

*PREFERENCE FOR FREE CHOICE OVER  
FORCED CHOICE IN PIGEONS*

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In a six-key chamber variable-interval initial links of concurrent-chain schedules operated on two lower white keys. Terminal links operated on four upper keys; green keys were correlated with fixed-interval reinforcement and red keys with extinction. Free-choice terminal links arranged three green keys and one red key; forced-choice terminal links arranged one green key and three red keys. Thus, terminal links were equivalent in number, variety, and information value (in bits) of the keylights. Preferences (relative initial-link rates) were studied both with location of the odd key color varying over successive terminal links and with the odd color fixed at key locations that had controlled either relatively high or relatively low terminal-link response rates. Free choice was consistently preferred to forced choice. Magnitude of preference did not vary systematically with terminal-link response rate or stimulus control by green and red keys. The origins of free-choice preference could be ontogenic or phylogenic: organisms may learn that momentarily preferred alternatives are more often available in free than in forced choice, and evolutionary contingencies may favor the survival of organisms that prefer free to forced choice.

*Key words:* concurrent chain schedules, preference, free vs forced choice, response variability, position preference, freedom, key peck, pigeon

Philosophical discussions of freedom of choice often involve the debate over free will and determinism (e.g., Berofsky, 1966; Enteman, 1967). But free choice implies the availability of alternatives, and thus the concept of freedom may also occasion empirical questions. To argue that organisms value freedom, for example, is to argue that free choices will be preferred to forced choices. It may then be asked whether such preferences exist, whether they are limited to humans, and whether they are products of ontogeny or phylogeny.

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An organism can choose among alternatives only to the extent that stimuli are correlated with their availability. For this reason the distinction between free and forced choice will typically be confounded with the number, variety, and information value of stimuli. An earlier concurrent-chain study (Catania, 1975) demonstrated preferences for free over forced choice in pigeons, but controlled for stimulus number, variety, and information only indirectly, across a sequence of procedures. The present research more directly separated free-choice preference from the effects of these other variables.

Free-choice and forced-choice conditions were arranged on four pigeon keys. In free choice, pecks on any of three green keys produced food according to a fixed-interval reinforcement schedule while pecks on the remaining red key had no scheduled consequences. In forced choice, pecks on only a single green key produced food according to the fixed-interval schedule while pecks on the three remaining red keys had no scheduled consequences. Preferences for free over forced choice were obtained even with the two conditions equated for stimulus number (four lit keys), stimulus variety (one odd color among four), and traditional measures of information (two bits of

information to specify either one or three of four keys).

## METHOD

### Subjects

Four male White Carneaux pigeons, about 1 yr old at the start, were maintained at about 80% of free-feeding weights. Each pigeon's key pecking had been established in a two-key autoshaping procedure in which one key was red and the other green (Fisher & Catania, 1977); in that procedure all pigeons pecked red keys more often than green.

### Apparatus

Daily sessions were conducted in a six-key pigeon chamber (Catania, 1975). Figure 1 shows the key configuration. The four upper keys could be lit red or green and the two lower keys could be lit white by 6-W lamps. The keys were matched to operate at minimum forces of about .14 N. Each peck on a lit key produced a feedback click from a relay behind the panel. Dark-key pecks had no scheduled consequences. A standard Gerbrands feeder was centered beneath the keys. During grain deliveries the feeder was lit and all keylights were off. Standard electromechanical equipment in an adjoining room arranged scheduling and recording.

### Procedure

Figure 1 illustrates the concurrent-chains procedure (Autor, 1969; Herrnstein, 1964). In initial links equal and independent variable-interval (VI) 30-sec schedules were arranged concurrently for pecks on the two white lower keys; the four upper keys were dark. The 15-interval VI 30-sec schedules were constructed according to Catania and Reynolds (1968, Appendix II), with the order for one the reverse of the other so that the two schedules could not become synchronized. The timing of intervals stopped for a given initial-link key when a terminal link was scheduled for the next peck on that key, and it stopped for both keys throughout terminal links and food deliveries. The first peck after a changeover from one initial-link key to the other was not eligible to produce a terminal link.

