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TIMEOUT AND CONCURRENT FIXED-RATIO SCHEDULES WITH HUMAN SUBJECTS[1]

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Human subjects given choices among 10 different pairs of concurrent fixed-ratio schedules preferred the smaller ratio. After a preference had been determined, timeout of increasing duration followed the completion of the preferred schedule. The larger the fixed-ratio difference, the longer the timeout necessary to produce the shift to the previously nonpreferred ratio. Responses by two of three subjects were unaffected by changes from response-dependent to response-independent pay.

Timeout, when used to eliminate effects of earlier behavior, is a specified period of time in which the organism does not engage in the behavior being studied (Verhave, 1966). It is a period where responding is not reinforced or when responding is not possible. In either case, no scheduled reinforcer can be obtained during timeout. Leitenberg (1965) pointed out that timeout has many practical implications, yet at present little is known about its parameters.

Timeout has frequently been used in punishment paradigms with human subjects. Holz, Azrin, and Ayllon (1963) reduced response rates of two out of four mental patients whose behaviors were being reinforced with cigarettes on a variable-interval schedule; also, every tenth response was punished with 30 sec of timeout. All four patients eliminated the punished response when an unpunished alternative response was made available. Zimmerman and Bayden (1963) used timeout of 2, 10, 60, and 120 sec to eliminate incorrect responses in matching-to-sample with human subjects. The longer durations of timeout were more effective in reducing incorrect responses. In another matching-to-sample task with humans (Miller and Zimmerman, 1966), incorrect responding was reduced when timeout was response-dependent but not when it was response-independent. A 4-min period was more effective than a 1-min timeout period in reducing incorrect responding. Overall parametric information on effects of systematically increasing durations of timeout is scarce.

The current study provides information on the effectiveness of systematically increasing durations of timeout. Inasmuch as most practical situations provide an alternative response to the behavior producing timeout, a concurrent responses situation was chosen. Ferster and Skinner (1957, p. 724), defined concurrent operants as: "two or more responses, of different topography at least with respect to locus, capable of being executed with little mutual interference at the same time or in rapid alternation, under the control of separate programming devices." The likelihood of fixed-ratio reinforcement cannot change as the organism responds on a second concurrent schedule. With fixed-ratio schedules, the schedule advances and reinforcement becomes more probable only with fixed-ratio responses. Concurrent fixed-ratio schedules are preferable for the collection of parametric information on increasing durations of timeout, because there are few changeovers (Herrnstein, 1958) and a preference is shown for the smaller ratio of a concurrent pair (Catania, 1966).

Response-dependent reinforcement is more effective in maintaining behavior than is response-independent reinforcement (Ayllon and Azrin, 1965; Winkler, 1970; Miller and Schneider, 1970). However, Weiner (1962;

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1963; 1964*a;* 1964*b;* 1965*a;* 1965*b;* 1967) found that even when pay is independent of behavior, the loss of a point after each response (response cost) reduces high response rates to lower levels over wide ranges of reinforcement schedules. Since Weiner's subjects were paid hourly or not at all, the effects of adjusting pay in relation to points earned in the response cost paradigm is contradictory to other findings in the response-dependent, response-independent literature (Ayllon and Azrin, 1965; Winkler, 1970). Since response cost and timeout are similar punishment paradigms, a manipulation in the current study assessed the effect of response-dependent *versus* response-independent pay. With timeout, the subject loses the opportunity to earn a reinforcer for some period of time; with response cost, the subject loses a point (potential reinforcer) after each response.

METHOD

Subjects

Three male undergraduate students served. An advertisement through the student employment service indicated that subjects were needed for 1 to 2 hr per day, seven days a week, with a rate of pay of about $1.50 per hour. Each subject signed an agreement to participate after receiving instructions similar to those presented by Baron and Kaufman (1968).

Apparatus

The 6 by 7 ft (1.8 by 2.1 m) experimental space contained a chair, a card table for the apparatus, and a random noise generator. The apparatus was two pieces of plywood joined at a right angle. On the upright piece of plywood were mounted a four-digit counter and a blue signal light. The plywood base contained two Switchcraft lever switches (number 6006) each mounted on a 2.0 by 1.75 by 0.25 in. (5.1 by 4.5 by 0.6 cm) white sheet of translucent plastic (Plexiglas). The plastic sheets were illuminated from underneath by a 1.1-w dc lamp.

