EFFECTS OF RESPONSE-ALLOCATION CONSTRAINTS ON MULTIPLE-SCHEDULE PERFORMANCE

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Four pigeons were trained on multiple variable-interval schedules in which components alternated after a fixed number of responses had been emitted. In Part 1, each component change occurred after 20 responses; in Part 2, the number was 40; and in Part 3, the number of responses before change was 10. Component reinforcer rates were varied over five experimental conditions in each of Parts 1 to 3. Component response rates decreased as the specified number of responses per component was increased. However, the relation between component response-rate ratios and component reinforcer-rate ratios was independent of the specified number of responses per component, and was similar to that found when components alternate after fixed time periods. In the fourth part of the experiment, the results from Parts 1 to 3 were systematically replicated by keeping the component reinforcer rates constant, but different, while the number of responses that produced component alternation was varied from 5 to 60 responses. The results showed that multiple-schedule performance under component-response-number constraint is similar to that under conventional component-duration constraint. They further suggest that multiple-schedule response rates are controlled by component reinforcer rates and not by principles of maximizing overall reinforcer rates or meliorating component reinforcer rates.

Key words: multiple schedules, time allocation, response allocation, response constraints, molar maximizing, melioration, generalized matching, pecking, pigeons

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The generalized matching law (Baum, 1974, 1979) provides a convenient description of behavior allocation as a function of reinforcers obtained in both concurrent and multiple variable-interval (VI) schedules. This law suggests that behavior ratios are a power function of obtained reinforcer ratios. For multiple schedules, if the two component responses are subscripted w and r, and if B is the number of responses emitted, T is the time spent in the components, and X is the number of reinforcers obtained, then:

$$\log\left(\frac{B_w/T_w}{B_r/T_r}\right) = a \log\left(\frac{X_w/T_w}{X_r/T_r}\right) + \log c, \quad (1)$$

where the parameter a is called sensitivity to reinforcement (Lobb & Davison, 1975) and $\log c$ is called bias. In multiple schedules with similar schedules and reinforcers in both components, a is normally about 0.45 (Charman & Davison, 1982; Lobb & Davison, 1977;

McSweeney, Farmer, Dougan, & Whipple, 1986). The expected value of $\log c$ is zero.

In multiple schedules, as conventionally arranged with fixed component durations, the experimenter determines a priori the time during which the subject is allowed to respond on the schedules. Time allocation, at least at this molar level, is thus completely constrained (e.g., see McLean & White, 1983). But, at a more molecular level, which will not concern us here, local time allocation—time allocated to responding and not responding in a component—may vary, as demonstrated by Bouzas and Baum (1976), Davison and Charman (1986), and by White (1978).

The purpose of the present experiment was to investigate performance in multiple schedules when the conventional time constraints were replaced with response-number constraints. That is, instead of components lasting for a fixed time period, they lasted only until a fixed number of responses had been emitted. This procedure is of interest because some of the contingencies of reinforcement in such a procedure are quite different from those in the conventional procedure. For instance, the behavior that would maximize the overall reinforcer rate in the fixed-number procedure

Table 1

Sequence of experimental conditions, component VI schedules (in seconds), number of responses per component, number of components per session, number of sessions per condition, and the parts of the experiment to which each condition contributed.

Condition	VI schedules		No. of responses to change		Components/ session	Sessions	Parts
	White	Red	White	Red			
1	34	270	20	20	40	18	1
2	46	90	20	20	40	17	1
3	90	46	20	20	40	31	1
4	270	34	20	20	40	30	1, 4
5	34	270	40	40	40	26	2
6	60	60	40	40	40	21	2
7	46	90	40	40	40	27	2
8	90	46	40	40	40	21	2
9	270	34	40	40	40	23	2, 4
10	60	60	20	20	40	21	1
11	270	34	60	60	14	24	4
12*	270	34	40	40	20	23	2
13*	270	34	20	20	40	37	1, 4
14	270	34	10	10	80	21	3, 4
15	270	34	5	5	160	18	4
16	34	270	10	10	80	30	3
17	60	60	10	10	80	22	3
18	46	90	10	10	80	29	3
19*	270	34	5	5	160	21	4
20	90	46	10	10	80	16	3
21*	270	34	10	10	80	29	3, 4
22*	60	60	10	10	80	22	3

* Replications.

would be that of responding slowly during the higher reinforcer-rate component, and quickly during the lower reinforcer-rate component. If such molar maximizing (e.g., Rachlin, 1982) is an important aspect of the control of behavior in multiple schedules, and if such behavior were to develop, then the relation between component response and reinforcer rates given by Equation 1 with a about 0.45 (as in conventional multiple schedules) would not result. Rather, the obtained a value would be negative. Such results would seriously compromise the generality of the generalized-matching description of multiple-schedule performance (McSweeney et al., 1986). On the other hand, if Equation 1 with a about 0.45 were to describe the results from the fixed-number procedure, the generalized-matching approach to multiple-schedule performance would remain intact, but the principle of molar maximizing, at least in multiple schedules, would become questionable.

