MULTIPLE SCHEDULES OF TIME-CORRELATED REINFORCEMENT

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Several recent studies (Schoenfeld, Cumming, & Hearst, 1956; Schoenfeld & Cumming, 1957; Hearst, 1958; Clark, 1959) have shown that behavior typical of both interval and ratio schedules can be observed within a framework of time-correlated reinforcement schedules which are not defined with reference to response "counts" or "ratios." In these studies a response was reinforced only during a restricted time period, t^D ,² which itself was programmed on a fixed-interval schedule. For example, a t^D of 1 second might be repeated every 2 minutes and the subject reinforced only for a single response during the 1-second t^D periods; responses in the intervening 2 minutes between t^D 's went unreinforced. No exteroceptive stimulus ever accompanied t^D in the above studies, so that the subject had no external cue as to when reinforcement was possible.³

Hearst (1958) has presented data for pigeons on a 30-second, fixed-interval schedule (or 30-second cycle length, in the terminology of Schoenfeld, Cumming, and Hearst) in which the length of t^D , expressed as a decimal fraction T of the total 30-second cycle, was systematically decreased from 1.00 (i.e., t^D was 30 seconds long) to 0.013 (t^D = 0.4 second). As the duration of t^D decreased, response rates rose sharply for all subjects and behavioral records switched from those resembling FI effects to those more resembling FR or VR effects. Clark (1959) has very recently presented data from a complementary experiment in which the fixed interval between t^D 's was kept constant at 2 minutes for one set of subjects and at 10 minutes for another set. A clear shift from "interval-like" to "ratio-like" behavior occurred here, too, as a result of successive decreases in the length of t^D superimposed on these FI's. Clark also showed that the effects of satiation on "ratio-like" time-correlated schedules duplicate the effects of satiation on FR rather than FI schedules, a finding which is added evidence for assigning the term "ratio-like" to these schedules and for considering the controlling variables to be very similar to those under ratio schedules. It appears, therefore, that schedules which make a certain periodicity of reinforcement likely and at the same time produce a high response rate will have behavioral effects analogous to those observed on ratio schedules, even though the latter are defined purely on the basis of response counts.

The sequence used by Hearst in varying the duration of t^D was one in which t^D was successively decreased during the experiment from its highest down to its lowest value. There was no attempt to randomize the order of exposure to different t^D values, because it was felt that subjects would extinguish, through "missing" many reinforcement opportunities, if placed on very small t^D without some experience on other schedules where "missed" reinforcements were likely.⁴ With this sequence of manipulations in t^D , however, it is not possible to estimate the contribution to the obtained effect of any long-term increases in rate (over the 5- to 6-month course of an experiment) that might occur even if the subject were maintained on simple FI for 5 to 6 months. Another shortcoming

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²"Limited-hold" (Ferster & Skinner, 1957) is an equivalent term.

³See Weissman, 1958, for a study in which an exteroceptive cue was associated with t^D .

⁴To draw a possible analogy to the fixed-ratio case, one usually trains an animal on successive FR's of 10, 20, 40, etc., before expecting performance on an FR 50 to be maintained.

of this decreasing sequence was that no attempt was made to determine the extent of reversibility of the experimentally obtained functions (Cumming & Schoenfeld, 1959).

In order to attack some of these questions, rats in the present experiment were trained on a two-ply multiple schedule⁵ of reinforcement. One component was maintained at cycle length 30 seconds, $\bar{T} = 1.00$ (a 30-second FI, as described by Ferster and Skinner, 1957) throughout the entire experiment, while the other component involved the successive decrease of $\bar{T}$, just as in Clark's and Hearst's studies. This sequence of successive decreases was followed by an attempt to determine the reversibility of the function by a return to a higher $\bar{T}$ value. To the extent that these components are independent of each other, one could thus observe changes in FI over long periods of time (unchanged component) while also observing the effects of variations in $\bar{T}$ on the other component. In addition, much smaller values of $\bar{T}$ (including extinction or $\bar{T} = 0.00$) were used than in Hearst's original study, in order to see the rate of falloff in responding at exceptionally low values of $\bar{T}$. In the earlier study, response rates steadily increased with decreases in $\bar{T}$ for all $\bar{T}$ values used; and it is clear that as $\bar{T}$ becomes exceedingly small and reinforcements close to zero in frequency, response rates ought eventually to decline to extinction levels. It is interesting, too, to compare the behavior of rats on these schedules with that of pigeons, which were used in virtually all prior work.