In terminal links the four upper keys were lit and the lower keys were dark. Forced-choice terminal links consisted of one green and

three red keys (Figure 1, left); free-choice terminal links consisted of three green and one red keys (Figure 1, right). In both types of terminal links, pecks on any green key were reinforced according to a fixed-interval (FI) 30-sec schedule; pecks on any red key had no scheduled consequences (EXT). The terminal-link reinforcer was a 3-sec food delivery, after which initial links were reinstated. Although the same keys lit in both cases, terminal links produced by the left and right initial-link schedules are referred to respectively as left and right terminal links.

*Establishing the concurrent-chain performance.* With each pigeon's key pecking already established through autoshaping, the procedures began with three sessions in which all six keys were dark during the timing of initial links and free-choice and forced-choice terminal links were each presented independently of responding at mean intervals of 30 sec. In terminal links, green-key pecks were reinforced according to an FI 5-sec schedule and red-key pecks had no scheduled consequences. In the next session the concurrent initial-link VI schedules were introduced on

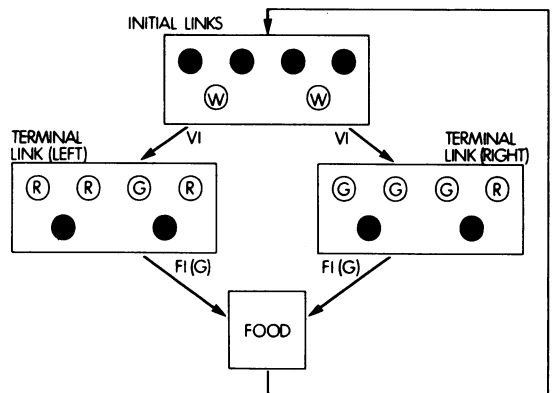


Fig. 1. Example of the concurrent-chains procedure. During initial links the four upper keys were dark and the two lower keys were white (W). According to independent variable-interval (VI) schedules, pecks on the left and right white keys produced their respective and mutually exclusive terminal links. During terminal links the upper keys were green (G) and red (R) and the lower keys were dark. In the example a forced-choice terminal link is shown on the left, and a free-choice terminal link on the right. In forced choice one key was green and the three remaining keys were red. In free choice three keys were green and the one remaining key was red. In both cases green-key pecks produced food according to a fixed-interval (FI) schedule, and red-key pecks had no scheduled consequences. After each food delivery initial-link conditions were reinstated.

the lower keys, lit white. The left initial-link key produced forced-choice terminal links, the right initial-link key produced free-choice terminal links, and the terminal-link green-key schedule was lengthened to FI 10-sec.

Over subsequent sessions free choice and forced choice were occasionally alternated as respective left and right terminal links, session durations and reinforcer durations were adjusted, and the terminal-link schedule was lengthened from FI 10-sec to FI 20-sec and then to FI 30-sec. The daily sessions of these conditions are combined with data in Figure 2. During these sessions the only key failure occurred on terminal-link Key 4 for Pigeon 10 in Session 52. Three sessions of left initial-link extinction and three of right initial-link extinction (a test of the sensitivity of the procedure to reinforcement variables) preceded subsequent experimental conditions.

*Terminal-link key positions: sequence of conditions.* In most sessions the position of the odd-colored key varied over successive terminal links. With the upper keys numbered from left to right, Figure 1 shows green located on Key 3 in forced choice (left) and red located on Key 4 in free choice (right). The location of the odd key was determined by a sequence of four alternatives over successive terminal links: AABA CACC DDAA CDBD CBBB DABB DCDA BCBA CCBD. The arbitrary correspondence between the lettered alternatives and the four key positions was occasionally changed over blocks of sessions. Because the concurrent initial-link VI schedules produced an irregular alternation of free-choice and forced-choice terminal links, this arrangement generated an effectively non-repeating sequence of locations for the odd key in each terminal link.

The effects of terminal-link response rates and stimulus control on initial-link preferences were examined by fixing the location of the odd key. For most pigeons Key 1 maintained the highest and Key 3 the lowest green response rates in both free and forced choice (Table 1). In one procedure Key 1 was always the odd green key in forced choice and the odd red key in free choice. In a second procedure Key 3 was always the odd green key in forced choice and the odd red key in free choice.