In the first three parts of the experiment, pigeons were trained on multiple VI VI schedules with components that alternated af-

ter 20 responses in each component (Part 1), after 40 responses in each component (Part 2), and after 10 responses in each component (Part 3). Under each of these three alternation contingencies, the component reinforcer rates were varied over five experimental conditions. Part 4 of the experiment systematically replicated the results from Parts 1 to 3 by arranging constant, different, component reinforcer rates and varying the number of responses per component from 5 to 60 responses.

METHOD

Subjects

Four homing pigeons, numbered 191, 192, 194, and 195, were maintained at 80% ± 15 g of their free-feeding body weights by feeding with supplementary mixed grain after each daily training session. Water and grit were always available in their home cages. These subjects had previously been trained on conventional multiple schedules by Charman and Davison (1983), and on multiple schedules

with switching requirements by Davison and Charman (1986).

Apparatus

The sound-attenuating experimental chamber, in which noise was masked by an exhaust fan, was situated remotely from solid-state control equipment. The chamber was that used by Charman and Davison (1983) and by Davison and Charman (1986). Briefly, it contained three translucent keys, 2 cm in diameter, 9 cm apart, and 24 cm from the grid floor. The center key, which was the only one used, could be illuminated either white or red. No further illumination was provided in the experimental chamber. A hopper containing wheat was situated below the center key and 9 cm from the grid floor. During reinforcement, the key was darkened, the hopper was raised for 3 s, and the grain was illuminated.

Procedure

The two components of the multiple VI VI schedule were differentially accompanied by the white or red illumination of the center key, and each schedule timer ran only during the corresponding component. There was a 1-s blackout between components, which alternated when a fixed number of responses had been emitted in a component. Thus, the number of responses emitted during a component was completely constrained, and the duration of the component was free to vary. The number of responses in each component was 20 in Part 1, 40 in Part 2, and 10 in Part 3 (see Table 1), and the component schedules were varied from multiple VI 34-s (white) VI 270-s (red) to multiple VI 270-s VI 34-s over five experimental conditions in each part. In Part 4, the component schedules were multiple VI 270-s (white) VI 34-s (red), and the component response requirements were varied from 5 responses in each component to 60 responses in each component over eight experimental conditions. The sequence of experimental conditions, and the parts of the experiment to which each condition contributed, are shown in Table 1.

The obtained overall reinforcer rate was dependent on how the subjects allocated time between the components, but if they allocated time equally, one reinforcer per minute was obtainable in all experimental conditions. A number of replications were carried out (Table 1): Condition 12 replicated Condition 9, Condition 13 replicated Condition 4, Condition 21 replicated Condition 14, and Condition 22 replicated Condition 17. Thus, Part 1 comprised Conditions 1, 2, 3, 4, 10, and 13; Part 2 comprised Conditions 5, 6, 7, 8, 9, and 12; Part 3 comprised Conditions 14, 16, 17, 18, 20, 21, and 22; and Part 4 comprised Conditions 4, 9, 11, 12, 13, 14, 15, 19, and 21.

Training continued on each experimental condition until all birds had met a stability criterion five, not necessarily consecutive, times. The criterion required that the median relative time allocated to the white component over five sessions be not more than .05 different from the median of the five sessions immediately preceding these. Thus, these criteria could not be met until at least 14 training sessions had been completed. When all birds had met this criterion five times, the experimental contingencies were changed for all 4 birds. Each VI schedule comprised intervals, arranged in irregular order, from the first 12 terms of an arithmetic progression in which the smallest interval was one twelfth the mean interval. Daily sessions began in blackout and ended in blackout after a fixed number of components had been completed (Table 1), or after 45 min had elapsed.

The data collected were the number of responses emitted during each of the two components (as a procedural check only), the time in seconds spent in each component (from keylight onset to keylight offset), and the number of reinforcers obtained in each component. Time measures did not include reinforcer time.

RESULTS

The data, summed over the last five sessions of each experimental condition, are shown in the Appendix. Component rates were obtained by dividing the numbers of responses emitted, and reinforcers obtained, by the time spent in the components.

Parts 1, 2, and 3

Figures 1, 2, and 3, respectively, show the absolute response rates in the two components for the 10-response requirement (Part 3), the 20-response requirement (Part 1), and the 40-response requirement (Part 2) alternation contingencies. The data shown were averaged
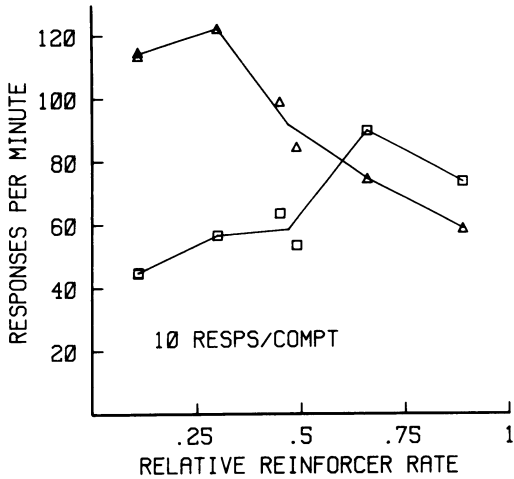
Fig. 1. *Part 3: 10 responses per component.* Responses per minute in the white component (squares) and in the red component (triangles) as a function of the relative white-component reinforcer rate. The data were averaged across subjects.