Each completed fixed-ratio registered a one-unit advance on the counter. A counter advance produced an audible click. Two 110-v ac relays produced auditory feedback whenever the subject operated either switch. Automatic equipment, impulse counters, and cumulative recorders (located in an adjacent room), were used to control the reinforcement schedules and record responses. The control room also contained a one-way mirror.

Procedure

Throughout the three phases of the experiment, each pair of fixed-ratio schedules was assigned to one of the two lever switches. In Phase 1 (response-dependent pay), each subject was told to respond on only one lever at a time and that each lever would allow him to earn points, which would register on a counter in front of him. He was also told how many points were worth a penny. The number of points required to earn a penny were four for Subject 1, three for Subject 2, and two for Subject 3. Subjects were paid solely on the basis of points earned. If the subject asked any questions the experimenter re-read the instructions.

In Phase 2 (response-independent pay), the subjects were told that they would be paid the average of their earnings for the previous 14 days, the amount being $2.00 for Subject 1, $1.95 for Subject 2, and $2.45 for Subject 3.

In Phase 3 (return to response-dependent pay), Subjects 1 and 3 were informed that they would be paid respectively a penny for every four or two points. Subject 2 did not participate in this phase.

The ratios associated with each lever were switched after every 12 ratios; this comprised a cycle. The switching of levers after each cycle ruled out position preference and determined the subject's preference for any of the concurrent ratio schedules. The first four completed ratios of each cycle were not considered in determining preferences. Each completed fixed ratio added one point to the subject's counter but did not reset the ratio in effect on the other lever.

Throughout the study each subject completed, at the start of each new ratio pair, three ratios on one lever followed by three ratios on the other lever (these ratios were excluded from the data). Each completed baseline consisted of the last eight ratios of each of 12 cycles. This baseline of 96 ratios was used to determine the number of ratios completed most frequently by each subject. If the number of concurrently available ratios completed was equal, preference was assigned to one ratio at random. Then, a timeout and a one point counter advance followed the completion of each preferred ratio.

During a timeout, the lever lights went out, responses did not activate the subject's counter, and no auditory feedback followed a response. Timeout duration increased after every five cycles. Initially, the timeout was 0.5 sec, then 1.0 sec, and then increased by 1.0-sec increments until at least 51% of the ratios were completed on the formerly nonpreferred ratio. Then, the next concurrent fixed-ratio pair was introduced and the sequence of baseline without timeout—followed by timeouts of increasing duration—was repeated. Each subject was presented with 10 pairs of fixed-ratios in the order shown in Table 1. The sequence of 10 concurrent schedules was repeated in the same order from two to six times in each phase.

Table 1

Sequence of experimental conditions and number of replications of experimental conditions for three subjects.

	Subjects:	*1*	*2*	*3*
Sequence of concurrent fixed ratios		30-40	30-30	20-80
		10-10	15-30	40-40
		40-40	30-60	20-40
		10-40	45-45	40-80
		20-20	30-45	60-60
		10-20	15-45	40-60
		20-40	45-60	20-60
		30-30	15-15	60-80
		20-30	60-60	20-20
		10-30	15-60	80-80
Number of replications	Phase 1	6	4	4
of each sequence	Phase 2	6	3	3
	Phase 3	2	–	3

After each session, the amount earned was recorded on a card that the subject had been given at the end of the first session. Each subject received a paycheck monthly, and after the experiment, a bonus equal to the amount earned during the entire experiment.

RESULTS

Figure 1 shows the median number of ratios completed on the preferred schedule for each pair of concurrent ratios during the baseline for all subjects. The medians are those for all replications of each condition for all phases of the experiment, and differed only slightly from those of the individual phases. For example, each point plotted for Subject 1 for each concurrent pair of ratios, is the median of 14 baselines (or 14 replications) of that condition. The maximum number of ratios that could be completed on the preferred schedule was 96. As the difference between the concurrent fixed ratios increased, the percentage of ratios completed on the preferred schedule increased to 100%. All three subjects preferred the smaller ratio of each pair during each baseline.

