

*CHAINED CONCURRENT SCHEDULES:
REINFORCEMENT AS SITUATION TRANSITION¹*

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Pigeons' pecks at two white response keys (initial-link situation) occasionally turned both keys red (terminal-link situation). When the two keys were red, pecks occasionally produced food, after which the keys were again white. In both situations, a changeover delay prevented the response-produced outcome from immediately following a change of responding from either key to the other. In the initial-link situation, the ratio of pecks at the keys closely paralleled the ratio of transitions into the terminal-link situation produced by the pecks, conforming to the well-known matching relation. In the terminal-link situation, the peck ratios deviated from the matching relation toward indifference. Overall response rate and rate of changeover were generally higher in the terminal-link situation than in the initial-link situation. The finding of matching in the initial-link situation supports a definition of reinforcement as situation transition. The differences in performance between the two situations, viewed in the light of other recent findings, suggest that the effects of a changeover delay depend on the overall reinforcing value of the choice alternatives.

According to the matching relation (Herrnstein, 1970), relative responding at two choice alternatives equals the relative reinforcement obtained from the two alternatives:

$$\frac{P_1}{P_1 + P_2} = \frac{r_1}{r_1 + r_2} \quad (1)$$

where P_1 and P_2 are the rates of responding at Alternatives 1 and 2, and r_1 and r_2 are the rates of reinforcement obtained from Alternatives 1 and 2. Found originally for food, a primary reinforcer, Equation 1 was extended also to conditioned reinforcers.

Autor (1960) and Herrnstein (1964) tested the proposition that the value of a conditioned reinforcer is directly proportional to the rate of primary reinforcement in its presence. They used a concurrent-chain procedure, in which responses at two alternatives in an initial link (identical concurrent variable-interval schedules) produced one of two mutually exclusive terminal-link schedules that produced food reinforcement. Both experimenters found Equation 1 to hold, with P_1 and P_2 the responses in the initial link, and r_1 and r_2 the

rates of reinforcement in the two terminal links.

Fantino and coworkers (Duncan and Fantino, 1970; Fantino, 1969; Squires and Fantino, 1971) cast doubt on the generality of this result. They found that the matching relation held only with certain schedule parameters. Varying the lengths of the identical variable-interval (VI) schedules in the initial link, for example, produced deviations from the relation.

The conception originally underlying Autor's and Herrnstein's experiments, that stimuli acquire reinforcing value by being paired with primary reinforcers such as food, has come under attack (see Baum, 1973a; Bloomfield, 1972, and Hendry, 1969). The concept of conditioned reinforcement can be preserved, however, if, instead of assigning reinforcing value to the signals of impending primary reinforcement, reinforcing value is assigned to the changes of situation that these signals indicate (Baum, 1973a). In a chain, the conditioned reinforcers would be the transitions from early links into ones closer to the primary reinforcer.

The question remains, therefore, whether conditioned reinforcers function the same way as primary reinforcers. If, for example, all reinforcement consists in situation transition (Baum, 1973a), then it should be possible to

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substitute a transition earlier in a chain—a conditioned reinforcer—for the final transition to eating—a primary reinforcer—and still obtain the matching relation (Equation 1). To do this, one would make the *terminal* links of the concurrent chain identical, and the initial-link VI schedules different. One would ask whether the relative responding in the initial link matched the relative rate of transition into the terminal link.

METHOD

Subjects

Three male White Carneaux pigeons were maintained at 80% of free-feeding weights. All had previous experience with concurrent-chain schedules.

Apparatus

The two identical experimental chambers, 31 cm high, 33 cm long, and 29.5 cm wide, conformed to the standard design for pigeons (Ferster and Skinner, 1957). Two response keys, 19 mm in diameter, 22 cm from the floor and 14.5 cm apart, each operable by a force of about 0.25 N, could be transilluminated with red or white light. The opening of the grain hopper was in the center of the same wall, 9 cm from the floor, which consisted of stainless steel rods, 5 mm in diameter, spaced 2 cm apart. Standard mixed grain was presented with a Gerbrands grain feeder lit with two 7-W lamps. The experimental chamber was enclosed in a sound-attenuating outer box.

A PDP-9T computer (Digital Equipment Corporation) controlled and monitored events in the apparatus.

Procedure

Since the pigeons were experienced, they were exposed to the basic procedure, a chain schedule, from the beginning. At the start of a day's session, the two response keys were white. In this situation, the initial link of the chain, pecks at one or the other key produced, on a variable-interval (VI) schedule, a second situation, the terminal link of the chain. In the terminal link, both response keys were red, and pecks at one or the other produced, on a VI schedule, 4-sec access to grain. During reinforcement, only the lights in the grain magazine were lit. After reinforcement, the initial link was reinstated.

