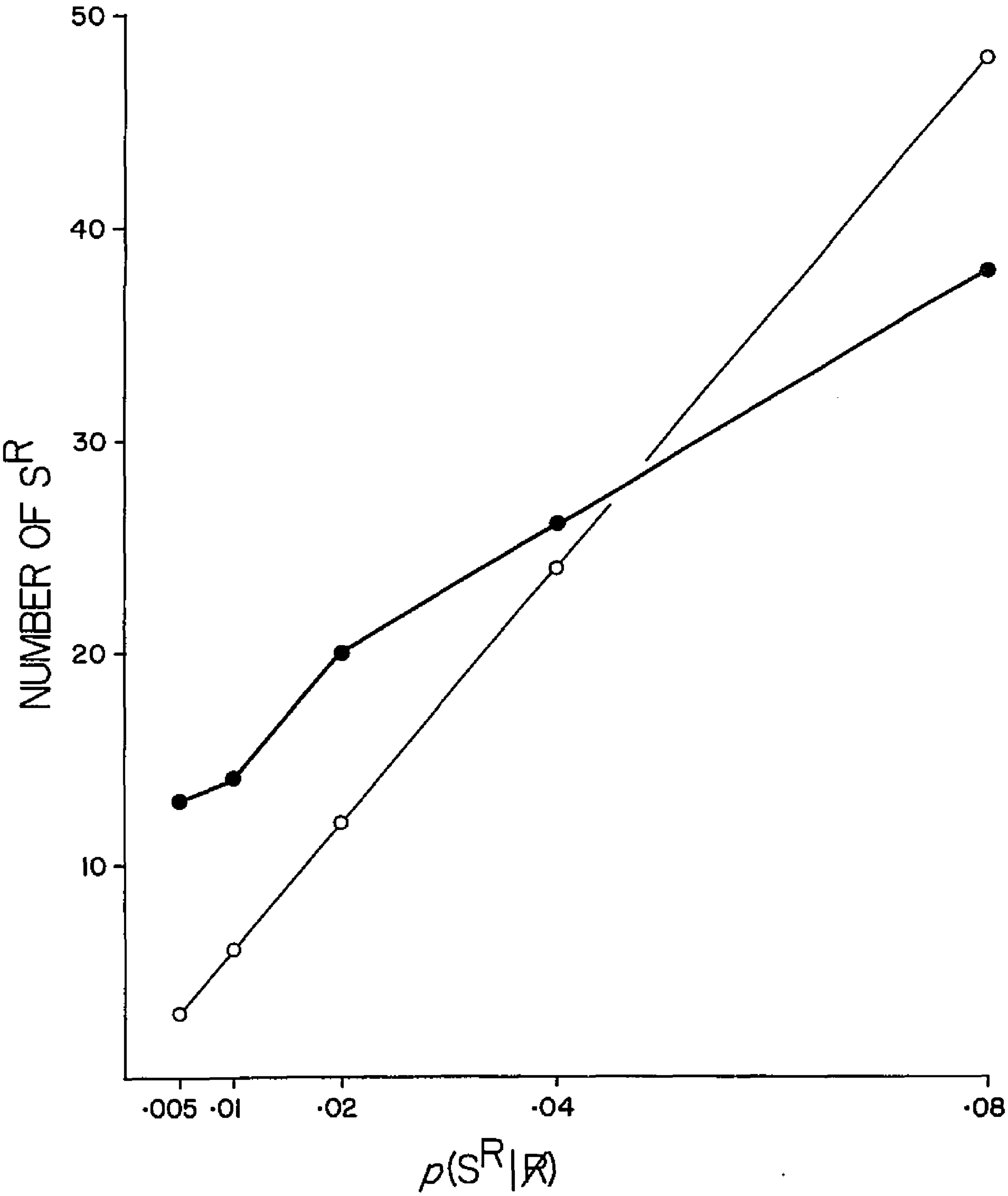

50
40
30
20
10
NUMBER OF S^R
·005
·01
·02
·04
·08
$p(S^R|\not{R})$

Figure 67: Number of S^Rs available for $\not{R}$ (open circles) and total number obtained for both R and $\not{R}$ (filled circles) as a function of $\underline{p}(S^R|\not{R})$ for Rat 8.