Fig. 3. *Part 2: 40 responses per component.* Responses per minute in the white component (squares) and in the red component (triangles) as a function of the relative white-component reinforcer rate. The data were averaged across subjects.
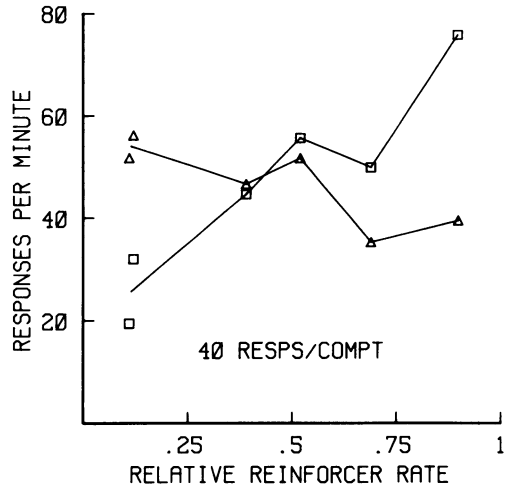
across birds to save space, but these averages were representative of the individual birds. As in conventional multiple-schedule performances (e.g., Charman & Davison, 1982; Lander & Irwin, 1968), component response rates changed as a direct function of obtained component relative reinforcer rates. However,

Fig. 2. *Part 1: 20 responses per component.* Responses per minute in the white component (squares) and in the red component (triangles) as a function of the relative white-component reinforcer rate. The data were averaged across subjects.

there appeared to be a general decrease in component response rates as the number of responses required for alternation was increased.

To assess the way in which the distribution of component reinforcer rates affected the distribution of component response rates (Equation 1), log component response-rate ratios were fitted, using linear regression, to log component reinforcer rates. The data used for these fits are those shown in the Appendix, with replications taken as a separate data set. The results of these analyses are shown in Figures 4, 5, and 6 for, respectively, the 10-response, 20-response, and 40-response alternation contingencies. The estimated parameters of Equation 1, with their standard deviations, are shown on the figures. The fits were generally good as evidenced by the small standard deviations of the parameter estimates. When the data were averaged across birds, the following parameter estimates were obtained: 10 responses per component, $a = 0.31$ (SD, 0.05) and log $c = -0.15$ (SD, 0.03); 20 responses per component, $a = 0.45$ (SD, 0.03) and log $c = -0.05$ (SD, 0.02); and for 40 responses per component, $a = 0.35$ (SD, 0.04) and log $c = 0$ (SD, 0.03). A nonparametric trend test (Ferguson, 1965) using the data from the individual subjects (Figures 4,
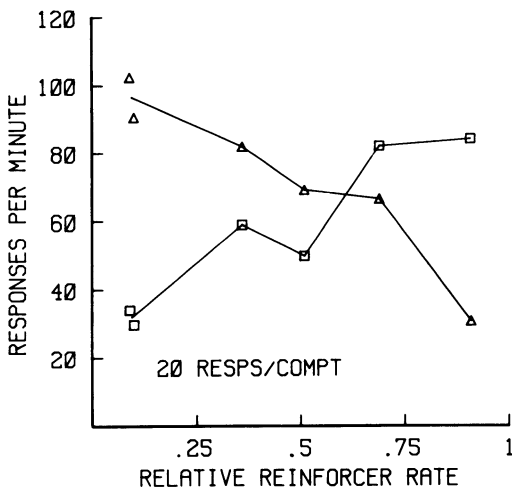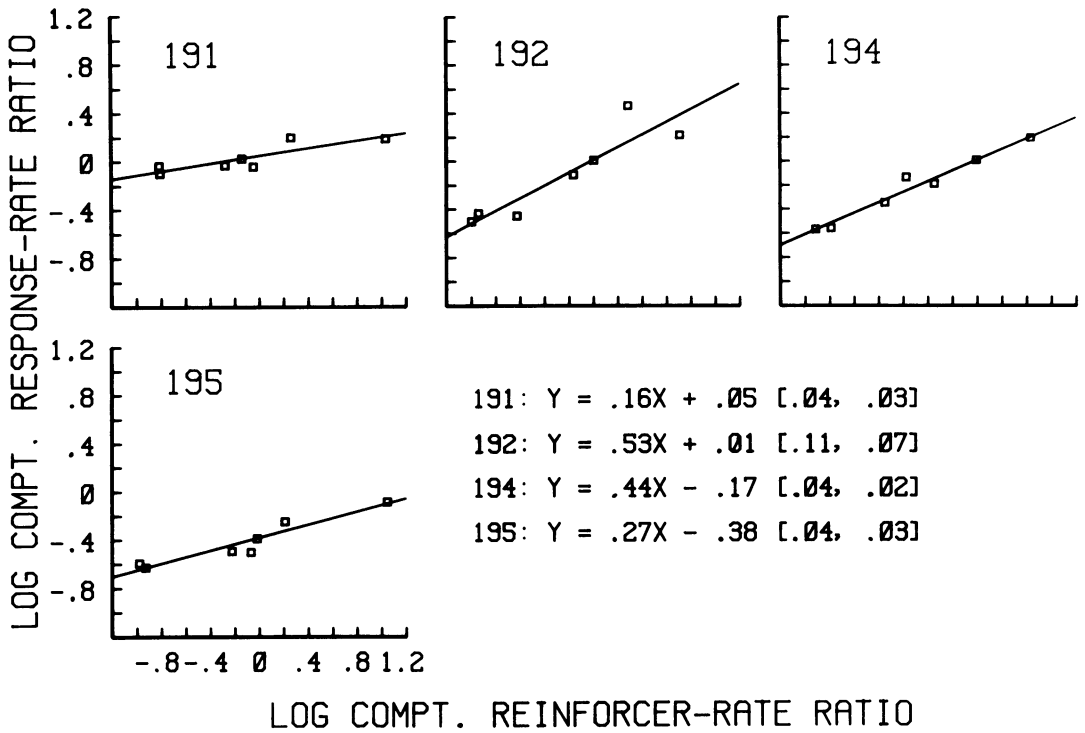
Fig. 4. *Part 3: 10 responses per component.* Log component response-rate ratios as a function of log component reinforcer-rate ratios. The straight lines were fitted by the method of least squares, and the equations of these lines are shown for each bird. After the equations, in square brackets, are the standard deviations of the slope and intercept estimates.