The schedule can be described as a chain in which each link consisted of a concurrent VI schedule. The outcomes (terminal link or food) were scheduled in a manner similar to that described by Stubbs and Pliskoff (1969). A single VI schedule arranged for the outcome to be produced by a peck, and a table, analogous to an electromechanical stepper, determined at which key the peck must be. Only a peck at one key could produce the outcome, once scheduled, but that key's identity varied irregularly from one outcome to the next. The intervals in the VI schedules formed an arithmetic series from a shortest interval of 0.11 (1/90) sec to a longest interval (a multiple of 0.11 sec), each interval larger than the one before by 0.11 sec. Intervals were selected randomly and were equiprobable. In the initial link, the scheduled intervals averaged to approximately 22.8 sec; in the terminal link, to approximately 45.5 sec.

In both links, a changeover delay (COD) prevented an outcome immediately after switching keys. Due to a limitation in the computer system, it was programmed in a somewhat unusual manner. A change of keys began a 1.5-sec timer, but, contrary to usual practice (Catania, 1966), changeovers while the timer was running did not reset it. This meant that a changeover near the end of the 1.5-sec interval could be followed closely by an outcome. The first peck, however, the changeover response itself, could never produce an outcome. If changeovers during the COD proved to be relatively rare, this technique would function more or less like the usual one.

Apart from the pecks producing the scheduled outcomes, all pecks produced auditory and visual feedback (a click and a flicker of the chamber lights about 45 msec in duration). A houselight was on throughout the session, except during response feedback and food presentation. Pecks during response feedback or food presentation went unrecorded and produced no scheduled consequences.

The relative frequencies with which pecks at the two keys produced the outcomes were varied as shown in Table 1. Each condition was continued until graphs of the performances of all the birds appeared to the eye to be stable from day to day.

Sessions were conducted daily, except for holidays and days necessary for computer maintenance. A session ended after 48 food

Table 1

Order of experimental conditions and number of sessions of exposure.

Condition	Ratio of Outcomes, Left:Right		Number of Sessions
	Initial Link	Terminal Link	
c	1:1	1:1	22
d	2:1	1:2	31
e	4:1	1:4	42*
d	2:1	1:2	31**
c	1:1	1:1	26
b	1:2	2:1	23
a	1:4	4:1	68
b	1:2	2:1	32
c	1:1	1:1	36

*Except Bird 10, which received 53 sessions.
 **Except Bird 10, which received 20 sessions.

presentations. Two pigeons (9 and 459) were given sessions sequentially in one experimental chamber; the third (10) had its session in the other chamber.

RESULTS

Stable performance was estimated by summing counts (reinforcements, pecks, and changeovers) and times (time left, time right, and COD times) over the last seven days of each condition in Table 1. These sums, which constitute the raw data, appear in the Appendix. The times spent on the left and right (time left and time right) were the cumulated time from a changeover to the left and right keys, respectively, until a changeover to the other key. These times excluded response feedback and reinforcement. The "COD time" refers to the total time during which the changeover delay was elapsing. "Pecks in COD" included changeovers that initiated a COD and all other pecks during the COD time.

Figure 1 shows choice as a function of relative frequency of the outcome (link transition or food) in both links. The ratio of pecks at the left key (P_1) to pecks at the right key (P_2) is plotted against the ratio of the number of outcomes from the left key (N_1) to the number of outcomes from the right key (N_2), in logarithmic coordinates. The arrows between points indicate the order of conditions. The solid lines were fitted by the method of least squares. The equation of the line fitted to the points from the initial (first) link ap-

pears in the upper part of each graph; the equation of the line fitted to the points for the terminal (second) link appears in the lower part.