The arrangement of free and forced choice as left and right terminal links and the sessions

at each condition are combined with data in Figure 3. Sessions were ordinarily scheduled for 25 min of initial links but were occasionally increased or decreased in steps of 5 min for a given pigeon to maintain 80% weights while minimizing postsession feeding. The shortest session scheduled was 20 min; the longest was 35 min.

Because changes in terminal links had rapidly affected relative initial-link response rates in earlier research (Catania, 1975), fixed numbers of sessions at each condition were originally planned. This plan was discarded primarily on the basis of occasional key failures and of the performance of Pigeon 10, which developed long initial-link pauses and variable responding (cf. standard deviations for Pigeon 10 in Figure 3). All key failures during these procedures occurred only on terminal-link keys. The key failures were detected through latencies from the end of the terminal-link FI to the reinforced green-key peck; these times were consistently short (mean values less than 1 sec) and did not differ systematically across free and forced choice. The following summarizes the sessions with such failures (session numbers correspond to those in Figure 3): Pigeon 3, Sessions 110, 126, 206, and 217; Pigeon 10, Sessions 122 and 217; Pigeon 18, Sessions 171 and 217; Pigeon 23, Sessions 110, 122, and 230. The key failure in Session 217 was an intermittency inadvertently created during apparatus testing after the procedure change in Session 216. Changes in terminal links nevertheless had rapid effects; for all pigeons the mean values of data based on Sessions 2 to 6 of each condition typically differed by less than one standard deviation from those based on the last five sessions of that condition (cf. Figure 3).

## RESULTS

Data from the sessions in which terminal links were increased from FI 10-sec to FI 30-sec and session and reinforcer durations were adjusted are shown in Figure 2. The *x*-axis is scaled so that a shift to the left corresponds to increasing preference for the left terminal link and a shift to the right corresponds to increasing preference for the right terminal link. The data are shown as filled apex-left triangles for free choice in left terminal links and unfilled apex-right triangles for free choice