At the end of the study, sodium pentobarbital, a drug which has been shown to influence interval and ratio behavior differentially (Dews, 1955; Morse & Herrnstein, 1956; Ferster & Skinner, 1957), was administered to see if it would selectively affect "interval" and "ratio" components of the multiple schedule, as might be suggested from the Schoenfeld, Cumming, and Hearst analysis.

METHOD

Subjects

Two male hooded rats, BA-11 and BA-12, were the subjects. Each was maintained at about 80% of its normal, free-feeding weight determined prior to the start of the experiment when the subjects were about 60 days old. Subjects were not run on a given experimental day if their weights exceeded the 80% criterion. These rats had not been used in any prior experiments.

Apparatus

The essential features of the experimental situation have been described elsewhere (e.g., Herrnstein & Brady, 1958). The manipulandum was a modified telegraph-key lever. Sweetened condensed milk, 0.1 milliliter, presented for 3 seconds, was delivered as reinforcement by means of a cam-operated dipper. A clicking noise and a nonaversive tone were used as auditory stimuli. Programming of stimuli, reinforcements, etc., was achieved automatically by the use of a system of timers and relays. Magnetic counters tabulated numbers of responses, reinforcements, and stimuli, while a Gerbrands cumulative recorder provided a continuous record of each subject's lever-pressing responses. White noise in the experimental room masked possible auditory cues from the control apparatus in an adjacent room.

⁵On multiple schedules of reinforcement, different schedules are programmed in the presence of different exteroceptive stimuli, so that the subject comes to respond differentially to each stimulus.

Procedure

After the subjects had been trained to approach and drink at the sound of the dipper's activation, they were run for several sessions in which every depression of the lever was rewarded (CRF). They were then placed on the multiple-schedule procedure to be described, and stayed on this procedure for the remainder of the experiment.

The multiple schedule contained two components which alternated every 5 minutes during the hour-long daily sessions. On Component A the schedule was maintained at 30-second FI (30-second cycle length, $\bar{T} = 1.00$, in Schoenfeld, Cumming, and Hearst's terminology) throughout the entire experiment. On Component B, for BA-11, the length of the t^D presented every 30 seconds was successively decreased over the course of the experiment as follows: 29.68, 5.12, 1.60, 0.89, 0.65, 0.42, 0.30, 0.20, 0.15, 0.10, 0.075, 0.05, and 0.00 seconds; and, for BA-12, as follows: 29.68, 5.12, 0.90, 0.65, 0.42, 0.37, 0.30, 0.15, 0.10, 0.075, 0.05, and 0.00 seconds. The respective $\bar{T}$ values for BA-11 (plotted in Fig. 1 and 2) are 0.99, 0.17, 0.05, 0.029, 0.022, 0.014, 0.010, 0.007, 0.005, 0.003, 0.0025, 0.0017, and 0.00 (extinction); and for BA-12 (as in Fig. 1 and 2), they are 0.99, 0.17, 0.03, 0.022, 0.014, 0.012, 0.010, 0.005, 0.003, 0.0025, 0.0017, and 0.00 (extinction).

The tone stimulus accompanied Component A and the clicker stimulus accompanied Component B for Subject BA-11. The functions of the two stimuli were reversed for BA-12, the clicker being in effect under Component A and the tone under Component B. Since stimuli alternated every 5 minutes, the subject could obtain ten reinforcements (ten 30-second cycles) during each stimulus presentation and a maximum of 60 reinforcements per component over the 1-hour session. On alternating experimental days, sessions began with either the A or B component of the schedule.

Subjects were maintained on the first schedule to which they were exposed ($\bar{T}$ in Component B = 0.99) for 20 days. Thereafter, they remained on a particular $\bar{T}$ value for ten sessions, by which time their behavior usually had stabilized. On a few occasions, several sessions (up to a total of 13 or 14) were added when an irregular daily record or apparatus failure gave reason to doubt the attainment of stability. An exception to this 10-day rule occurred during extinction, when BA-11 was run for 18 extinction sessions ($\bar{T} = 0.00$) and BA-12 for 33 extinction sessions. At the conclusion of these extinction periods, BA-11 was returned to a $\bar{T}$ value of 0.010 on Component B and BA-12 to a $\bar{T}$ value of 0.005 to obtain some idea of the extent of reversibility of the behavioral functions.