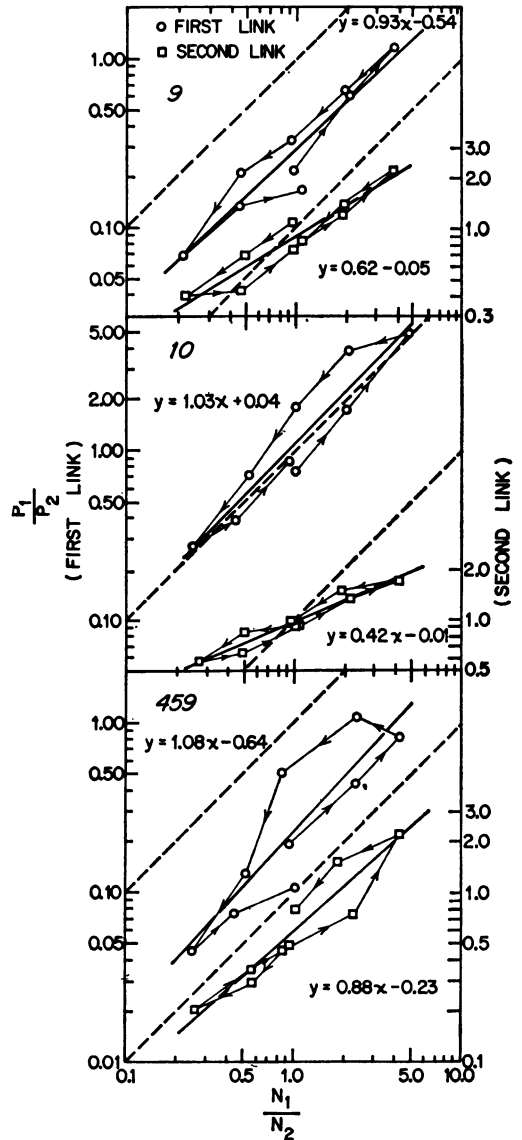


Fig. 1. Choice as a function of reinforcement distribution. Each graph shows data from one pigeon. P_1 and P_2 are pecks at the left and right keys. N_1 and N_2 are the numbers of reinforcers obtained from the left and right keys. Ordinate and abscissa are logarithmic scales. The ordinate for first-link responding is on the left; the ordinate for second-link responding is on the right. The arrows show the order of conditions. The solid lines were fitted by the method of least squares. The upper equation in each graph is for the first-link line; the lower equation, for the second-link line. The broken lines show the locus of perfect matching.

Graphed in these coordinates, the matching relation appears as a line of slope one passing through the origin [(1,1) in the graphs; see the broken diagonal lines]. If the slope of the fitted line equals one, but the line fails to pass through the origin (*i.e.*, the intercept of the equation differs from zero), then choice was biased. This form of bias follows from the general rule that the ratio of the frequencies of responding at two alternatives, B_1/B_2 , matches the ratio of the reinforcing values of the alternatives:

$$\frac{B_1}{B_2} = \frac{V_1}{V_2} \quad (2)$$

where value, V , is defined as the product of all reinforcement variables (see Baum and Rachlin, 1969, Equation 10, and Baum, 1973*a,b*). Some invariant asymmetry, either in the apparatus (*e.g.*, the characteristics of the response keys) or in the animal (*e.g.*, position preference) would make one alternative inherently more attractive than the other. The matching relation would become:

$$\frac{P_1}{P_2} = \frac{w_1}{w_2} \cdot \frac{N_1}{N_2} \quad (3)$$

where w_1 and w_2 indicate the values (left and right) of the asymmetrical parameter. In logarithmic coordinates, Equation 3 becomes:

$$\log\left(\frac{P_1}{P_2}\right) = \log\left(\frac{N_1}{N_2}\right) + \log\left(\frac{w_1}{w_2}\right) \quad (4)$$

The quantity $\log(w_1/w_2)$ indicates the extent of the bias. As long as the slope of the fitted line approximates one, Equation 4 and the generalized matching relation (Equation 2) are confirmed.

When biased choice data are graphed in terms of the proportions in Equation 1 (*e.g.*, Catania, 1966; Herrnstein, 1961), they conform to a bowed curve, rather than a straight line. Deviations from a slope of one in the logarithmic coordinates (Figure 1) appear as still more complicated curves in graphs of proportions. The present method of display is preferable, therefore, because it reveals simple linear relations.

The slopes of the lines fitted to the first-link data are all close to one. Their average is 1.01. For Pigeon 10, choice was almost unbiased (w_1/w_2 in Equation 3 equal to 1.10). For the other two birds, the negative intercepts indi-

cate that choice was biased in favor of the right key.

The slopes of the lines fitted to the second-link data all fell short of 1.00. Since the intercepts were closer to zero than those for the first-link data, choice was less biased in the second link, even though it failed to conform to the matching relation.

A similar analysis was done for time spent on the left and right. These times were estimated by cumulating the times between changes of pecking from one key to the other (*i.e.*, the inter-changeover times). A changeover to the right or left key started the time for that key cumulating and stopped the time for the other key from cumulating. The ratio of the times was considered as a function of the ratio of outcomes, the same abscissa as in Figure 1. Although both the slopes and the intercepts of the fitted lines varied more from subject to subject, the results were comparable to those in Figure 1. The average slope for the first-link times was 0.98.