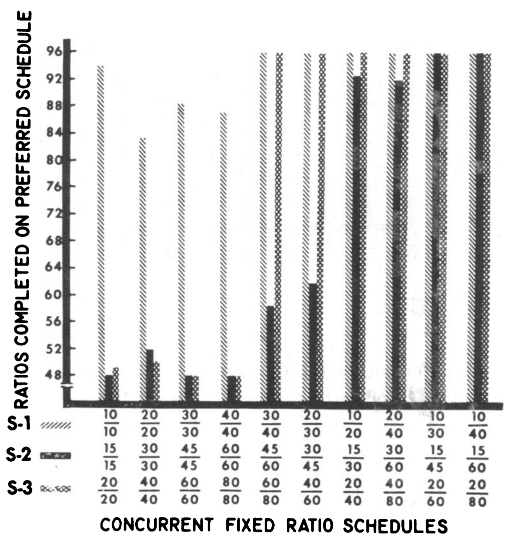

Fig. 1. Median number of ratios completed on preferred schedules (out of a possible 96) during baseline for all replications of each concurrent pair of ratios for all subjects. The ratio preferred during the baseline is always listed at the top of each pair of ratios on the abscissa.

Figure 2 shows the median switching thresholds for each pair of concurrent ratios for each phase of the experiment. The abscissa is arranged according to the difference in the size of the ratios. The switching threshold was the timeout duration at which the subject completed at least 51% of the ratios on the previously nonpreferred ratio. The shift from the punished to the nonpunished ratio was abrupt and complete in approximately 50% of the cases for all three subjects.

With a timeout of 0.5 sec, all subjects switched to the unpunished alternative if the ratios were equal. As the difference between the concurrent ratios became larger, the switch-

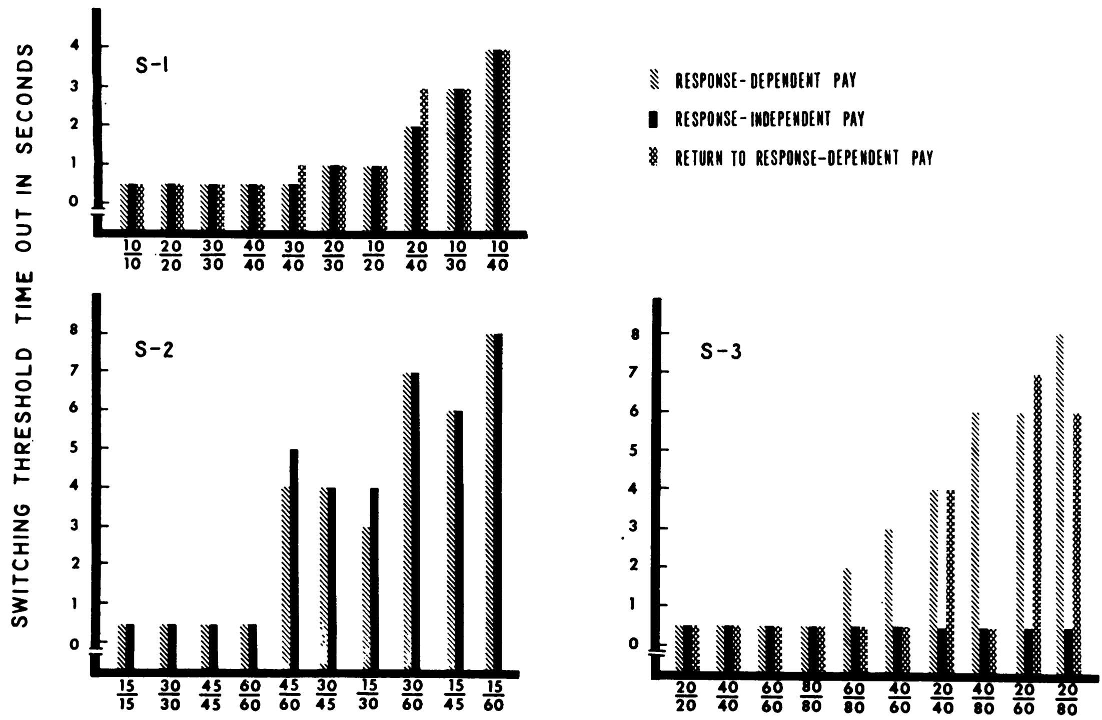

Fig. 2. Median switching thresholds for each subject for all concurrent ratio pairs during the phases of the experiment. The ratio preferred during the baseline is always listed at the top of each pair of ratios on the abscissa.

ing threshold became longer in all three phases for Subjects 1 and 2, and in Phase 1 for Subject 3. During response-independent pay (Phase 2), Subject 3 switched preferences with timeout of 0.5 sec duration. In Phase 3, Subject 3 required longer durations of timeout to produce the switchover; however, this recovery of behavior similar to Phase 1 occurred only when one or both of the ratios required 20 responses. For the other conditions, the switching threshold was 0.5 sec.