RESULTS

Figure 1 presents separate curves for each subject relating response rate on each component to the changing values of $\bar{T}$ on Component B. The depicted rates are means from the last 5 days on each schedule and have been corrected for "drinking time" by subtracting dipper-presentation time from total time on each component. Closed circles indicate redetermined points obtained after each rat had been exposed to all other $\bar{T}$ values. Note that $\bar{T}$ is plotted logarithmically on the abscissa of this and the subsequent figure.

Response rate on Component B does not change very much for either animal as $\bar{T}$ is decreased from 0.99 down to approximately 0.05; but subsequent decreases in $\bar{T}$ lead to marked increases in rate up to the maximum in each subject's function: 0.010 for BA-11, 0.005 for BA-12. These marked increases in rate are correlated with appreciable declines in number of reinforcements obtained, i.e., the animals "missed" more and more reinforce-

Figure 1. Corrected rate in responses per minute as a function of the $\bar{T}$ value on Component B. Closed circles represent recovered data points.

ments once $\bar{T}$ went below 0.05. The general form of this section of the relationship is similar to that obtained by Hearst (1958), whose pigeon subjects were exposed to $\bar{T}$ schedules from 1.00 down to only 0.013.

When exposed to $\bar{T}$ values below 0.005 the subjects in the present experiments show a more or less steady decrease in response rate until minimum rates are obtained when responding on Component B was extinguished. The fact that subjects still respond at fairly high rates on Component B during extinction may possibly be attributed to (1) induction from still-reinforced responding on Component A and (2) "superstitious" reinforcement of responding in Component B by production of the Component A stimulus on an FI schedule (Fig. 3 and 4), as though the subject were on a chained schedule (Ferster & Skinner, 1957).

Responding on Component A, during which a 30-second FI was in effect for the entire experiment, did not show any obvious systematic changes as a function of manipulations in $\bar{T}$ on Component B. However, a good deal of variability is apparent for each subject when datum points of Component A are compared (Fig. 1).

The redetermined rate values of each subject (closed circles of Fig. 1) are quite close to their earlier levels on both Component A and Component B. This correspondence suggests that points on the original individual functions are to a good degree recoverable, and that the sequence of $\bar{T}$ changes used was not a very critical variable in accounting for the shape of the relationship obtained.

The way in which variations in the $\bar{T}$ value on Component B influence the number of responses per reinforcement on each component is shown in Fig. 2. Both subjects show appreciable increases in number of responses per reinforcement on Component B as $\bar{T}$ values are decreased below 0.05, with the obvious exception of BA-11's decrease on the smallest $\bar{T}$ at which reinforcement was still possible. Above the 0.05 $\bar{T}$ value, where very few reinforcements were "missed" due to nonresponse during t^D , there is little or no change in the number of responses per reinforcement on Component B.

Values of Component A plotted in Fig. 2 show clearly that variations in $\bar{T}$ on Component B have no appreciable effect on responses per reinforcement under Component A. Redetermined points for both components (closed circles) again show a fairly close correspondence with the original values.

The possibility exists that the differences between the response rates on the two components shown in Fig. 1 merely reflect the fact that fewer reinforcements are obtained on Component B than on Component A at low $\bar{T}$ values; the resulting decline in number of pauses after reinforcement (characteristically at least 15 seconds for each component) on Component B thus could possibly account for the rate differences obtained. One way of checking on this interpretation is to subtract mean pause-after-reinforcement time from the total time on each component and recalculate response rates on this basis. The "running rates" so obtained do in fact indicate less of a difference between the two components than is shown in Fig. 1; but in the vicinity of the peak rate differences, i.e., around $\bar{T}$'s of 0.005 and 0.01, the running rates on the two schedules still differ appreciably, with the running rate on Component B averaging 20-40% higher than that on Component A. At the peak of BA-11's curve ($\bar{T} = 0.010$), for example, the mean running rate on Component A was 66.0 responses per minute; and on Component B, 81.6 responses per minute, with a mean number of reinforcements per session of 55.8 on A and 27.8 on B. A similar comparison for BA-12's Fig. 1 peak at $\bar{T} = 0.005$ shows a running rate of 89.2 responses per minute on A and 112.8 responses per minute on B, when BA-12 was averaging 56.0 rein-