The different preferences in different presentations of the same situation, depending on whether the ratio of outcomes was increasing or decreasing, reveal some order dependence. The preference observed when the ratio was increasing tended to fall below that observed when the ratio was decreasing. This tendency toward *hysteresis* ("lagging behind"; see Stevens, 1957) appeared, to one degree or another, in the data of every bird and both links.

Did the unusual method of programming the changeover delay (COD) produce unusual performance? It has commonly been observed (*e.g.*, Silberberg and Fantino, 1970) that the conventionally programmed COD produces bursts of responding, following changeover, that generally exceed the COD in duration. Whether this was true in the present experiment can be judged by examining the time that the COD timer ran per changeover (*i.e.*, the "COD time" divided by the number of changeovers). If any changeovers occurred before the end of the COD, the COD time per changeover would fall short of the COD.

Figure 2 shows the frequency distribution of COD time per changeover across the 27 (three birds in nine conditions) initial-link and 27 terminal-link situations. The shaded portions indicate data from terminal-link situations, the open portions from initial-link situations. The frequency of premature changeovers was gen-

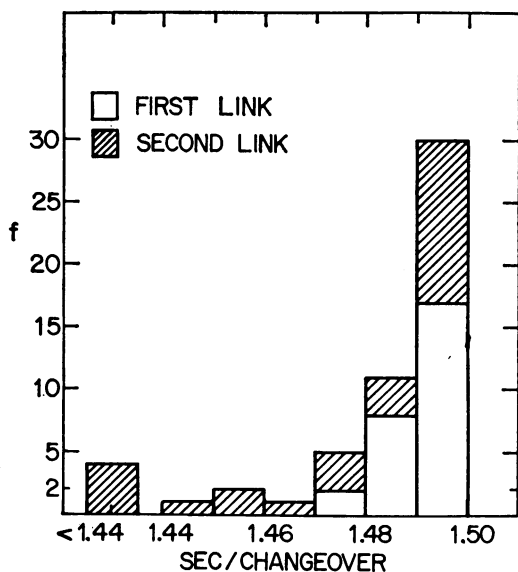


Fig. 2. Frequency distribution of the COD time per changeover across the 54 experimental situations. See text for explanation.

erally less than two per hundred (time per changeover equal to 1.47 sec). The eight situations in which frequency of premature changeover exceeded this were all terminal-link situations. Pigeon 10 produced five of them, Pigeon 459 the other three. Although there seem to be no published data to compare with Figure 2, my own experience indicates that these results closely resemble those with the conventional COD.

Silberberg and Fantino (1970) found that, in a simple concurrent VI schedule, pecking during the COD was insensitive to relative reinforcement; relative responding during the COD showed almost no systematic variation as the distribution of reinforcement changed. Relative responding after the COD, on the other hand, related to relative reinforcement by a steeper function than the matching relation. Overall responding, the sum of pecks during and after the COD, conformed to the matching relation.

Figure 3 shows the results of partitioning responding in the present experiment after the manner of Silberberg and Fantino. Each graph shows, for one bird in one link, relative responding (P_1/P_2) as a function of the relative number of outcomes (N_1/N_2). The coordinates are as in Figure 1. The left column of graphs shows data from first-link situations, the right column second-link situations. The

circles show relative responding during the COD, the squares show relative responding after the COD. The solid lines were fitted by the method of least squares. In each graph, the equation of the line for responding during the COD appears above the equation of the line for responding outside the COD. The broken lines indicate the locus of perfect matching.

The fitted lines reveal that relative responding outside the COD varied more steeply (slopes) and was generally more biased (intercepts) than relative responding during the COD. Except for Pigeon 10 in the first-link situations, where the three intercepts were nearly equal, the slopes and intercepts in Figure 1 all fell between the pairs of slopes and intercepts in Figure 3. The difference in slopes was in the same direction as that found by Silberberg and Fantino, but, particularly in the first-link situations, was less than the difference they found. The discrepancy in slope changed dramatically from the first link to the second. Whereas the ratio of the slopes in the second-link situations ranged from 7.6 to 148, the ratio of the slopes in the first-link situations ranged only from 2.1 to 4.6. Overall, the smaller was the ratio of slopes in Figure 3, the nearer to 1.00 was the slope in Figure 1. The greatest change in slope from first to second link occurred for responding during the COD (Figure 3). On the whole, as responding during the COD approached the matching relation, so too did overall responding.

Figure 2 showed that changeovers during the COD tended to be more likely in the second link. Figure 4 compares the rates of changeover in the two situations. The abscissa, P_1/P_2 , corresponds to the ordinates of Figure 1. The squares indicate rates of changeover in second-link situations, the circles in first-link situations.

