RATE-CHANGE EFFECTS DURING A PRE-SCHEDULE-CHANGE STIMULUS

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During the last 3 minutes of each exposure to either component in a multiple variable-interval, variable-interval schedule of reinforcement (mult VI VI), a pre-schedule-change stimulus ("warning" stimulus) was presented, and the response rate during the warning stimulus was compared with the pre-stimulus rate.

SUBJECTS AND APPARATUS

The subjects were four experimentally naive, male Silver King pigeons, approximately 3.5 years old. All of these birds were run at about 80% of their free-feeding weights.

A converted picnic ice chest served as the experimental box. Its main features were similar to those described by Ferster and Skinner (1957), except that no houselight was used. Illumination was provided by the key lights only. The two white Christmas-tree bulbs that served as the warning stimulus were located at the top of the angles made by the front wall and the sides of the animal space.

The box was in a sound-deadened room, and a white noise was present continuously. The entire experiment was automatically programmed in the usual fashion, with data recorded on running-time meters, electromagnetic counters, and a cumulative recorder.

PROCEDURE

All the birds received magazine training and had about 150 reinforcements (4-second access to the grain tray) on CRF.

Initial Training

Before the introduction of a two-ply multiple schedule with different-value VI's, each bird was trained to stable performance on a mult VI VI in which the two VI's were of the same value. For two of the birds (1SK and 5SK), both VI's were 1 minute; for the remaining two (6SK and 12SK), both were 10 minutes.

For all birds, the two legs of the multiple schedule alternated every 15 minutes. While one leg of the multiple schedule was in effect, the reinforcement tape programmer for the other was stopped. During the last 3 minutes of every 15-minute exposure to a VI, the warning lights were illuminated. At the end of the 3 minutes, the lights were extinguished coincident with the change to the alternate key-color and VI. Birds 1SK and 5SK (mult VI 1 VI 1) were run for 1-hour sessions; Birds 6SK and 12SK (mult VI 10 VI 10) were run for 2.5-hour sessions.

Experimental Variable

The multiple schedule for each bird was changed to mult VI 1 VI 10. Thus, for 1SK and 5SK, one of the

VI's in the multiple schedule was increased, from VI 1 to VI 10, while for 6SK and 12SK, one VI was decreased, from VI 10 to VI 1. The VI associated with either key color was counterbalanced over the four birds.

All the birds were run for 2-hour sessions. As before, either leg of the multiple schedule lasted for 15 minutes, with the pre-schedule-change stimulus present during the last 3.¹

After the main data of the experiment were obtained at stable performance (no visible change in performance for five consecutive sessions), procedural changes were introduced in order to provide additional information. The changes were:

(a) For Birds 1SK and 6SK, the 1-minute VI component of the multiple schedule was changed to a 30-second (0.5 minute) VI.

(b) For Birds 5SK and 12SK, in the above procedure, schedule change occurred automatically at the end of the 3-minute warning stimulus. The circuit was now changed, and schedule transition became response contingent; i.e., the function of the 3-minute warning stimulus was changed to that of a discriminative stimulus for a 3-minute fixed interval. The reinforcer was the change from one leg of the multiple schedule to the other, and the response producing the change was a key peck.²

RESULTS

Figures 1 and 2 show the results of the experiment. The data for each bird are presented in three rectangular sections. Each rectangle consists of two blocks of four records, and each block of four records shows typical, final performance under the labeled experimental condition. In all cases, the offset portions of the records (i.e., depression of the signal marker) were produced while the warning stimulus was present in the box. Periods of time before the onset of the

¹Bird 5SK soon developed a tendency to produce negatively accelerated cumulative records on each exposure to VI 10. (The negative acceleration was probably the same effect to be reported below, but under the control of temporal factors rather than the warning stimulus.) For this bird alone, the constant 15-minute exposure to either leg of the multiple schedule was changed to variable-length exposures between 6 and 24 minutes, averaging 15 minutes. The negative acceleration was markedly reduced and, in many instances, no longer appeared.

²When the 3-minute FI timed out, the grain-reinforcement tape programmer was stopped. This feature eliminated a potential source of differential reinforcement, viz., a pause beyond 3 minutes increasing the probability that the peck which changed the schedule would also produce grain reinforcement.

Fig. 1. Representative cumulative records for Birds 1SK and 5SK. Each rectangle contains two blocks of four records. A block of four shows typical performance under the labeled experimental condition. The signal marker was depressed while the warning stimulus was present in the box.

warning stimulus, approximately equal to warning-stimulus duration, are included for rate comparison.

For each bird, the first rectangle on the left contains data from the multiple schedule involving equal VI's. The upper and lower blocks are distinguished only by the sequence of key colors at the transition from one VI to the other.

The middle rectangle for each bird shows final performance during the warning stimulus on mult VI 1 VI 10. The upper blocks of four records, which show warning-stimulus behavior during the last 3 minutes of VI 10, should be compared with the blocks of four immediately to the left (equal VI's), which involved the same key-color change. The same is true of the lower blocks of four, showing warning-stimulus behavior during the last 3 minutes of VI 1.

In terms of direction, essentially the same rate changes during the warning stimuli occur for all four birds. Consider the upper blocks of records in the middle rectangles. They are labeled VI 10 to VI 1, and, as stated previously, they show warning-stimulus performance during the last 3 minutes of VI 10. The rate tends to fall below the VI 10 rate previous to the warning stimulus. This tendency is particularly marked

Fig. 2. Representative cumulative records for Birds 6SK and 12SK. Each rectangle contains two blocks of four records. A block of four shows typical performance under the labeled experimental condition. The signal marker was depressed while the warning stimulus was present in the box.

with Birds 5SK and 12SK, although still unmistakable with Birds 1SK and 6SK.