Figure 2. Responses per reinforcement on both components as a function of the $\bar{T}$ value on Component B. Closed circles represent recovered data points.

forcements per session on Component A and 32.0 reinforcements per session on Component B. On very low $\bar{T}$ values, this way of calculating running rates is particularly complicated by the fact that relatively long pauses occur in Component B which quite often do not follow reinforcement (as on a partially strained ratio, perhaps) and make such calculation open to some question. The cumulative curves of Fig. 3 and 4 for these low $\bar{T}$ values indicate that the subjects responded rapidly on Component B (i.e., in "bursts") whenever they did respond, and that long pauses uncorrelated with reinforcement occur more often than previously.

The mean pause-time to the first response after each reinforcement was calculated for both components of the multiple schedule as $\bar{T}$ was varied. No systematic changes related to the value of $\bar{T}$ could be noted in this measure. Both Clark and Hearst similarly found that on short cycle lengths no shift in latency occurs as a function of decreases in $\bar{T}$.

Some typical cumulative-response curves on various values of $\bar{T}$ are given for each subject in Fig. 3 and 4. All these records were selected from the last 5 days on each schedule, the same five "stability" days from which the numerical data of Fig. 1 and 2 were calculated. Sections of each daily record have been "telescoped" (Ferster & Skinner, 1957, p. 26) beneath each other to save space.

On each record the signal marker dips down to indicate the beginning of the B component of the schedule; but for easier reference, the beginning of each component is also shown by the respective letters A and B. Since the signal marker was used to mark stimulus changes, reinforcements are not shown on the record. The number of reinforcements per session obtained by BA-11 in the Fig. 3 records were as follows for decreasing $\bar{T}$ values: on Component A, 55, 54, 60, 55, 55, 55, and 54 reinforcements; on Component B, 62, 39, 27, 9, 8, 5, and 0 reinforcements. For Rat BA-12 the number of reinforcements per session obtained in the Fig. 4 curves were: on Component A, 54, 54, 50, 54, 57, 56, and 56 reinforcements; on Component B, 60, 38, 20, 19, 9, 7, and 0 reinforcements.

When the schedules in effect do not result in the "missing" of any reinforcements on Component B, e.g., upper left-hand curve of Fig. 3 and 4 and some lower $\bar{T}$ values not included in the figures, e.g., down to about 0.05, the behavior shown on each component is approximately the same. Once an appreciable number of reinforcements is "missed," however, the behavior on Component B is marked by high running rates, little responding at intermediate rates, and pauses or breaks much more numerous than the number of reinforcements obtained and, therefore, not all correlated with reinforcements. All these are characteristics generally observed on "ratio" schedules (Ferster & Skinner, 1957) and low $\bar{T}$ values (Clark, 1959; Hearst, 1958). Responding on Component A is not very stable throughout the experiment, but is characterized by much lower rates than on Component B and behavior similar to that normally observed on 30-second FI studied in isolation.

It is interesting to note that Component B responding does not approach a zero value at $\bar{T} = 0.00$, i.e., when no responses were reinforced in that component. Particularly BA-11, but also BA-12, shows some "scalping" during each 5-minute B period, indicating that the subject is responding superstitiously "to produce" 5-minute A periods in which reinforcement is still possible. (See Morse, 1955, for extended discussion of similar effects.)

When Rat BA-11 was returned to a $\bar{T}$ of 0.01 and BA-12 to a 0.005 $\bar{T}$ value to check on the recoverability of the function, cumulative-response curves did not differ much in appearance from the prior determination. Samples of these records are shown in the "NO DRUG" curves of Fig. 5 and 6.

Figure 3. Typical cumulative-response curves for Rat BA-II on various Component B $\bar{T}$ values. Date and respective $\bar{T}$ values for Component A and Component B are shown on each record. Signal-marker depressions indicate the beginning of each B period.

Figure 4. Typical cumulative-response curves for Rat BA-12 on various Component B $\bar{T}$ values. Date and respective $\bar{T}$ values for Component A and Component B are shown on each record. Signal-marker depressions indicate the beginning of each B period.

Figure 5. A comparison of responding on each component during sodium pentobarbital and control sessions for Rat BA-11. The two upper curves display successive Component A periods on drug and nondrug days, while the two lower curves show successive Component B periods under the drug and nondrug conditions.

