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Some Temporal Parameters of Non-contingent Reinforcement

by

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This manuscript has been read and accepted for the University Committee in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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With a little help from my friends

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Introduction

Implicit in the concept of a reinforcement contingency, is the notion of a specific temporal relationship between a response and a reinforcer. Since behavior is continuous, the delivery of a reinforcer must occur in close temporal proximity to some preceding response. Therefore, whenever a reinforcement is delivered, it must be assumed that some conditioning is taking place. Whether or not a response is specified, in no way alters the power of reinforcement to exert its effect.[1] When reinforcement is delivered without reference to the ongoing behavior, the resultant effects are said to be produced by superstitious or non-contingent reinforcement. More specifically, a non-contingent schedule of reinforcement may be defined as one in which the distribution of inter-response times (IRT's) in no way effects the distribution of inter-reinforcement times (IS^{R}T's).

The power of reinforcement to exert an effect when no response requirement existed was demonstrated by Skinner.[2] Food deprived pigeons were placed in a chamber, with food delivered at regular intervals, regardless of the ongoing behavior. After exposure to this procedure, the birds

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

2. Ibid

exhibited well-defined stereotyped behavior which, although different for each pigeon, remained stable and consistent. Since no pre-specified response was required for reinforcement, the behavior which resulted from this procedure was not predictable beforehand.

When a contingent schedule of reinforcement is instituted, the resulting behavior is readily predictable, due to the specificity of the temporal relationship between a response and a reinforcer. When a non-contingent reinforcement procedure is instituted this temporal specificity is necessarily absent. Skinner[1] has demonstrated, however, that the delivery of reinforcement without a response requirement can maintain behavior previously established on an intermittent schedule of reinforcement [6 minute fixed interval (FI)], when the same frequency of reinforcement is employed (i.e. every 6 minutes). The initial rate of responding was slightly less than 300 responses per hour. The removal of the response contingency, and the subsequent delivery of non-contingent reinforcement every 6 minutes, was accompanied by a decrease in rate of approximately one-thirdduring the first experimental session. The rate continued to decline for three succeeding sessions, after which it stabilized at one-quarter of the original value for the remaining five sessions.

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[1] Skinner, B. F. The behavior of organisms. New York: Appleton-Century Crofts, 1938, pp. 163-165.

Herrnstein[1] has obtained essentially the same findings using an 11 second FI schedule of reinforcement. Following initial training on this schedule, the response-independent delivery of reinforcement every 11 seconds was sufficient to maintain the behavior at a rate which, although below that maintained on the FI schedule, was above that shown in subsequent extinction.

Zeiler[2] employed 5 minute fixed and variable interval (VI) schedules as baselines, and investigated the effects of delivering non-contingent reinforcements in a fixed sequence (every 5 minutes), or in a variable sequence (mean $IS^{R}T$ 5 minutes). The previously cited results[3,4] were replicated, in that responding was maintained at a lower rate by the non-contingent than the contingent reinforcement procedure. Additionally, Zeiler[5] found that non-contingent reinforcement schedules, like their contingent counterparts, resulted in distinctive temporal patterns of responding.

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[1] Herrnstein, R. J. Superstition: a corollary of the principles of operant conditioning. In W. K. Honig (Ed.) *Operant behavior: areas of research and application.* New York: Appleton-Century-Crofts, 1966, pp. 35-37.

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

[3] Skinner, B.F. (1938) op. cit.

[4] Herrnstein, R.J. (1966) op. cit.

[5] Zeiler, M.D. (1968) op. cit.

The behavior maintained by the fixed non-contingent reinforcement procedure, displayed a distribution of responses in time, similar to that which is generally attributed to contingent fixed interval schedules.[1]

Several investigations have been concerned with the effects of non-contingent reinforcement upon a concurrently maintained baseline schedule of reinforcement.[2,3] The basic procedure was to superimpose the non-contingent reinforcement upon an already established schedule of reinforcement. When a baseline which differentially reinforced low rates of responding (DRL) was employed, the introduction of a non-contingent reinforcement procedure resulted in an increase in the rate of responding. When the same procedure was employed with a free-operant avoidance baseline,[4,5] the introduction of non-contingent shocks also resulted in an increased rate of responding. In all of these investigations,

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[1] Ferster, C.B. & Skinner, B.F. Schedules of reinforcement. New York: Appleton-Century-Crofts, 1957.

[2] Herrnstein, R.J. & Morse, W.H. Some effects of response independent positive reinforcement on maintained operant behavior. Journal of Comparative and Physiological Psychology, 1957, 50, 461-467.

[3] Harris, A.H. The effects of free reinforcements on behavior maintained by a DRL schedule. Paper presented at Eastern Psychological Association, Washington, D.C., April, 1968.

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

[5] Byrd, L.D. Responding in the cat maintained under response-independent electric shock and response-produced electric shock. Journal of the Experimental Analysis of Behavior, 1969, 12, 1-10.

the effect of the non-contingent reinforcement procedure was to interfere with the control achieved by the baseline schedule over the rate of responding.

Another class of procedures is concerned with the non-contingent intrusion, into an ongoing stream of behavior, of a stimulus which is not initially a reinforcer.[1,2] The degree of control achieved by such a stimulus is evidenced by the changes in rate of responding that become correlated with the presence or absence of the stimulus. Depending upon the baseline schedule employed, and the temporal separation of the stimulus and reinforcement, either an increase or decrease in the rate of responding was found in the presence of the stimulus. The temporal contiguity of a stimulus and a reinforcement appeared to be sufficient to impart to that stimulus a differential control over the rate of responding.

The previous investigations have established that a consideration of the baseline schedule of reinforcement is basic to an understanding of the means by which non-contingent reinforcement maintains behavior. Although some investigation

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1. Morse, W.H. & Skinner, B.F. Notes and discussions, A second type of superstition in the pigeon. American Journal of Psychology, 1957, 70, 308-311.

2. Farmer, J. & Schoenfeld, W.N. Varying temporal placement of an added stimulus in a fixed-interval schedule. Journal of the Experimental Analysis of Behavior, 1966, 9, 369-375.

of the baseline schedule variable has been carried out, no parametric investigation has as yet been undertaken.

The definition of the schedule variable in the present investigation was accomplished within the context of the temporally defined reinforcement schedule classification originally described by Schoenfeld, Cumming and Hearst,[1] and further delineated by Farmer.[2] In this extension of the original system, the two defining parameters of a given schedule are cycle length (T), a repeating time interval, and probability of reinforcement (P). Additionally, the restriction that only the first response in any T be capable of being reinforced was employed. When T is of greater duration than the average IRT, and P is reduced to some value less than unity but greater than zero, then the ratio of T/P specifies the mean number of T cycles separating reinforcement availabilities. When an organism responds at a rate equal to or greater than 1/T, then T/P specifies the mean IS^RT. Since reinforcement is equally probable for any T cycle schedules defined in this manner are designated random interval schedules.

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1. Schoenfeld, W.N., Cumming, W. W. & Hearst, E. On the classification of reinforcement schedules. Proceedings of the National Academy of Sciences, 1956, 42, 563-570.

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

When T is held constant at a value shorter than the minimal IRT, a fixed P applied to every emitted response results in reinforcement being equally probable for every response. In this instance, a second class of schedules called random ratio are defined.[1]

The values of T and P employed for the baseline in the present investigation were selected in order to sample a wide range of rates of responding.

The second parameter under investigation, frequency of non-contingent reinforcement, has previously been investigated only at values which corresponded to that of the baseline schedule employed.[2,3,4] The importance of this variable was noted by Skinner, when he stated that the effects of non-contingent reinforcement are frequency dependent, since "The sooner a second reinforcement appears, therefore, the more likely it is that the second reinforced response will be similar to the first, and also that they will both have one of a few standard forms."[5]

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1. Brandauer, C.M. The effects of uniform probabilities upon the response rate of the pigeon. Unpublished doctoral dissertation, Columbia University, 1958.

2. Skinner, B.F., (1938) op. cit.

3. Herrnstein, R.J., (1966) op. cit.

4. Zeiler, M.D., (1968) op. cit.

5. Skinner, B.F., (1948) op. cit. p. 169.

Making use of a recently developed procedure,[1] the present investigation employed a complex baseline consisting of five temporally defined schedules, each separately cued by exteroceptive stimuli and each presented in every experimental session. The utilization of such a baseline enabled any given frequency of non-contingent reinforcement to intrude upon the behavior generated by schedules which had previously provided reinforcement at frequencies both greater and lesser than the non-contingent value.

The present experiment then, was concerned with a systematic investigation of baseline reinforcement schedule and non-contingent reinforcement frequency as parameters determining the effectiveness with which behavior is maintained by non-contingent reinforcement.

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1. Cole, B. K. Reinforcement schedule and probability of stimulus change as determinants of stimulus control. Unpublished doctoral dissertation, Columbia University, 1968.

Method

Subjects

The subjects were four white Carneaux hen pigeons 6-8 years old at the start of the experiment. Each pigeon was individually housed, and for the first 30 days in the laboratory had free access to food, grit, and water. During this time each pigeon was weighed daily to determine its *ad libitum* body weight. Each pigeon's body weight was then reduced to 80% of the *ad libitum* weight. The pigeons were maintained and trained at this weight (± 15 grams) throughout the course of experimentation.

Apparatus

The experimental station consisted of a Lehigh Valley Electronics pigeon chamber (Model 1519C) containing a key as an operandum. A pressure of 25 grams was required to close the key switch. The chamber received overall illumination from a house light located directly above the key. The house light was off during the delivery of a reinforcement, which consisted of 2.5 seconds access to a lighted hopper of mixed grain. The chamber was ventilated by a blower, which also provided some masking noise. The stimuli correlated with the different schedules of reinforcement were produced either by (a) transillumination of the transparent key with 1.8 log foot-lamberts of "white," "green," or "red" light projected through a uniform diffusing ("milk" plastic) medium by a 24 volt Lehigh Valley Electronics stimulus projector (Model 1348QL), or (b) pulsing the key transillumination at a frequency of 5 cps with 1.8 log footlamberts of "green" or "red" light. All experimental contingencies were programmed employing Behavioral Research Systems digital logic circuitry. Data were recorded on Sodeco mechanical counters, a Moduprint printing-counter, and a Gerbrands cumulative recorder.

Procedure

The basic procedure consisted of three stages. (1) baseline, (2) non-contingent reinforcement, and (3) baseline recovery. The baseline recovery stage was interpolated between each change to a new frequency of non-contingent reinforcement. Each stage of the procedure is discussed in detail below.

(1) Baseline

After shaping the key-pecking response by the method of successive approximations,[1] the probability of reinforcement was gradually reduced to 0.10 over ten experimental sessions. The probability of reinforcement was held constant at 0.10 once this value was reached. A schematic representation of a typical baseline session is shown in Fig. 1, which indicates the various schedules employed and the key stimulus with which each schedule was correlated. During all phases of training, each animal was exposed within a single session to T values of 0, 3, 6, 12, and 24 seconds.

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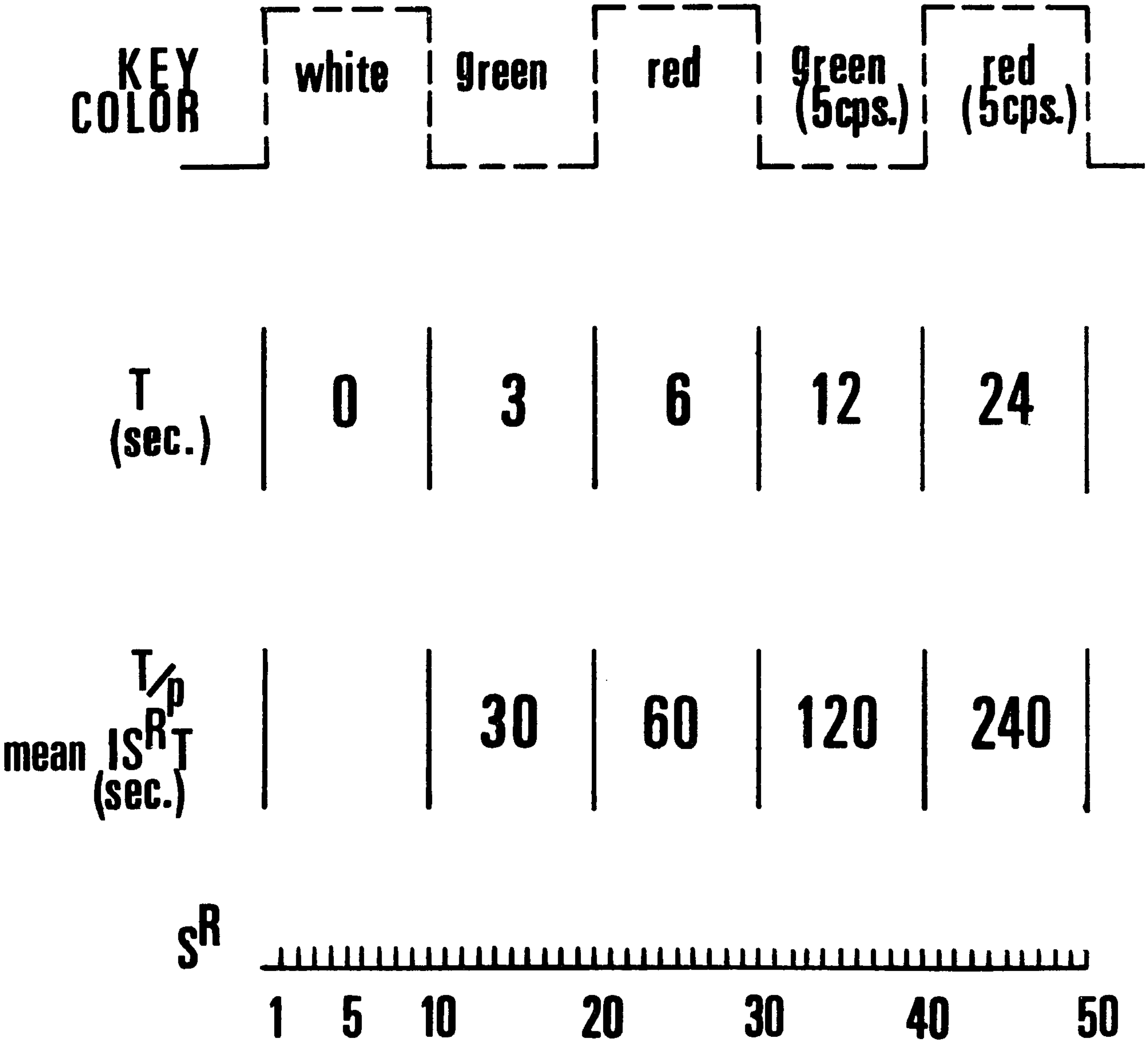
[1] Keller, F. S. & Schoenfeld, W.N. Principles of psychology. New York: Appleton-Century-Crofts, 1950.

Figure 1: Diagrammatic representation of a typical baseline session, indicating key stimuli, reinforcement schedule and reinforcement presentation. Variable durations of each reinforcement schedule are indicated by the discontinuous lines around each stimulus. Predicted mean inter-reinforcement time (T/P) is unspecified at T=0, since at this value the IS^R T is a function of both response rate and P.


KEY COLOR
white
green
red
green (5cps.)
red (5cps.)
T (sec.)
0
3
6
12
24
T/p mean IS^{R}T (sec.)
30
60
120
240
S^{R}
1
5
10
20
30
40
50

The predicted mean IS^RT (T/P) for the schedules is also shown in Fig. 1. At T=0 the predicted mean IS^RT is not shown, since at this value the mean IS^RT is a function of both the rate of responding and P. With a P of 0.10, ten responses on the average are required for reinforcement. Each value of T was correlated with a different exteroceptive stimulus as shown in Fig. 1. The order of presentation of the schedules within a session was randomized, with the restriction that in every block of five sessions each schedule appear once in each position. Once in effect, a given schedule remained in force until 10 reinforcements had been delivered. A session was terminated following the tenth reinforcement obtained on the fifth schedule of the session. In this manner, a total of 50 reinforcements were obtained in each experimental session. This procedure remained in effect for 75 sessions.

(2) Non-contingent reinforcement

Frequencies of non-contingent reinforcement of 30, 60 and 120 seconds were employed. Additionally, two procedures for delivering the non-contingent reinforcements were used. Fixed non-contingent reinforcements (FNC) were those which were delivered at a fixed time interval on T/P schedules composed of T values of 30, 60, and 120 seconds, and a P value of 1.0.

These schedules correspond to FI schedules timed by the clock, rather than from the last reinforcement except that no response was required for reinforcement. In the case of the random non-contingent reinforcements (RNC), the mean $IS^{R}T$ was predetermined, but the sequence was free to vary. RNC reinforcements were delivered on T/P schedules composed of T values of 3, 6, and 12 seconds, and a P value of o.10. These schedules correspond to the random interval schedules employed in the baseline procedure, except that no response was required for reinforcement. Each subject was exposed to all frequencies of non-contingent reinforcement in the following order.

Subject	#1	60 RNC	30 FNC	120 RNC
	#2	60 RNC	120 FNC	30 RNC
	#3	60 FNC	30 RNC	120 FNC
	#4	60 FNC	120 RNC	30 FNC

Each non-contingent reinforcement procedure remained in effect for 30 sessions. The stimuli correlated with the T values, and the randomization procedure, remained the same as in the baseline procedure.

(3) Baseline recovery

Following the thirtieth session of each non-contingent reinforcement procedure, the original baseline procedure was reinstituted. These baseline recovery sessions remained in effect for the 30 sessions following exposure to a non-contingent reinforcement procedure. In this manner, each change to a new frequency of non-contingent reinforcement was preceded by 30 sessions of exposure to the initial baseline.

Results and Discussion

The primary data consisted of two measures. (1) rate of responding, computed by subtracting reinforcement duration and post-reinforcement pause from the time base on which the overall rate of responding was computed, and (2) post-reinforcement pause (PS^RP), defined as the time interval between a reinforcement and the first succeeding response. A third measure, mean IS^RT was also obtained, and is presented to verify that the time between reinforcements was approximated by T/P. Throughout the entire experiment, the data obtained over the period spanning the first three reinforcements in every session were excluded from all calculations to allow for accommodation to the experimental chamber. Baseline and baseline recovery data were examined as a function of T. The data from the non-contingent reinforcement procedures were examined as a function of (1) the number of sessions of exposure to the procedure, and (2) the length of T.

The values of T and P employed in the present investigation had previously been shown to encompass a relatively wide range of response rates.[1] This finding was confirmed by the data presented in Fig. 2. For all four subjects, the rate of responding

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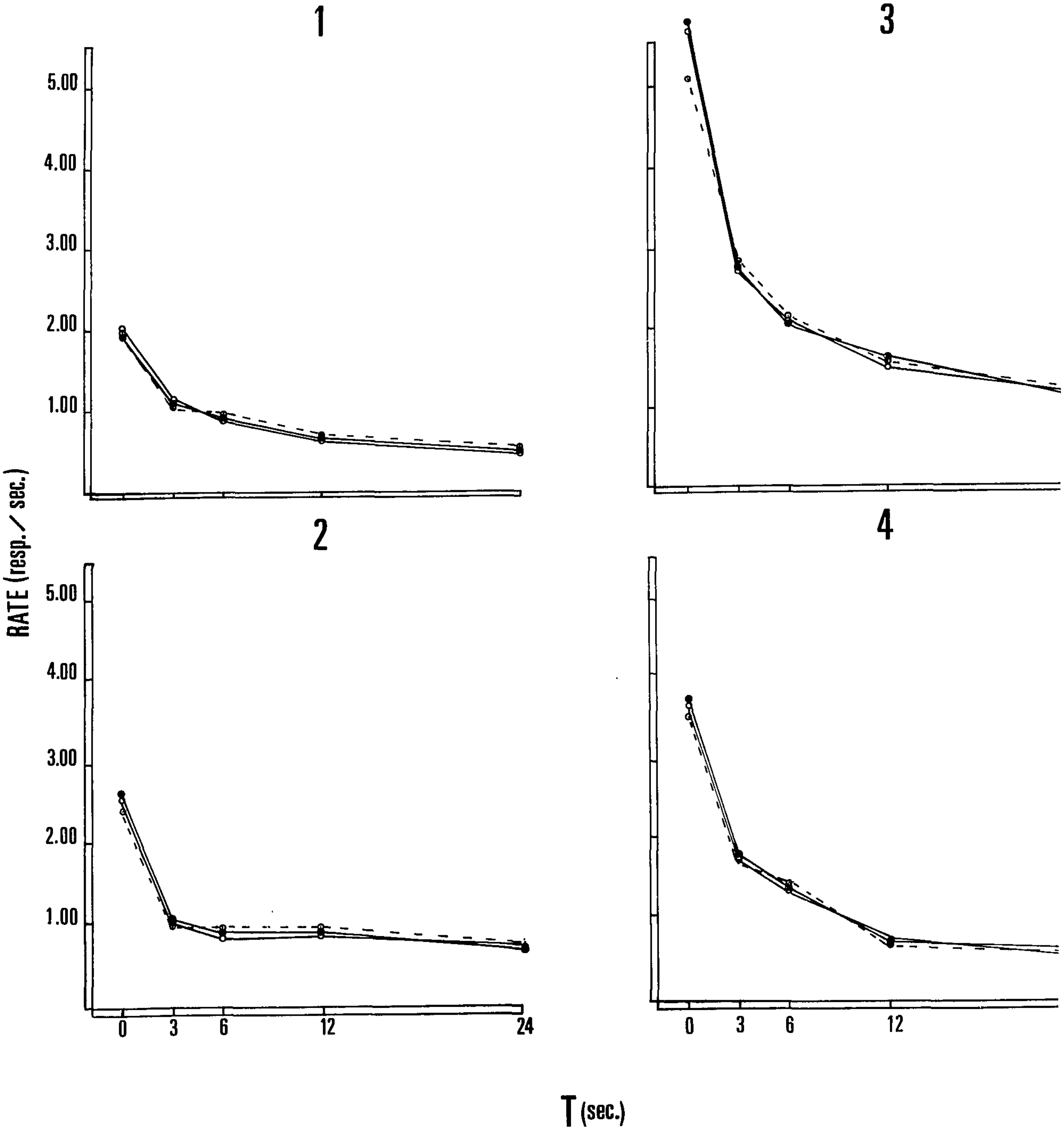
[1] Cole, B.K. (1968) op. cit.

Figure 2: Response rate as a function of T for the baseline procedure for subjects 1, 2, 3,4. The open-circle function was obtained by pooling the data over sessions 56-75. The filled-circle function was obtained by pooling the data over sessions 66-75,,and the centered-circle function was obtained by pooling the data over sessions 71-75.


1
2
3
4
RATE (resp./sec.)
5.00
4.00
3.00
2.00
1.00
0
3
6
12
24
T (sec.)

is a decreasing generally monotonic function of the length of T. The three figures in each panel were obtained by pooling the data over the last 5 (71-75), 10(66-75), and 20 (56-75) sessions of the baseline procedure, and are presented as an indication of the reliability of the function.

The related pause data (Fig. 3) indicates a monotonic increasing relationship between $PS^{R}P$ and T for all four subjects. Those schedules which generate high rates of responding (T=0, T=3) result in a correspondingly smaller $PS^{R}P$ than those schedules which generate lower rates of responding (T=12, T=24).

The functions shown in Fig. 4 confirm the reliability of T/P as a predictor of the mean $IS^{R}T$. The departure of the obtained $IS^{R}T$ data from that predicted by T/P is very slight and can be attributed to the duration of reinforcement.

The institution of a 60 second non-contingent reinforcement procedure resulted in a disruption of the behavior maintained by the initial baseline procedure. The functions relating rate of responding to the number of sessions of exposure under the non-contingent reinforcement procedure are generally decreasing. This relationship is evident in the presence of all the stimuli previously correlated with the baseline schedules. (Figs. 5,6,7,8). Although all the functions are not monotonic, the trend is evident. As

Figure 3: Post-reinforcement pause as a function of T for the baseline procedure for subjects 1,2,3,4. The function was obtained by pooling the data over sessions 56-75.

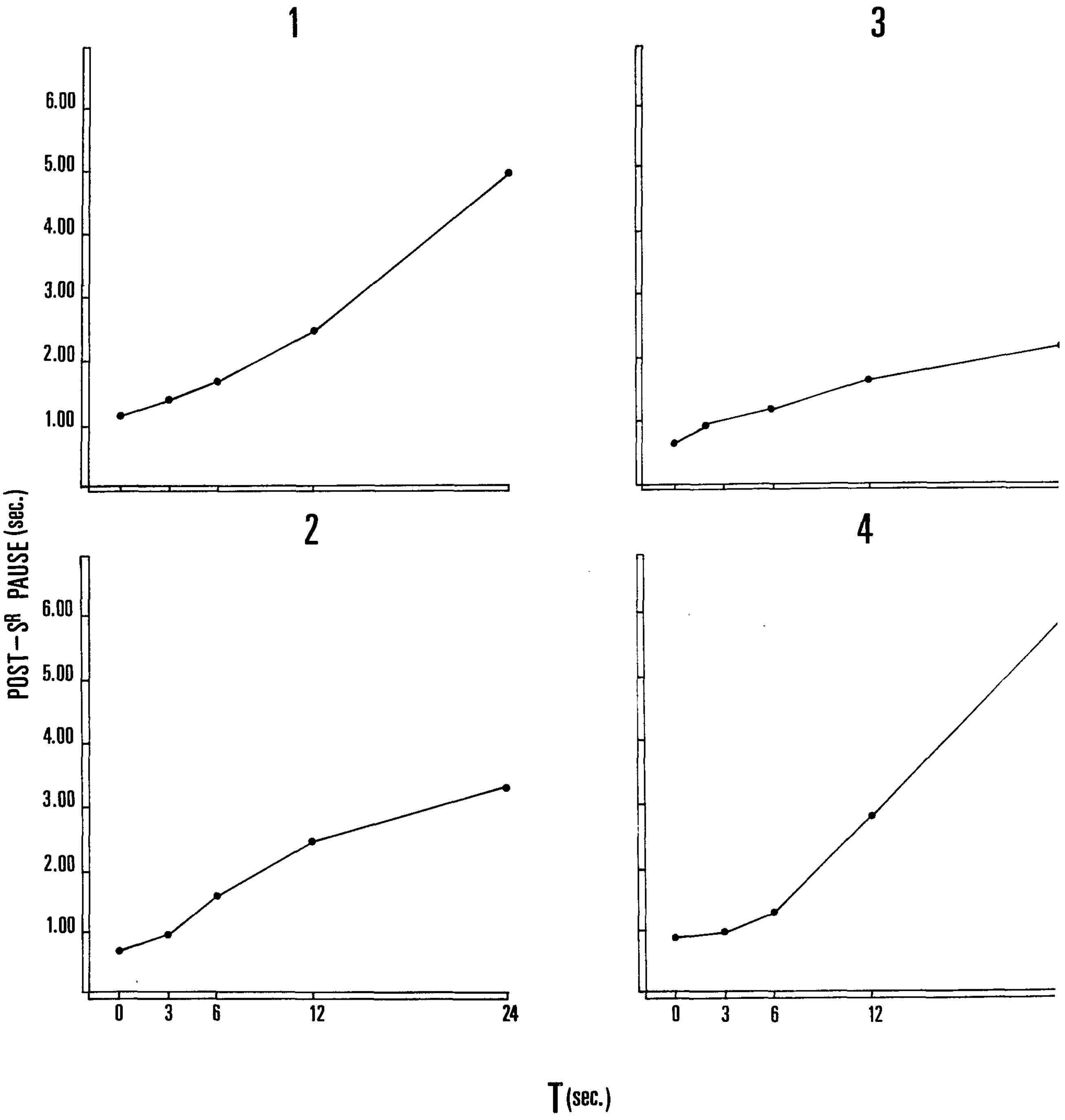

1
3
2
4
POST–S^R PAUSE (sec.)
6.00
5.00
4.00
3.00
2.00
1.00
0
3
6
12
24
T (sec.)