5, & 6) found no significant change in a values across alternation requirements ($N = 4$, $k = 3$, $\Sigma S = -1$, $p > .05$). Bias (log c) values changed nonsystematically across alternation requirements, although one large bias was obtained for Bird 195 with a 10-response alternation contingency. It appeared, therefore, that the alternation contingency had no systematic effect on the relation between component response and reinforcer rates, and the relation may be summarized by a linear regression between these variables across all the conditions and subjects in Experiment 1. This gave the following parameter estimates: $a = 0.38$ (*SD*, 0.03) and log $c = -0.07$ (*SD*, 0.02).

Part 4

Figures 7 and 8 show data from Part 4 averaged across subjects; these data are representative of the individual performances, as can be verified by examining individual birds' data in the Appendix. Figure 7 shows the number of responses per minute in each component as a function of the alternation requirement, and Figure 8 shows the relative component response rates (response rate in the white component divided by the sum of the component response rates) as a function of the alternation requirement.

Figure 7 shows clearly the decrease in component response rate with increasing alternation requirements obtained in Parts 1 to 3. According to a nonparametric trend test (Ferguson, 1965), the trends in both components were significant ($N = 1$, $k = 5$, ΣS (white) = -10, ΣS (red) = -8). As Figure 8 shows, there was no trend in relative component response rates ($\Sigma S = 2$) with increasing alternation requirements. Inasmuch as the component reinforcer rates (see Appendix) were constant, this latter result implies no change in the a values of Equation 1 with the size of the alternation requirement.
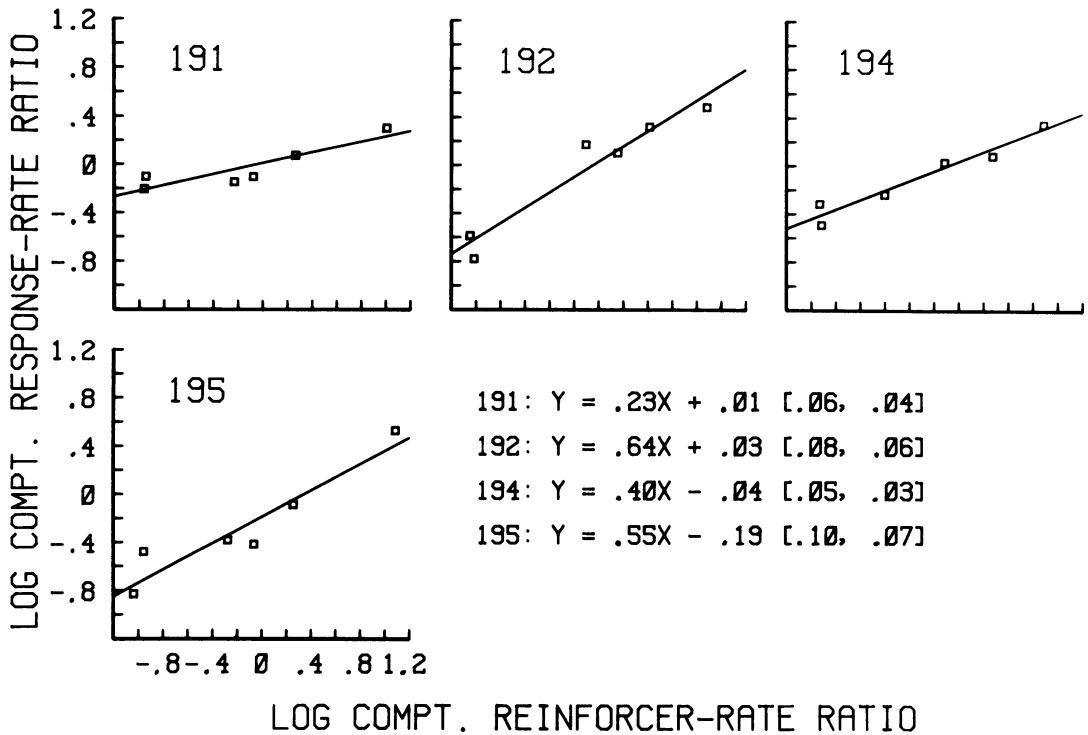
The results of Part 4 therefore replicated,

Fig. 5. *Part 1: 20 responses per component.* Log component response-rate ratios as a function of log component reinforcer-rate ratios. The straight lines were fitted by the method of least squares, and the equations of these lines are shown for each bird. After the equations, in square brackets, are the standard deviations of the slope and intercept estimates.

and extended the generality of, the results of Parts 1 to 3 of this experiment.