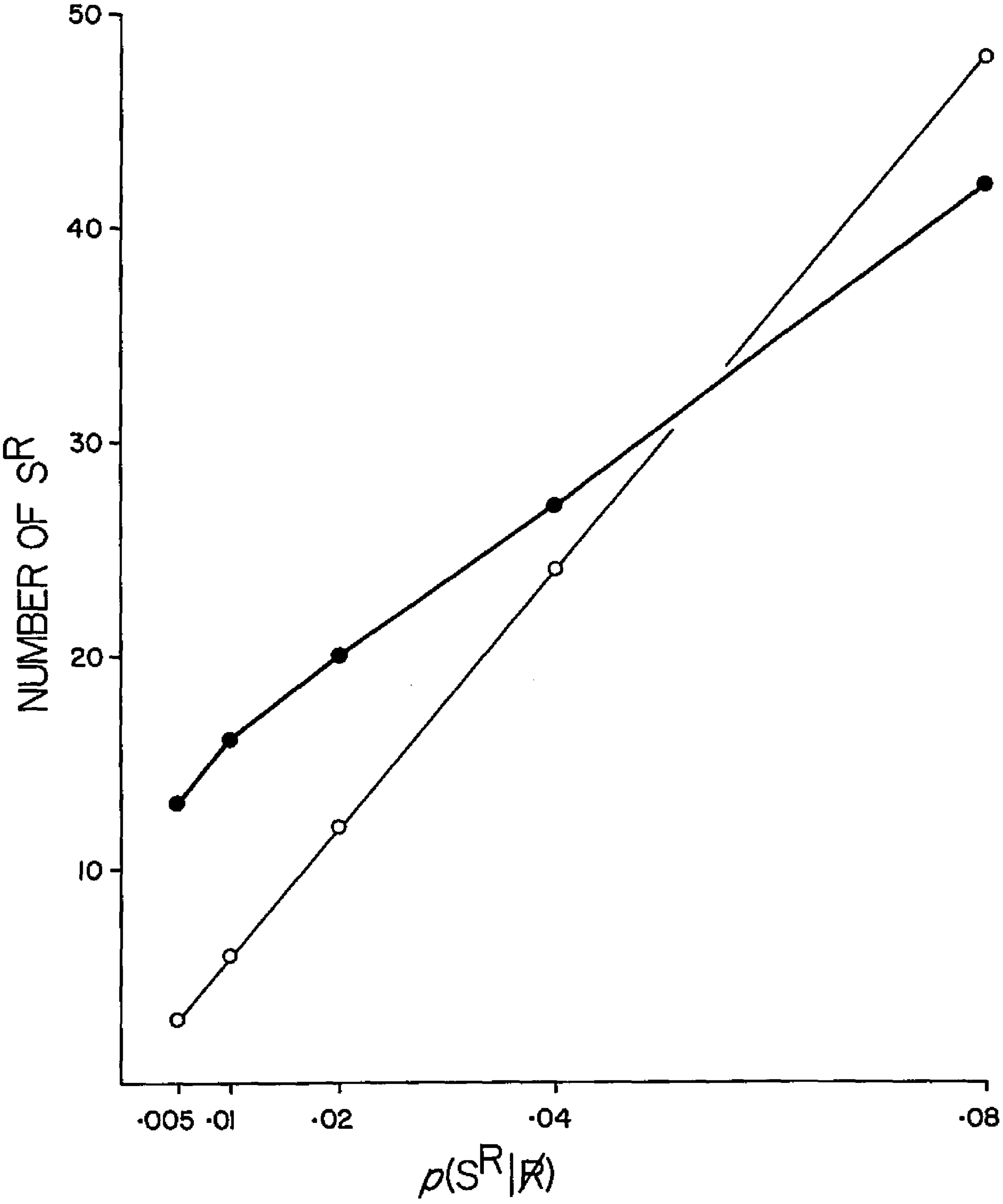
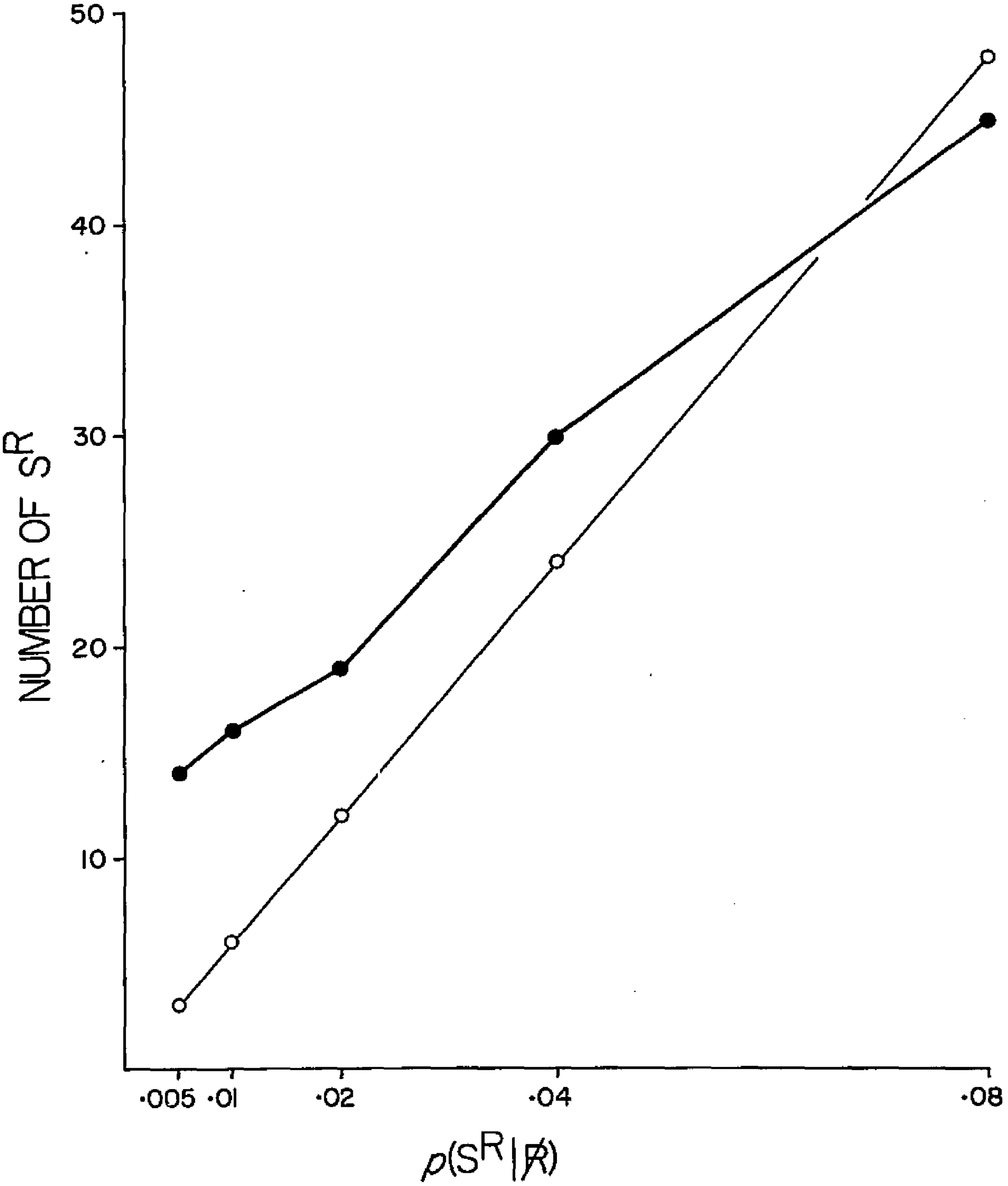

