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RESPONSE RATE UNDER VARYING FREQUENCY OF NON-CONTINGENT REINFORCEMENT[1]

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Two White Carneaux hen pigeons were exposed to a 60-sec random-interval baseline procedure. Six different exteroceptive stimuli were successively correlated, within a single session, with blocks of 10 reinforcement presentations. Following this training, a non-contingent reinforcement procedure was instated with inter-reinforcement intervals of 5, 15, 30, 60, 120, and 240 sec. Within a single session, each non-contingent frequency was correlated with one of the previously presented discriminative stimuli. After an initial increase in the rate of responding as the result of a high density of non-contingent reinforcements, the rate declined as exposure to each non-contingent frequency was prolonged.

A customary operational definition of reinforcement contingency is that the reinforcer follows the "contingent-upon" response closely in time (Skinner, 1948). When the response to be conditioned is specified in advance, the contingency invoked is that of the usual operant conditioning arrangement. When, however, "superstitious" conditioning was demonstrated (Skinner, 1948), its explanation rested upon the concept of reinforcement contingency. It was possible to salvage the concept by appeal (a) to the fact that the behavior stream is continuous; (b) to the inference that a reinforcer, even when applied without pre-selection of a response, must be contingent upon some response; and (c) to the presumption that whatever response is in the proper temporal relation to the reinforcer takes the impact of the "contingency" and emerges as the conditioned response. To rescue contingency in this way, however, is to rob it of at least part of its meaning, because every reinforcement schedule must then be asserted as being contingent, or, conversely, that no schedule can be said to be non-contingent. But that theoretical maneuver aside, it might be desirable to broaden the definition of the term so that the non-contingent case is the one in which the temporal distribution of the experimentally pre-specified response does not affect the temporal distribution of reinforcers, and the contingent case is the one where the two distributions are related (Schoenfeld and Farmer, 1970).

A procedure for estimating the effects of a non-contingent reinforcement schedule has been to deliver such reinforcers at a frequency approximately equal to that of a preceding baseline schedule of reinforcement. In the earliest study of this kind (Skinner, 1938), a 6-min fixed-interval schedule of reinforcement (FI 6-min) was instated, and was later replaced by delivery of non-contingent reinforcers every 6 min. The finding, corroborated several times since (Herrnstein, 1966; Zeiler, 1968; Lachter, 1970), was that the rate of response tends to fall as exposure to the non-contingent reinforcement procedure is prolonged, at least at several values of the schedule parameters. Skinner (1948) noted that the outcome of such studies may depend upon the frequency of the non-contingent reinforcers: "The sooner a second reinforcement appears . . . 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" (p. 169). In a previous experiment employing a complex baseline schedule of reinforcement, the effect of reinforcer non-contingency was found to depend upon the response rate produced by that schedule (Lachter, 1970). To ascertain the influence of reinforcer frequency, unconfounded by the schedule variable, the present experi-

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ment used a single-schedule baseline against which to evaluate several different frequencies of non-contingent reinforcement.

METHOD

Subjects

Two experimentally naive White Carneaux hen pigeons 6 to 8 yr old, were maintained at 80% ±15 g of their free-feeding weights throughout the experiment.

Apparatus

The experimental station consisted of a Lehigh Valley Electronics pigeon chamber (Model 1519C) containing a translucent key as an operandum. A static mass of 25 g was required to close the key switch. The chamber received overall illumination from a source located directly above the key. This light went off during reinforcement, which consisted of 2.5-sec access to a separately lighted hopper of mixed grain. The chamber was ventilated by a blower that also provided some masking noise. The six stimuli successively present during the baseline schedule of reinforcement were produced either by (a) transillumination of the key with 1.8 log foot-lamberts of glass filtered broad spectrum white, green, or red steady light projected through a uniform diffusing ("milk" plastic) medium, or (b) flickering key transillumination (100 millisec on, 100 millisec off) of the same intensity and composition of white, green, or red light. All experimental events were arranged with digital logic circuitry.

Procedure

(1) *Baseline.* After "shaping" of the key-peck response by successive approximations, a 60-sec random interval (RI 60-sec) schedule of reinforcement (Farmer, 1963; Millenson, 1963) was instated using a 6-sec time cycle (T) and a probability of reinforcement (p) of 0.10. In the t-τ systems, T refers to a repeating time cycle of fixed length, p to the probability of reinforcement for the first response in each T cycle, and T/p to the predicted mean inter-reinforcement interval when each T cycle intercepts at least one response. The six different exteroceptive stimuli were presented on the key in random order within each session, each stimulus remaining on the key until 10 contingent reinforcements had been delivered, so that a total of 60 reinforcements were obtained in each session. This procedure remained in effect for 78 sessions.

(2) *Non-contingent reinforcement.* The non-contingent reinforcement procedure was instated in place of the baseline procedure described above. Mean inter-reinforcer periods of 5, 15, 30, 60, 120, and 240 sec were chosen for delivery of non-contingent reinforcements, based on T/p schedules with T values of 0 (white key), 1.5 (green key), 3 (red key), 6 (flashing white key), 12 (flashing green key), and 24 sec (flashing red key), and a p value of 0.10.[2] Each non-contingent frequency was correlated with one of the exteroceptive stimuli present during the baseline procedure. In every session, each frequency and its correlated discriminative stimulus remained in effect until 10 non-contingent reinforcers had been delivered. The order of occurrence of the frequencies and their correlated stimuli was randomized from session to session. The non-contingent procedure was maintained for 30 sessions.