DISCUSSION

The first question to ask of the present data is whether behavior under response-number constraint in multiple schedules is similar to behavior under component-duration constraint. Figures 1, 2, and 3 showed that component response rates changed as a function of relative component reinforcer rates in the same ordinal manner as in conventionally arranged multiple schedules. That is, component response rates were an increasing function of relative component reinforcer rates (Herrnstein, 1970; Lander & Irwin, 1968).

In terms of the relative amounts of behavior allocated to the two components, Figures 4, 5, and 6 showed that component response-rate ratios were a positive and linear function of component reinforcer-rate ratios as has generally been found (see the review by Mc-

Sweeney et al., 1986). More quantitatively, although the overall value of *a* (Equation 1) found in Parts 1 to 3 (0.38) was a little lower than the mean value (0.45) that has been reported (Charman & Davison, 1982; Lobb & Davison, 1977; McSweeney et al.), 3 of the 12 estimates shown in Figures 4, 5, and 6 were higher than this mean value. Thus, the present estimates were not significantly different from the mean value on a binomial test. A stronger test of the consistency of the present *a* values is also possible: Charman and Davison (1983) reported multiple-schedule sensitivity values for the subjects used here in the same equipment, but with 180-s fixed-component durations. The sensitivity values they obtained were, in order of subject number, 0.40, 0.59, 0.37, and 0.58. A Friedman nonparametric analysis of variance showed that there was no significant difference between the presently obtained values of sensitivity and those reported by Charman and Davison ($N = 4$, $k = 4$, $\chi_r^2 = 5.7$, $p > .05$).

191: Y = .21X - .02 [.03, .02]

192: Y = .39X + .18 [.10, .07]

194: Y = .35X - .04 [.04, .03]
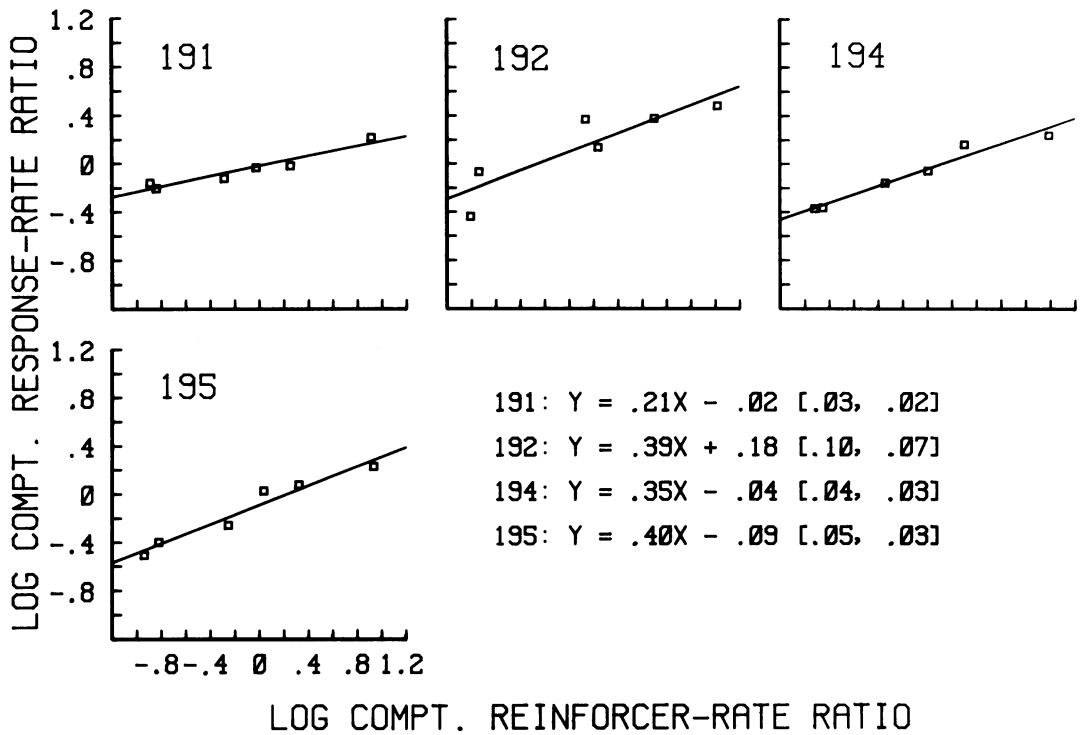
195: Y = .40X - .09 [.05, .03]

Fig. 6. *Part 2: 40 responses per component.* Log component response-rate ratios as a function of log component reinforcer-rate ratios. The straight lines were fitted by the method of least squares, and the equations of these lines are shown for each bird. After the equations, in square brackets, are the standard deviations of the slope and intercept estimates.