Figure 4: Predicted (T/P) and observed mean inter-reinforcement time for the baseline procedure for subjects 1, 2, 3, 4. The predicted curve has suppressed data points. No predicted IS^RT is shown for T=0, since at this value IS^RT is a function of both response rate and P. The observed IS^RT function was obtained by pooling the data over sessions 56-75.

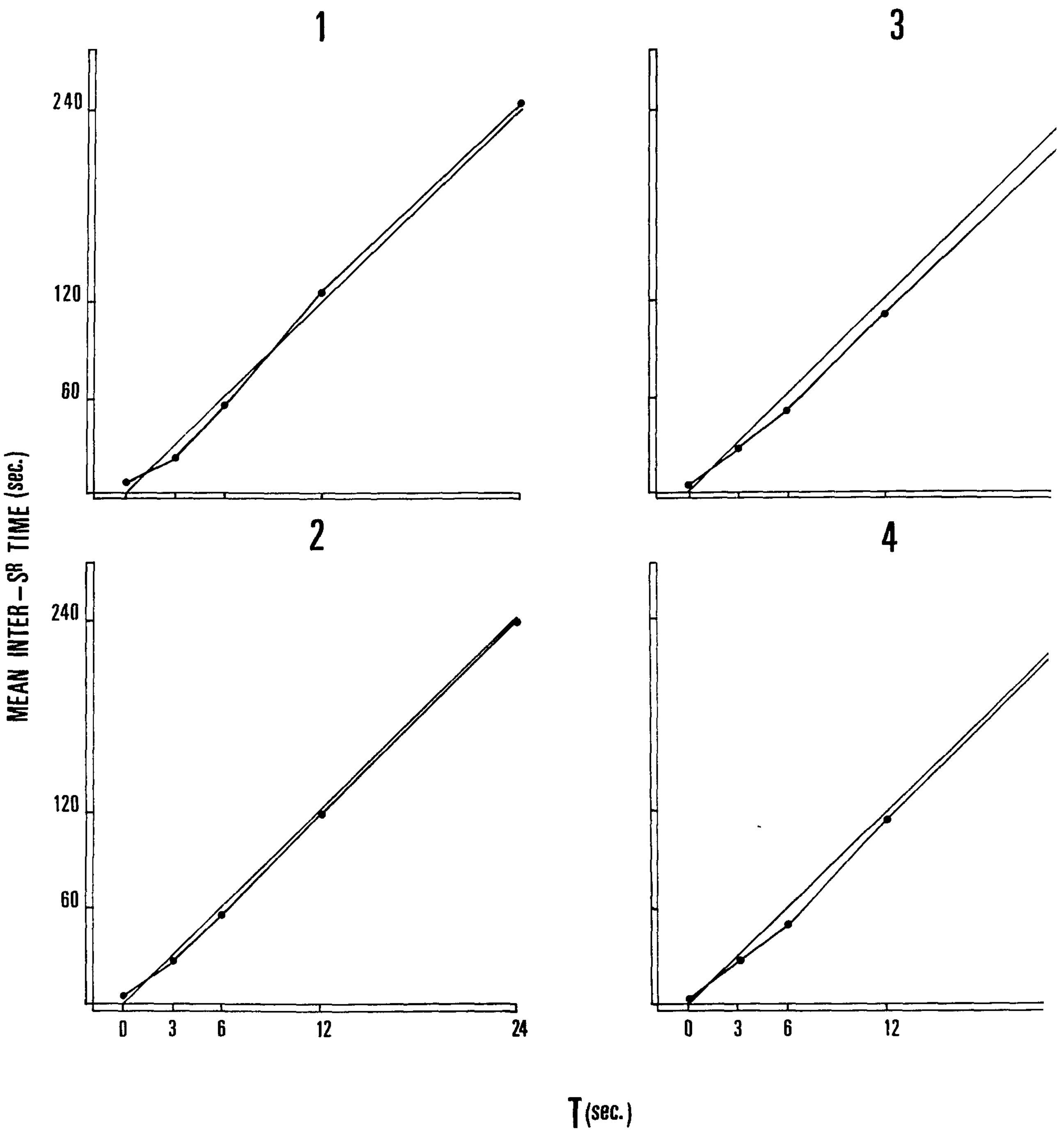

1
3
2
4
240
120
60
240
120
60
MEAN INTER-S^R TIME (sec.)
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 5: Response rate as a function of blocks of five sessions of exposure to the 60 second non-contingent reinforcement procedure for subject 1. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five blocks of exposure.

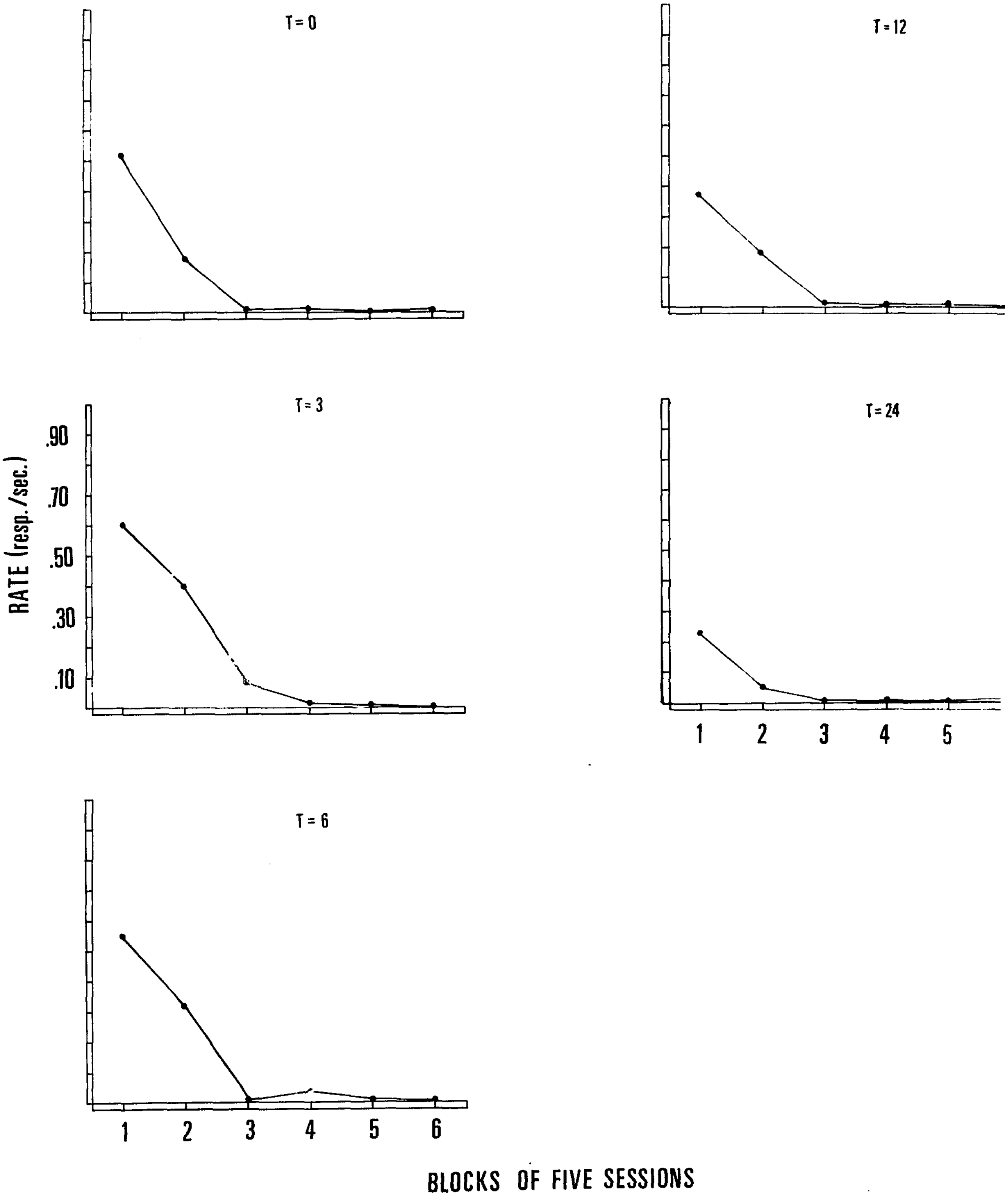

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.90
.70
.50
.30
.10
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 6: Response rate as a function of blocks of five sessions of exposure to the 60 second non-contingent reinforcement procedure for subject 2. The functions of each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure.

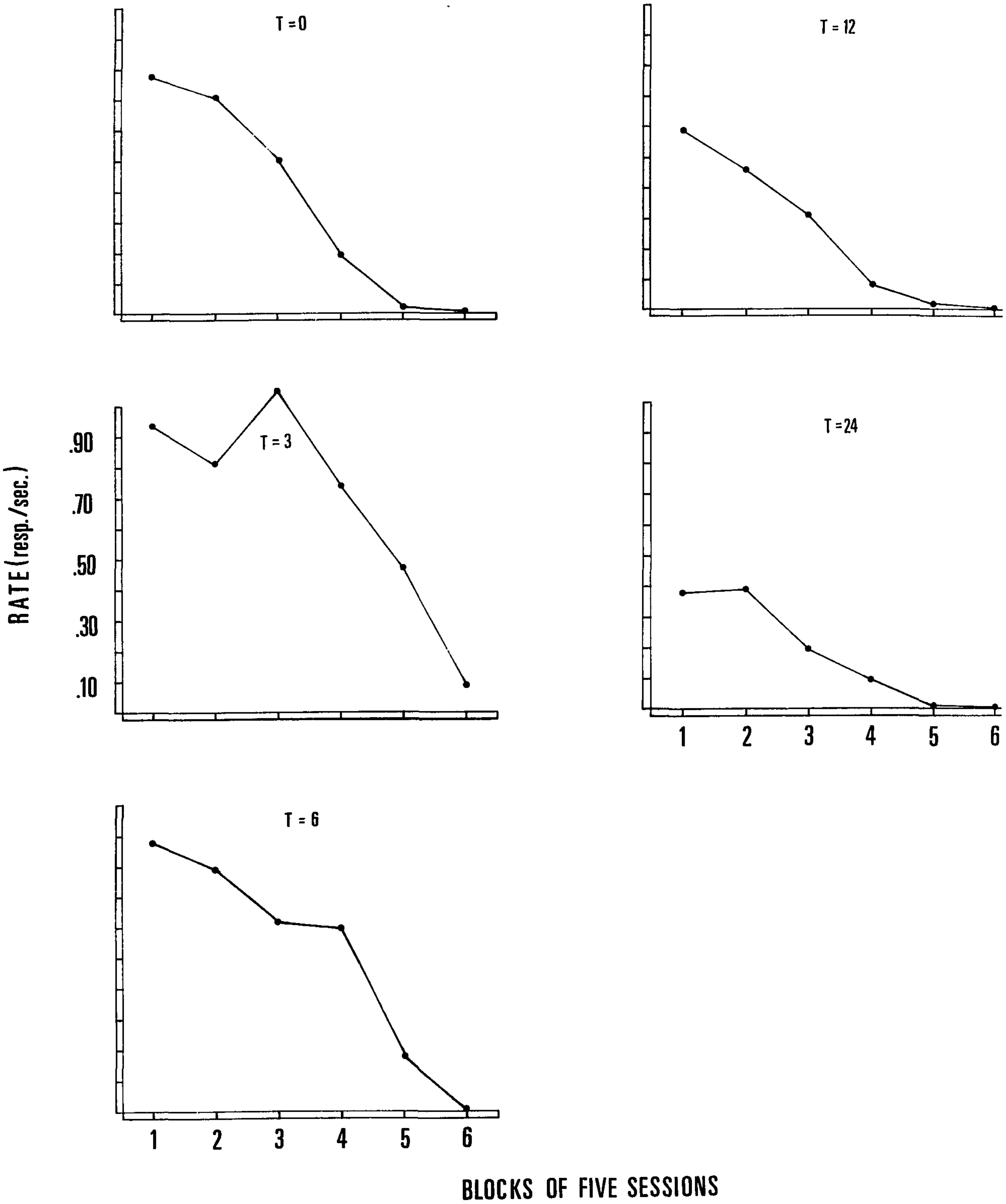

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.90
.70
.50
.30
.10
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 7: Response rate as a function of blocks of five sessions of exposure to the 60 second non-contingent reinforcement procedure for subject 3. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure.

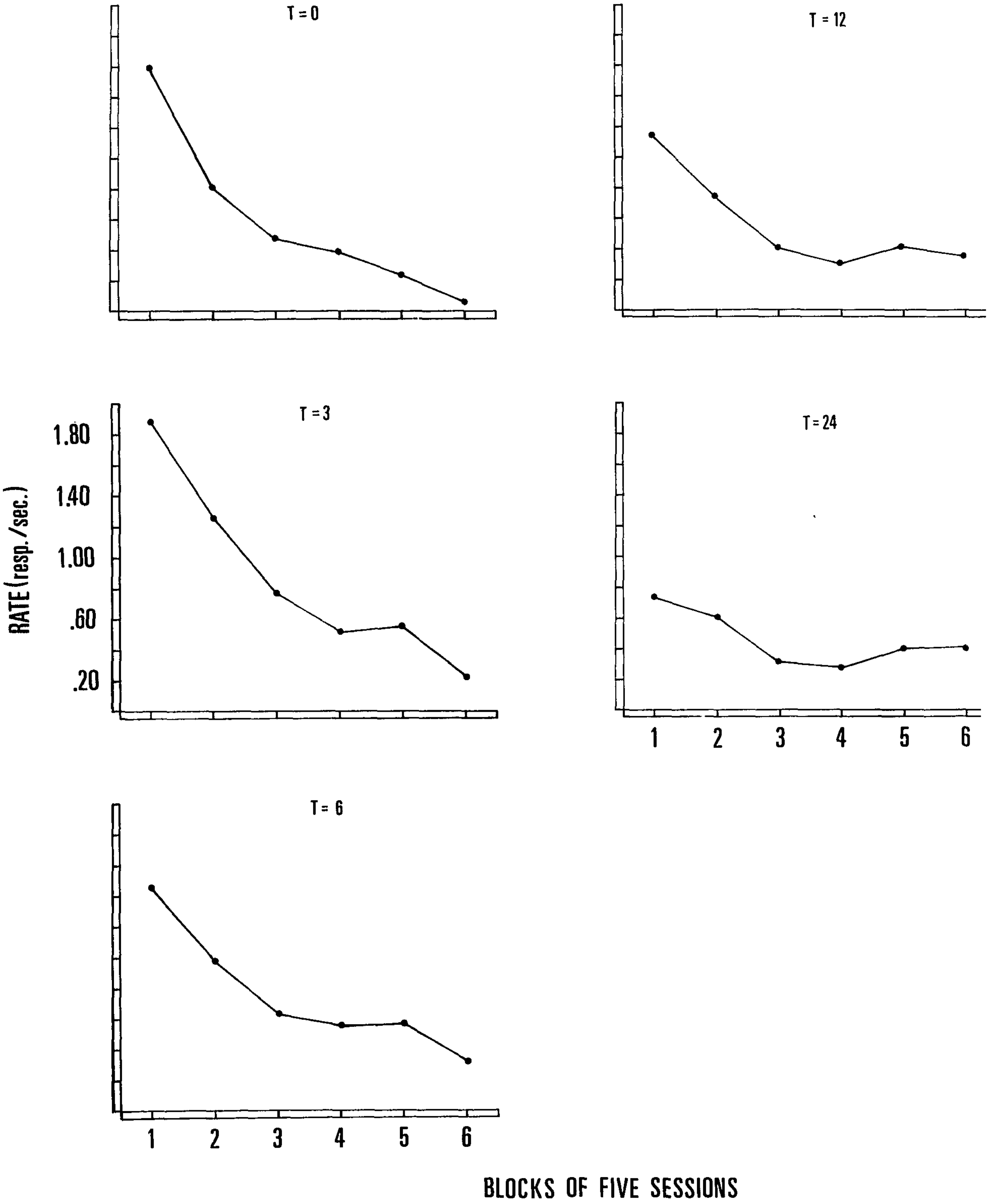
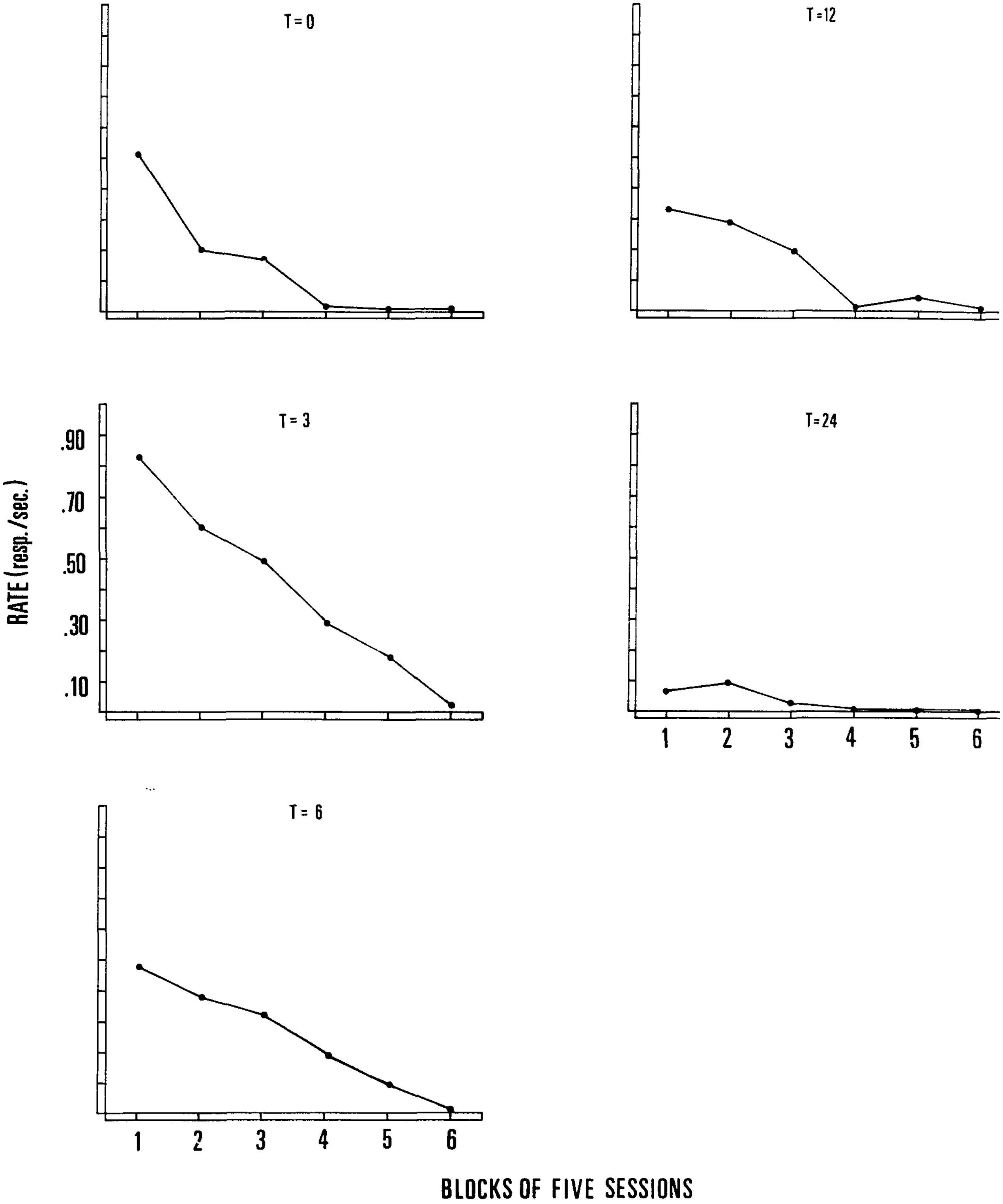

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp. /sec.)
1.80
1.40
1.00
.60
.20
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 8: Response rate as a function of blocks of five sessions of exposure to the 60 second non-contingent reinforcement procedure for subject 4. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure.


T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.90
.70
.50
.30
.10
1
2
3
4
5
6
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

exposure to the 60 second non-contingent reinforcement schedule prolonged, the rate of responding decreases. This is in agreement with the findings previously cited.[1,2,3]

The decrease in rate of responding occurring during the 60 second non-contingent reinforcement procedure may be attributed at least in part to the response variability which may be presumed to be introduced by the procedure. Since the delivery of a reinforcement is not dependent upon the emission of a pre-specified response, the possibility exists that some other behavior will intervene between a response and a non-contingent reinforcement. This intervening behavior is usually not present in a contingent schedule of reinforcement, except for those procedures which explicitly interpose a delay either between responses or between a response and a reinforcement. In these cases intervening stereotyped behavior may be seen to develop during the delay interval.[4,5] In the non-contingent case, as the intervening behavior becomes strengthened it comes to occur at a higher rate which is, of course, accompanied

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1. Skinner, B.F. (1938) op. cit.

2. Herrnstein, R.J. (1966) op. cit.

3. Zeiler, M.D. (1968) op. cit.

4. Ferster, C.B. Sustained behavior under delayed reinforcement. <u>Journal of Experimental Psychology</u>, 1953, <u>45</u>, 218-224.

5. Wilson, M.P. and Keller, F.S. On the selective reinforcement of spaced responses. <u>Journal of Comparative and Physiological Psychology</u>, 1953, <u>46</u>, 190-193.

by a corresponding decrease in the rate of key-pecking.

It has been found that an organism's discrimination of a contingent from a non-contingent reinforcement procedure is not perfect.[1] Therefore, it would be expected that the behavior would be optimally maintained in the presence of the stimulus which was previously correlated with that baseline schedule whose mean $IS^{R}T$ was equal to the frequency of the non-contingent reinforcement. With a 60 second non-contingent reinforcement procedure, therefore, the behavior should be maintained to the greatest extent in the presence of the stimulus which was previously correlated with the T=6 baseline schedule, since this schedule results in a mean $IS^{R}T$ of 60 seconds.