RESULTS

The data reported were obtained from 57 reinforcements in each session, the first three being excluded to allow for accommodation to the experimental chamber.

During the last six sessions of the baseline procedure, different rates in responses per second were noted among the several key stimuli ranging from 0.80 to 0.88 for Subject #1, and from 0.48 to 0.65 for Subject #2. Session-to-session variability in a particular stimulus was also contained within these ranges.

The instatement of a non-contingent reinforcement procedure resulted in changes in response rate that were similar for both subjects (Fig. 1). For both subjects, at each frequency of non-contingent reinforcement, response rate decreased as exposure to the schedule was prolonged. At those frequencies that resulted in a high density of reinforcers in time, the initial result of the change to the non-contingent procedure was an increase

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[2] Non-contingent schedules were arranged by substituting an independent pulse train for responses. The mean time between pulses was 0.5 sec, producing a mean inter-reinforcer interval of 5 sec at $T=0$ since, at $p=0.10$, the mean number of pulses per reinforcer was 10. The pulses were prevented from occurring during reinforcer delivery for all schedules.

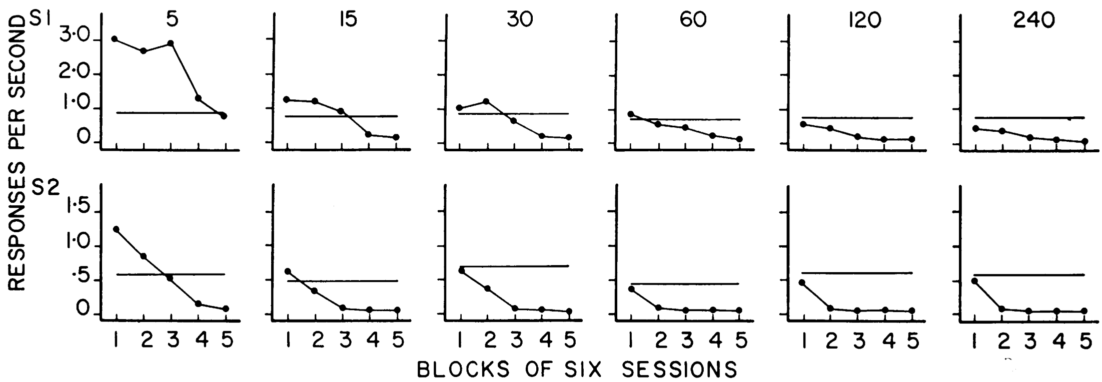

Fig. 1. Response rate as a function of six session blocks of exposure to the non-contingent reinforcement procedure for Subjects 1 and 2. The numbers inset into each column of the figure indicate the mean interval between non-contingent reinforcers in seconds. The horizontal lines within each set of coordinates were obtained by calculating a rate for the last six sessions (73 to 78) of the baseline procedures. For this calculation, all responses on a given schedule during the six days were divided by the total time that the schedule was in effect minus the total reinforcement duration and total post-reinforcement pause.

in response rate above the baseline level of responding. This first effect was eventually followed by a fall in rate. At lower frequencies, the rate of responding began to decline at once, without first rising above the baseline level of responding.

DISCUSSION

These data may be viewed in terms of extinction of the experimentally observed response, and the strengthening of "not-responding", the class of behaviors previously ineligible for reinforcement (Schoenfeld and Farmer, 1970). When a non-contingent procedure is introduced in which reinforcer frequency is lower than that of the contingent schedule preceding it, an "extinction-like" effect appears, which is similar to that noted by others following an increase in an interval or ratio requirement (Skinner, 1938; Keller and Schoenfeld, 1950). This drop in response rate has as a consequence a lowering of the probability of temporal coincidence between a response and a reinforcer, so that behaviors other than the response are now strengthened. Moreover, varieties of "not-responding" are controlled by the intermittency variable even if the reinforcers are non-contingent. The net effect of increases in the rate of "not-responding" is at the expense of response frequency, and this outcome is exhibited in the present data. Yet, given a relatively high baseline rate of response, and a high frequency of non-contingent reinforcers, the temporal contiguity of a response and a reinforcer can remain close on the average. Should the non-contingent reinforcers occur at a higher frequency than in the baseline schedule, an increase in response rate (observed above) might be expected, at least temporarily. Temporarily, because there will also be occasions when "not-responding" will feel the stronger influence because of its temporal relation to reinforcement, and, as its rate rises, there will be a reciprocal fall in response rate. The counterplay of response extinction and "not-responding" conditioning ultimately produces the "superstitious" responding described by Skinner and by others after him. But if this account is correct, it deserves to be generalized. The relative amounts of conditioning and counter-conditioning must be variable depending upon the schedule parameters that are experimentally manipulated. As measured upon the response, the effects of reinforcement contingency and non-contingency are not absolute or all-or-none, but rather will vary as desired by means of appropriate choices among experimental parameters. Further, whether the effects are visually discernible or not—whether the intriguing special cases are stumbled upon or intuitively designed, as they have been in the past—they should be measurable within whatever systematic formulation the experimenter has adopted. A complete spectrum of interactions is possible between responding and "not-responding", and experimental analysis alone can reveal them and supplant theoretical arguments based on special cases.

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