At the peak of BA-11's and BA-12's functions (Fig. 1), we have noted that though far fewer reinforcements are obtained on Component B, response rate (both corrected and "running") is much higher on Component B than on Component A. In addition, it has been suggested that responding under small $\bar{T}$ values on Component B resembles behavior generated on "ratio" schedules in several ways, while Component A responding is reasonably typical 30-second FI behavior when compared with 30-second FI studied out of the context of a multiple schedule. Since sodium pentobarbital has been shown in several instances to have a greater effect on "interval" behavior than on "ratio" behavior, this drug was ad-

ministered in the present experiment after responding on the redetermined $\bar{T}$ values (0.01 for BA-11 and 0.005 for BA-12, the peak values for each) had stabilized.

Sodium pentobarbital was dissolved in saline solution and injected intraperitoneally about 5 minutes before the beginning of the hour-long sessions. A dose of 4 milligrams per kilogram was tried first; but since no clearcut behavioral effects of this dose were observed, the dose was doubled to 8 milligrams per kilogram, as shown in the drug records of Fig. 5 and 6. A week later, another injection of 8 milligrams per kilogram was given which had a qualitative effect on multiple-schedule performance similar to that displayed in Fig. 5 and

Figure 6. A comparison of responding on each component during sodium pentobarbital and control sessions for Rat BA-12. The two upper curves display successive Component A periods on drug and nondrug days, while the two lower curves show successive Component B periods under the drug and nondrug conditions.

6, though to a lesser degree. The control records (left-hand curves of Fig. 5 and 6) were taken from the day immediately preceding the day on which the drug was given.

In the upper records of Fig. 5 and 6, all Component A periods, a total of six for the session, are shown in order of occurrence during the session, No. 1 to No. 6. Just as throughout the entire experiment, these A periods were alternated with 5-minute, Component B periods, which are shown in order in the lower curves of Fig. 5 and 6. Ten reinforcements are possible during each A or B period. Rat BA-11 obtained 60 reinforcements on A and 40 on B during the control session, and 60 reinforcements on A and 34 on B during the drug day. Rat BA-12 received 61 reinforcements on A and 23 on B during the control day, and 59 on A and 13 on B during the drug session.

These figures indicate that Component A responding is much more affected by the injection of sodium pentobarbital than is Component B responding. Response rate in Component A is much higher than it is on the control record, and the drug curve is characterized mostly by breaks after reinforcement and high rates; very few intermediate response rates can be observed in the drug records, while there are several noticeably different rates in the control record. On the other hand, Component B records display high rates alternating with pauses in responding in both the control and drug curves.

Changes in pause-after-reinforcement time on both components and the extent of the interval "scallop" on Component A were calculated from other data recorded on control and drug days. The pause after reinforcement on both components decreased by 20-40% during the drug session, as compared with mean control values. "Quarter-life" measures (Herrnstein, 1958) of the extent of interval "scallop" on Component A showed a decrease of about 10% for both subjects, indicating that responding did not accelerate within each interval so gradually as on control days; rather, a terminal response rate was achieved earlier in each interval.

DISCUSSION

Though variations in $\bar{T}$ were accomplished in the present study within the context of a multiple schedule, the major results are in line with the findings of Schoenfeld, Cumming, and Hearst (1956), Hearst (1958), and Clark (1959), who studied the effects of changes in $\bar{T}$ on a single time-correlated schedule. All these experimenters found large increases in response rate as $\bar{T}$ was decreased below the $\bar{T}$ value, at which appreciable numbers of reinforcements first began to be "missed." This was found to hold in the present experiment, since between $\bar{T}$'s of 0.05 and approximately 0.010 there were large increases in Component B response rate. Between these same $\bar{T}$ boundaries, Hearst found a similar rate increase in pigeons. Along with this change, there was here a shift to a more "ratio-like" type of behavior: following the pause after reinforcement, a very sharp acceleration to long-maintained high rates, very few intermediate rates of response, etc. This also confirms findings of the previous studies.