The data in Figs. 9, 10, 11, and 12 fail to bear out this expectation. The behavior of all four subjects was generally maintained at the highest rate in the presence of the stimulus previously correlated with the T=3 baseline schedule. The behavior maintained in the presence of the other stimuli decreased as the length of T increased. In the presence of the T=0 stimulus, the behavior showed the most dramatic decrease. This can be attributed to the effects of extinction which were produced by greatly increasing the mean $IS^{R}T$. The mean $IS^{R}T$ for the T=0 schedule during the baseline

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

Figure 9: Response rate as a function of T for the 60 second non-contingent reinforcement procedure for subject 1. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

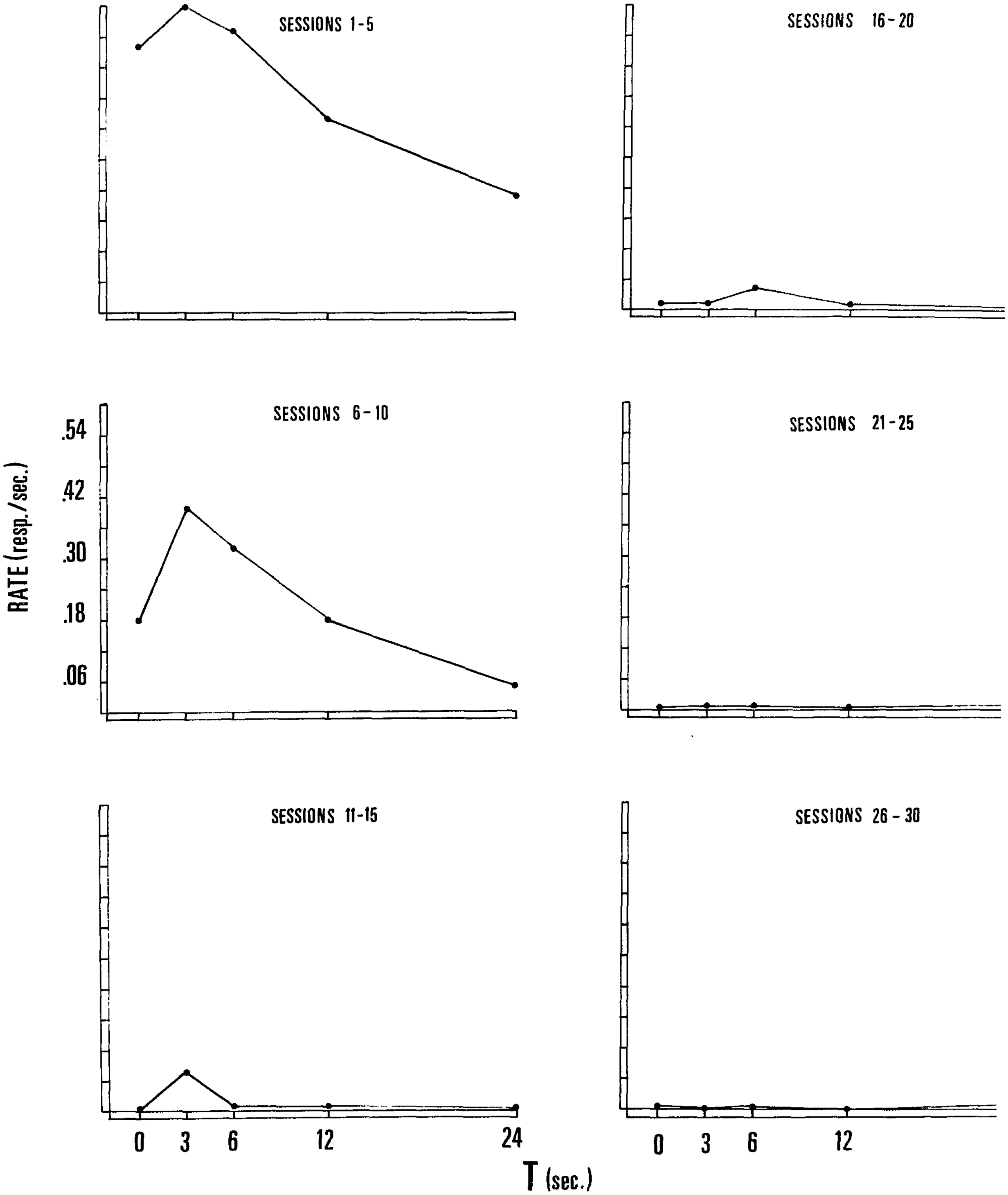

SESSIONS 1-5
SESSIONS 16-20
SESSIONS 6-10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
.54
.42
.30
.18
.06
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 10: Response rate as a function of T for the 60 second non-contingent reinforcement procedure for subject 2. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

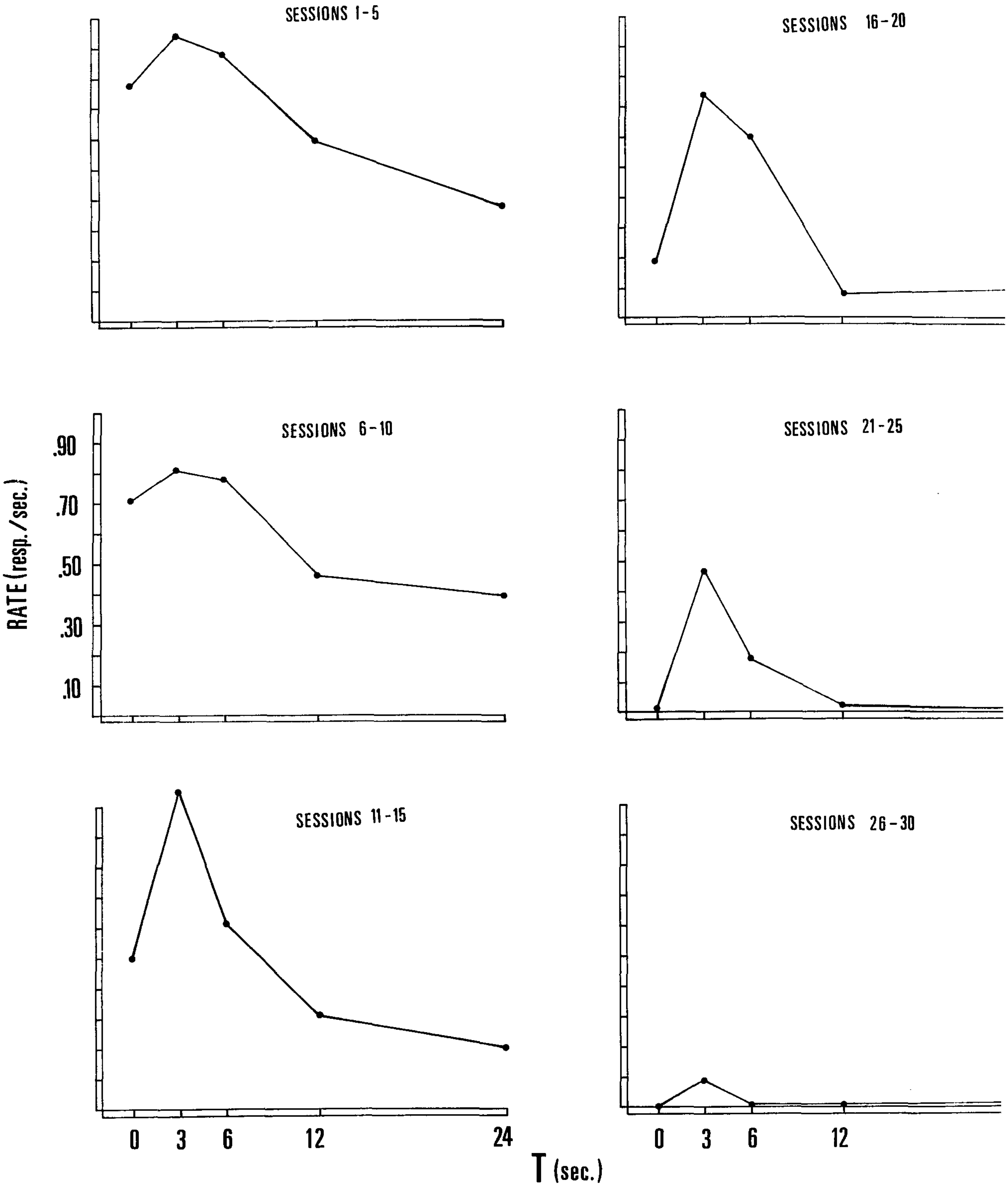

SESSIONS 1-5
SESSIONS 16-20
SESSIONS 6-10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
.90
.70
.50
.30
.10
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 11: Response rate as a function of T for the 60 second non-contingent reinforcement procedure for subject 3. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

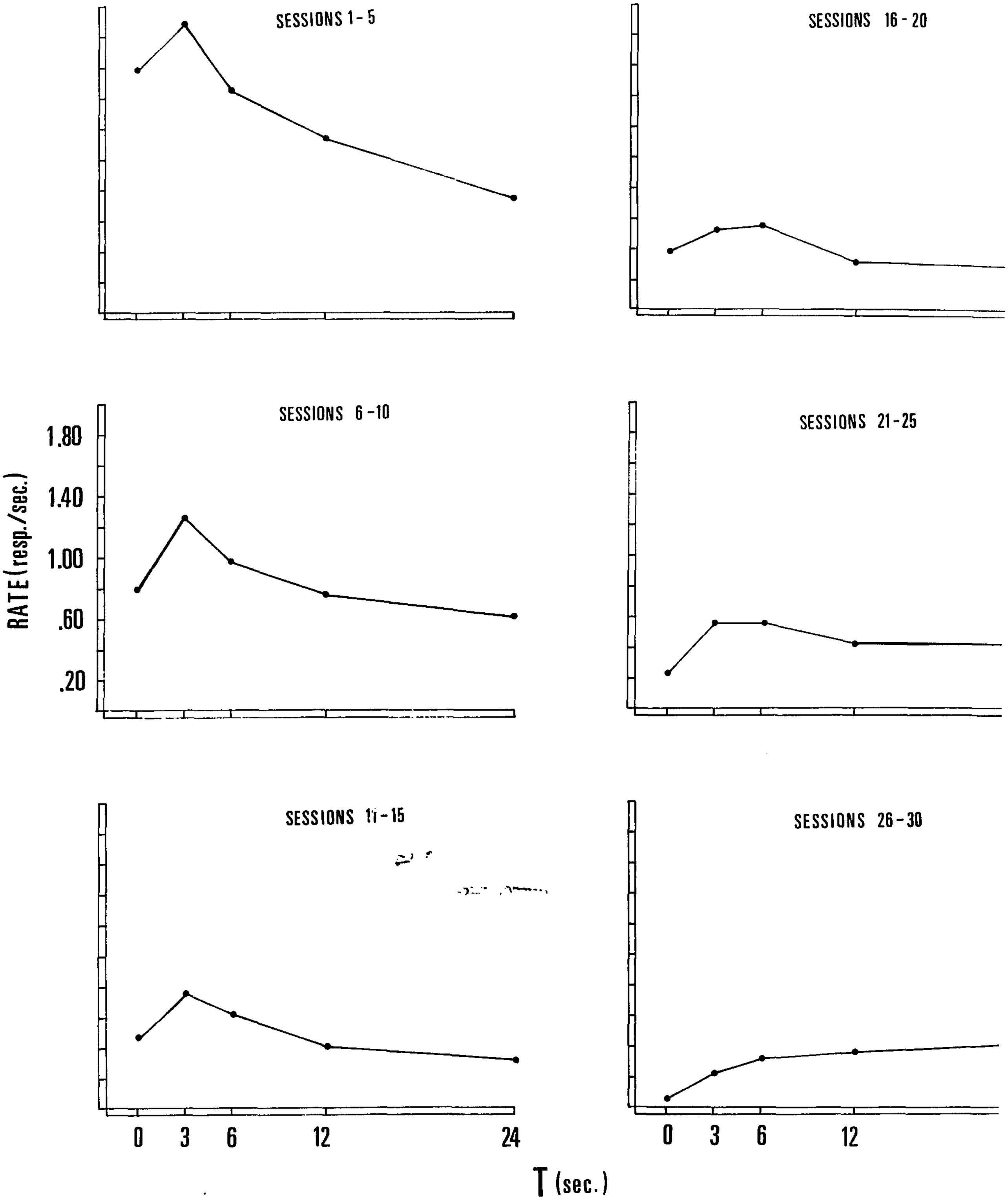
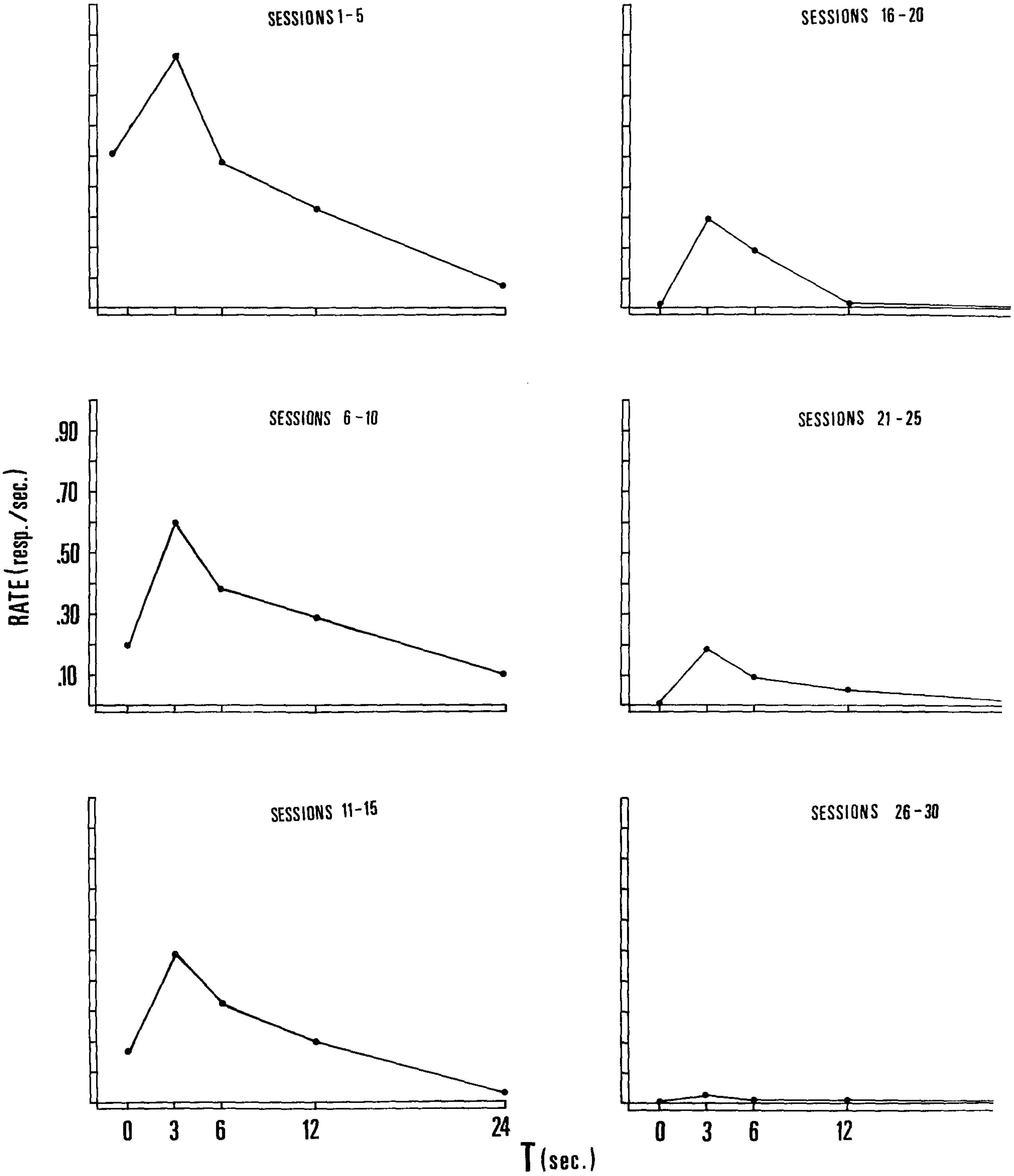

SESSIONS 1- 5
SESSIONS 16 - 20
SESSIONS 6 -10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
1.80
1.40
1.00
.60
.20
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 12: Response rate as a function of T for the 60 second non-contingent reinforcement procedure for subject 4. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.


SESSIONS 1-5
SESSIONS 16-20
SESSIONS 6-10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
.90
.70
.50
.30
.10
0
3
6
12
24
0
3
6
12
T (sec.)

procedure was approximately four seconds (Fig. 4). The 60 second non-contingent reinforcement procedure, therefore, resulted in a fifteen-fold increase in mean $IS^{R}T$. An increase of this magnitude would be expected to produce a decrease in the rate of responding due to extinction. For the T=12 and T=24 stimuli, the 60 second non-contingent reinforcement procedure represents a decrease in the mean $IS^{R}T$ of 50% and 75%, respectively. Since the T=12 and T=24 schedules resulted in the lowest rates of responding during the baseline procedure (Fig. 2), the decrease in mean $IS^{R}T$ increases the probability that "not-R" ($\not{R}$)[1] will be strengthened by the non-contingent reinforcement. "Not-R" refers to the class of behaviors which had previously been ineligible for reinforcement. This is due to the fact that the more widely spaced the responses, the greater the probability that a non-contingent reinforcement will follow some behavior other than a key-pecking response. This gradual strengthening of $\not{R}$ results in a concomitant decrease in the rate of key-pecking. The rate of responding decreases less rapidly in the presence of the T=3 and T=6 stimuli, since the schedules correlated with these stimuli resulted in relatively higher baseline rates of responding, which makes it more difficult for any intervening behavior to be strengthened.

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[1] Farmer J. and Schoenfeld, W.N. Reinforcement schedules and the behavior stream. In W.N. Schoenfeld (Ed.) The theory of reinforcement schedules. New York: Appleton-Century-Crofts, 1970 (In Press).

The $PS^{R}P$ data (Fig. 13) are consistent with the rate findings. Although all the $PS^{R}P$'s are considerably elevated above the baseline value (compare Figs. 3 and 13), the smallest $PS^{R}P$ is found in the presence of the T=3 stimulus. The functions are generally increasing as the length of T increases beyond three seconds, with a considerable increase in $PS^{R}P$ in the presence of the T=0 stimulus. The $IS^{R}T$ data (Fig. 14) show a good approximation to that predicted by T/P.

The temporal discrimination noted by Zeiler[1] was not found in the present investigation. No differentiation between the behavior maintained by the RNC and FNC procedures was noted. Although the elevation in $PS^{R}P$ above the baseline level suggests that responding, when maintained, occurred later in the interval between reinforcements, no distinction between the data obtained on the RNC and FNC procedures is apparent.

When the baseline procedure was reinstated, the functions previously described were recovered. The two functions in each panel of Figs. 15 and 16 were obtained by pooling the data over sessions 21-25 and 26-30, respectively, and are presented as an indication of the reliability of the functions. The rate of responding is a decreasing and generally monotoncially increasing function of T (Fig. 16). The related $IS^{R}T$ functions (Fig. 17) are again in close agreement to those predicted by T/P.

The institution of a 120 second non-contingent

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1. Zeiler, M.D. (1968) op. cit.

Figure 13: Post-reinforcement pause as a function of T for the 60 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The function was obtained by pooling the data over sessions 1-30.

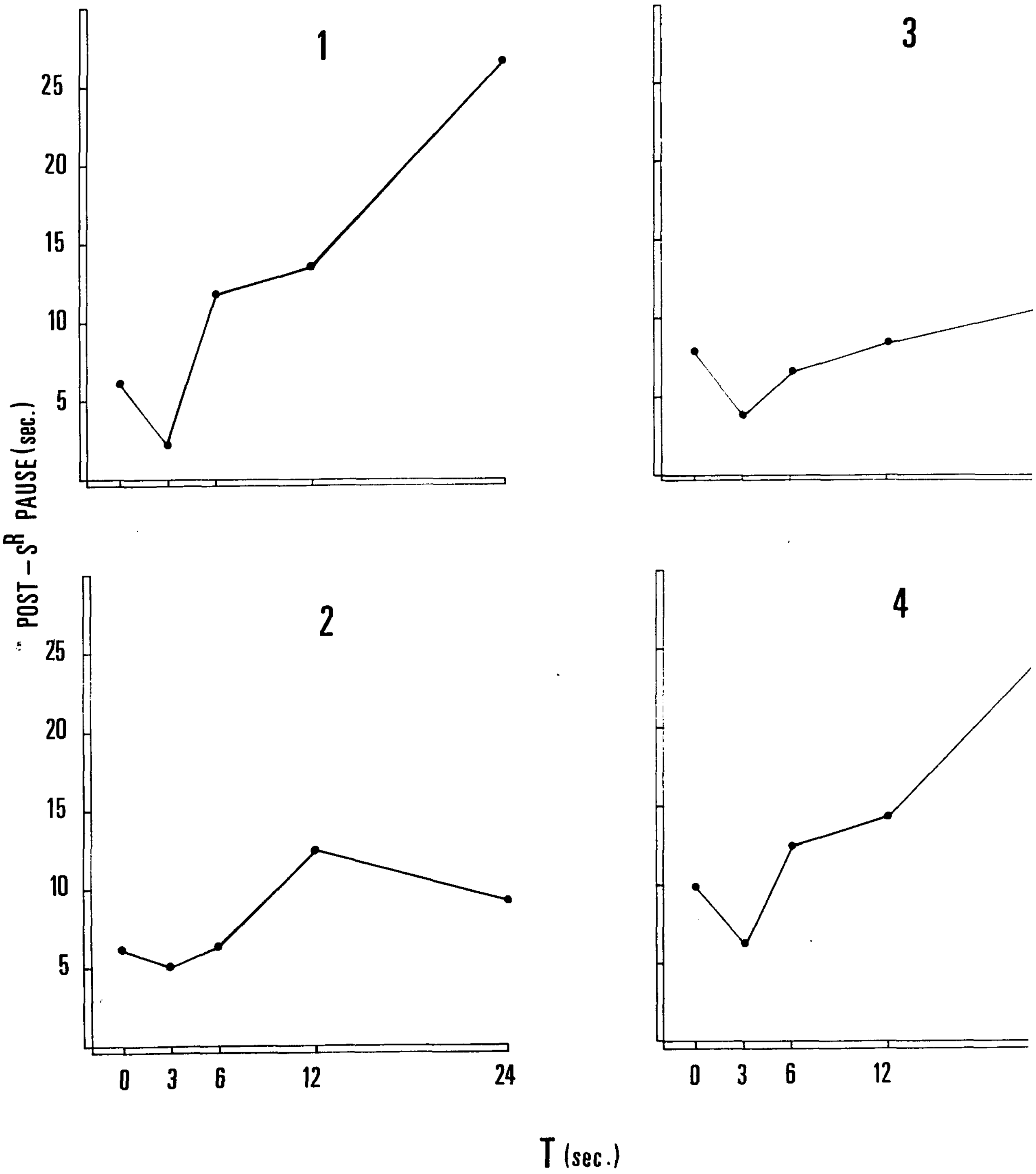

1
2
3
4
POST – S^R PAUSE (sec.)
25
20
15
10
5
0
3
6
12
24
T (sec.)

Figure 14: Predicted (T/P) and observed mean inter-reinforcement time as a function of T for the 60 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The predicted curve has suppressed data points. The observed $IS^{R}T$ function was obtained by pooling the data over sessions 1-30.

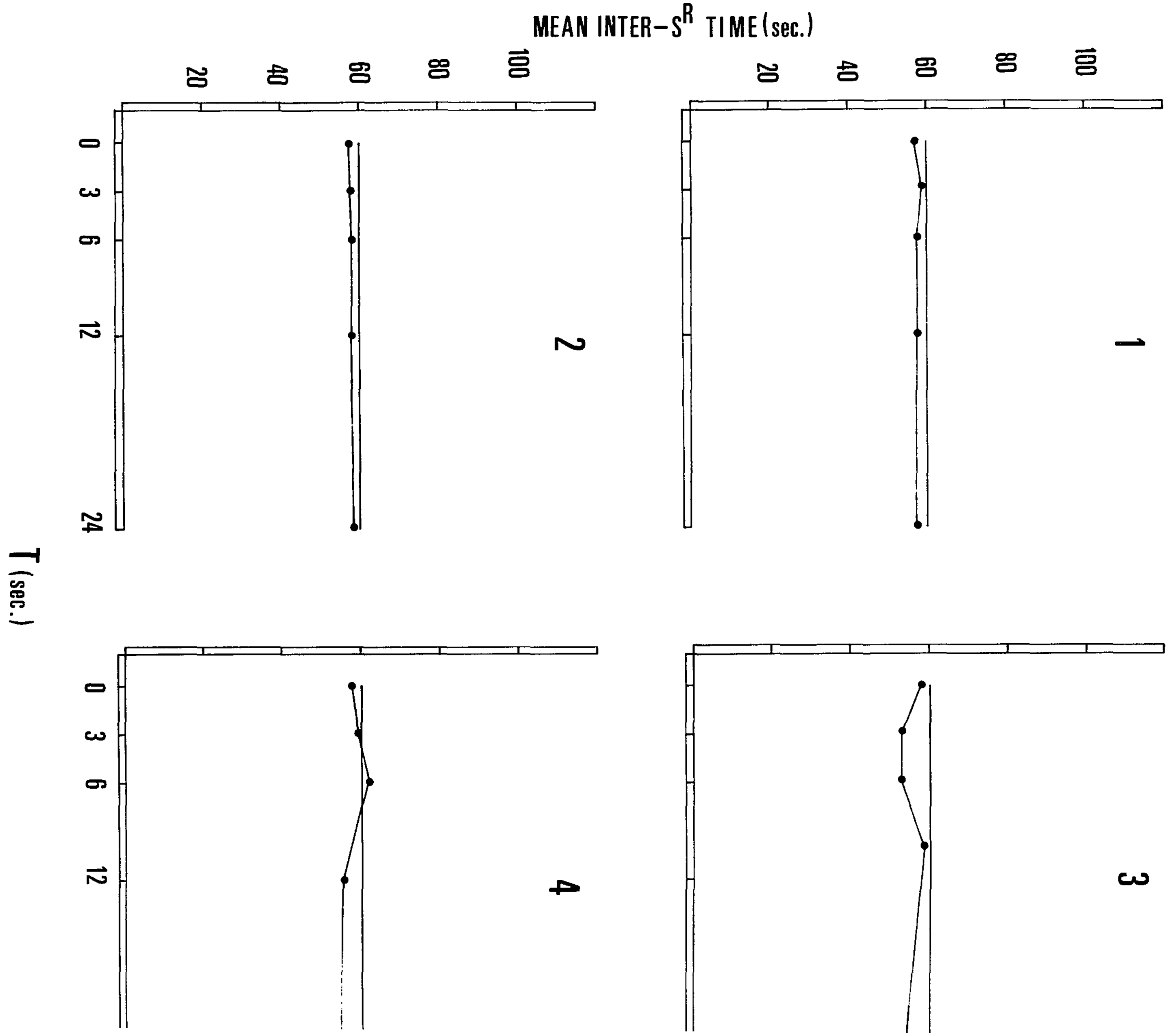

MEAN INTER-S^R TIME (sec.)
20
40
60
80
100
1
2
3
4
0
3
6
12
24
T (sec.)

Figure 15: Rate of responding as a function of T for baseline recovery following exposure to the 60 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The open-circle function was obtained by pooling the data over sessions 21-25. The filled-circle function was obtained by ppoling the data over sessions 26-30.