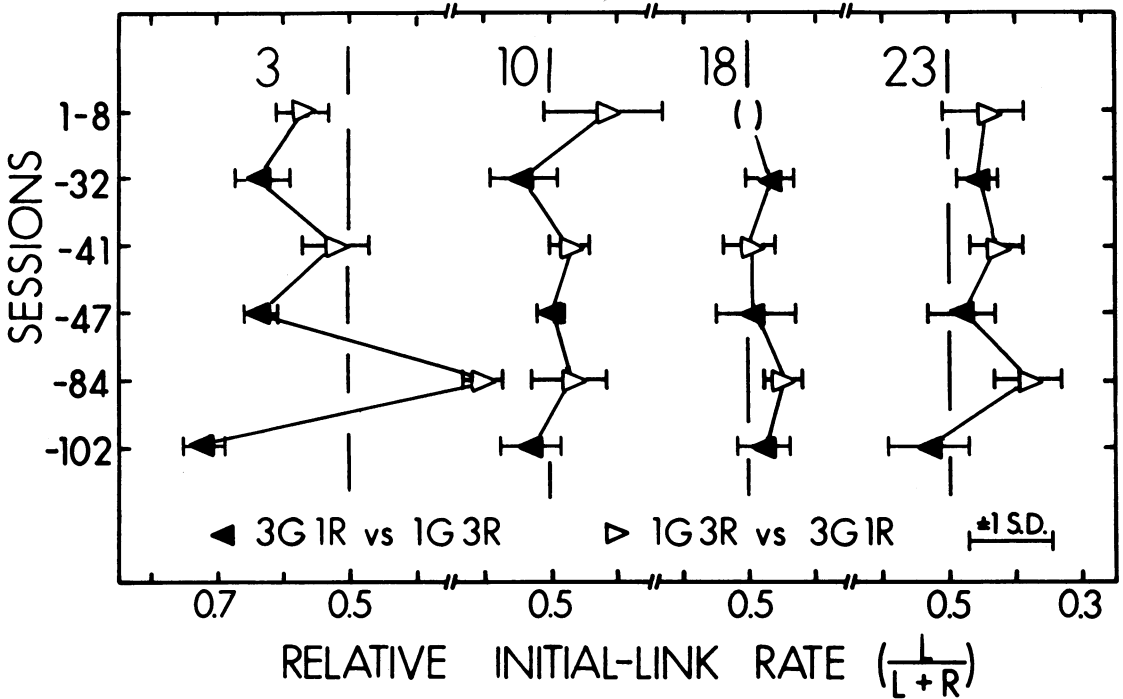


Fig. 2. Relative initial-link response rates during preliminary conditions. Arithmetic means over the last five sessions with free choice in left terminal links are shown by filled apex-left triangles; those with free choice in right terminal links are shown by unfilled apex-right triangles. The x-axis scale is arranged so that a shift to the left corresponds to an increasing preference for left terminal links. Terminal links were lengthened from FI 10-sec through FI 20-sec to FI 30-sec over successive pairs of conditions, during which reinforcer and session durations were also adjusted. Pigeon 18 missed several sessions of the first condition. Over these conditions mean initial-link response rates (resp/min, both keys) and changeover rates (changeovers/min, one direction) for each pigeon were, respectively: Pigeon 3, 37.6/5.8; Pigeon 10, 39.7/6.1; Pigeon 18, 30.2/5.3; and Pigeon 23, 40.5/5.7. 3G1R—three green keys and one red key (free choice); 1G3R—one green key and three red keys (forced choice); SD—standard deviation.

in right terminal links. Thus, shifts in relative initial-link response rate that follow the directions in which the triangles point correspond to changes in preference that follow free choice. The data suggest a baseline preference (equal terminal links) of about .6 for Pigeon 3, about .5 for Pigeons 10 and 18, and about .45 for Pigeon 23 (cf. Catania, 1975, Figure 4). The evidence for free-choice preference is that, except for the early conditions for Pigeon 18, each shift to left or right of the free-choice terminal link produced a corresponding shift in preference (seventeen out of the nineteen possible cases in Figure 2). For Pigeons 3 and 23 the magnitude of this shift increased over successive conditions. For Pigeon 10 it decreased; over these sessions this pigeon's initial- and terminal-link response rates decreased and variability increased (data in Figure 2 are based on the last five sessions of each condition only). For Pigeon 18 the

shift in preference emerged only in the last two conditions and was small relative to the variability of relative initial-link response rates; for this pigeon initial- and terminal-link response rates increased and variability decreased over these sessions.

Figure 3 shows relative initial-link response rates from the sequence of conditions with varied or fixed positions of the green and red terminal-link keys. For all four pigeons preferences shifted from right to left when free choice was switched from right to left terminal links (after Sessions 116 and 216), and from left to right when free choice was switched from left to right terminal links (after Session 159). Compared to this main effect, manipulating the position of the odd terminal-link keys had relatively small effects that were inconsistent from pigeon to pigeon. The two largest effects (at Sessions 143 through 147 for Pigeon 18 and Sessions 201 through 205 for Pigeon