The points in Figure 4 show some tendency to conform to an inverted U-shape. Such a trend supports the oft-reported finding that rate of changeover tends to decrease as the disparity between alternatives increases and to increase as the alternatives become more alike (e.g., Brownstein and Pliskoff, 1968; Herrnstein, 1961).

Since the ordinate in Figure 4 is logarithmic, the separation between the two sets of points corresponds to a ratio of the rates of changeover. The separation indicates that the rates of changeover in the second-link situations

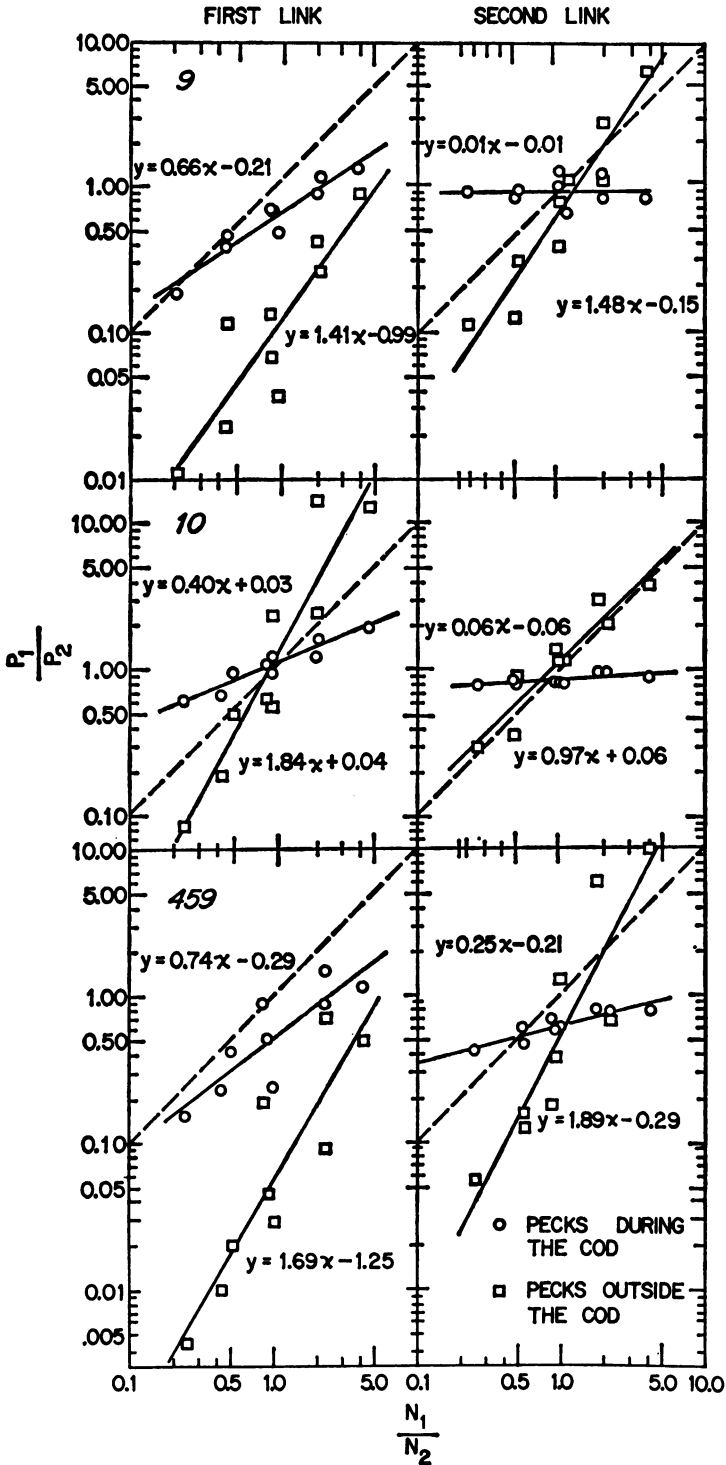


Fig. 3. Relative responding during (circles) and after (squares) the COD as a function of overall relative reinforcement. Each pair of graphs (left-hand, first link; right-hand, second link) shows the data from one pigeon. P_1 , P_2 , N_1 , and N_2 are as in Figure 1. Ordinate and abscissa are logarithmic scales. The solid lines were fitted by the method of least squares. The upper equation in each graph is for responding during the COD; the lower equation, for responding after the COD. The broken lines show the locus of perfect matching.