On the other hand, the lower blocks in the middle rectangles, which are labeled VI 1 to VI 10 and show warning-stimulus performance during the last 3 minutes of VI 1, exhibit an increased rate compared with the VI 1 rate previous to the warning stimulus.⁹ The tendency is particularly clear with 1SK. Because of the fairly high rate during VI 1, the increase in rate during the warning stimulus is not immediately evident. However, foreshortening the page reveals the rate increase. A tendency to decelerate later in the warning stimulus also appears in several instances.

The right-hand rectangles for each bird show typical performances on the final procedures studied. For 1SK and 6SK, with the 30-second VI replacing the 1-minute VI in the multiple schedule, both birds show an even more marked rate decrease during the

⁹This rate increase should be assessed with respect to an observable tendency to increase warning-stimulus rate on the multiple schedule involving equal VI's. It is interesting here to note that the rate increase occurred with Birds 1SK and 5SK on mult VI 1 VI 1, but not with Birds 6SK and 12SK on mult VI 10 VI 10.

warning stimulus on VI 10. The rate increase during the warning stimulus on VI 30 seconds is sharper for Bird 6SK.

Note the effects on Birds 5SK and 12SK of converting the 3-minute warning stimulus to a 3-minute FI. With the schedule change now contingent on a key peck, response rate during the warning stimulus on VI 10 often shows an initial tendency to fall, followed by positive acceleration (scallop). Response-rate changes during the warning stimulus on VI 1 are more difficult to evaluate. The performance of Bird 5SK was not markedly different from that obtained previously when schedule change was automatic. Bird 12SK showed a somewhat irregular performance during the warning stimulus on VI 1 compared with its performance when schedule change was automatic.

DISCUSSION

It may be concluded that (a) a VI schedule of reinforcement will generate a decreased response rate in a short, discriminated interval before a shift to a higher-frequency-of-reinforcement VI schedule, and (b) a VI schedule of reinforcement will generate an increased response rate in a short, discriminated interval before a shift to a lower-frequency-of-reinforcement VI schedule.

The effects described in the present report can be interpreted in either of two ways:

1. The rate changes observed during the warning stimuli were generated primarily by the reinforcement properties of the transition from one VI schedule to the other. Several aspects of the data support the quite reasonable assumption that the transition from VI 1 to VI 10 had negative-reinforcement properties, whereas the transition from VI 10 to VI 1 had positive-reinforcement properties. The initial procedure, it will be remembered, involved automatic transition from one VI to the other, thus favoring accidental contingencies between the birds' behavior and the reinforcement properties of the transitions. If one believes that the probability was rather low that the actual transitions occurred in a neat reinforcement relationship to a key peck (or, more exactly, motion of the head forward and striking the key), the main results of the experiment can be rationalized quite simply. The transition from VI 10 to VI 1 positively reinforced behavior which competed with pecking, so that it directly drove the observed response rate downward. On the other hand, the transition from VI 1 to VI 10 punished behavior which competed with pecking, so that it indirectly drove the observed response rate upward. The next step is to assume that the rates thus generated came under the stimulus control of the warning lights and key-color combination.

2. On the other hand, one can grant the reasoning in 1. but can also maintain that it cannot by itself adequately account for the observed results. Support for this contention might follow considering the data

of Birds 5SK and 12SK when the transitions were made contingent on a key peck. One would have expected a reversal of the original rate changes during the warning stimuli. However, not only were the original effects not wholly negated, but the modifications brought about by a precise and consistent contingency between key pecking and the reinforcement properties of the transitions were not so striking as the initial effects themselves. It is then debatable whether the initial effects could have resulted from unspecified (and, hence, imprecise and inconsistent) key-peck-schedule-change contingencies.

Granting the reasoning in 2. implies that the conclusions stated at the beginning of this discussion are understandable in terms of not only the reinforcement properties of the transitions but also some other presumptive behavioral principles such as schedule "contrast," motivational systems not primarily dependent upon deprivation,⁴ or "emotion"-induced changes in response rate. Unfortunately, such kinds of principles are not so well understood as is the principle of reinforcement.

Herrnstein (1955) and Ferster (1958) studied rate-change effects during a pre-time-out stimulus.⁵ Herrnstein observed rate increases during the pre-time-out stimulus on a VI schedule of positive reinforcement provided that the reinforcement frequency was not high (relatively). Ferster found a similar effect with time out from a 3-minute VI. The present experiment was structurally similar to the Herrnstein and Ferster studies. However, among several differences, perhaps the most prominent was that the time out was replaced by a 10-minute VI. The rate increase during the warning stimulus preceding the VI 1 to VI 10 transition possibly is analogous to the rate increases observed by Herrnstein and by Ferster. One advantage in the use of a 10-minute VI, which maintained pecking behavior, over a time out is that it permitted the observation of rate-change effects with the schedule transition going in the other direction—the other side of the coin, so to speak. It is interesting, but not surprising, that the opposite effect was obtained.

SUMMARY

Four pigeons were run to stable performance on a mult VI 1 VI 10 schedule of reinforcement. Either leg lasted 15 minutes; during the last 3 minutes, a pre-schedule-change stimulus was present. Response rate dropped during the pre-schedule-change stimulus on VI 10 and rose during the stimulus on VI 1. The results were discussed with respect to alternative interpretations.

⁴Cf. the Hull-Spence concepts of "incentive motivation" (1952, 1956).

⁵See also Herrnstein and Morse (1957) for an effect which might relate to the one described above. The writer is indebted to Dr. Murray Sidman for this observation.

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