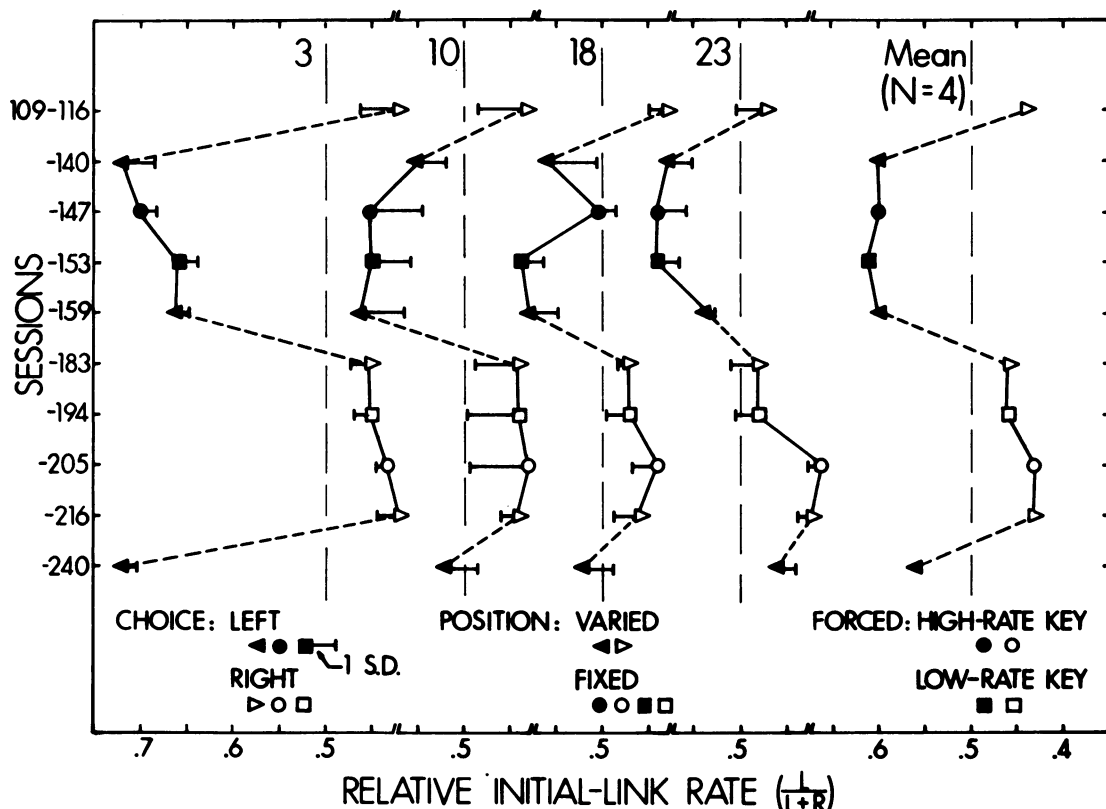


Fig. 3. Relative initial-link response rates over the last five sessions of each condition, represented as in Fig. 2. Standard deviations (SD) are shown only in one direction (toward baseline) to reduce crowding. Free-choice terminal links included three green keys and one red key (3G1R); forced-choice links included one green and three red keys (1G3R). The positions of red and green in successive terminal links were either varied or fixed. When fixed, the odd key was Key 1 with forced-choice responding restricted to a formerly high-rate key, or Key 3 with forced-choice responding restricted to a formerly low-rate key. During these sessions mean initial-link response rates (resp/min, both keys) and changeover rates (changeovers/min, one direction) for each pigeon were respectively: Pigeon 3, 63.3/11.5; Pigeon 10, 19.4/2.9; Pigeon 18, 45.5/8.8; and Pigeon 23, 39.8/6.7.

23) occurred with responding forced to the high-rate green key, but they were in opposite directions; the magnitude of free-choice preference decreased for Pigeon 18 and increased for Pigeon 23. No consistent effects of key position are evident in the mean data on the right in Figure 3.

The selection of the fixed positions of the odd terminal-link keys was based on the terminal-link performances summarized in Table 1. In general, differences in responding as a function of position were more evident in free than in forced choice and depended primarily on the relative frequencies with which pigeons initiated pecking on different keys when they were concurrently available; occasional changeovers among green keys occurred in free choice, but responding was more often restricted to a single key during any one presentation of a

terminal link. Across the six conditions with green on Key 1 in free choice, that position maintained the highest response rate for Pigeon 3 and was consistently one of the two highest-rate positions for the remaining pigeons except for the last condition with Pigeon 23. Across the six conditions with green on Key 3 in free choice, that position was consistently one of the two lowest-rate positions for all pigeons, again except for the last condition for Pigeon 23. Thus, with positions fixed so that Key 1 was always red in free choice and green in forced choice, the high-rate green-key position was restricted to forced choice; with positions fixed so that Key 3 was always red in free choice and green in forced choice, the high-rate green-key position was restricted to free choice, and a key position that might have been correlated with a lower

**Table 1**  
 Percentage of total green-key (FI) pecks at each location in each terminal link. For both free-choice-left and free-choice-right, arithmetic means over the last five sessions are shown for the first three conditions, and arithmetic means over the first five sessions are shown for the fourth condition. R = red, G = green.