50
40
30
20
10
NUMBER OF S^R
·005
·01
·02
·04
·08
$p(S^R|\not{R})$

Figure 68: Number of S^Rs available for $\not{R}$ (open circles) and total number obtained for both R and $\not{R}$ (filled circles) as a function of $\underline{p}(S^R|\not{R})$ for Rat 9.


50
40
30
20
10
NUMBER OF S^R
·005
·01
·02
·04
·08
$p(S^R|\not{R})$

ted "avoidance" behavior to presumed internal variables (Anger, 1963; Dinsmoor, 1954; Schoenfeld, 1950), the conception of reduction of stimulus frequency as a stimulus appears strained. More recently, Schoenfeld (1969) presents the case for dismissal of "avoidance" as a separate category of behavioral phenomena, and thus for the dissolution of the "problem". The data from the present study confirm this position that the traditional categorization of both behavioral data and stimulus events leads to situations in which such categorization is most difficult to maintain.

Figures 61 through 68 present functions which relate total number of S^Rs available based upon the $\not R$ contingency (open circles) and total S^Rs obtained for both R and $\not R$ (filled circles) to $p(S^R|\not R)$. It is immediately apparent that for all subjects, the latter function falls below the former for at least one value of $p(S^R|\not R)$. Prior to a discussion of the implications of this finding, some aspects of these functions require clarification. It was noted earlier that the third value of $p(S^R|\not R)$ represented the point at which number of Rs and $\not R$s had no effect upon S^R frequency. More strictly, this statement should be amended to read that if all $T_{\not R}$ cycles contain at least one R or no $T_{\not R}$ cycles contain an R, S^R frequency remains constant. Since, in the context of the present study, it was possible for a subject to sample all T_R cycles while disqualifying only one-fifth of the $T_{\not R}$ cycles, it was possible to obtain all the S^Rs available for R and four-fifths of those available for $\not{R}$. The crucial datum in the determination of the functions in Figures 61 through 68 was the number of $\not{R}$ cycles which were sampled by R. Since not all $\not{R}$ cycles were so sampled (see Figures 13 through 20), total S^Rs obtained at the "break-even" point was greater than the number available for $\not{R}$ alone for all subjects. The linear growth of the number of S^Rs available for $\not{R}$ is a direct result of the geometric progression of $\underline{p}(S^R|\not{R})$ values employed.