Switching from one schedule to the concurrent schedule occurred primarily after a ratio was complete. The only exceptions were at the end of a cycle when the positions of the schedules in effect were switched. In such cases, the subjects sometimes switched to the other lever after they had made fewer responses than were necessary to complete a ratio. Pauses in responding for Subject 1 and 3 occurred mainly after a ratio was complete. The occurrence of any pauses in responding by Subject 2 was usually during a fixed-ratio run rather than at a ratio's completion. Slight changes in running rate are apparent if one looks closely at the fine grain of the cumulative recordings. In this respect, the data are not typical of the subjects' responding, since the rates of responding varied within and between conditions and sessions for Subjects 1, 2, and 3.

Figure 3 shows the median rate of reinforcement for both the preferred and nonpreferred schedule of each concurrent ratio pair at the timeout duration at which switching occurred. The median is that of the last three replications of each condition. The rate of reinforcement was computed for both the preferred and nonpreferred schedule by dividing the number of ratios completed on each schedule by the time taken to complete the ratios. When the rate of reinforcement was higher on the preferred ratio, switching to the other ratio produced a lower rate of reinforcement. If reinforcement rate was higher on the nonpreferred ratio at the timeout duration at which the subject switched, the rate of reinforcement

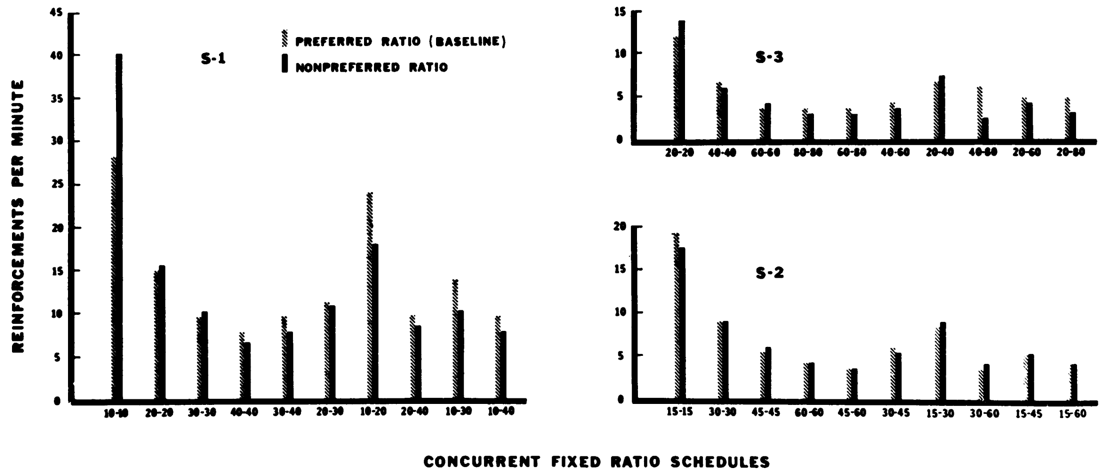

Fig. 3. Median rate of reinforcement (last three replications) for both preferred and nonpreferred schedule of each concurrent ratio pair at timeout duration at which switching occurred. The ratio preferred during the baseline is always listed at the left of each pair of ratios on the abscissa.

was being maximized. In some cases, rates of reinforcement were equal on the preferred and nonpreferred ratios.

Switching was usually accompanied by an increased response rate; in most cases this was not sufficient to produce an increased rate of reinforcement for Subjects 1 and 3. For Subject 2, the increased response rate accompanying switching was often followed by a higher or equal rate of reinforcement. To that extent Subject 2 differed from Subjects 1 and 3. In most cases when switching was associated with a lower rate of responding, the rate of reinforcement also decreased. This finding was consistent for all three subjects.