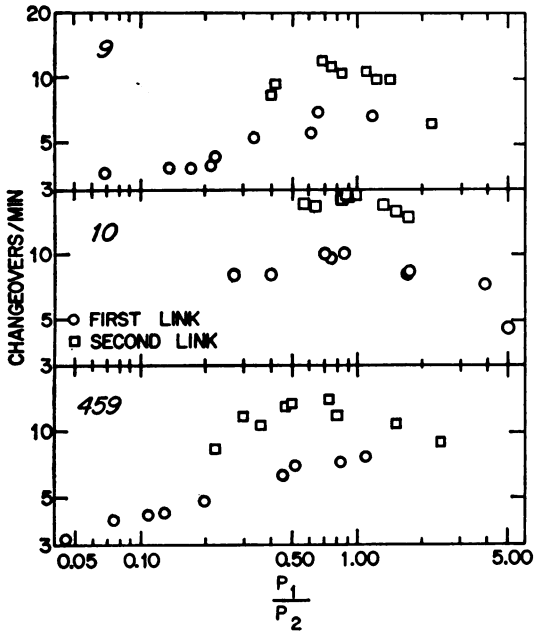


Fig. 4. Rate of changeover as a function of preference. Each graph shows data from one pigeon. The abscissa corresponds to the ordinates of Figure 1. Ordinate and abscissa are logarithmic scales.

were approximately twice those in the first-link situations.

One might suppose that this difference in rate of changeover arose simply out of a difference in overall response rate. If the probability of a changeover remained constant, then rate of changeover would be directly proportional to response rate. Figure 5 shows overall response rate as a function of the same abscissa as in Figure 4. Since the ordinate is again logarithmic, the separation between the two sets of points should equal the separation in Figure 4 if rate of changeover were directly proportional to response rate. Since the separation in Figure 5 is less, the probability of changeover differed between the two links, and the rate of changeover must have depended on other factors besides overall response rate.

DISCUSSION

This experiment can be described in terms of three situations (*cf.* Baum, 1973a): (1) the first-link situation, (2) the second-link situation, and (3) the presentation of food. There were two similar peck-produced transitions: (1) from the first-link situation into the

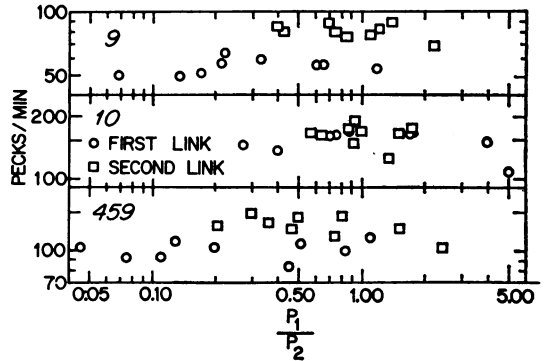


Fig. 5. Overall response rate as a function of preference. Each graph shows data from one pigeon. The abscissa corresponds to the ordinates of Figure 1. Ordinate and abscissa are logarithmic scales.

second-link situation and (2) from the second-link situation into the presentation of food. The second of these transitions is generally acknowledged as a reinforcer. Numerous experiments with choice situations like the present second-link situations have used this transition to produce the well-known matching relation (Equations 1 and 2). The finding that this matching relation held in the first-link situations indicates that the transition from first to second link functioned as a reinforcer in the same way as the more familiar transition. It supports the view that *reinforcement* consists in transition from a lower-valued situation to a higher-valued situation (Baum, 1973a).

Why did the second-link situations, so similar to those in which matching normally holds, fail to produce the relation? There were at least two factors that probably worked against matching: hysteresis and the inadequacy of the changeover delay (COD). The method of varying the ratio of reinforcements (*i.e.*, situation transitions or "outcomes") through ascending and descending series has the advantage that it shows up any hysteresis, and, except for the end points of the series, tends to correct for it. If the end points suffer from hysteresis, they will necessarily decrease the slope of the line fitted to all the points together. Since Figure 1 shows that hysteresis did occur, it may have contributed to the low slopes for the second-link situations. This applies particularly to the left-hand end points in the graphs for Pigeons 9 and 459.

Although hysteresis might account for the moderately low slope produced by Pigeon 459,

and possibly even the more deviant slope for Pigeon 9, it clearly fails to account for the flatness of the line fitted to the data of Pigeon 10. For this bird, and possibly the others, as well, inadequacy of COD may have been a more important factor.