Further, Davison and Charman (1986) reported sensitivity values for these subjects when they were allowed to switch into the multiple-schedule components for 2, 5, or 7.5 s. If those data are also used in a Friedman analysis of variance, there are again no significant differences in the data set ($N = 4$, $k = 7$, $\chi_r^2 = 9$, $p > .05$). We can conclude, therefore, that the fixed response-number procedure provides data similar to the fixed component-duration procedure. But there is one exception to this conclusion: the relation between component response rates and the alternation ratio requirement found in Experiment 1 and replicated in Experiment 2. This result has not been found in conventional multiple-schedule performance when component duration is varied (Charman & Davison, 1982; Edmon, 1978). We can offer no explanation for this difference.

On a related point, it is interesting to note that although components were very short when only 10 responses were required for al-ternation (Appendix), a values were not any higher under this requirement (Part 3) nor were a values related to the number of responses that produced component alternation in Part 4 (i.e., relative response rates remained constant: Figure 8). Research by Shimp and Wheatley (1971) and by Todorov (1972) reported that a values were an inverse function of component durations in conventional multiple schedules. However, Charman and Davison (1982) found that this relation obtained only when schedules were kept constant and component durations were varied, and not when both schedules and components were varied. Given that the schedules were frequently varied in the present experiments, the results here add further support to Charman and Davison's interpretation of the conditions under which the "short-component effect" occurs.

How was time allocated between the components in Experiment 1? The relation between time-allocation ratios and component
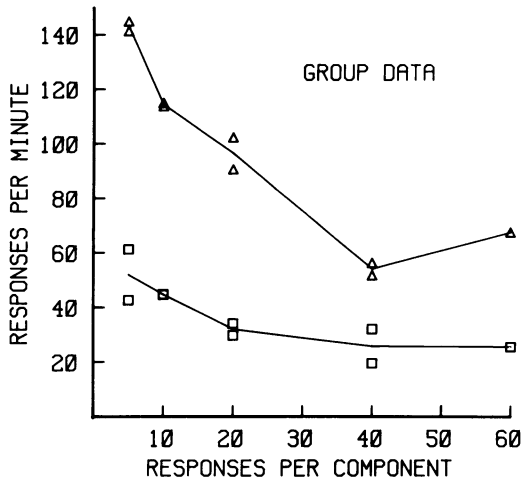
Fig. 7. *Part 4.* Responses per minute in each component of the multiple schedule, as a function of the size of the ratio (number of responses per component) that produced component change. The schedule was multiple VI 270-s (white component, squares) VI 34-s (red component, triangles). The data were averaged over the 4 subjects.
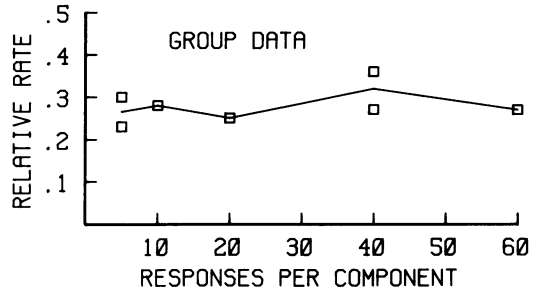

Fig. 8. *Part 4.* Relative white-component response rates (white-component rate divided by the sum of the component rates) as a function of the size of the ratio (number of responses per component) that produced component change. The schedules were VI 270-s (white component) VI 34-s (red component). The data were averaged over the 4 subjects.

reinforcer-rate ratios need not be empirically assessed because it follows algebraically from the fits of Equation 1 already shown in Figures 4, 5, and 6. Noting that $B_w = B_r$ in Equation 1 allows that equation to be simplified and rewritten as:

$$\log\left(\frac{T_w}{T_r}\right) = -a \log\left(\frac{X_w/T_w}{X_r/T_r}\right) - \log c. \quad (2)$$

Hence, the relation between time-allocation ratios and component reinforcer rates has parameters that are simply the negations of the parameters shown in Figures 4, 5, and 6. Overall, the sensitivity ($-a$ in Equation 2) was -0.38, and the bias ($\log c$) was $+0.07$, and the time spent in the components was an *inverse* function of the component reinforcer rates. In other words, the subjects responded at lower overall rates in lower reinforcer-rate components, and at higher overall rates in higher reinforcer-rate components. This result is *not* incompatible with the report by Davison and Charman (1986) that *local* time allocation in multiple schedules was a direct function of component reinforcer rates. In the present experiment, molar time-allocation measures were taken, and these include both time spent responding and time engaged in other, incompatible, behavior.