Pigeon:	3				10				18				23			
	Keys:				Keys:				Keys:				Keys:			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<b>FREE-CHOICE TERMINAL LINKS</b>																
<i>Free-choice-left</i>																
Varied position, 3G1R-1G3R	39	25	19	18	50	24	12	4	42	26	31	2	35	35	13	17
Fixed position, RGGG-GRRR	—	81	3	16	—	72	3	25	—	98	2	0	—	53	12	35
Fixed position, GGRG-RRGR	70	9	—	21	70	6	—	24	60	15	—	25	37	55	—	8
Varied position, 3G1R-1G3R	61	24	10	4	56	29	7	9	48	23	25	4	32	37	19	12
<i>Free-choice-right</i>																
Varied position, 1G3R-3G1R	46	30	11	13	39	44	11	5	35	35	18	13	36	36	17	12
Fixed position, RRGR-GGRG	56	24	—	19	72	16	—	13	88	5	—	7	24	64	—	12
Fixed position, GRRR-RGGG	—	96	3	1	—	82	6	16	—	81	6	13	—	66	16	17
Varied position, 1G3R-3G1R	51	30	13	5	34	35	26	5	60	24	16	1	24	33	31	13
<b>FORCED-CHOICE TERMINAL LINKS</b>																
<i>Free-choice-left</i>																
Varied position, 3G1R-1G3R	28	24	27	22	23	23	29	24	25	26	29	20	30	27	22	22
Fixed position, RGGG-GRRR	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—
Fixed position, GGRG-RRGR	—	—	100	—	—	—	100	—	—	—	100	—	—	—	100	—
Varied position, 3G1R-1G3R	33	34	35	18	25	26	25	24	30	38	18	24	31	25	22	22
<i>Free-choice-right</i>																
Varied position, 1G3R-3G1R	22	26	21	31	21	32	21	27	16	25	24	35	24	26	17	32
Fixed position, RRGR-GGRG	—	—	100	—	—	—	100	—	—	—	100	—	—	—	100	—
Fixed position, GRRR-RGGG	100	—	—	—	100	—	—	—	100	—	—	—	100	—	—	—
Varied position, 1G3R-3G1R	29	21	23	27	25	30	23	22	23	25	28	24	26	27	23	24

*Note:* In the respective free-choice and forced-choice terminal links, overall green-key response rates (resp/min) were: Pigeon 3, 38.6 and 42.5; Pigeon 10, 64.8 and 66.3; Pigeon 18, 20.4 and 17.1; and Pigeon 23, 72.9 and 82.0.

ratio of responses to reinforcers by virtue of its lower response rate was restricted to forced choice.

Another property of terminal-link responding perhaps relevant to preference was stimulus control by the green and red keys. Only one red key was present during free choice, whereas three red keys were present during

forced choice. In the absence of stimulus control, the probability of pecking any red (EXT) key was .75 in forced choice but only .25 in free choice. Red-key responding is summarized in Table 2, which shows that under most conditions less red-key pecking occurred in free choice (one red key) than in forced choice (three red keys). In seven instances, however,

**Table 2.**  
 Rate of pecking (resp/min) on red (EXT) keys in free-choice and forced-choice terminal links. Data are arithmetic means over the last five sessions of each condition. R = red; G = green.

Pigeon:	3		10		18		23	
	Free	Forced	Free	Forced	Free	Forced	Free	Forced
<b>FREE-CHOICE-LEFT</b>								
Varied position, 3G1R-1G3R	.01	.06	.09	1.13	.02	.12	.01	.03
Fixed position, RGGG-GRRR	.02	.02	.46	.24	.11	.04	.08	.00
Fixed position, GGRG-RRGR	.00	.17	.00	2.25	.00	.00	.00	.07
Varied position, 3G1R-1G3R	.01	.10	.34	2.36	.00	.01	.00	.04
<b>FREE-CHOICE-RIGHT</b>								
Varied position, 1G3R-3G1R	.03	.12	.26	1.09	.00	.00	.30	.03
Fixed position, RRGR-GGRG	.03	.12	.03	2.93	.07	.00	.10	.45
Fixed position, GRRR-RGGG	.00	.10	.14	.10	.00	.01	.22	.03
Varied position, 1G3R-3G1R	.00	.14	.16	.46	.00	.00	.02	.14