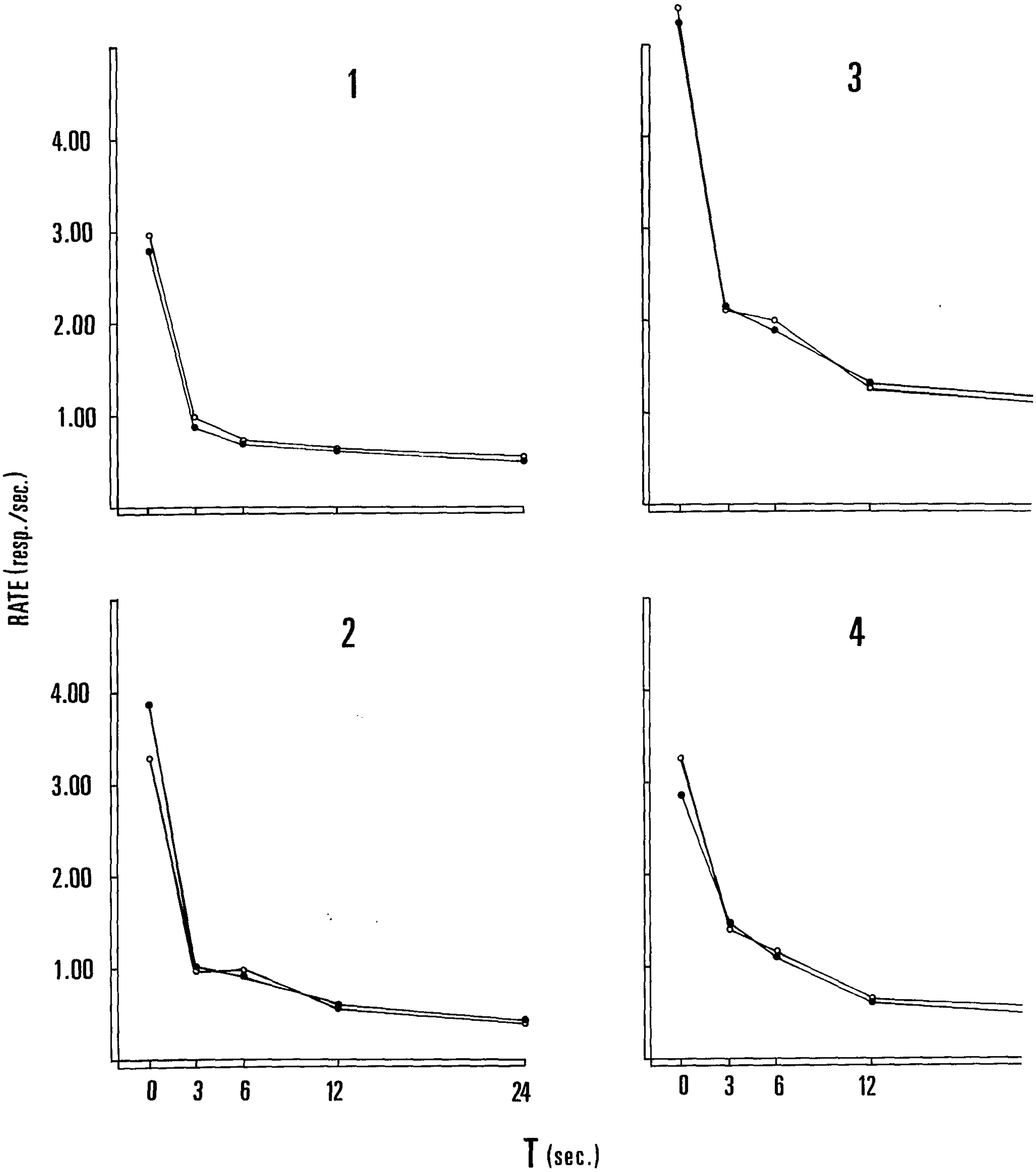

1
3
2
4
RATE (resp./sec.)
4.00
3.00
2.00
1.00
4.00
3.00
2.00
1.00
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 16: Post-reinforcement pause as a function of T for baseline recovery following exposure to the 60 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The open-circle function was obtained by pooling the data over sessions 21-25. The filled circle function was obtained by pooling the data over sessions 26-30.

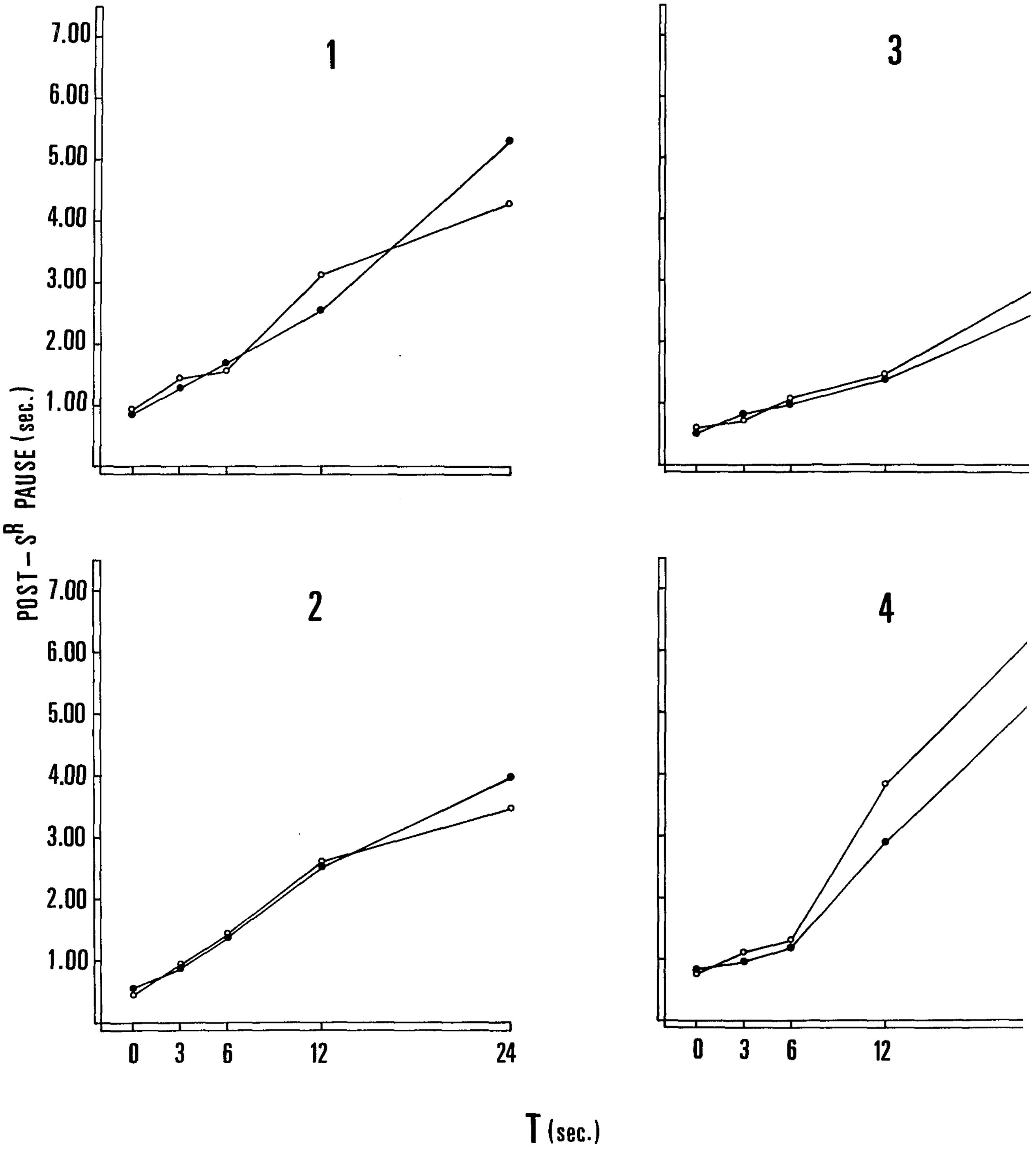
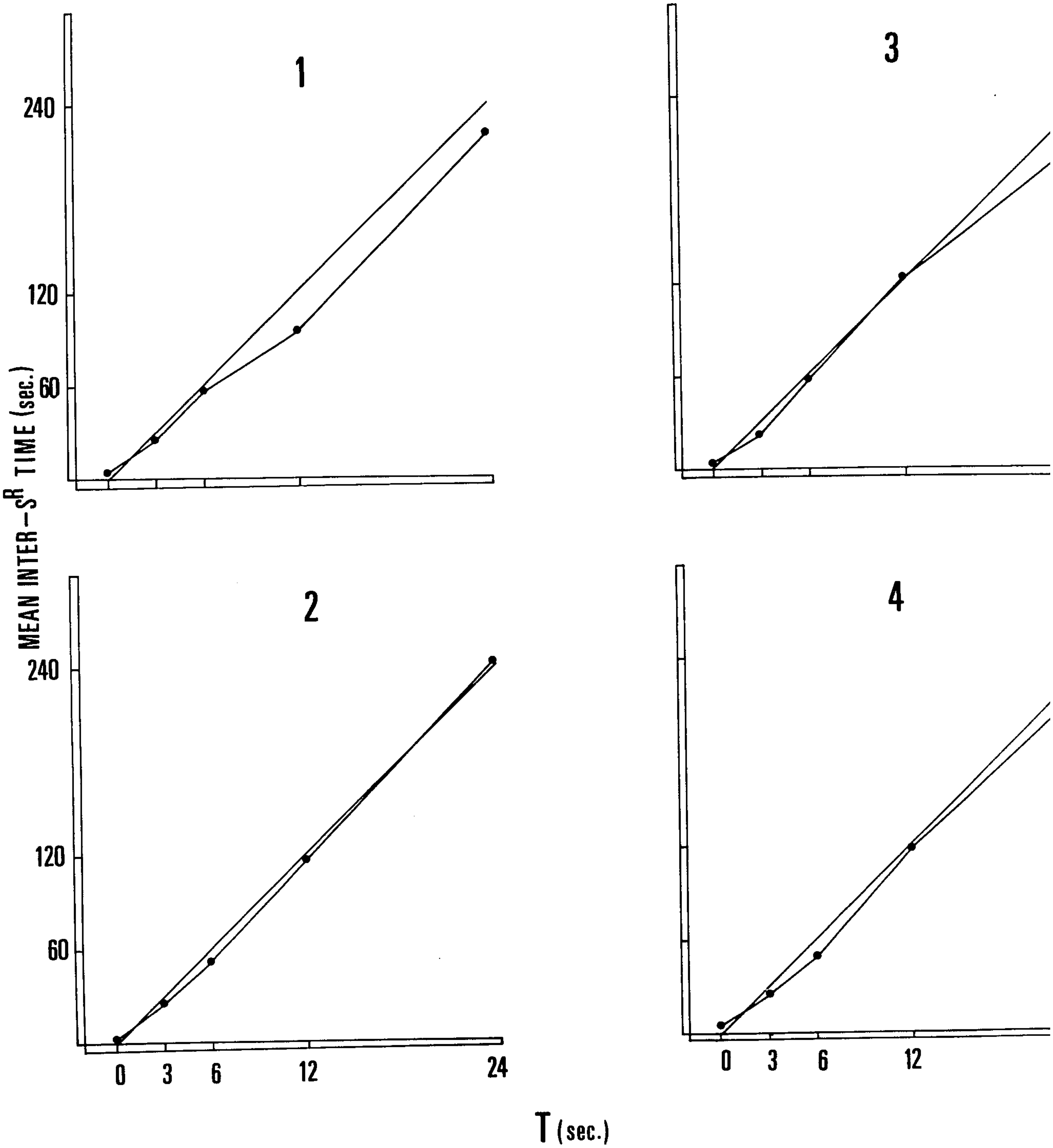

1
2
3
4
POST – S^R PAUSE (sec.)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0
3
6
12
24
T (sec.)

Figure 17: Predicted (T/P) and observed mean inter-reinforcement time as a function of T for baseline recovery following exposure to the 60 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The predicted curve has suppressed data points. No predicted IS^{R}T is shown for T=0, since at this value IS^{R}T is a function of both response rate and P. The observed IS^{R}T function was obtained by pooling the data over sessions 1-30.


1
2
3
4
240
120
60
240
120
60
MEAN INTER-S^R TIME (sec.)
0
3
6
12
24
0
3
6
12
T (sec.)

reinforcement procedure resulted in a behavioral disruption which was similar to that produced by the 60 second non-contingent reinforcement procedure. As exposure to the procedure lengthens, the rate of responding decreases in the presence of all the stimuli previously correlated with the baseline procedure (Figs. 18, 19, 20, 21). This is in agreement with the previously cited findings[1,2,3] as well as with the data obtained with the 60 second non-contingent reinforcement procedure.

The behavior is maintained best in the presence of the stimuli previously correlated with the T=3 and T=6 baseline schedules (Figs. 22, 23, 24, 25). The behavior maintained in the presence of the T=0 stimulus again shows the most dramatic decline. This finding is not unexpected since the 120 second non-contingent reinforcement procedure represents a thirty-fold increase in mean IS^RT above the baseline value, and based on the earlier analysis would be expected to result in a decrease in the rate of responding due to extinction. In the presence of the T=12 and T=24 stimuli, the decline in response rate is not as rapid as that seen in the presence of the T=0 stimulus, but the behavior is generally maintained at a lower rate than in the presence of the T=3 and T=6 stimuli.

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1. Skinner, B.F. (1938) op. cit.
2. Herrnstein, R.J. (1966) op. cit.
3. Zeiler, M.D. (1968) op. cit.

Figure 18: Response rate as a function of blocks of five sessions of exposure to the 120 second non-contingent reinforcement procedure for subject 1. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the baseline.

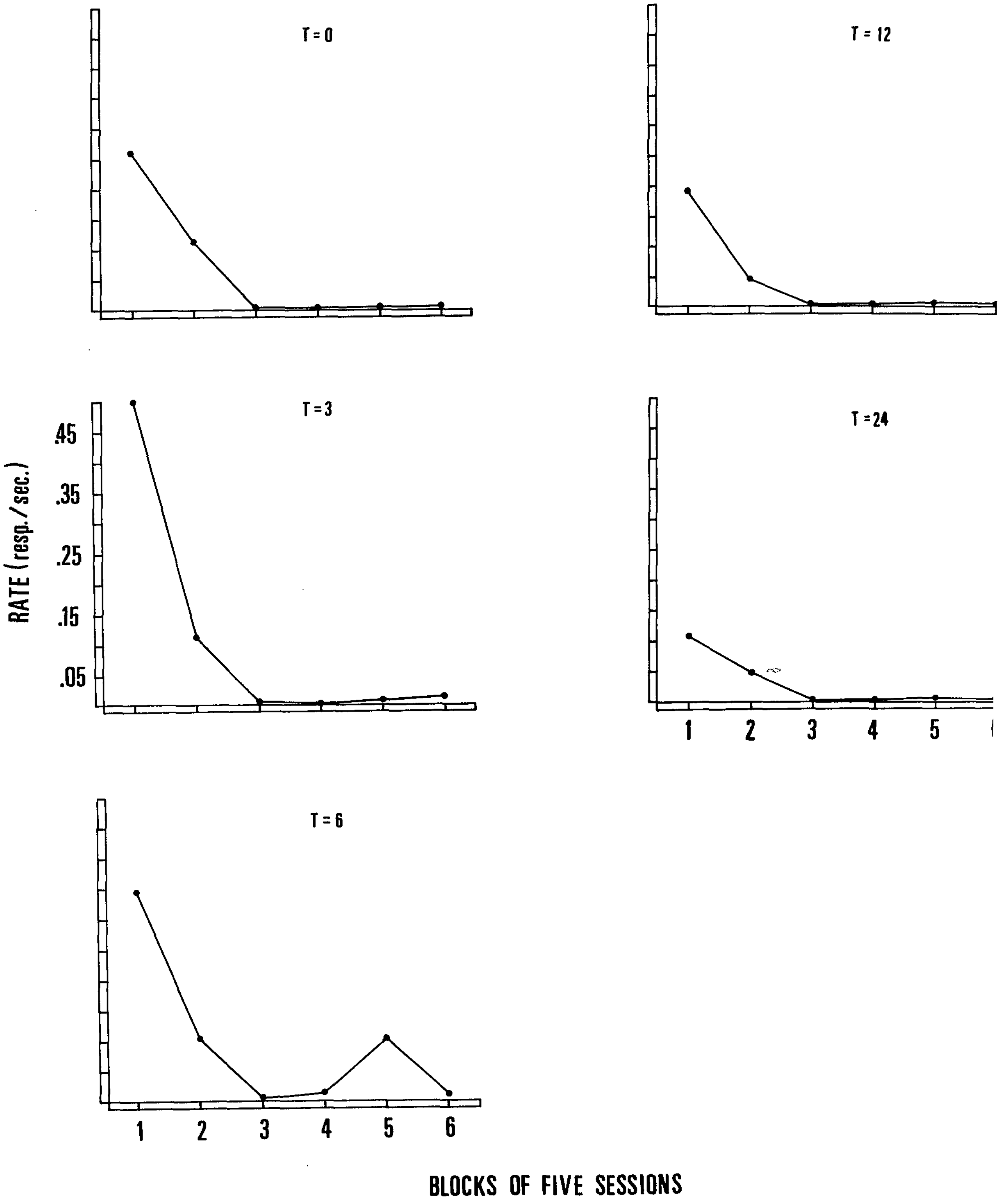

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.45
.35
.25
.15
.05
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 19: Response rate as a function of blocks of five sessions of exposure to the 120 second non-contingent reinforcement procedure for subject 2. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the procedure.

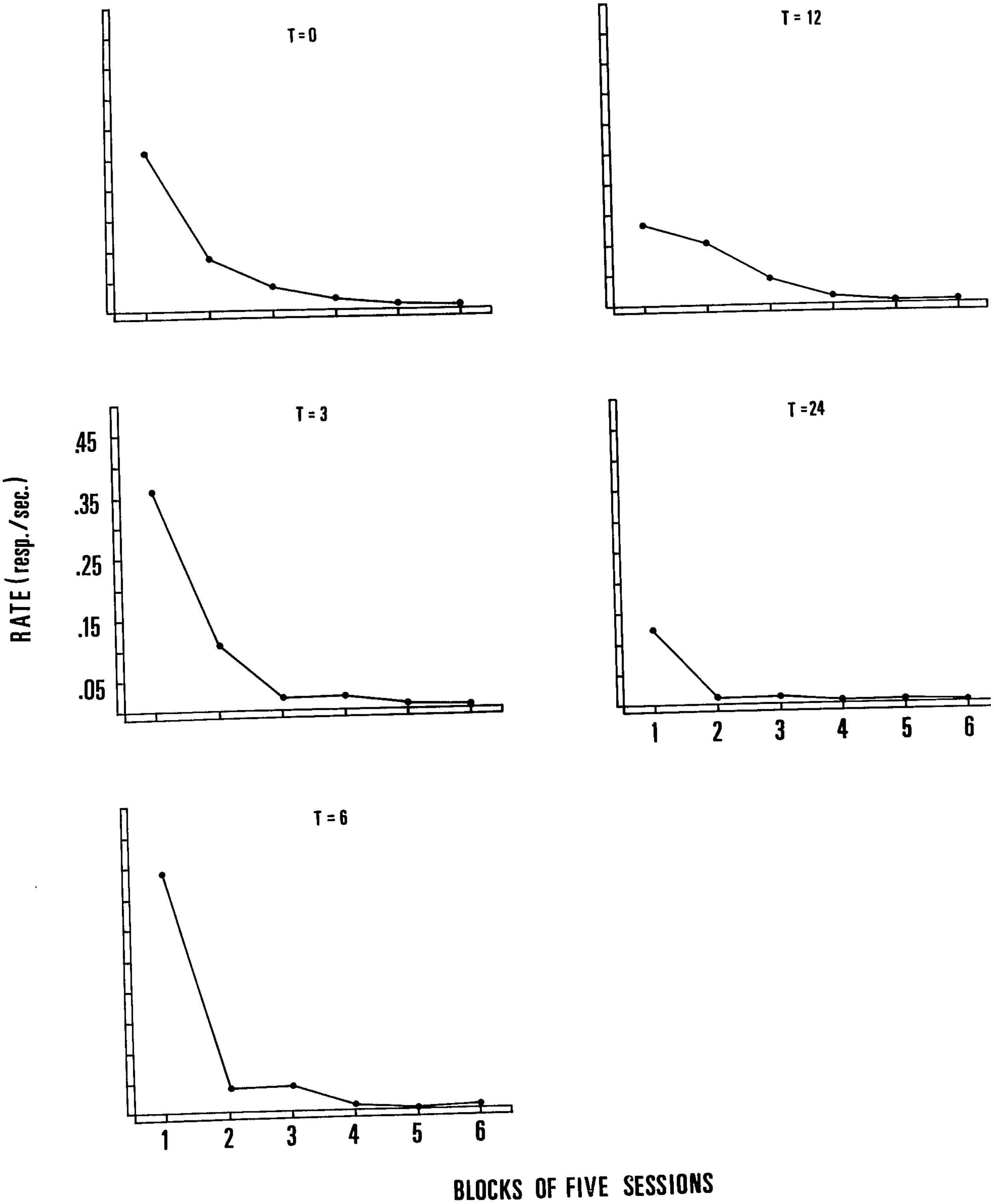

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.45
.35
.25
.15
.05
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 20: Response rate as a function of blocks of five sessions of exposure to the 120 second non-contingent reinforcement procedure for subject 3. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the procedure.

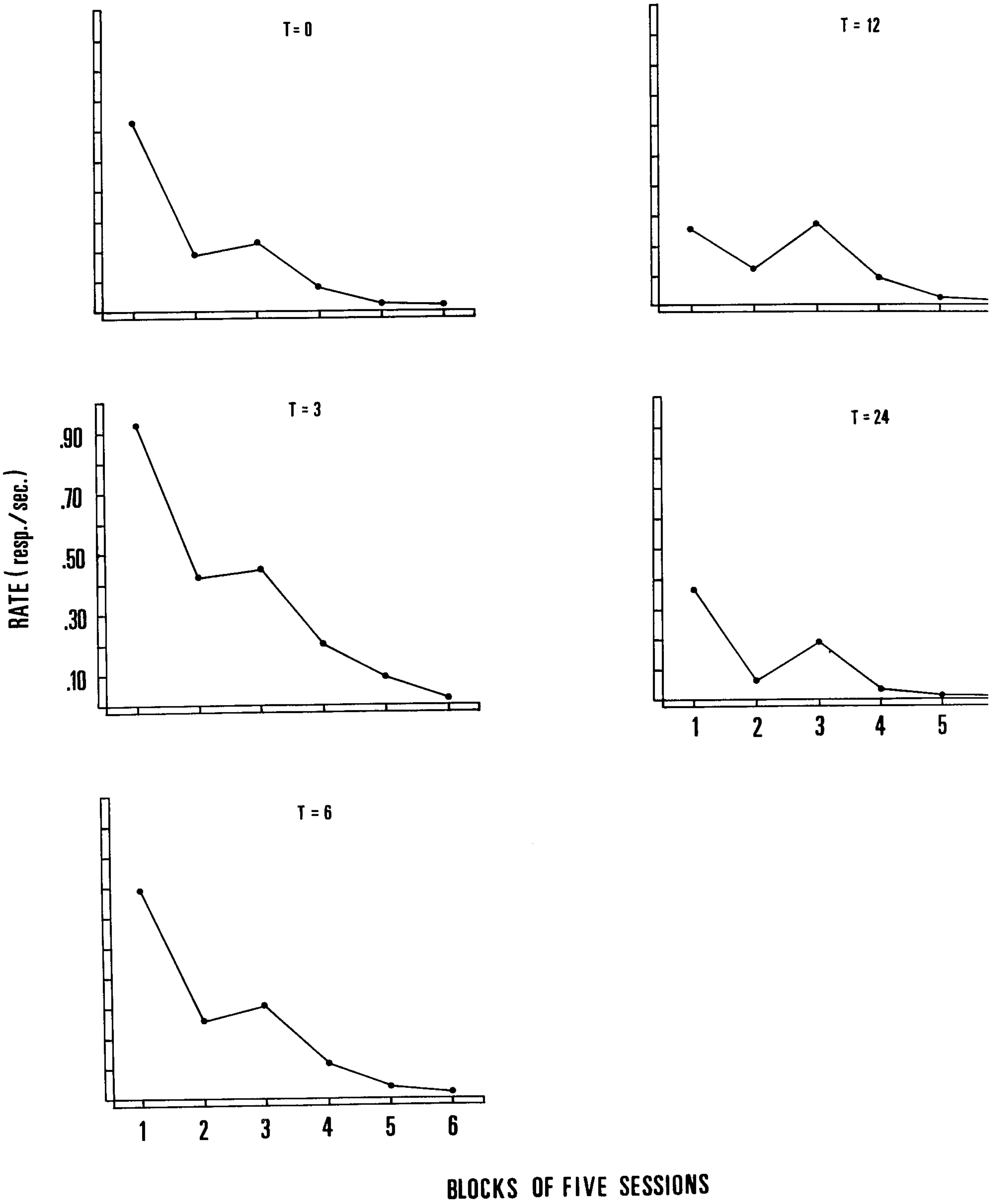

T = 0
T = 12
T = 3
.90
.70
.50
.30
.10
RATE (resp./sec.)
T = 24
1
2
3
4
5
T = 6
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 21: Response rate as a function of blocks of five sessions of exposure to the 120 second non-contingent reinforcement procedure for subject 4. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the procedure.