Since $\bar{T}$ was here decreased far below values it had taken in Hearst's prior study with a 30-second cycle length, where the smallest $\bar{T}$ was 0.013, it was possible to observe how response characteristics changed as $\bar{T}$ became small enough to approach extinction. Of all the prior studies, only Clark's work with a 10-minute cycle length included a $\bar{T}$ value small enough to result in so few reinforcements being obtained that response rate decreased from its peak values. In his study, there was no sharp decline in rate from the previous peak value when this low $\bar{T}$ (0.0016) was in effect. In the present experiment, Component B response rates for both subjects decreased more or less gradually below $\bar{T}$'s of 0.005, down

to their minimum values in the entire experiment at $\bar{T} = 0.00$ (extinction). Despite these declines in rate, the cumulative records of responding for these low $\bar{T}$'s on Component B were still marked by high rates of response; breaks in responding, however, occurred more often and lasted longer, as also happens on a "strained ratio" (Ferster & Skinner, 1957). The decline obtained in the Component B rate at very low $\bar{T}$'s probably would be much less gradual if studied outside the context of a multiple schedule, since the continued reinforcement of responding in Component A probably helped to maintain the strength of Component B responding. Ferster and Skinner make a similar point, perhaps, when in discussing multiple FI FR they state (p. 512) that "the ability to sustain a large ratio in a multiple schedule may be due in part to induction from the fixed-interval reinforcements." As noted earlier, too, the animals clearly showed some "scalloping" in individual Component B periods when B responding was extinguished ($\bar{T} = 0.00$), which indicates that Component B responding might have been partially maintained at low $\bar{T}$ values by its superstitious production of the Component A stimulus. For these reasons, it would be worthwhile to compare the rate declines obtained here on very low $\bar{T}$'s to a function obtained through varying $\bar{T}$ on a simple, one-component schedule.

One of the reasons for including Component A in the schedule was to see if 30-second FI responding showed any consistent change during a long experiment. Clark (1959) found no systematic change in a 2-minute FI during a long-term control study, a fact which strengthens his conclusion that the rate increases he obtained after $\bar{T}$ decreases were due to the changes in $\bar{T}$ and not to long-term rate increases that might have occurred independently of any variations in $\bar{T}$. Behavior on unchanged Component A in the present experiment did not show any systematic rate increase or decrease during the experiment, which supports the belief that the clearcut changes in Component B responding were primarily due to variations in $\bar{T}$.

The drug data of Fig. 5 and 6 indicated a greater disruption of Component A behavior than of Component B behavior. Dews (1955), working with simple FI and FR schedules, Morse and Herrnstein (1956), using a multiple FI FR schedule, and Ferster and Skinner (1957, p. 627), using a mixed FI FR schedule, found that ratio schedules were more resistant than interval schedules to the influence of sodium pentobarbital in doses close to the 8-milligram-per-kilogram dose administered here. The first two investigators found, however, that interval behavior under the drug usually exhibited a large decrease in response rate over control levels, while Ferster and Skinner indicated an excitatory effect, in which FI responding increased under the drug. In the present study the behavior on the B components of Fig. 5 and 6 was definitely more resistant to sodium pentobarbital than Component A behavior, and Component A behavior exhibited a large increase in rate over the control level. The differences in the specific FI results of these experiments cannot be resolved here (i.e., may be due to differences in the FI length, method of alternation of schedules, etc.), but the great resistance of Component B to the drug at least does not contradict the other evidence which indicates that Component B responding is "ratio-like."

SUMMARY

Two components of a multiple schedule were studied, one of which (A) was maintained at 30-second FI throughout the experiment, while the other (B) involved variation in the length of a "limited hold" (t^D) superimposed on a 30-second FI schedule. In the second component, reinforcement was possible only for a response during t^D . Two hooded rats were the subjects and the response measured was lever pressing.

In the results to follow, the independent variable, length of t^D , is expressed as the ratio T of the duration of t^D to the total duration of each interval (30 seconds).

(1) As T decreased from 0.99 to a value of about 0.010, response rates and responses per reinforcement increased with positive acceleration on Component B. Subsequent decreases in T down to extinction of Component B at $T = 0.00$ resulted in a gradual decline in Component B response rate, though responses per reinforcement continued to increase. Component B cumulative-response curves showed ratio-like characteristics on low T values.

(2) Component A responding did not change systematically during these manipulations in Component B.

(3) When subjects were returned to a higher $\bar{T}$ value in Component B after being exposed to the successive decreases above, essentially the same rates as before were recovered on both components.

(4) Sodium pentobarbital was found to affect Component A (fixed-interval) performance much more than Component B performance on low $\bar{T}$ values.

(5) The data are in accord with prior findings which indicate that both interval and ratio effects can be observed within time-correlated schedules.

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