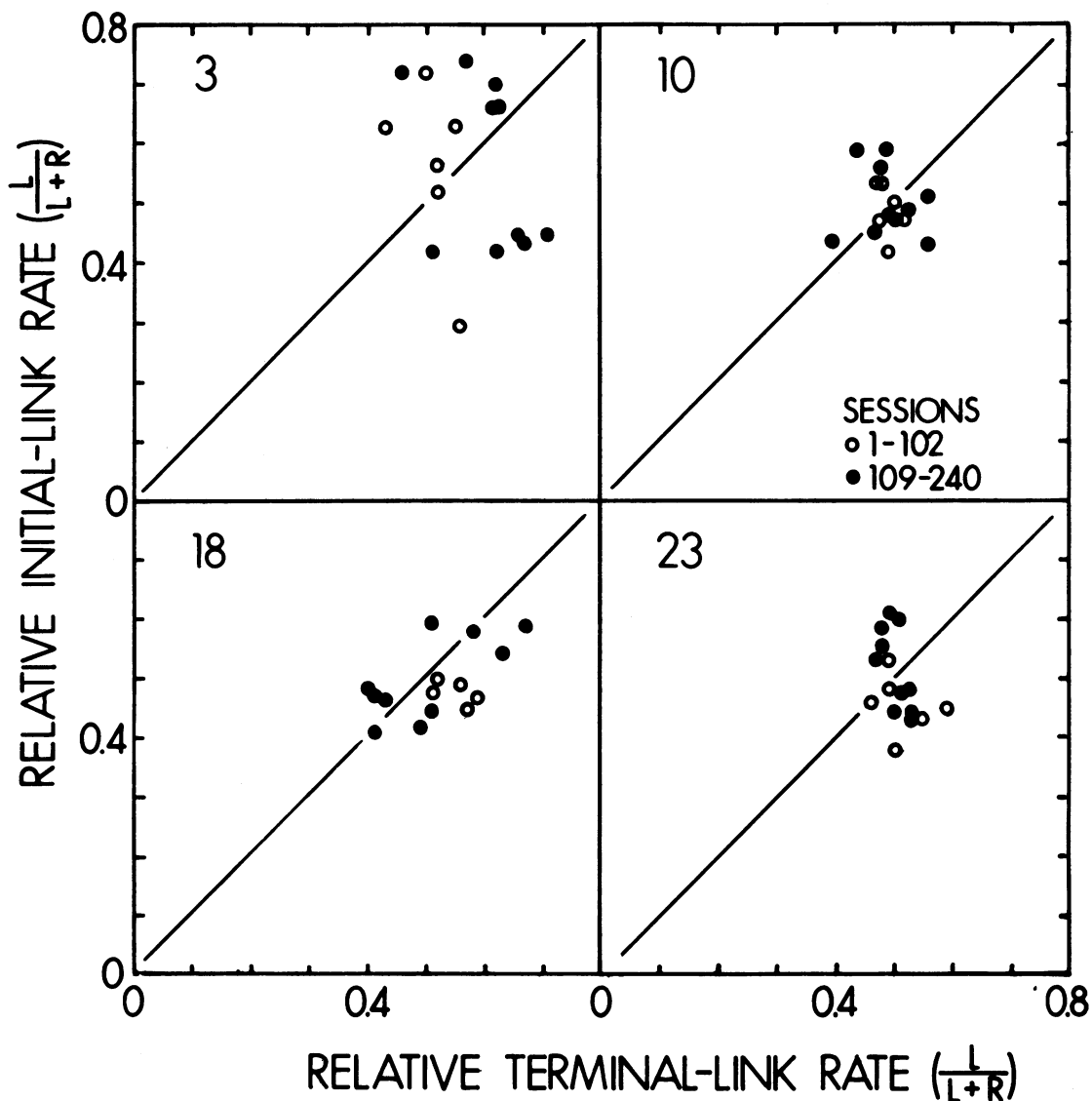


Fig. 4. Scatterplot of relative initial-link and terminal-link response rates, from sequences of sessions corresponding to Figures 2 and 3. Diagonals show equal relative initial-link and terminal-link rates.

this relation was reversed; five of these reversals occurred when the red key was fixed at the high-rate (Key 1) position in free choice. These reversals were not systematically related to changes in preference.