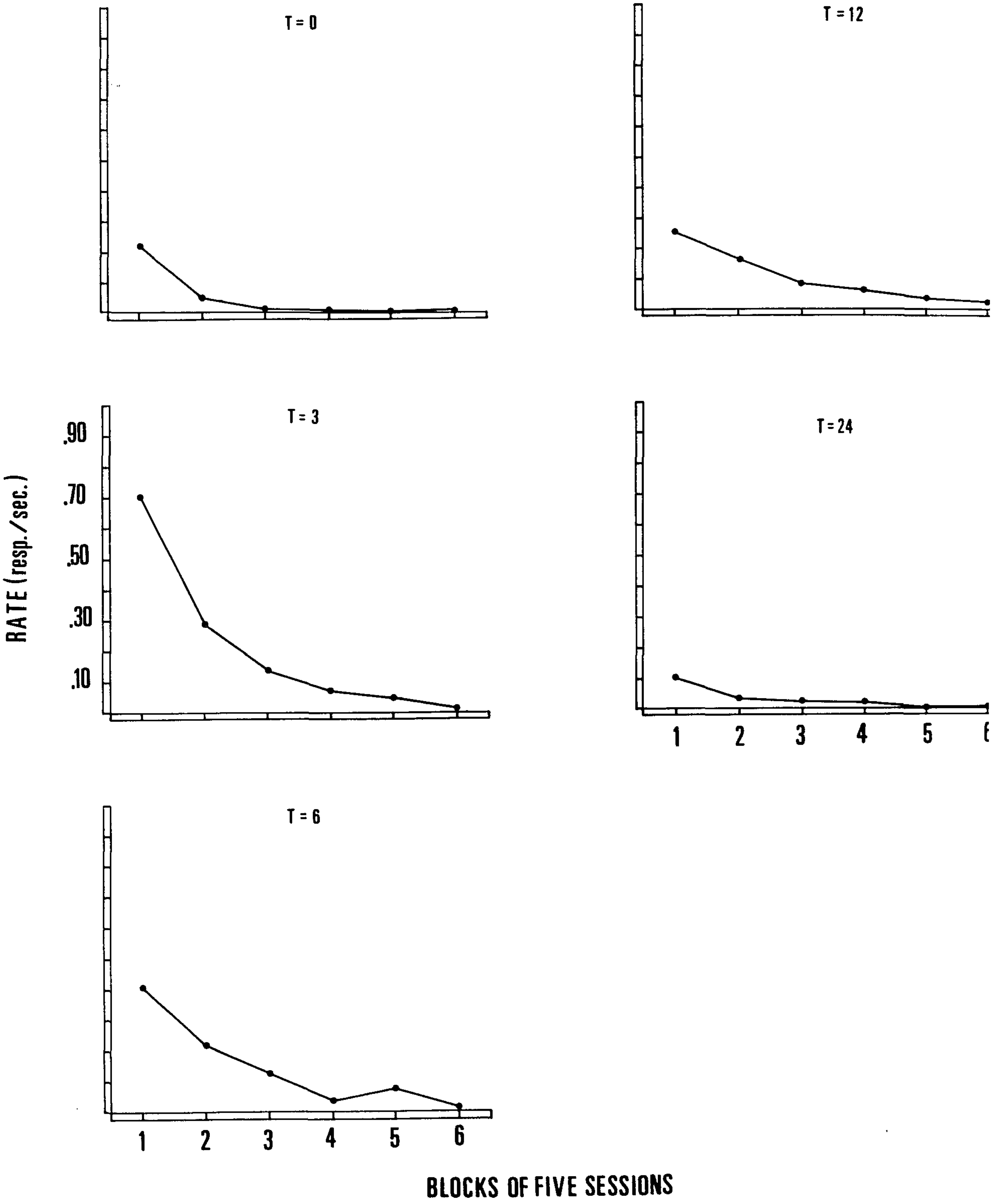

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.90
.70
.50
.30
.10
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 22: Response rate as a function of T for the 120 second non-contingent reinforcement procedure for subject 1. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

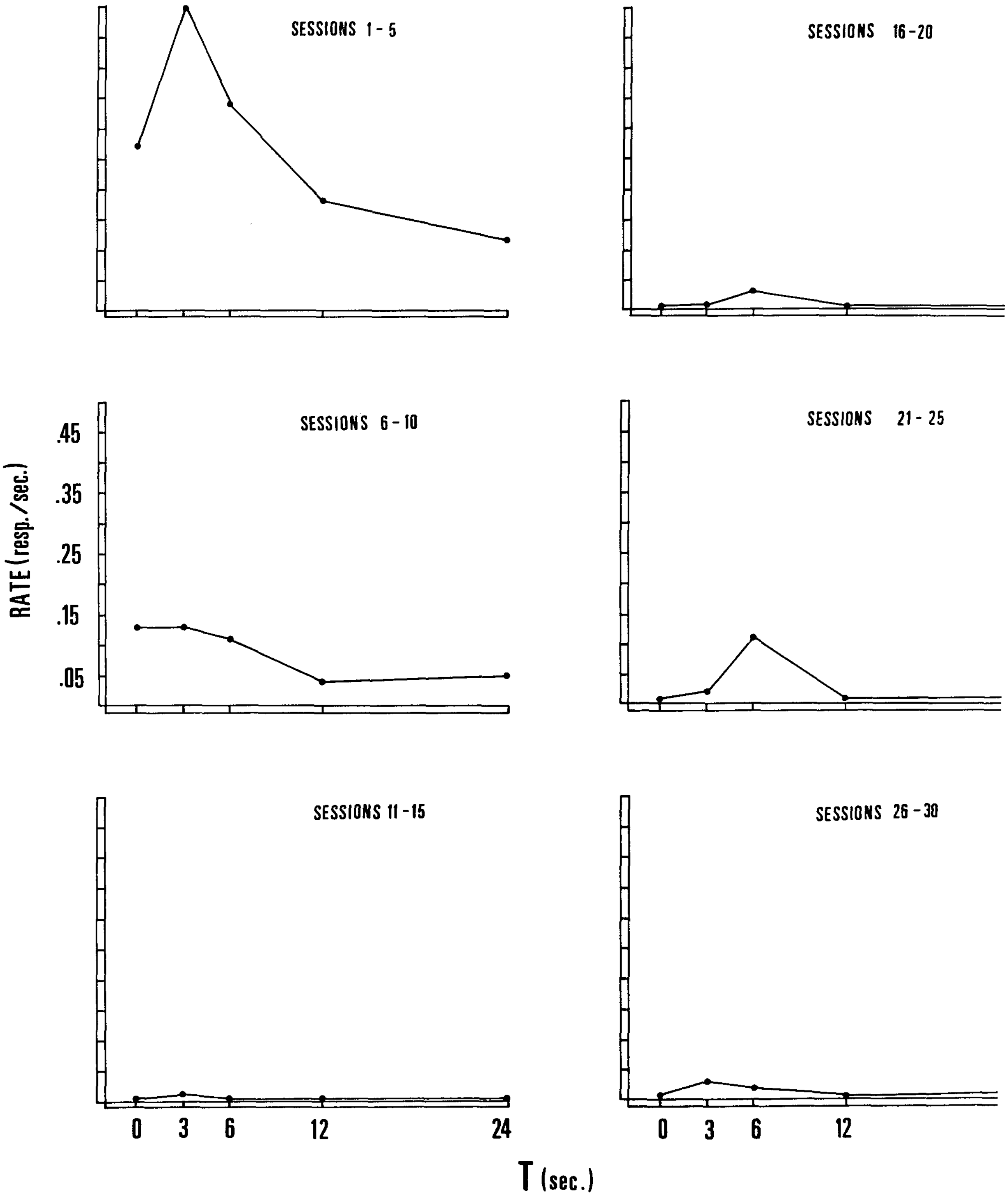

SESSIONS 1 - 5
SESSIONS 16-20
SESSIONS 6 - 10
SESSIONS 21 - 25
SESSIONS 11 -15
SESSIONS 26 - 30
RATE (resp./sec.)
.45
.35
.25
.15
.05
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 23: Response rate as a function of T for the 120 second non-contingent reinforcement procedure for subject 2. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

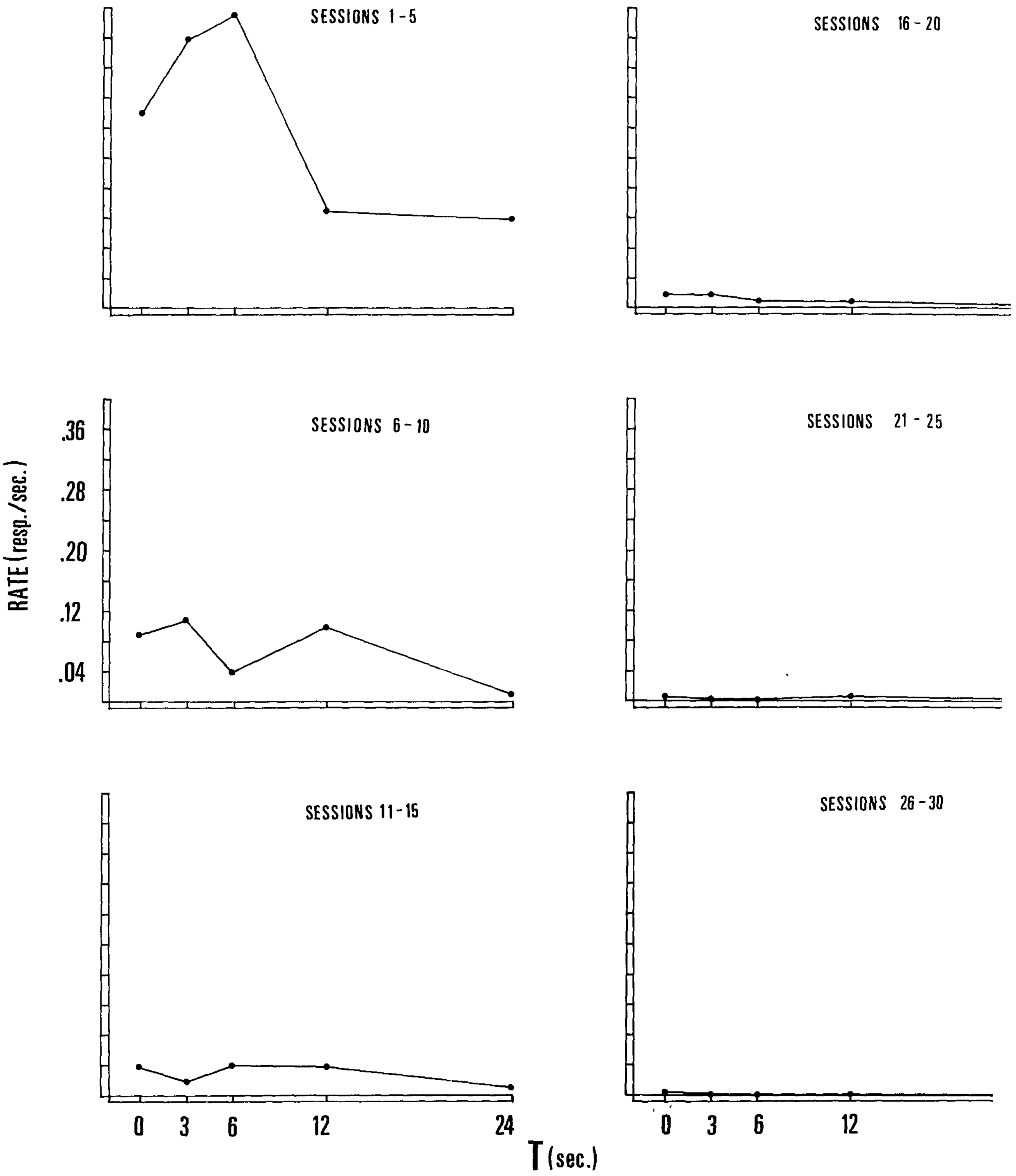

SESSIONS 1-5
SESSIONS 16-20
SESSIONS 6-10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
.36
.28
.20
.12
.04
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 24: Response rate as a function of T for the 120 second non-contingent reinforcement procedure for subject 3. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

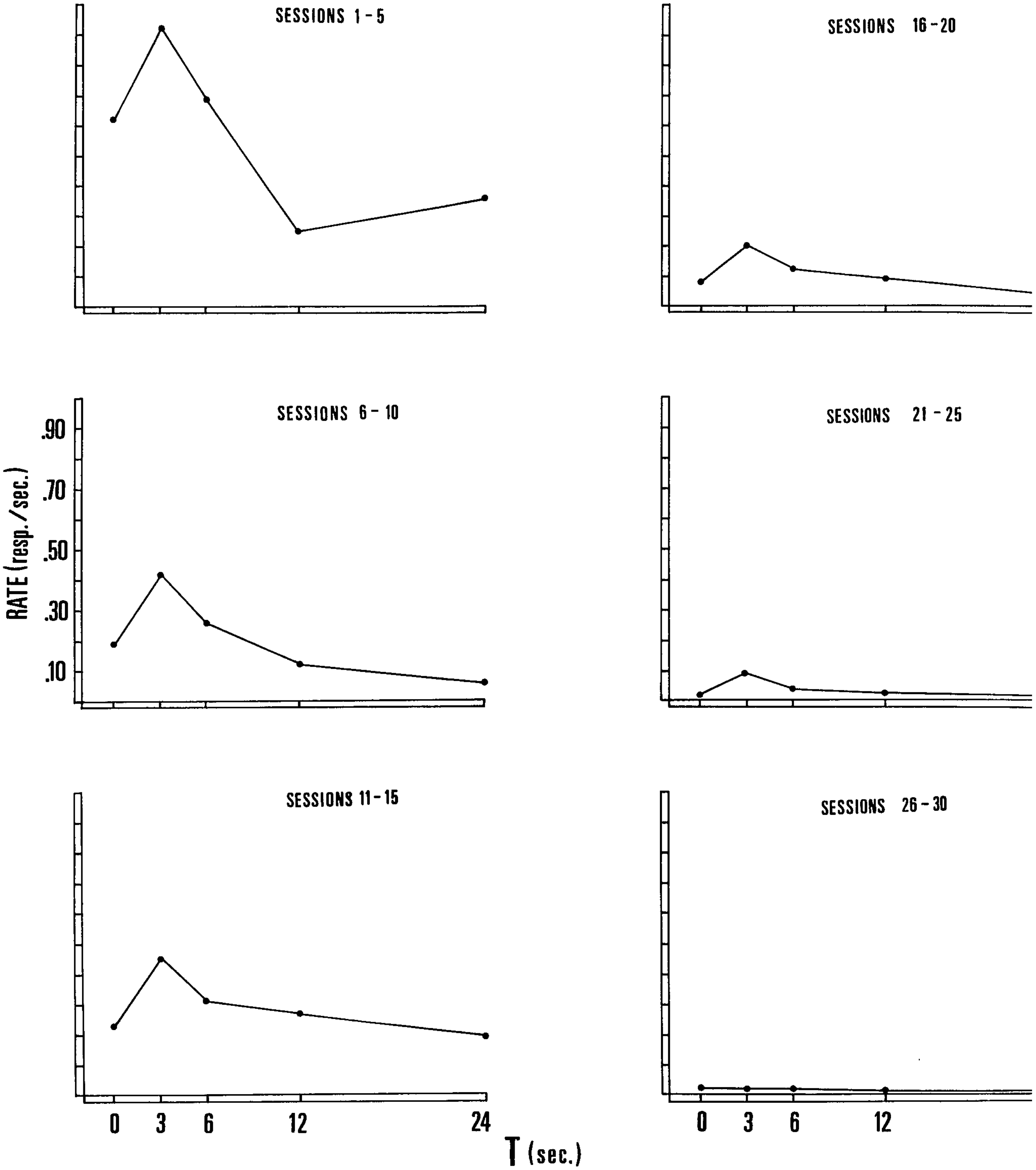
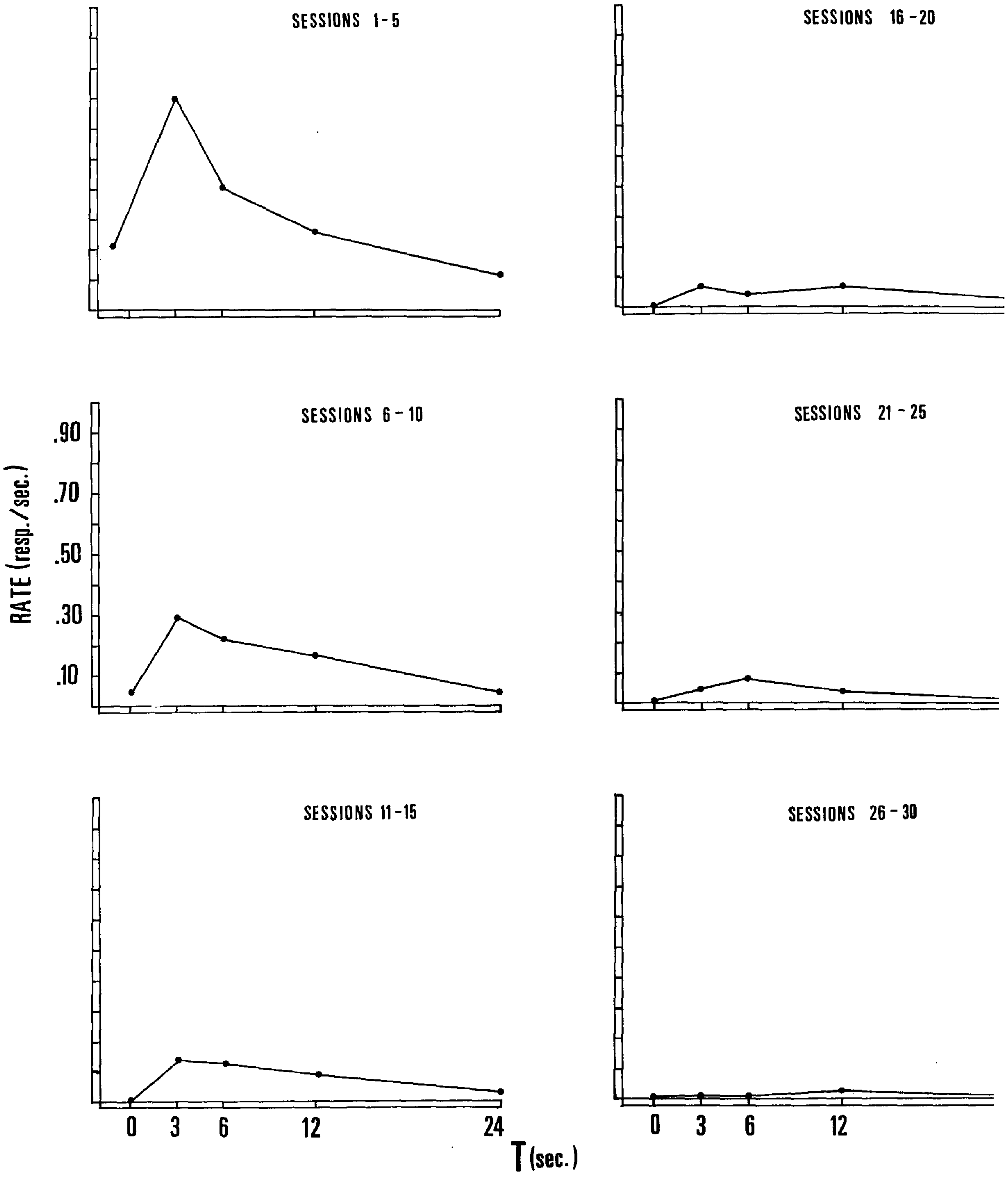

SESSIONS 1 - 5
SESSIONS 16 - 20
SESSIONS 6 - 10
SESSIONS 21 - 25
SESSIONS 11 - 15
SESSIONS 26 - 30
RATE (resp./sec.)
.90
.70
.50
.30
.10
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 25: Response rate as a function of T for the 120 second non-contingent reinforcement procedure for subject 4. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.


SESSIONS 1-5
SESSIONS 16-20
SESSIONS 6-10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
.90
.70
.50
.30
.10
0
3
6
12
24
0
3
6
12
T (sec.)

The PS^RP functions are basically the same as those shown for the 60 second non-contingent reinforcement procedure (compare Figs. 13 and 26). However, the PS^RP's for the 120 second non-contingent reinforcement procedure are generally longer than those found for the 60 second non-contingent reinforcement procedure. The smallest PS^RP's are found in the presence of the T=3 stimulus, with an increase at higher T values, as well as at T=0. The PS^RP's are again elevated above the baseline recovery values. As was the case with the 60 second non-contingent reinforcement procedure, no temporal discrimination was noted with either the RNC or FNC procedures. The IS^RT data again show a good correspondence to that predicted by T/P (Fig. 27).

When the baseline procedure was reinstated, the basic functions previously described were recovered. The rate of responding is a decreasing, generally monotonic function of the length of T (Fig. 28), while PS^RP is a generally monotonic increasing function of T (Fig. 29). The IS^RT data again show a close approximation to that predicted by T/P (Fig. 30).

The results obtained following exposure to the 30 second non-contingent reinforcement procedure were similar to those shown for the 60 and 120 second non-contingent reinforcement procedures. As exposure to the non-contingent reinforcement schedule continues, the rate of responding declines in the presence of all the stimuli previously correlated with the

Figure 26: Post-reinforcement pause as a function of T for the 120 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The functions were obtained by pooling the data over sessions 1-30.

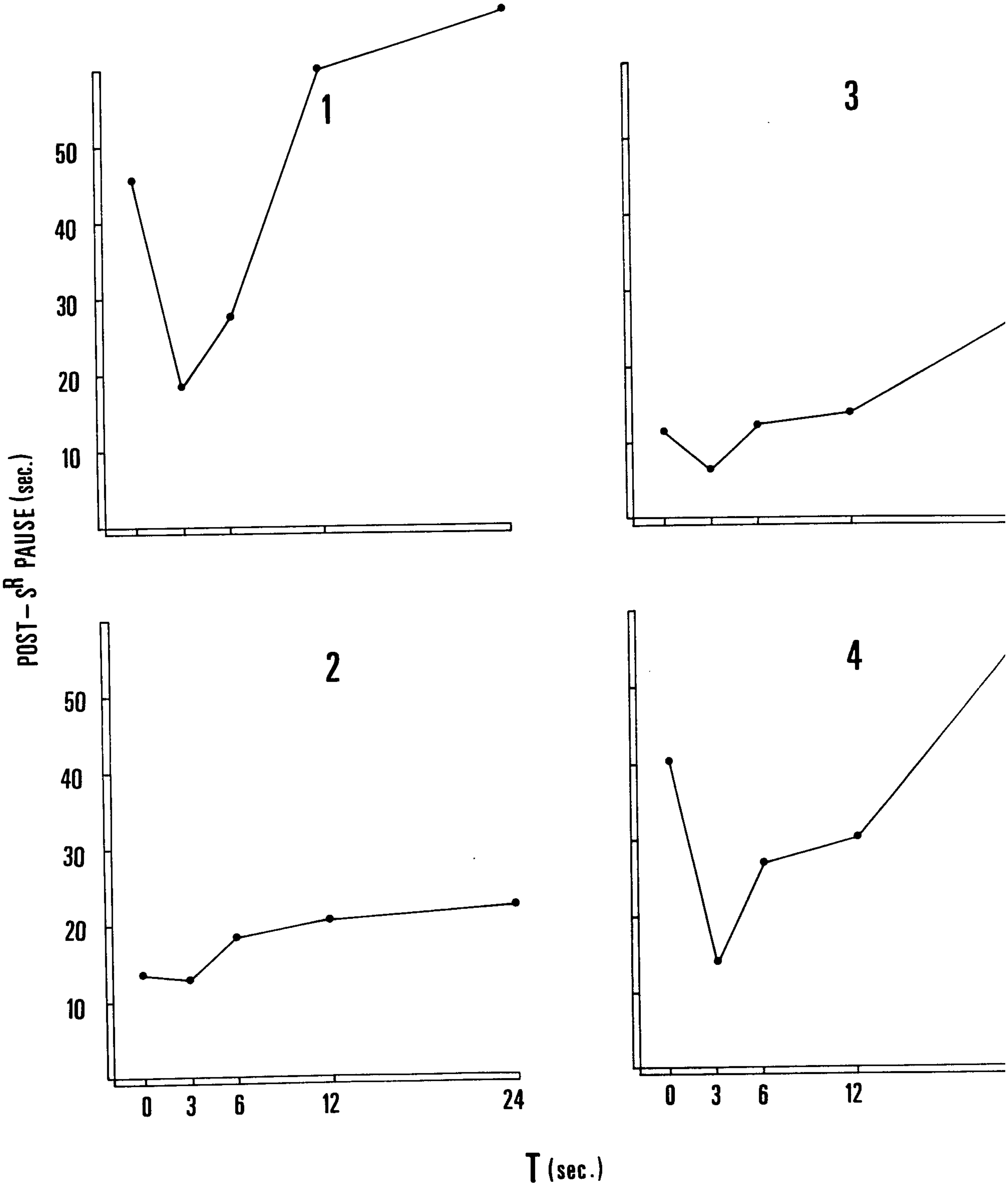

1
3
2
4
50
40
30
20
10
50
40
30
20
10
0
3
6
12
24
0
3
6
12
POST–S^R PAUSE (sec.)
T (sec.)

Figure 27: Predicted (T/P) and observed mean inter-reinforcement time as a function of T for the 120 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The predicted curve has suppressed data points. The observed IS^{R}T function was obtained by pooling the data over sessions 1-30.