DISCUSSION

This study replicated findings of other experiments showing that human subjects prefer the smaller ratio of a concurrent pair when the completion of either schedule is followed by comparable reinforcement (Catania, 1966; Weiner, 1966). These results also concur with those of Dardano and Sauerbrunn (1964), where pigeons preferred lower ratios.

Dardano and Sauerbrunn (1964) found that pigeons' preferences switched to a high ratio when responding on a lower ratio was followed by shock presentation. The present procedure showed similar effects with timeout rather than electric shock, and provides parametric information on the role of timeout duration. The subjects switched from the preferred ratio to the formerly nonpreferred one when timeout of sufficient duration followed the completion of the previously preferred schedule. The introduction of timeout after the preferred schedule was completed did, in fact, reduce the rate of reinforcement on the schedule on which it was response-dependent, whereas the rate of reinforcement on the unpunished alternative remained fairly constant. Such a finding was expected because timeout by definition, reduces the total amount of time available for responding. To maintain a constant rate of reinforcement as the duration of timeout increased, a compensatory increase in response rate would have been necessary. An increase in responding did accompany switching, but it was generally not sufficient to maintain a constant rate of reinforcement. Even though their response rates increased, Subjects 1 and 3 switched to the unpunished alternative more often when the rate of reinforcement there was lower than on the schedule preferred during baseline. The increased response rate that accompanied switching for Subject 2 may have produced some of the higher rates of reinforcement associated with switching. The data for all three subjects must be qualified by the fact that the differences in rate of reinforcement between the preferred and nonpreferred schedules were generally small. Also, subjects often switched preferences immediately after the first timeout. It is possible that switching was associated with aversive properties of timeout other than changes in reinforcement rate. Holz, Azrin, and Ayllon (1963) also found that timeout suppressed a response if an alternative response was made available. In their study, as in the present one, responses on the punished manipulandum necessarily produced a lower rate of reinforcement. However, Herman and Azrin (1964) achieved similar results using noise instead of timeout. No appreciable decrement in reinforcement rate is inherent when noise is used as a punishing stimulus.

Previous studies show that response-dependent reinforcement is more effective in maintaining behavior than is response-independent reinforcement. This study shows that one subject's response pattern changed when pay was independent of responding; such a finding is difficult to explain if pay were the only reinforcing event. It does provide some basis for questioning Weiner's results on the point that all his subjects were paid on a response-independent basis or not at all. In Weiner's studies, the opportunity to gain points is not the opportunity to gain money, thus, money was not the controlling variable. For two of three subjects in the present study, the same conclusion must hold, because their behavior patterns were no different under response-dependent *versus* response-independent pay conditions. For the third (Subject 3), timeout apparently was a loss of the opportunity to gain money. It is not possible to account for the difference in the results obtained in Weiner's study and in the present one. However, both response cost and timeout are punishment paradigms that result in stimulus change; that one of the three present subject's behavior pattern was different under response-dependent *versus* response-independent pay may well indicate that data obtained using response cost would be different if pay were dependent on behavior. Research concerning response-dependent pay with a response cost paradigm seems warranted.

The results of the present and previous investigations (Zimmerman and Bayden, 1963; Miller and Zimmerman, 1966) indicate that timeout has different effects at different durations and that these effects depend on the alternative response(s) available. This implies that, in practical situations where it is desirable to eliminate some behavior, one must use different timeout durations, depending on the situation. Relatively brief timeout durations can eliminate a behavior when an alternative response is available. Timeout may well be the ideal punishing stimulus (Azrin and Holz, 1966). A more useful distinction might be to re-define the term response cost to include timeout. Thus, a response cost could be defined as any stimulus, the response-dependent removal of which reduces the future probability of that response class. Such a definition could well embrace timeout stimuli. The counterpart of response cost stimuli would be labelled punishing stimuli in accordance with the precedence in reinforcement paradigms in which stimuli are defined as either positive or negative reinforcers, depending on whether the stimuli are response-dependently presented or removed. In punishment paradigms, no such distinctions currently exist.

The current study has implications for research dealing with delays in reinforcement. Since relatively short timeout durations modified behavior, the relative duration of a delay in reinforcement may act as a timeout period that decreases (punishes) behavior that is to be increased. Furthermore, these results have implications for theories dealing with extinction because the effects of timeout and extinction are similar.

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