Several experimenters (*e.g.*, Brownstein and Pliskoff, 1968; Fantino, Squires, Delbrück, and Peterson, 1972; Herrnstein, 1961; Shull and Pliskoff, 1967) have found that too short a COD leads to the sort of undermatching (slope less than one) observed in the second-link situations. As the COD decreases, not only does undermatching tend to occur, but the rate of changeover increases, as well (Brownstein and Pliskoff, 1968; Pliskoff, 1971; Stubbs and Pliskoff, 1969; Silberberg and Fantino, 1970). Undermatching (Figure 1) and elevated rates of changeover (Figure 4) went together in the second-link situations of this experiment, just as they go together when the usual COD is too short. The failure to obtain matching in the second-link situations, therefore, may have resulted from inadequacy of the COD, due either to its unusual programming or to its shortness.

Why should the COD have been inadequate in the second-link situations, but adequate in the first-link situations? Operations that increase response rate (*i.e.*, "incentive"-increasing operation) also seem to make for undermatching. Conversely, operations that reduce responding seem to favor matching. Decreasing deprivation, for example, brings relative responding in a multiple schedule up to matching (Herrnstein and Loveland, 1974). Pigeons living in situations in which they obtain all their food from concurrent VI schedules (*e.g.*, Baum, 1972) require a short COD or no COD at all to produce matching. Constant living in the situation reduces both deprivation and response rate.

The difference in overall response rates (Figure 5) suggests that the reinforcer in the first link was smaller than the reinforcer in the second link. Even though the rate of reinforcement in the first link was approximately twice that in the second link, the response rates in the second link were generally higher. If the lower value of the reinforcer in the first link of a chain functions like a decrease in deprivation, this might account for the adequacy of the COD for producing matching in the first-link situations in this experiment and

the inadequacy of the COD in the second-link situations.

This interaction between reinforcer value and the need for a COD may account for the discrepancy between the present results and those of Squires and Fantino (1971). They studied concurrent-chain schedules in which identical, non-concurrent VI schedules comprised the terminal links produced by the choice alternatives in the initial link. They varied the VI schedules in the initial link. Except for the terminal link consisting of a single-key VI schedule and the absence of a COD, their procedure closely resembled the present one. Their results indicated undermatching rather than matching. They proposed a formula to account for their results that would predict undermatching in the present first-link situations. The finding of matching in the first-link situations (Figure 1) goes against their formula.

The difference in results probably arises from the use of a COD in the first link of the present procedure. Although the smaller value of the reinforcer apparently favored matching in the first link, high incentive (high deprivation, high rates of reinforcement, large amounts of reinforcement) may necessitate a COD even here.

It remains to be seen what relation exists, if any, between response rate and rate of changeover. If operations that vary one also vary the other, they might be interdependent aspects of concurrent performance. One may broaden this question to ask also whether response rate and rate of changeover are independent of preference. Are all three interdependent, or are they separate parameters of concurrent performance?

Figure 4 can shed some light on this question. Rate of changeover has usually been graphed as a function of some measure of the difference in reinforcement produced by the alternatives. Since preference covaries with the difference in reinforcement, however, it is possible that preference determines rate of changeover. When preference fails to conform exactly to the matching relation of Equation 1, as when bias occurs (Figure 1), this proposition can be tested. When the rates of changeover in Figure 4 were graphed as a function of N_1/N_2 , the abscissa of Figure 1, the inverted U-shape remained evident, but the maximum rates of changeover appeared at abscissa values clearly

different from equal reinforcement ($N_1/N_2 = 1.0$). Figure 4, on the other hand, indicates that these maximum rates occurred near indifference ($P_1/P_2 = 1.0$). The greater symmetry of Figure 4 supports the suggestion, made in a previous paper (Baum, 1973b), that rate of changeover and preference are interdependent aspects of performance, rather than independently manipulable parameters. Further research will show whether this is generally true, and whether these two covary with overall response rate, as well.

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APPENDIX: TABLE OF DATA FOR INDIVIDUAL BIRDS IN EACH CONDITION

The data are summed over the last seven days of exposure to each condition. They appear in the order in which they were gathered, all the first-link situations first, and then the second-link situations. The total number of reinforcements was 336 in every situation.