Two major mechanisms have been offered to account for the allocation of behavior in choice situations: maximizing (Rachlin, 1982) and melioration (Herrnstein, 1982; Herrnstein & Vaughan, 1980). Molar maximizing, as discussed by Rachlin, is the principle that animals allocate time to activities in ways that maximize overall utility. It is difficult to understand what unidimensional utility could be maximized by subjects' spending more time in the lower reinforcer-rate component than in the higher reinforcer-rate component, as found here. Figure 9 shows the overall reinforcer rates obtained in Parts 1, 2, and 3 of this experiment. The overall reinforcer rate was highest when the schedules were equal, and progressively fell as they were made more unequal. A simple calculation shows, for example, that on multiple VI 34-s VI 270-s, if time allocation was directly proportional to the component reinforcer rate, the overall obtained reinforcer rate would be about 1.6 per minute—two to three times higher than the reinforcer rate actually obtained.

Obviously, the overall obtained reinforcer rate was not maximized by these subjects. It is difficult to see how the maximizing account might be saved. For instance, if utility is multidimensional, and consisted of jointly maximizing overall reinforcer rate and leisure (Rachlin, Kagel, & Battalio, 1980), the rational behavior is to allocate more leisure, and hence more time, to the higher reinforcer-rate components. But the subjects allocated more time to lower reinforcer-rate components. The present study therefore supports the growing

number of studies (see DeCarlo, 1985) that have failed to find evidence to support a molar maximizing account of behavior.

Melioration is the process proposed by Herrnstein and Vaughan (1980; see also Herrnstein, 1982) that suggests that time allocation shifts toward the response producing the higher rate of reinforcement until, at equilibrium, the local reinforcer rates for the available responses are all equal. Herrnstein (1982) specifically stated that the appropriate measures are "reinforcements per total available time (session duration)" (p. 435). Although the total time available for responses, and the session duration, are the same in concurrent schedules (which Herrnstein was discussing), they are not the same in multiple schedules. We assume that component reinforcer rates are the appropriate measures in multiple schedules. There was no reason, in the present experiment, that the subjects, by varying their response rates, should not have allocated more time to the higher reinforcer-rate component than to the lower reinforcer-rate component. Melioration at the component level would require performance reminiscent of that emitted under differential-reinforcement-of-low-rate (DRL) schedules in the higher reinforcer-rate component. Although pigeons do perform poorly on such schedules, such conditions clearly do produce lowered response rates (Catania, 1970). Thus, we would have expected some indication of greater time allocation to the higher reinforcer-rate component. But none was found.

The present results provide considerable support for Vaughan and Miller's (1984) suggestion that pigeons' behavior is insensitive to the slope of the feedback function between response rate and reinforcer rate. Those researchers trained pigeons on schedules in which response-rate increases produced reinforcer-rate decreases. The birds produced high response rates, and thus reinforcer rates that were lower than those available in the situation. Vaughan and Miller concluded that reinforcement may simply increase the tendency to respond, and the present data support this conclusion. Thus, a parsimonious, although still molar, account of the present results might merely note that the relation between component response ratios and component reinforcer-rate ratios is similar whether the overall reinforcer rates are fixed at a maximum
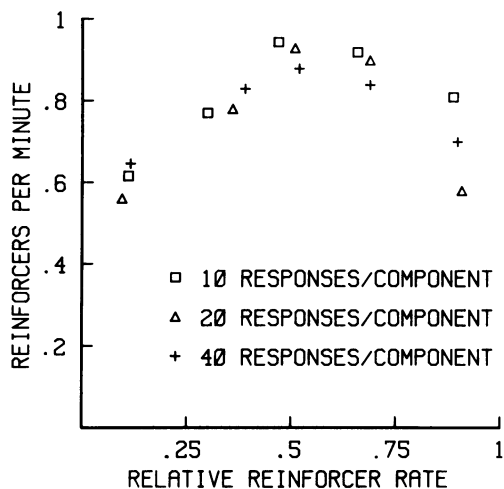

Fig. 9. Overall reinforcers per minute obtained in Parts 1 to 3 as a function of the relative component-reinforcer rate. The data were averaged over the 4 subjects, and also over replications.

value (the fixed component-duration procedure) or are in principle under the control of the subject (the fixed component-response-number procedure). Similar generalized-matching parameter values appear to be obtained under four differing procedures: (1) the standard procedure with fixed-duration components, whatever the component durations (Charman & Davison, 1982); (2) when numbers of reinforcers (X_1, X_2) remain equal between components, and hence component durations vary inversely with component reinforcer rates (Charman & Davison, 1982; Lobb & Davison, 1977); (3) when subjects are required to emit a response in order to access each component (Davison & Charman, 1986); and (4) when the number of responses in each component is kept constant and the duration of each component is allowed to vary (the present experiment). The invariant relation seems to be that component response-rate ratios are a fixed-parameter power function of component reinforcer-rate ratios. Furthermore, Vaughan and Miller's Experiment 2 data suggest that the generalized matching law (Equation 1) may apply with similar parameter values to both simple concurrent-schedule performance and to concurrent schedules in which there is a negative correlation between response and reinforcer rates. These considerations show the wide applicability of the

generalized-matching description of behavior allocation.

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APPENDIX

Time in seconds spent in each component, number of responses emitted in each component, and the number of reinforcers obtained in each component in each condition of the experiment. The data have been summed over the last five sessions of each experimental condition. In some experimental conditions, fewer than the set number of responses were emitted because sessions were terminated when 45 min had elapsed rather than when a fixed number of components had been completed.