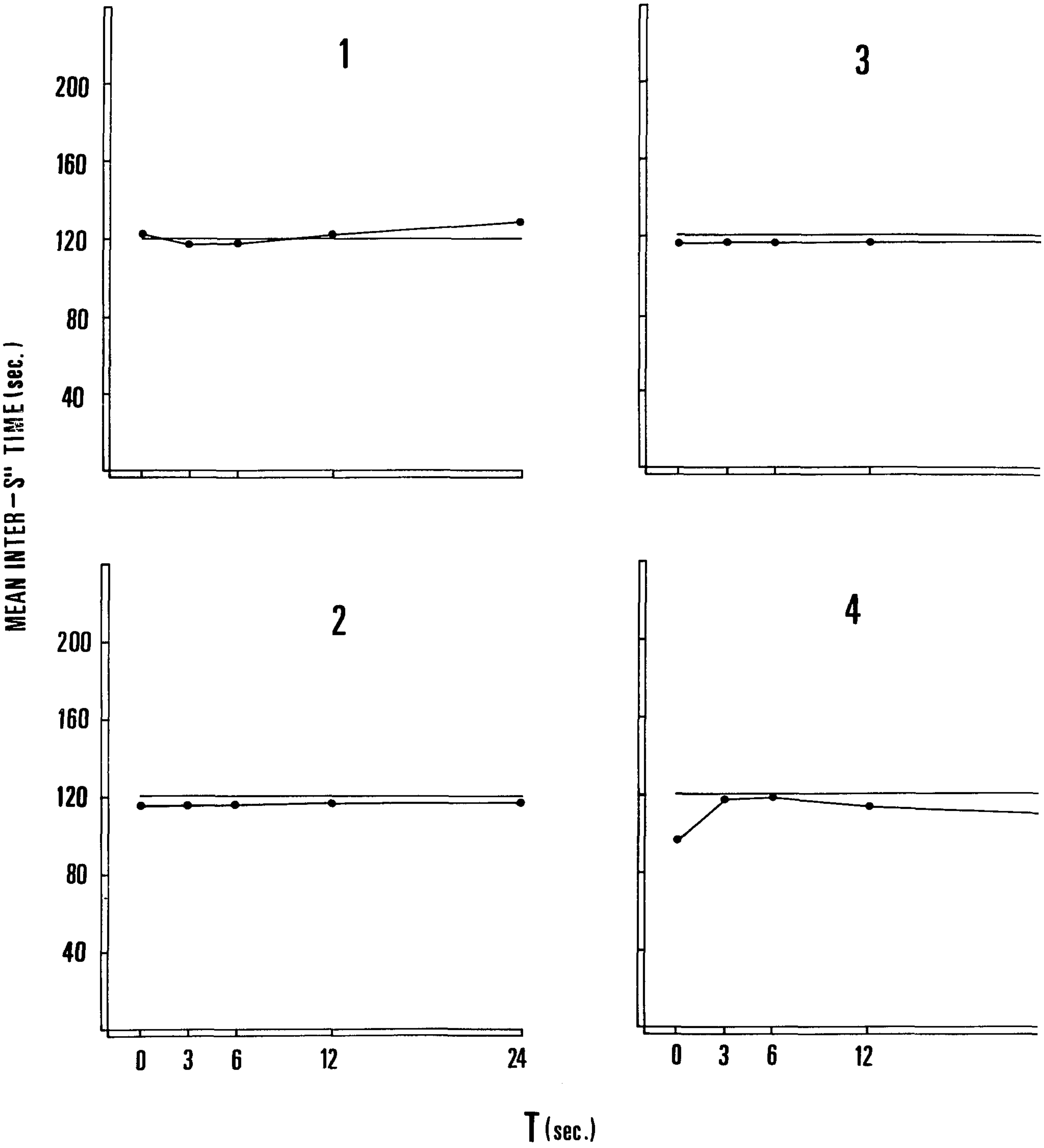

MEAN INTER-S" TIME (sec.)
1
2
3
4
200
160
120
80
40
0
3
6
12
24
T (sec.)

Figure 28: Rate of responding as a function of T for baseline recovery following exposure to the 120 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The open-circle function was obtained by pooling the data over sessions 21-25. The filled-circle function was obtained by pooling the data over sessions 26-30.

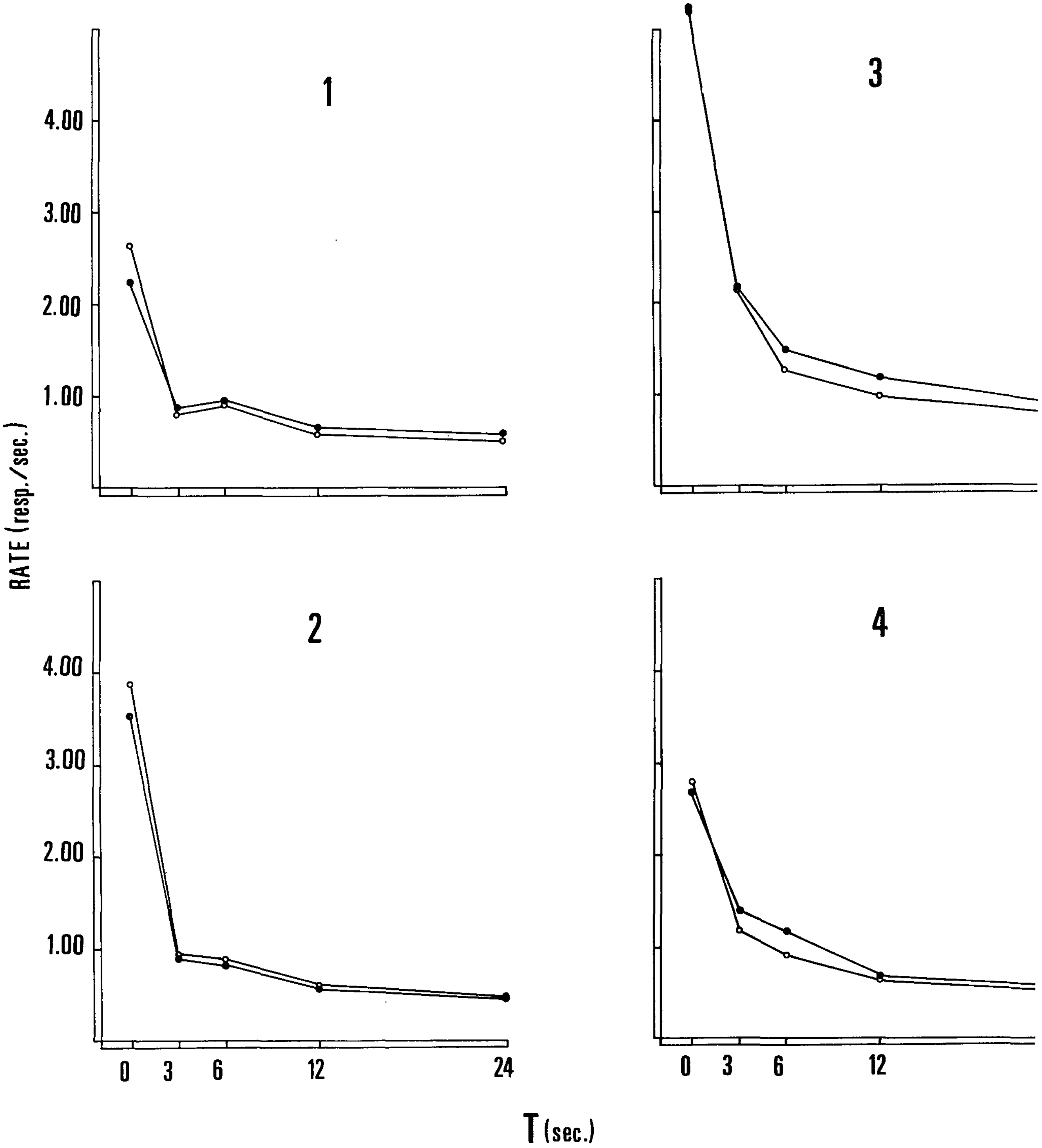

1
2
3
4
RATE (resp./sec.)
4.00
3.00
2.00
1.00
0
3
6
12
24
T (sec.)

Figure 29: Post-reinforcement pause as a function of T for baseline recovery following exposure to the 120 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The open-circle function was obtained by pooling the data over sessions 21-25. The filled-circle function was obtained by pooling the data over sessions 26-30.

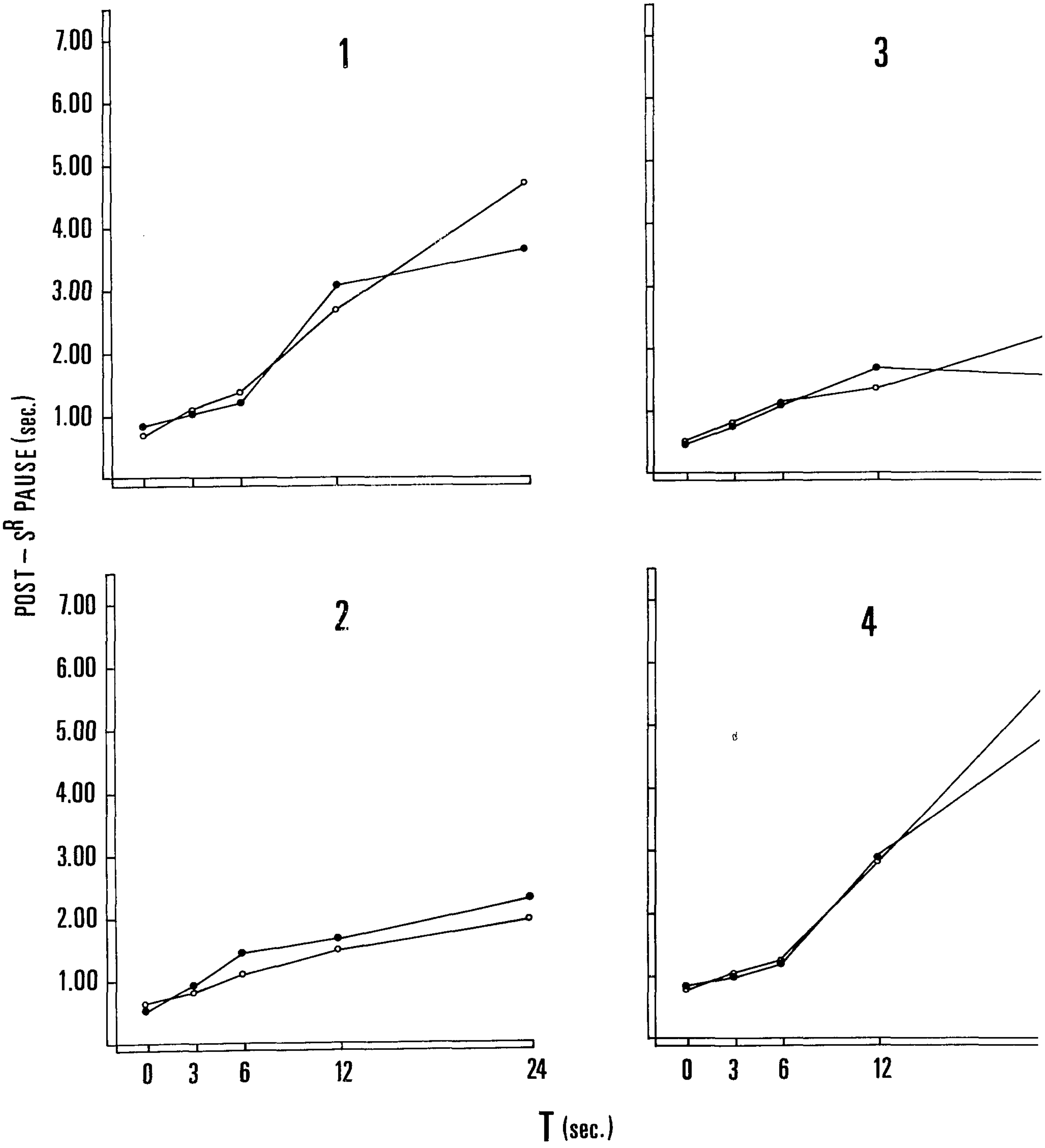
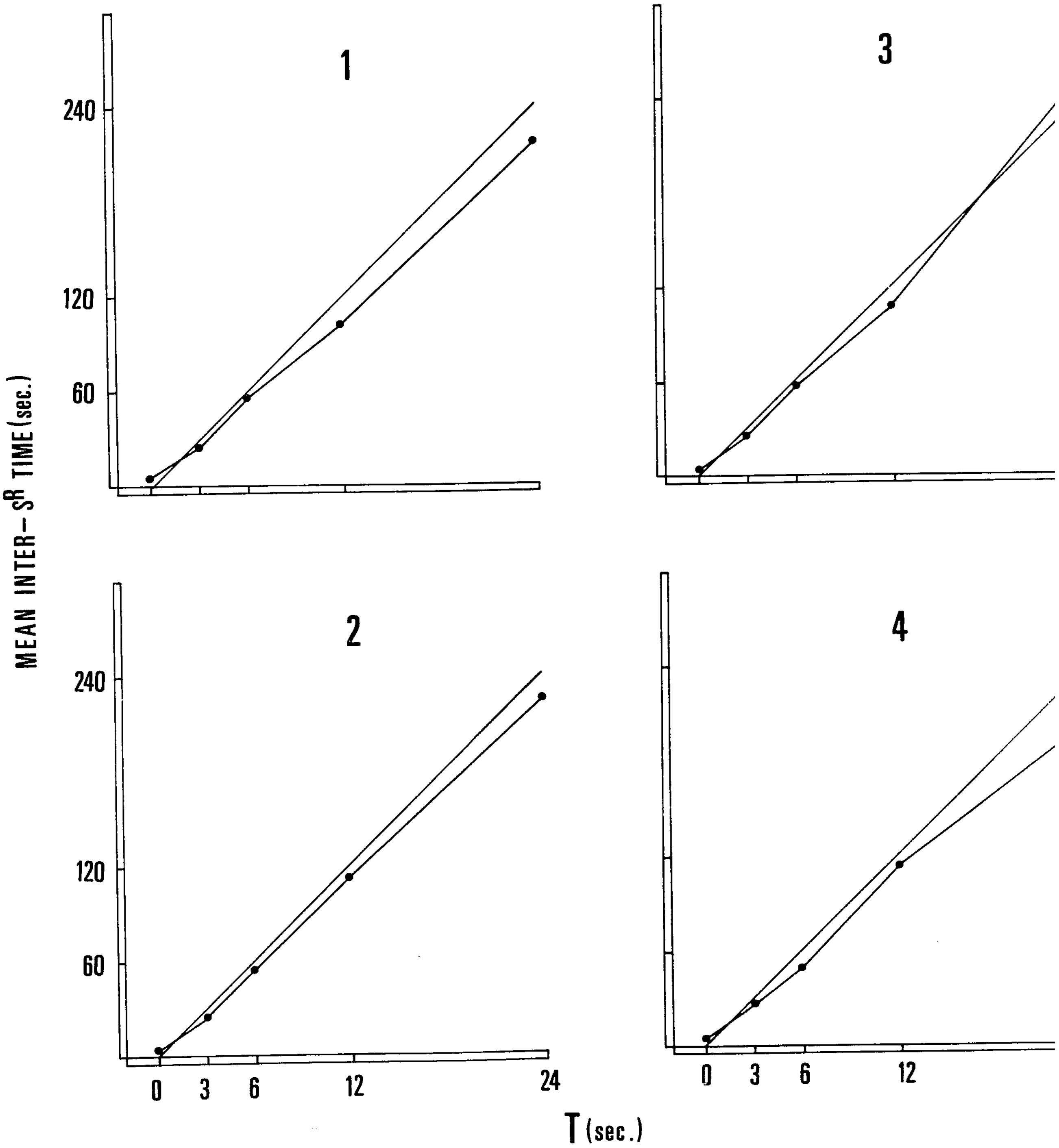

1
2
3
4
7.00
6.00
5.00
4.00
3.00
2.00
1.00
POST – S^R PAUSE (sec.)
0
3
6
12
24
T (sec.)

Figure 30: Predicted (T/P) and observed mean inter-reinforcement time as a function of T for baseline recovery following exposure to the 120 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The predicted curve has suppressed data points. No predicted IS^RT is shown for T=0, since at this value IS^RT is a function of both response rate and P. The observed IS^RT function was obtained by pooling the data over sessions 1-30.


1
3
2
4
MEAN INTER-S^R TIME (sec.)
240
120
60
240
120
60
0
3
6
12
24
0
3
6
12
T (sec.)

baseline procedure (Figs. 31, 32, 33, 34). This is in agreement with the previously cited findings [1,2,3] as well as with the results reported for the 60 and 120 second non-contingent reinforcement procedures.

The behavior is maintained best in the presence of the stimuli which had been correlated with those schedules which generated reasonably high baseline rates of responding (T=0, T=3, T=6), as shown in Figs. 35, 36, 37, and 38. The behavior maintained in the presence of the T=12 and T=24 stimuli appears to be disrupted the most by this procedure. For the T=12 and T=24 stimuli, the 30 second non-contingent reinforcement procedure represents a decrease in mean $IS^{R}T$ of 75% and 87.5%, respectively. With the relatively low baseline rates generated by the T=12 and T=24 schedules, this decrease in mean $IS^{R}T$ results in a greater probability that $\not{R}$ will be strengthened by the non-contingent reinforcement.

The $PS^{R}P$ functions are not as uniform as those previously reported (compare Figs. 13, 26 and 39). Two basic functions appear to be in evidence. An increasing function from T=3 on, with an increase at T=0, or a generally monotonic increasing function with the smallest $PS^{R}P$ at T=0. The $PS^{R}P$'s are again

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1. Skinner, F.B. (1938) op. cit.
2. Herrnstein, R.J. (1966) op. cit.
3. Zeiler, M.D. (1968) op. cit.

Figure 31: Response rate as a function of blocks of five sessions of exposure to the 30 second non-contingent reinforcement procedure for subject 1. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the procedure.

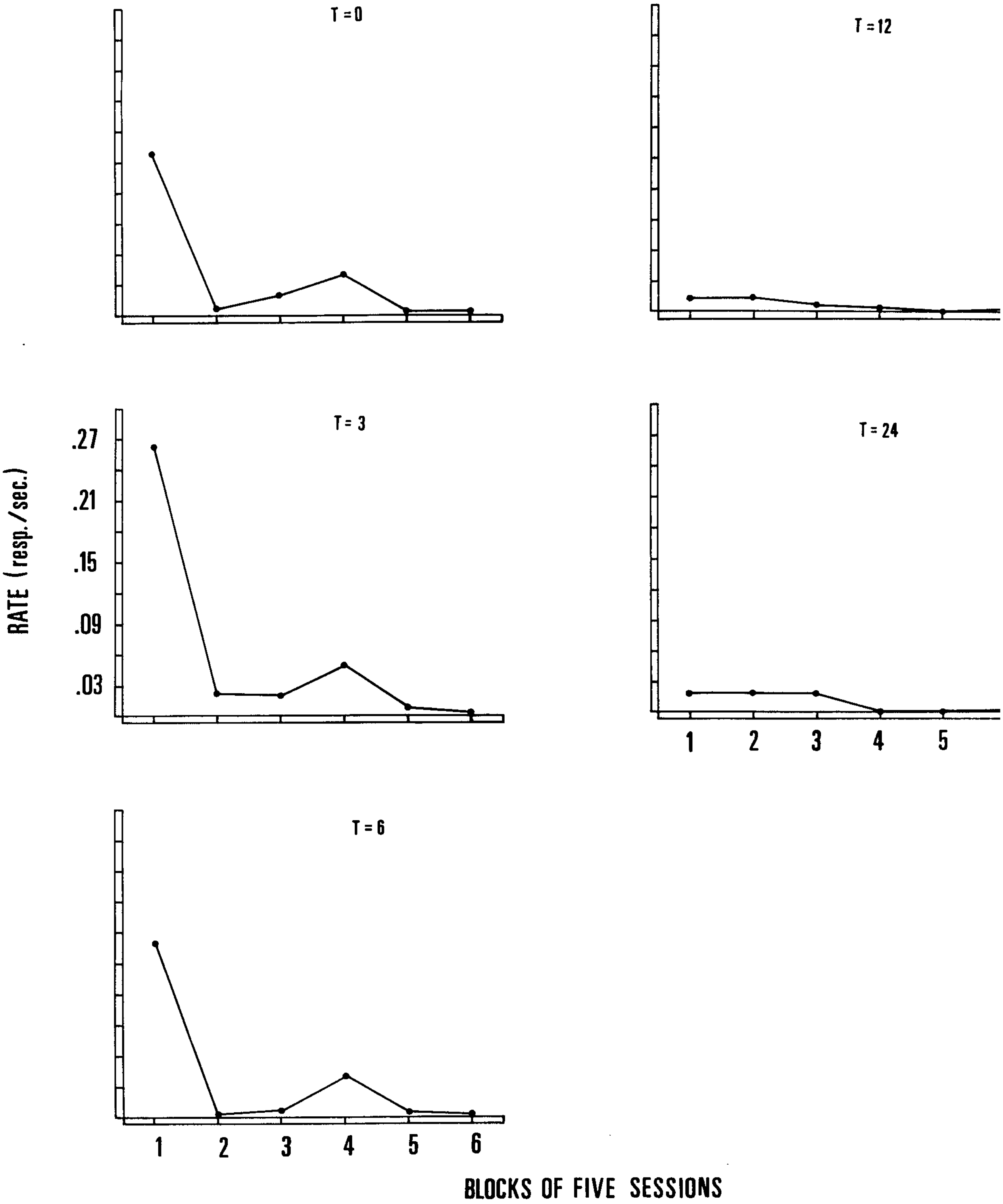

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.27
.21
.15
.09
.03
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 32: Response rate as a function of blocks of five sessions of exposure to the 30 second non-contingent reinforcement procedure for subject 2. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the procedure.

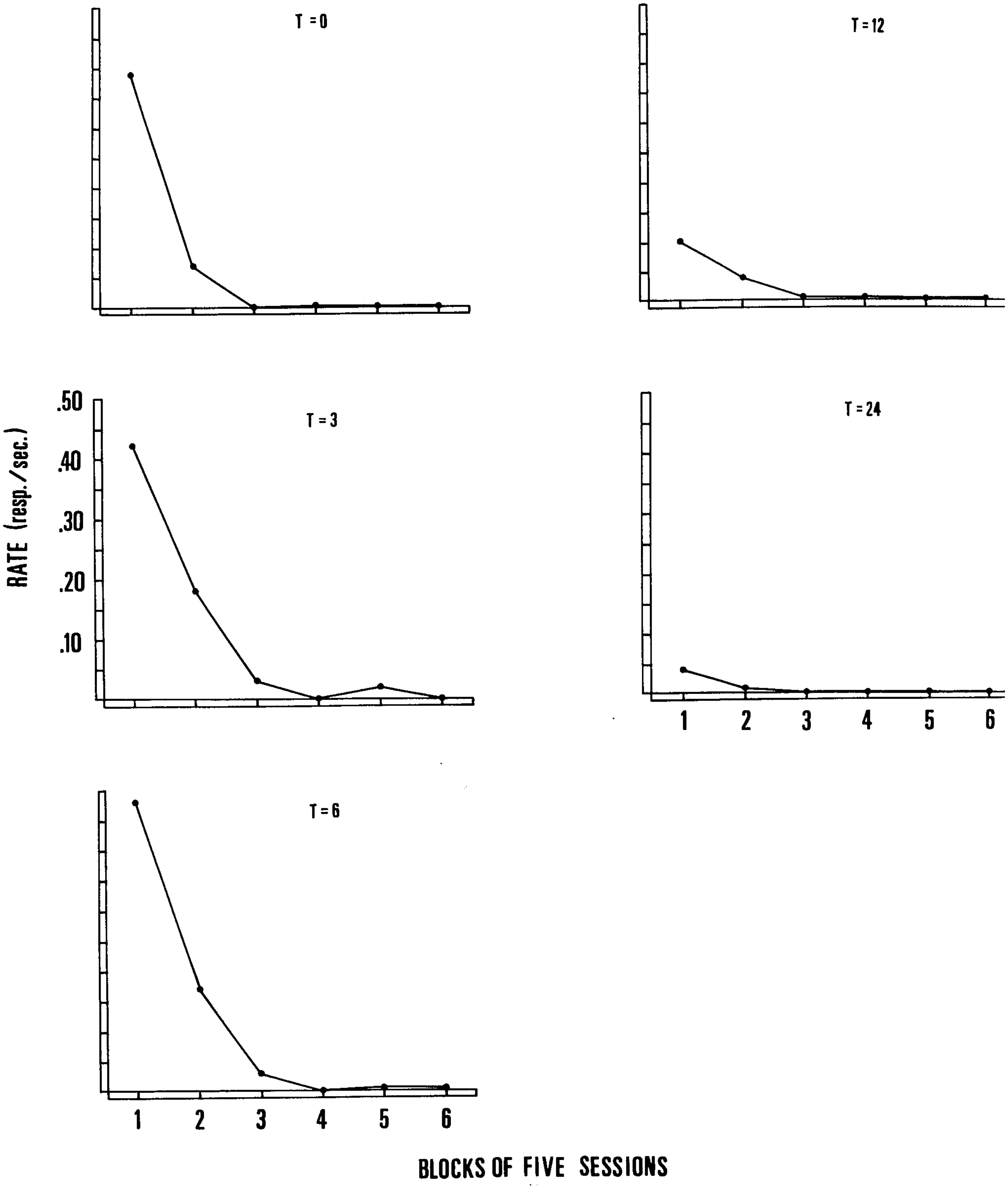

T = 0
T = 12
.50
.40
.30
.20
.10
RATE (resp./sec.)
T = 3
T = 24
1
2
3
4
5
6
T = 6
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 33: Response rate as a function of blocks of five sessions of exposure to the 30 second non-contingent reinforcement procedure for subject 3. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the procedure.