While there has been no consensus concerning the stimuli which maintain "avoidance", neither has there been any problem in determining whether or not a given set of data represent "avoidance". The criterion employed has been and continues to be a decrease in the frequency of stimulus presentation when such a decrease occurs as a result of some response-dependent contingency. Based upon such a criterion, the behavior exhibited by the subjects in the present experiment qualifies as "avoidance" behavior. As the determination that a stimulus was "aversive" was based upon the observation that subjects would respond in a manner which reduced the frequency of its presentation, the argument that water represents an "aversive" stimulus to water-deprived rats is supported by the evidence obtained in the present study. Given that both these propositions are consistent with the traditional classification scheme, but are at least dubious in the wider context of behavior theory, a restructuring of the classification is indicated. The most profitable approach to such a restructuring might well take the form of the elimination of the search for categories in favor of a search for appropriate continua upon which to establish a broader view of these phenomena. The probability continua outlined in Figure 1 and implicit throughout the description of the present experiment′may be employed in such a fashion.

The behavior reported in Figures 61 through 68 are in support of a continuous view of schedules of reinforcement and support the rejection of "avoidance" as a separate behavioral genre. The behavior depicted in these functions is initially of the variety associated with "positive" reinforcers; the subjects respond in a manner which increases S^R frequency. But manipulation of the $\underline{p}(S^R|\not{R})$ continuum produces "avoidance" behavior. At some values of this parameter, subjects behave as though S^R were "positive", while at other values subjects behave as though S^R were "negative". Given that such changes are due solely to the manipulation of a single stimulus parameter, the notion that separate categories are necessary or desirable in the description of schedules of reinforcement or stimulus events loses much of its potency.

The "avoidance problem" ceases to exist when a continuous approach is adopted. For the data presented above, there would be no difficulty in identifying the stimuli which maintain the "avoidance" behavior exhibited.

No appeal to the internal state of the organism is required, and the argument that S^R frequency reduction is responsible for the maintenance of behavior is singularly awkward. The variables upon which attention must be focussed are clearly the history of the organism and the stimuli which occur at any given value of $\underline{p}(S^R | \not{R})$. Phenomena which were previously viewed as unrelated emerge as various points along a single continuum. That this should be the case augurs well for a further effort in the search for the continua which will serve to integrate other phenomena in the study of behavior.

APPENDIX

Statistical information was computed for the data presented in Figures 61 through 68 in order to test the hypothesis that the number of S^Rs obtained was not different from the number available for $\cancel{R}$ alone. These data are presented in Table 2. Asterisks indicate that the obtained statistic was significant at $p=0.05$.

Analysis of variance was conducted for the data concerning response rates observed on the experimental points. None of the obtained F ratios was significant at $p=0.05$.

The reader is cautioned to draw conclusions from these calculations with care; the assumptions necessary for these statistical analyses must be closely examined for compatibility with the design of the present study.

Table 2

Differences between number of S^Rs obtained and number available for $\not{R}$ alone.

Rat	Experimental Point	$\underline{p}(S^R \mid \not{R})$	z	
1	4	0.16	-1.05	n.s.
1	5	0.32	-5.24	*
2	4	0.16	-2.77	*
2	5	0.32	-6.57	*
3	4	0.16	-0.02	n.s.
3	5	0.32	-1.47	n.s.
4	4	0.08	-0.44	n.s.
4	5	0.16	-2.37	*
5	4	0.08	-0.51	n.s.
5	5	0.16	-2.67	*
7	5	0.08	-1.57	n.s.
8	5	0.08	-0.86	n.s.
9	5	0.08	-0.31	n.s.

Table 3

Analysis of variance for rate data from experimental points.

	Source	SS	df	MS	F
RI 200	treatments	4.55	4	1.14	1.18
	residual	7.68	8	0.96	

	Source	SS	df	MS	F
RI 100	treatments	223.63	4	55.90	
	residual	123.15	4	30.79	1.82

	Source	SS	df	MS	F
RI 50	treatments	781.84	4	195.46	
	residual	429.96	8	53.75	3.64

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