Con- dition	Time		Responses		Reinforcers	
	White	Red	White	Red	White	Red
Bird 191						
1	1,585	3,255	2,000	2,000	45	9
2	1,614	1,926	2,000	2,000	36	23
3	1,691	1,212	2,000	2,000	20	24
4	2,162	1,717	2,000	2,000	7	49
5	3,312	5,501	4,000	4,000	95	19
6	3,525	3,260	4,000	4,000	56	54
7	4,260	4,074	4,000	4,000	91	48
8	4,192	3,168	4,000	4,000	45	65
9	5,684	3,952	4,000	4,000	20	108
10	1,949	1,546	2,000	2,000	29	27
11	3,014	1,667	2,100	2,100	15	47
12	3,181	2,000	2,000	2,000	13	56
13	2,970	1,866	2,000	2,000	10	57
14	2,230	1,789	2,000	2,000	10	51
15	2,054	1,239	2,000	2,000	7	35
16	1,222	1,916	2,000	2,000	35	5
17	1,361	1,241	2,000	2,000	24	24
18	996	1,594	2,000	2,000	22	19
19	1,341	1,019	2,000	2,000	5	26
20	1,461	1,368	2,000	2,000	16	28
21	1,598	1,482	2,000	2,000	7	42
22	1,208	1,285	2,000	2,000	18	26
Bird 192						
1	1,225	3,785	2,000	2,000	30	12
2	1,032	2,190	2,000	2,000	21	17
3	1,568	2,341	2,000	2,000	18	34
4	4,928	1,278	2,000	2,000	12	35
5	1,997	6,157	4,000	4,000	55	16
6	3,041	4,184	4,000	4,000	36	45
7	2,945	7,209	3,462	3,514	64	49
8	3,344	8,132	3,401	3,504	38	107
9	5,530	4,790	3,080	3,103	15	113
10	1,469	1,870	2,000	2,000	26	23
11	3,038	1,454	2,100	2,100	9	40
12	4,326	1,584	2,000	2,000	12	45
13	5,601	934	2,000	2,000	15	26
14	2,932	921	2,000	2,000	8	25
15	3,422	997	2,000	2,000	11	23
16	1,278	2,124	2,000	2,000	25	8
17	1,580	1,221	2,000	2,000	17	19
18	769	2,247	2,000	2,000	14	21
19	2,179	874	2,000	2,000	9	29
20	2,734	956	2,000	2,000	15	22
21	3,739	1,378	2,000	2,000	10	32
22	1,932	1,969	2,000	2,000	24	24

APPENDIX (*Continued*)

Con- dition	Time		Responses		Reinforcers	
	White	Red	White	Red	White	Red
Bird 194						
1	1,020	2,294	2,000	2,000	31	9
2	1,178	1,436	2,000	2,000	27	11
3	1,627	948	2,000	2,000	15	22
4	1,937	939	2,000	2,000	7	29
5	2,216	3,845	4,000	4,000	62	11
6	2,613	2,301	4,000	4,000	42	36
7	3,035	4,443	4,000	4,000	64	46
8	3,560	2,494	4,000	4,000	34	52
9	7,519	3,213	4,000	4,000	26	92
10	1,632	1,764	2,000	2,000	27	24
11	3,406	1,567	2,100	2,100	16	43
12	2,704	1,178	2,000	2,000	11	34
13	2,954	955	2,000	2,000	9	24
14	2,376	659	2,000	2,000	10	17
15	2,073	550	2,000	2,000	8	19
16	1,126	1,751	2,000	2,000	31	7
17	1,492	1,101	2,000	2,000	21	23
18	1,217	1,242	2,000	2,000	27	11
19	1,745	820	2,000	2,000	7	25
20	1,703	769	2,000	2,000	16	16
21	2,358	639	2,000	2,000	9	20
22	1,717	1,121	2,000	2,000	28	16
Bird 195						
1	1,861	6,344	2,000	2,000	54	15
2	2,017	1,655	2,000	2,000	42	19
3	3,251	1,356	2,000	2,000	28	22
4	5,090	753	2,000	2,000	13	21
5	4,559	7,779	3,311	3,312	127	25
6	6,406	7,223	2,479	2,615	102	105
7	5,935	7,385	1,989	2,068	117	69
8	7,607	4,260	2,520	2,539	84	84
9	7,478	2,974	2,903	2,873	29	76
10	4,580	1,758	2,000	2,000	70	31
11	9,363	2,493	1,704	1,795	26	64
12	14,508	4,519	2,000	2,000	44	119
13	4,653	1,544	2,000	2,000	16	48
14	3,167	809	2,000	2,000	9	22
15	3,708	610	2,000	2,000	15	15
16	2,872	2,365	2,000	2,000	82	6
17	3,110	1,276	2,000	2,000	52	22
18	2,347	1,335	2,000	2,000	49	17
19	2,580	603	2,000	2,000	12	14
20	2,563	822	2,000	2,000	30	16
21	3,075	723	2,000	2,000	12	24
22	4,107	1,293	2,000	2,000	63	23