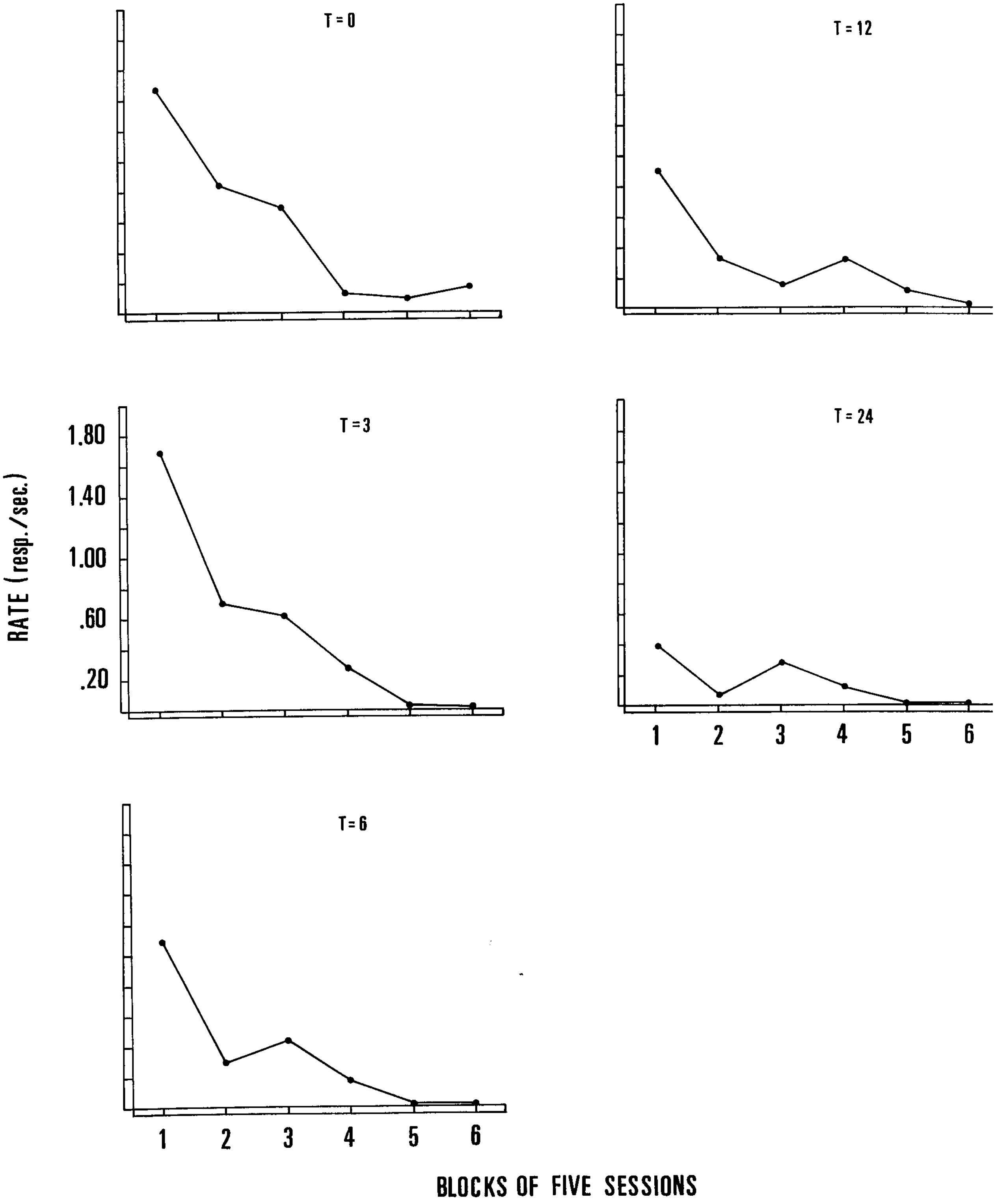

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
1.80
1.40
1.00
.60
.20
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 34: Response rate as a function of blocks of five sessions of exposure to the 30 second non-contingent reinforcement procedure for subject 4. The functions in each panel were obtained by pooling the data obtained in the presence of each of the stimuli previously correlated with the baseline procedure over five session blocks of exposure to the procedure.

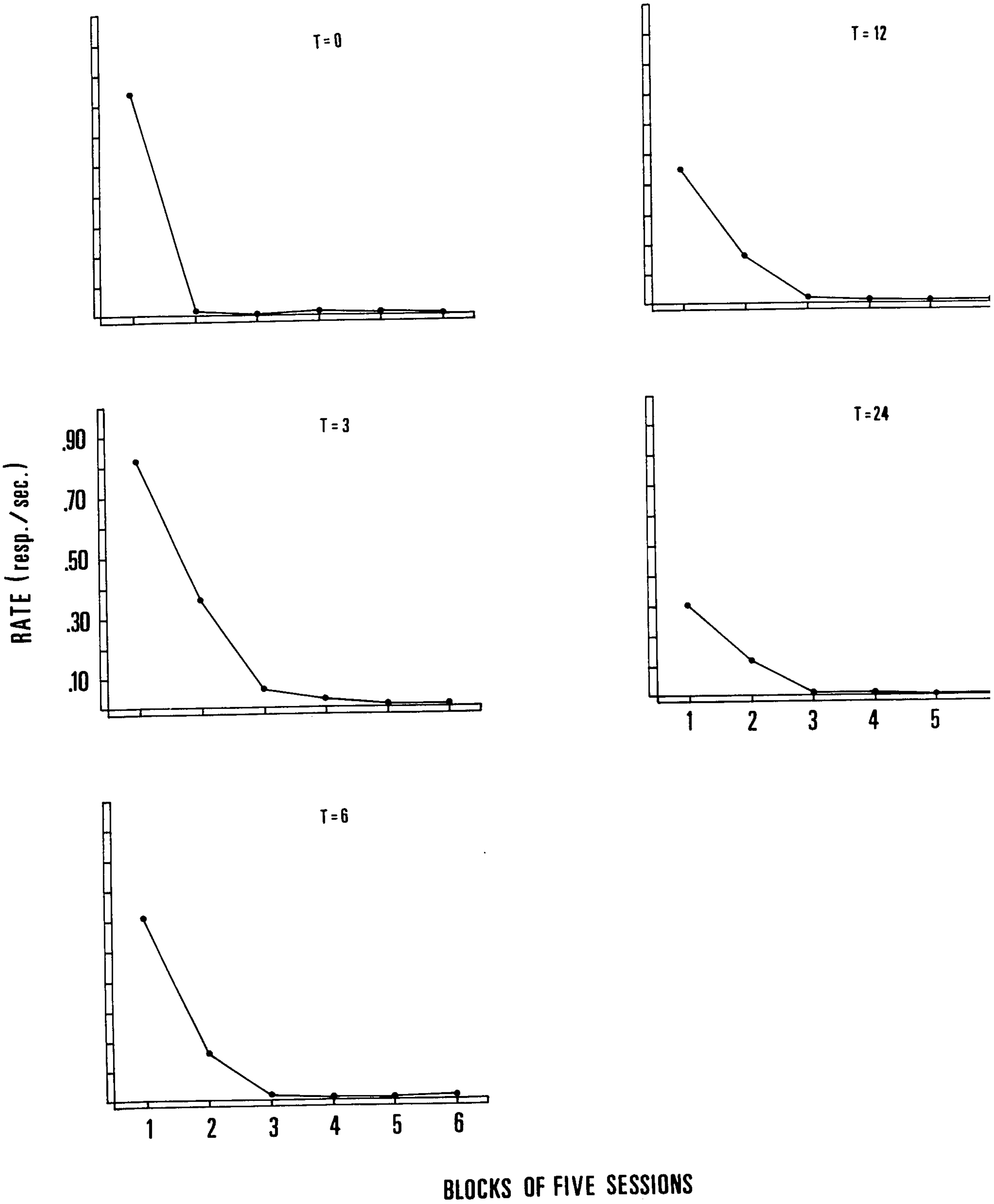

T = 0
T = 12
T = 3
T = 24
T = 6
RATE (resp./sec.)
.90
.70
.50
.30
.10
1
2
3
4
5
6
BLOCKS OF FIVE SESSIONS

Figure 35: Response rate as a function of T for the 30 second non-contingent reinforcement procedure for subject 1. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

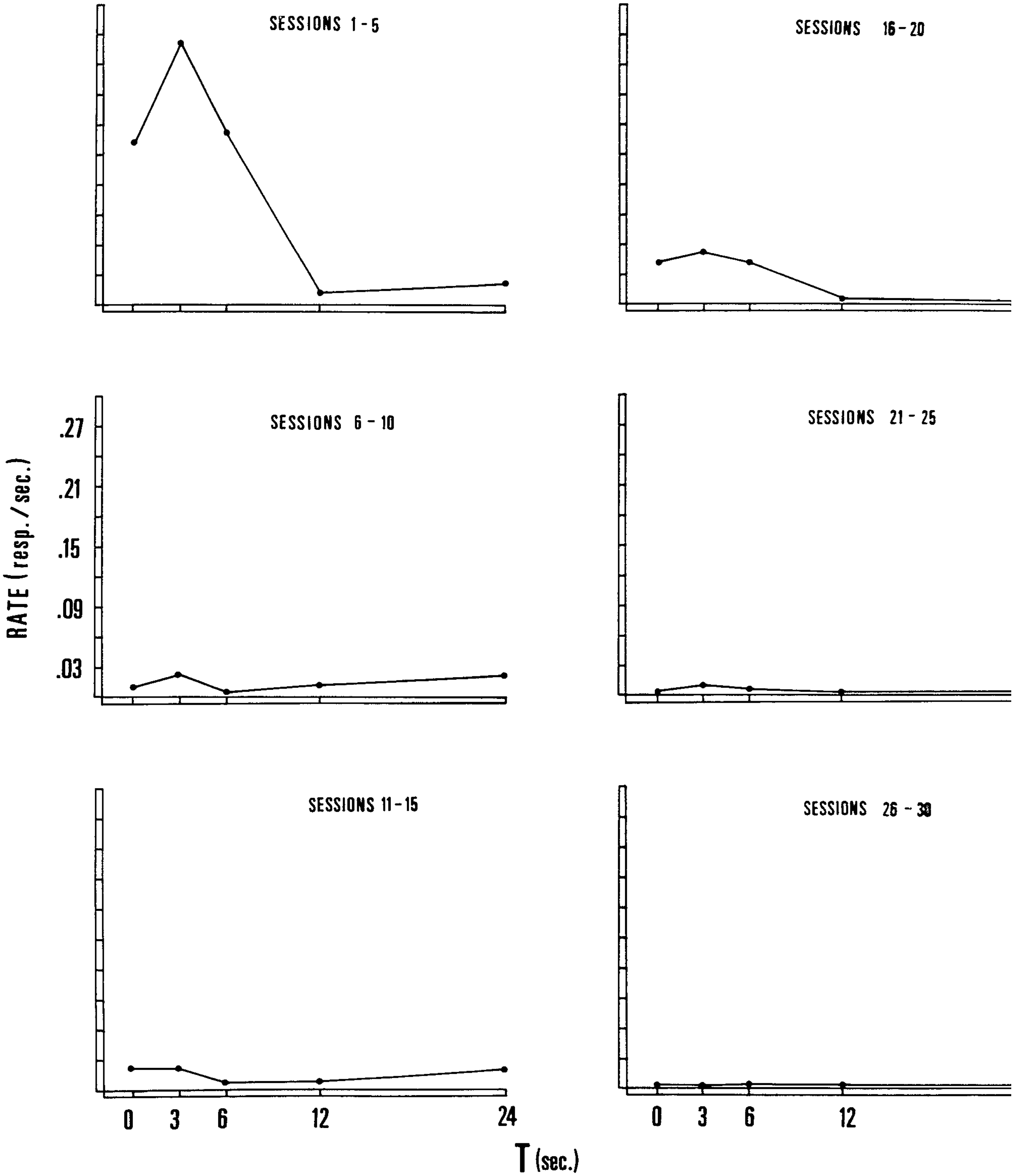

SESSIONS 1 - 5
SESSIONS 16 - 20
SESSIONS 6 - 10
SESSIONS 21 - 25
SESSIONS 11 - 15
SESSIONS 26 - 30
RATE (resp./sec.)
.27
.21
.15
.09
.03
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 36: Response rate as a function of T for the 30 second non-contingent reinforcement procedure for subject 2. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

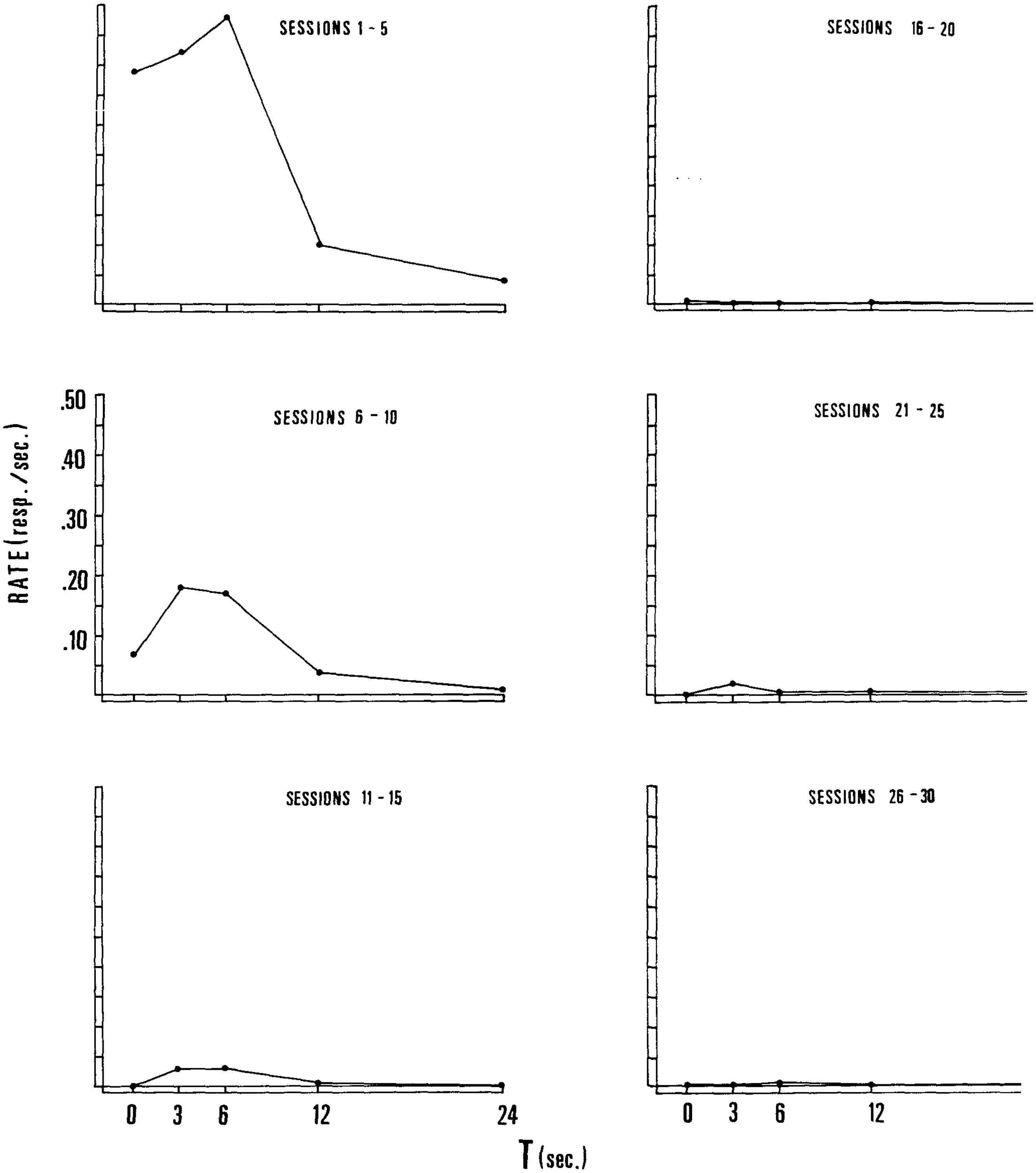

SESSIONS 1 - 5
SESSIONS 16 - 20
SESSIONS 6 - 10
SESSIONS 21 - 25
SESSIONS 11 - 15
SESSIONS 26 - 30
RATE (resp./sec.)
.50
.40
.30
.20
.10
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 37: Response rate as a function of T for the 30 second non-contingent reinforcement procedure for subject 3. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

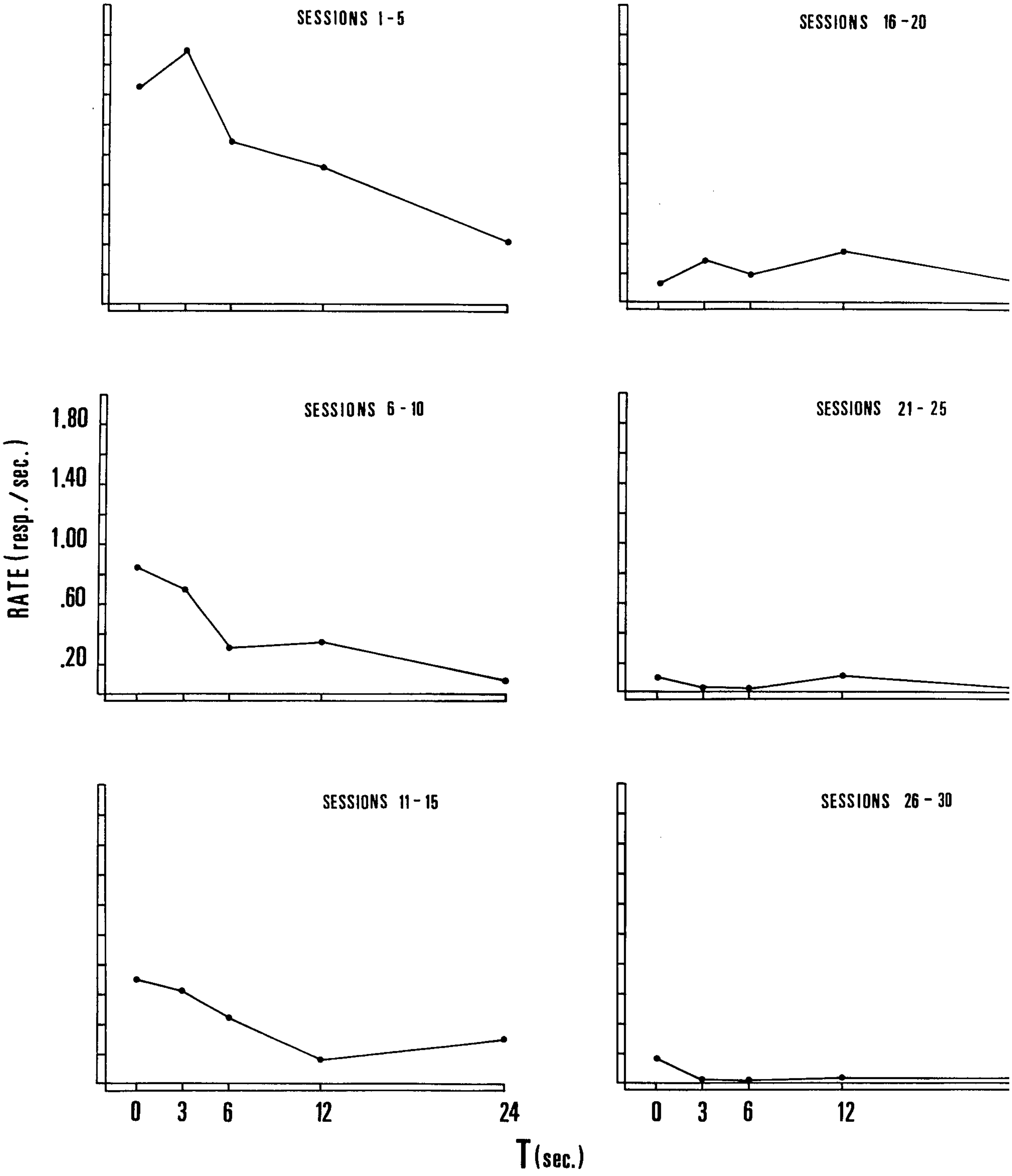

SESSIONS 1-5
SESSIONS 16-20
SESSIONS 6-10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
1.80
1.40
1.00
.60
.20
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 38: Response rate as a function of T for the 30 second non-contingent reinforcement procedure for subject 4. The functions in each panel were obtained by pooling the data over five sessions of exposure to the procedure for each of the stimuli previously correlated with the baseline procedure.

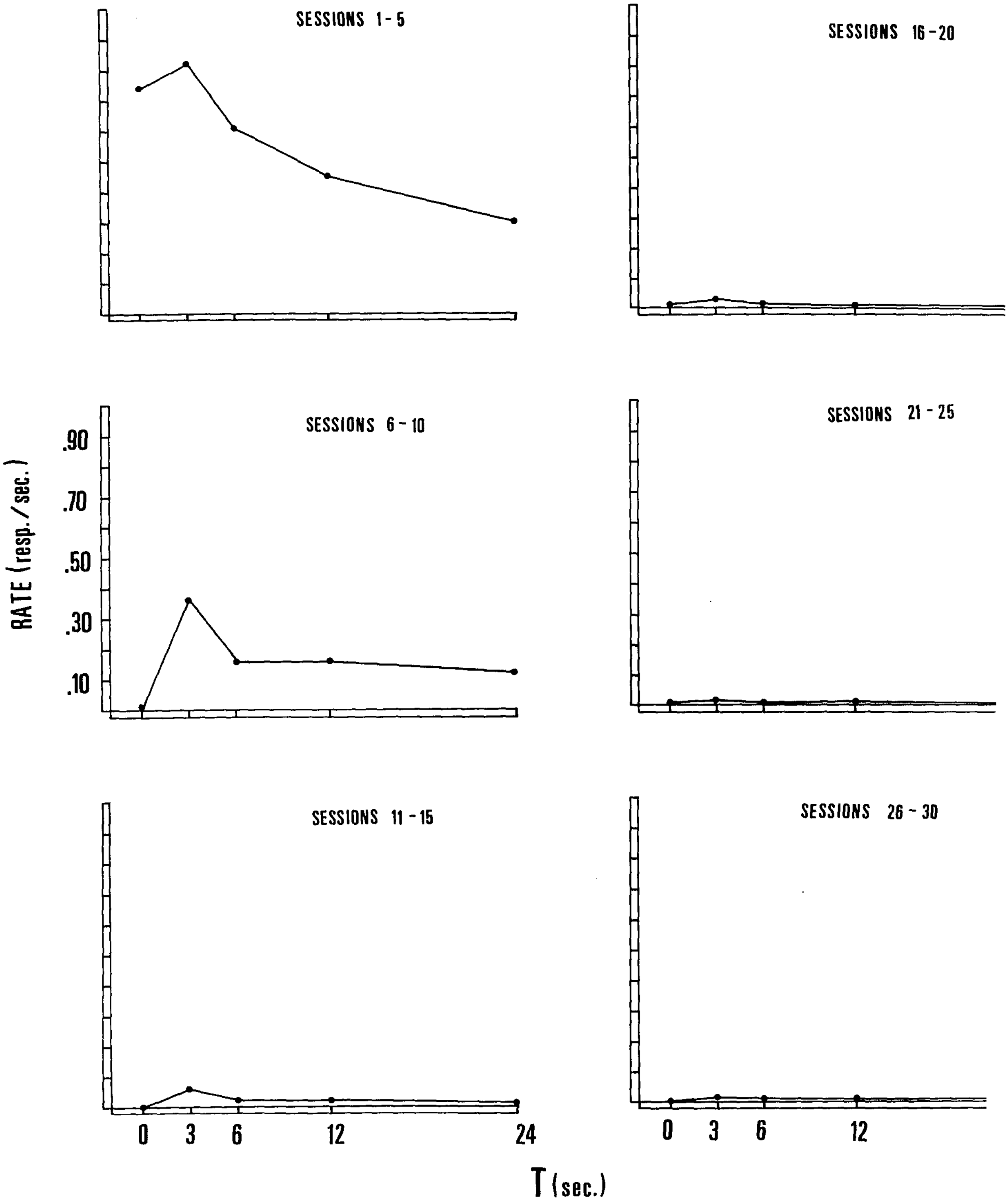
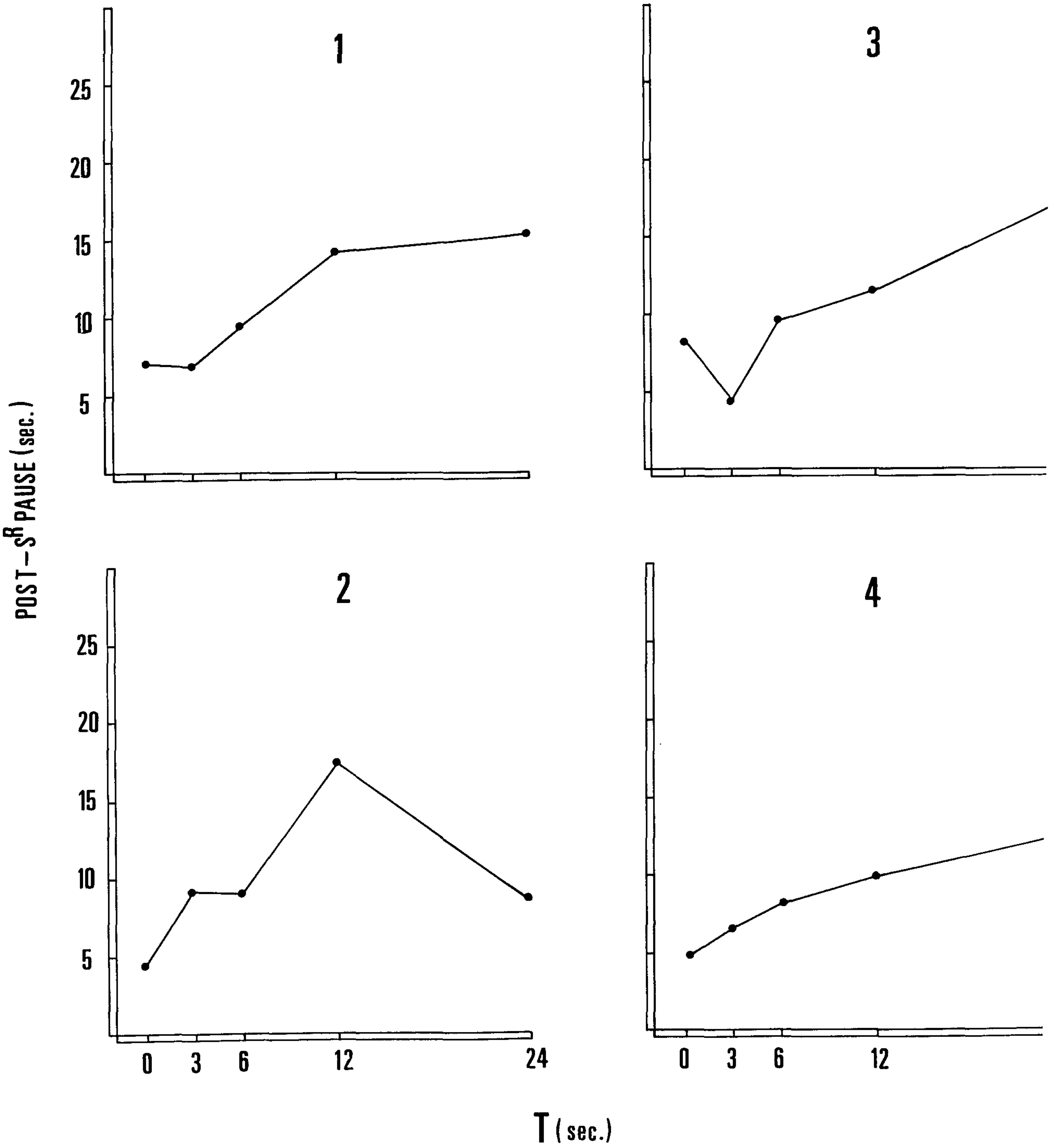

SESSIONS 1-5
SESSIONS 16-20
SESSIONS 6-10
SESSIONS 21-25
SESSIONS 11-15
SESSIONS 26-30
RATE (resp./sec.)
.90
.70
.50
.30
.10
0
3
6
12
24
0
3
6
12
T (sec.)