Pigeon 9: first-link situations

Condition	Reinforce- ments Left	Pecks Left	Pecks Right	Time Left (sec)	Time Right (sec)	Pecks in COD Left	Pecks in COD Right	Change- overs	COD Time (sec)
c	167	1885	8495	1040	8767	1443	2100	711	1066
d	229	3488	5709	1602	8260	2526	2081	920	1379
e	268	4031	3470	2195	6215	2530	1834	943	1402
d	225	3404	5225	2257	7033	2165	2328	1067	1587
c	165	2227	6754	1303	7871	1630	2288	808	1209
b	109	1562	7325	726	8609	937	1997	599	898
a	60	419	6106	358	7529	373	1973	467	699
b	107	935	6929	656	8943	825	2108	603	901
c	176	1210	7137	730	9124	1024	2090	628	942

Pigeon 9: second-link situations

Condition	Reinforce- ments Left	Pecks Left	Pecks Right	Time Left (sec)	Time Right (sec)	Pecks in COD Left	Pecks in COD Right	Change- overs	COD Time (sec)
c	166	12501	11483	10633	7730	8188	6219	3308	4946
d	114	10438	15184	7187	10211	8184	8271	3516	5270
e	62	6923	17544	4567	12657	5558	5768	2384	3575
d	109	6710	15798	5278	11212	5427	6169	2562	3839
c	166	9973	13213	7694	9394	7511	7033	3258	4885
b	222	13512	11121	9333	8368	7609	5928	2878	4317
a	267	13916	6327	13389	3946	4300	4848	1803	2707
b	223	14250	10168	10692	5586	6789	7597	2685	4023
c	177	10391	12356	9262	8570	5923	8469	3114	4656

Pigeon 10: first-link situations

Condition	Reinforce- ments Left	Pecks Left	Pecks Right	Time Left (sec)	Time Right (sec)	Pecks in COD Left	Pecks in COD Right	Change- overs	COD Time (sec)
c	169	9384	12526	3246	4941	5669	5915	1311	1951
d	226	12955	7477	4792	2532	5270	4274	1001	1497
e	278	16235	3230	9809	1113	4748	2362	827	1229
d	227	15638	3978	6444	1440	5359	3280	951	1423
c	170	13458	7913	5312	2609	5619	4585	1065	1598
b	118	7934	11122	2918	4239	4973	5133	1179	1754
a	67	3321	12190	1119	5313	2646	4253	856	1266
b	104	4188	10606	1564	4983	3032	4464	878	1315
c	162	9099	10513	3088	3947	5905	5490	1183	1774

Pigeon 10: second-link situations

Condition	Reinforce- ments Left	Pecks Left	Pecks Right	Time Left (sec)	Time Right (sec)	Pecks in COD Left	Pecks in COD Right	Change- overs	COD Time (sec)
c	169	24926	26973	8583	7885	15749	18999	5212	7649
d	113	22828	26674	8668	8707	14819	17855	5172	7696
e	72	16404	28844	6611	9743	12413	15484	4685	6821
d	110	17582	27368	7029	9791	13119	14881	4716	6984
c	174	20218	22123	8603	8585	13389	16149	5261	7668
b	230	20613	15332	9863	7375	10548	10620	4868	6671
a	272	29945	17452	10384	5963	11454	12731	4058	5993
b	220	27376	18203	9907	6792	13520	13713	4359	6309
c	164	21270	21583	8285	7065	13965	16370	4839	7128

Pigeon 459: first-link situations

Condition	Reinforce- ments Left	Pecks Left	Pecks Right	Time Left (sec)	Time Right (sec)	Pecks in COD Left	Pecks in COD Right	Change- overs	COD Time (sec)
c	163	2684	13707	913	8551	2263	4424	760	1123
d	236	3482	7777	1145	7041	3090	3511	865	1297
e	273	5829	7017	2447	5341	4153	3608	942	1409
d	236	8398	7684	2948	5362	5703	3840	1072	1606
c	155	4984	9679	1619	6478	4008	4494	939	1406
b	115	1818	14041	594	8068	1617	3894	606	898
a	67	638	14109	232	8364	595	3880	455	675
b	103	959	12729	488	8548	869	3757	580	865
c	170	1535	14123	707	9440	1274	5232	694	1032

Pigeon 459: second-link situations

Condition	Reinforce- ments Left	Pecks Left	Pecks Right	Time Left (sec)	Time Right (sec)	Pecks in COD Left	Pecks in COD Right	Change- overs	COD Time (sec)
c	163	13698	28026	7040	10389	9511	16714	3951	5897
d	122	9721	33090	5201	11776	7693	16732	3336	4951
e	68	6139	30375	3504	13214	5144	12201	2352	3477
d	120	10072	28350	4977	11833	7683	12970	3018	4509
c	156	11345	24629	5938	10883	9512	14298	3676	5485
b	233	14382	19370	8652	8810	10505	13501	4187	5762
a	272	20064	8368	11956	4542	5513	6963	2484	2997
b	217	20722	13736	10153	6087	9097	11731	2966	3969
c	170	18811	23595	8295	9198	10253	16928	3488	5210