Figure 39: Post-reinforcement pause as a function of T for the 30 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The functions were obtained by pooling the data over sessions 1-30.


1
3
2
4
POST-S^R PAUSE (sec.)
25
20
15
10
5
0
3
6
12
24
T (sec.)

elevated above the baseline recovery values, but as was the case with the 60 and 120 second non-contingent reinforcement procedures, no temporal discrimination was noted in either the RNC or FNC procedures. The IS^RT data is again in good agreement with that predicted by T/P (Fig. 40).

The last baseline recovery procedure resulted in data very similar to that previously described. The rate of responding is a decreasing generally monotonic function of the length of T (Fig. 41), while PS^RP is an increasing monotonic function of T (Fig. 42). The IS^RT data again show a close approximation to that predicted by T/P (Fig. 43).

It has been suggested that a non-contingent reinforcement procedure maintains behavior as a result of (1) the accidental contiguity between a response and a non-contingent reinforcement, (2) the slowness of extinction relative to conditioning, and (3) the notion that reinforcement requires only an approximate rather than an exact temporal contiguity in order to strengthen a response.[1] It may be more profitable, however, in light of the evidence which indicates a decline in maintained behavior as exposure to an non-contingent reinforcement procedure increases,[2,3,4] to focus the thrust of the present analysis on those factors which contribute to this decline.

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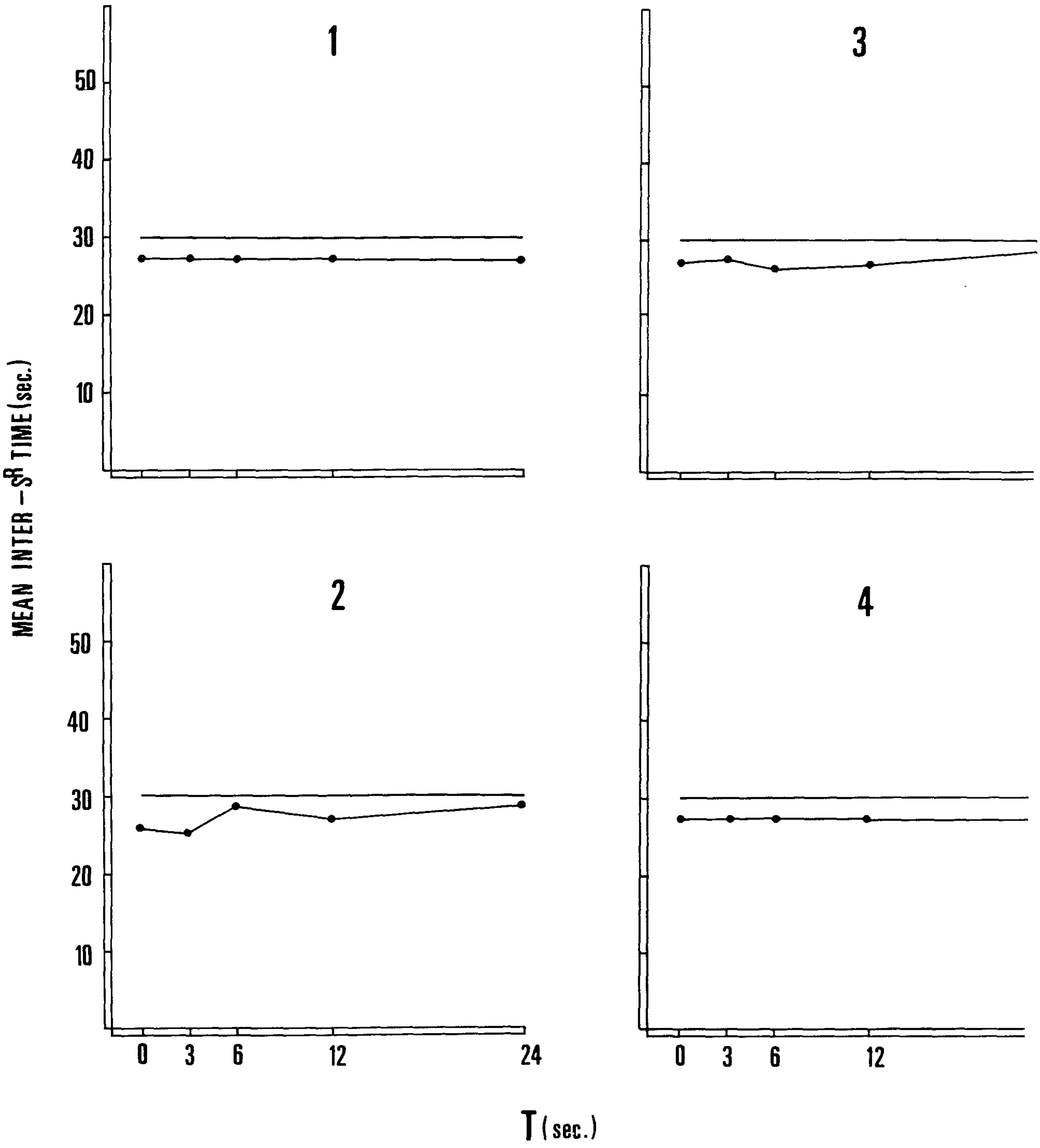
[1] Herrnstein, R.J. (1966) op. cit.

[2] Ibid

[3] Skinner, B. F. (1938) op. cit.

[4] Zeiler, M.D. (1968) op. cit.

Figure 40: Predicted (T/P) and observed mean inter-reinforcement time as a function of T for the 30 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The predicted curve has suppressed data points. The observed IS^RT function was obtained by pooling the data over sessions 1-30.



1
3
2
4
MEAN INTER – S^R TIME (sec.)
50
40
30
20
10
0
3
6
12
24
T (sec.)

Figure 41: Rate of responding as a function of T for baseline recovery following exposure to the 30 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The open-circle function was obtained by pooling the data over sessions 26-30.

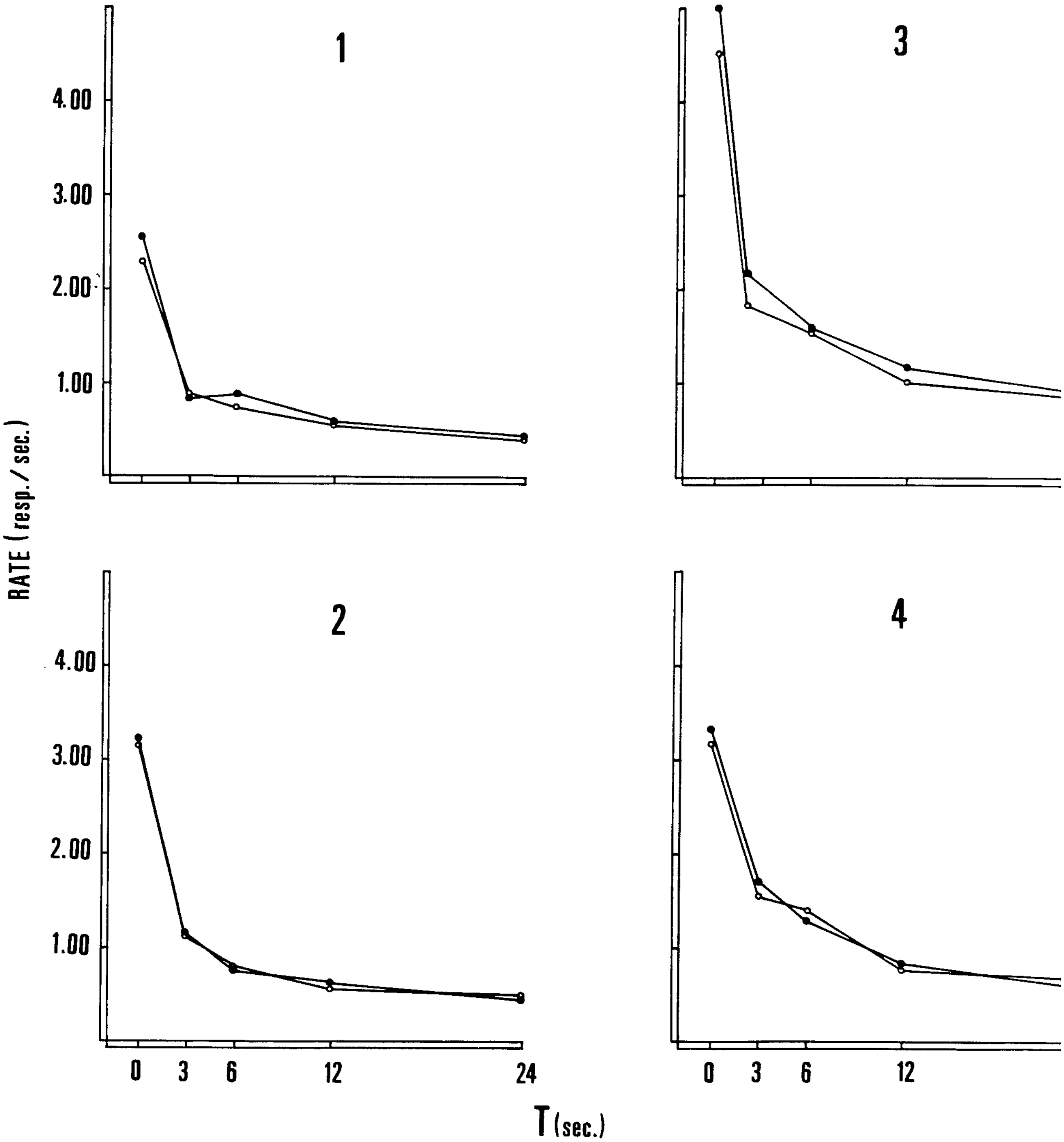
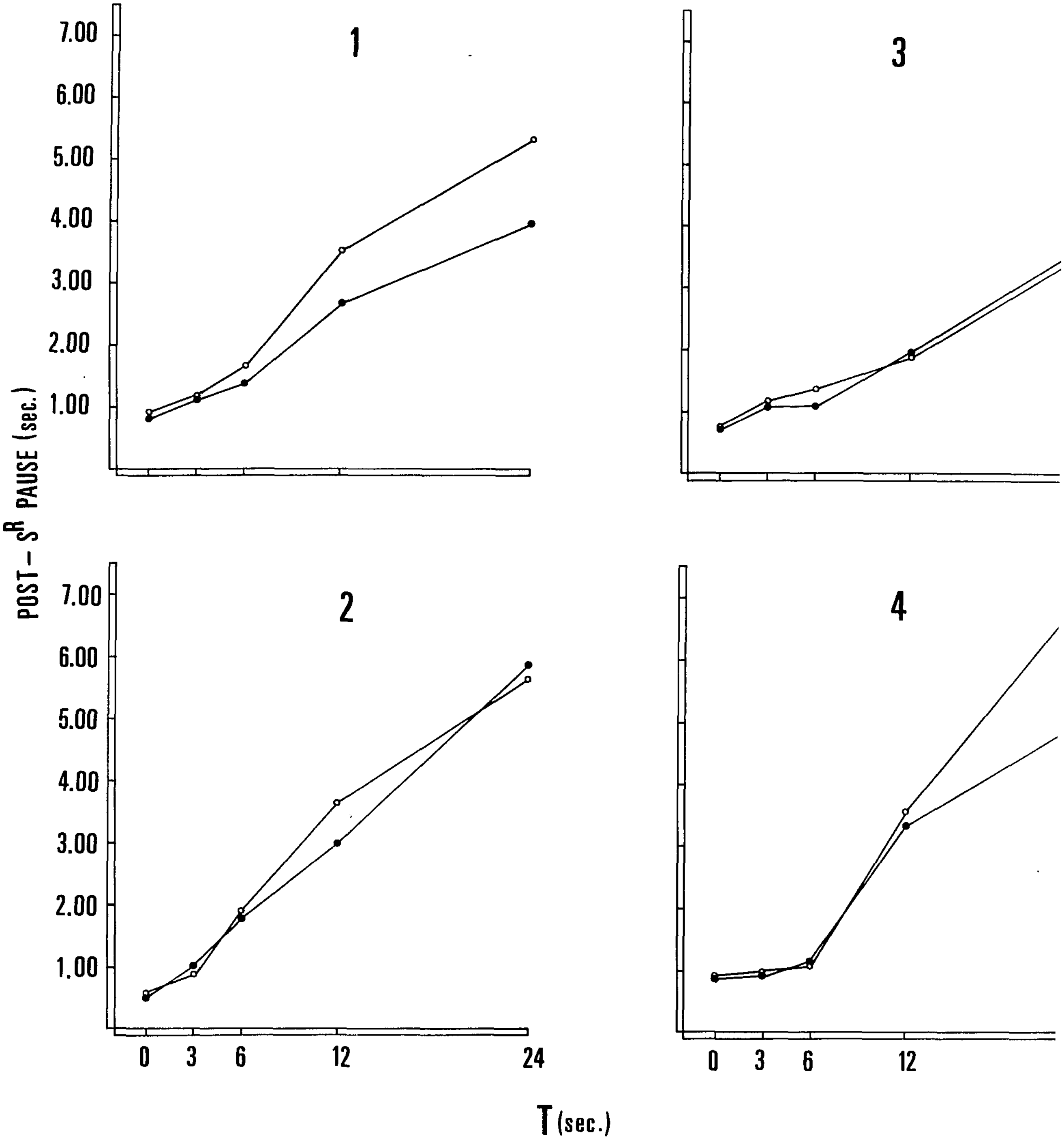
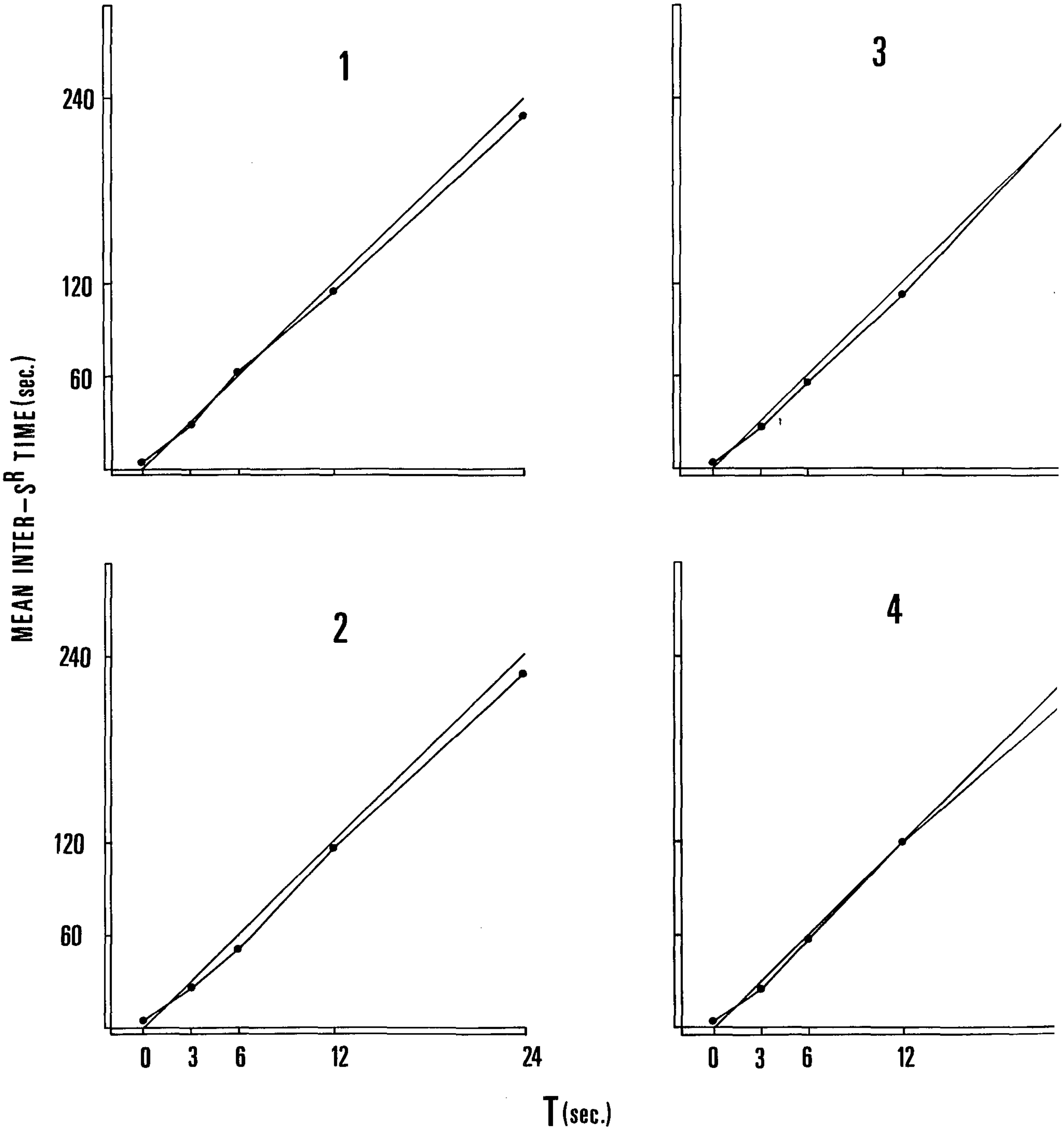

1
2
3
4
4.00
3.00
2.00
1.00
RATE (resp./sec.)
0
3
6
12
24
T (sec.)

Figure 42: Post-reinforcement pause as a function of T for baseline recovery following exposure to the 30 second non-contingent reinforcement procedure for subjects 1, 2 3, 4. The open-circle function was obtained by pooling the data over sessions 21-25. The filled-circle function was obtained by pooling the data over sessions 26-30.



1
2
3
4
POST – S^R PAUSE (sec.)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0
3
6
12
24
T (sec.)

Figure 43: Predicted (T/P) and observed mean inter-reinforcement time as a function of T for baseline recovery following exposure to the 30 second non-contingent reinforcement procedure for subjects 1, 2, 3, 4. The predicted curve has suppressed data points. No predicted IS^RT is shown for T=0, since at this value IS^RT is a function of both response rate and P. The observed IS^RT function was obtained by pooling the data over sessions 1-30.


1
2
3
4
240
120
60
240
120
60
MEAN INTER-S^R TIME (sec.)
0
3
6
12
24
0
3
6
12
T (sec.)

It has already been well established with schedules of contingent reinforcement, that behavior can be maintained even when a delay is interposed between a response and a reinforcement.[1] However, the introduction of a long delay of reinforcement, without previous training on delays of shorter duration, results in a rapid decline in response rate. By beginning with shorter delays which were then gradually increased, however, it was possible to maintain the normal rate of responding under long delayed reinforcement.[2] This was attributed to the establishment of some superstitiously conditioned response which served to bridge the gap introduced by the delay. These findings are consistent with an analysis of non-contingent reinforcement effects in terms of extinction and $\not{R}$. When a long delay of reinforcement is introduced, the delivery of a reinforcement results in the strengthening of the immediately preceding behavior. At the same time, the rate of responding decreases due to the effects of extinction.

Wilson[3] has shown that resistance to extinction varies non-monotonically with the length of the interval between reinforcements, when FI schedules are employed. The function

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[1] Ferster, C.B. (1953) op. cit.

[2] Ibid

[3] Wilson, M.P. Periodic reinforcement interval and number of periodic reinforcements as parameters of response strength. Journal of Comparative and Physiological Psychology, 1954, 47, 51-56.

increases to a maximum at approximately one minute, then decreases. Although Wilson employed rats as subjects in this investigation, the major finding, that of a non-monotonic relationship between the length of the inter-reinforcement interval and resistance to extinction, may be applied to the present investigation.

As the response rate decreases due to the effects of extinction, the probability of an accidental contiguity between a response and a non-contingent reinforcement is also decreased. This leads to a further strengthening of $\not{R}$ and a concomitant decrease in the rate of responding.

Similar results have been obtained by Wilson and Keller[1] in a spaced responding situation. In this instance, the intervening behavior which is strengthened becomes part of a chain which is terminated by a reinforced response. This occurs when the intervening behavior occupies an interval which exceeds the delay value required for reinforcement, thus guaranteeing that the next response will be followed by reinforcement.

It might be profitable at this point, to briefly mention another hypothesis as an alternative explanation of non-contingent reinforcement effects. A reinforcing stimulus

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1. Wilson, M.P. and Keller, F.S. (1953) op. cit.

may be viewed as having certain discriminative properties.[1,2] One measure of this discriminative control, is in the length of the PS^RP. The stronger the control, the shorter the PS^RP, when the reinforcing stimulus is viewed as an interupter of ongoing behavior. Certain difficulties are inherent in this attempted explanation of the results of the present investigation. Primarily this is due to the difficulty in assessing discriminative properties apart from the reinforcing aspects of the stimulus. An acknowledgment of the discriminative properties of the reinforcing stimulus however, does not appear to be out of place at this juncture.

In conclusion, it must be noted that the effects of a non-contingent reinforcement procedure depend to a great extent upon the behavior with which the procedure makes contact. When a contingent schedule of reinforcement is in effect, and a non-contingent reinforcement procedure is additionally superimposed, the general result of the non-contingent reinforcement procedure is to increase the rate of responding.[3,4,5,6]

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1. Azrin, N.H. and Holz, W.C. Punishment. In W.K. Honig (Ed.) <u>Operant behavior: areas of research and application</u>. New York: Appleton-Century-Crofts, 1966.

2. Farmer, J. and Schoenfeld, W.N. Inter-reinforcement times for the bar-pressing response of white rats on two DRL schedules. <u>Journal of the Experimental Analysis of Behavior,</u> 1964, <u>7</u>, 119-122.

3. Herrnstein, R.J. and Morse, W.H. (1957) op. cit.

4. Sidman, M., Herrnstein, R.J. and Conrad, D.G. (1957) op. cit.

5. Harris, A.H. (1968) op. cit.

6. Byrd, L.D. (1969) op. cit.

Another result is obtained when the non-contingent reinforcement procedure is in effect without an additional reinforcement contingency present. This was the procedure employed in the present investigation. In this case, the non-contingent reinforcement procedure results in a decline in the rate of responding.[1,2,3] The mixing of contingent and non-contingent reinforcement procedures is a parameter, of which the present investigation represents only one point along a continuum. However, one fact stands out as being important. The effects of a non-contingent reinforcement procedure depend upon the relationship between the response frequency and the reinforcement frequency. The manipulation of these two frequencies will serve to produce all the results previously cited.

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1. Skinner, B.F. (1938) op. cit.
2. Herrnstein, R.J. (1966) op. cit.
3. Zeiler, M.D. (1968) op. cit.

Summary and Conclusions

The present experiment was concerned with a systematic investigation of (1) reinforcement schedule and (2) frequency of non-contingent reinforcement, as parameters of the control of behavior by non-contingent reinforcement.

Within a single session four white Carneaux hen pigeons were exposed to a complex baseline consisting of five temporally defined schedules of reinforcement, each correlated with a distinctive exteroceptive discriminative stimulus. Schedule specification was in terms of cycle length (T) and probability of reinforcement (P). The mean IS^RT (T/P) for each schedule was as follows:

T = 0 indeterminate (mean IS^RT is a function of both rate of responding and P. With a P of 0.10, ten responses on the average are required for reinforcement.)

T = 3 30 seconds

T = 6 60 seconds

T = 12 120 seconds

T = 24 240 seconds

Reinforcement consisted of 2.5 seconds of access to a lighted hopper of mixed grain.

Following exposure to this baseline, a non-contingent reinforcement procedure was instituted, and remained in effect for 30 experimental sessions. Frequencies of non-contingent reinforcement of 30, 60 and 120 seconds were employed. Each animal was exposed to each frequency of non-contingent reinforcement. Interpolated between each 30 session block of exposure to a given non-contingent frequency, were 30 sessions of the initial baseline procedure. These recovery sessions provided a baseline for the subsequent non-contingent reinforcement frequency. The non-contingent reinforcements at all frequencies were delivered in the following two ways: fixed non-contingent (FNC) were those which were delivered at a fixed time interval on T/P schedules composed of T values of 30, 60 and 120 seconds, and a P value of 1.0. In the case of the random non-contingent reinforcements (RNC), the mean IS^RT was predetermined, but the sequence was free to vary. RNC reinforcements were delivered on T/P schedules composed of T values of 3, 6 and 12 seconds, and a P of 0.10.

The following conclusions were drawn from the results of the present investigation; For the initial baseline procedure, and for all the baseline recovery procedures:

(1) The rate of responding, for all subjects, was a generally monotonic decreasing function of the length of T.

(2) For all subjects, PS^RP was an increasing generally monotonic function of the length of T.

For the non-contingent reinforcement procedures employed:

(3) At all frequencies of non-contingent reinforcement, the rate of responding was a decreasing function of the number of sessions

of exposure to the procedure.

(4) Behavior was optimally maintained, during the 60 second non-contingent reinforcement procedure, in the presence of the stimulus previously correlated with the T=3 baseline schedule.

(5) During the 120 second non-contingent reinforcement procedure the behavior was maintained best in the presence of the stimuli previously correlated with the T=3 and T=6 baseline schedules.

(6) At the 30 second non-contingent reinforcement frequency, the behavior was maintained optimally in the presence of those stimuli which were previously correlated with those baseline schedules that generated relatively high rates of responding (T=0, T=3, T=6).

An analysis of the findings in terms of extinction and Ꝁ was presented, and its relationship to the experimental literature was discussed.

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Vita

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