A scatterplot of initial-link and terminal-link relative response rates is shown in Figure 4. No systematic relation is evident, although these two variables varied only over relatively limited ranges. The findings are consistent with those obtained in other research (Catania, 1975, Figure 9; in press, Figure 6).

#### DISCUSSION

This study systematically replicated pigeons' preferences for free over forced choice within concurrent-chain schedules. The preference was obtained with terminal-link stimuli that were equivalent in number, variety, and bits of information. Furthermore, it was not highly correlated with terminal-link position preferences, stimulus control by terminal-link stimuli, or relative rates of terminal-link responding. The finding that initial-link preferences

were not systematically related to terminal-link response rates (Figure 4) is consistent with other studies of determinants of preference in concurrent chains (e.g., Moore & Fantino, 1975; Neuringer, 1969).

The present study used concurrent-chain schedules to examine preference. These procedures separate preference for different conditions from the contingencies that maintain responding in those conditions. In these concurrent chains, preferences are observed in initial links whereas the contingencies operate in terminal links. In simple concurrent schedules, however, relative rates are not necessarily equivalent to preferences. For example, if variable-ratio (VR) reinforcement maintained higher response rates than the concurrent differential reinforcement of low rate (DRL), it would be inappropriate to assume a preference for VR over DRL responding. Although pairs of concurrent schedules can be arranged concurrently (e.g., as in Menlove, Moffitt, & Shimp, 1973), the contingencies controlling separate responses and the changeovers among them may override the relative magnitudes of the reinforcers correlated with each schedule.

A relevant example is provided by Leigland (1979). Pigeons could change over between a single lit key and two lit keys by pecking on a third (changeover) key. Independent concurrent VI schedules of food reinforcement operated for pecks on the single lit key and for pecks on the two lit keys. Responses that occurred within 2 sec of a changeover from one schedule to the other could not be reinforced (changeover delay or COD 2-sec: Herrnstein, 1961a). A critical comparison, examined between groups of pigeons rather than within individual pigeons, was between two contingencies arranged for pecks on the two lit keys. In one case a peck on either key was eligible to produce any scheduled VI reinforcers. In the other a peck on only one of the two keys was eligible to produce scheduled reinforcers; the eligible key varied from one reinforcer to the next, but no discriminative stimuli were correlated with its position.

Consider now how these contingencies might make the relative rate of pecking on the two keys higher when reinforcers are scheduled for only one of them than when they are scheduled for either. Suppose responding on one of the keys continues past the changeover

delay without producing a reinforcer. In the first procedure this occurs either when no reinforcer has yet been scheduled or when a reinforcer already scheduled has been assigned to the other key. In the second procedure this occurs only when no reinforcer has yet been scheduled, because a peck on either key produces any scheduled reinforcers. Thus, the former contingencies are likely to generate a few pecks on the other key before a changeover to the single-key schedule, whereas an immediate changeover to the single-key schedule will be favored by the latter contingencies. Those few additional pecks on the other key would make relative response rates maintained by the two-key schedule higher in the first than in the second procedure. These properties of the Leigland experiment were not subjected to an experimental analysis, but it is sufficient to note the different contingencies on changeovers in the two procedures. The advantage of concurrent-chain schedules is that they separate preference from the contingencies that distribute responses among the alternatives.

Either or both of Leigland's two-key procedures might be regarded as free-choice conditions. The question is an experimental one. Once free-choice preference has been demonstrated, further research may be devoted to refining its definition by exploring the boundaries of the preference. For example, prior research showed that EXT keys, whether lit or dark, do not constitute choices (else every condition in the present apparatus would involve six free-choice alternatives). The present research does not distinguish free choice as the availability of independent discriminated operants from free choice as the opportunity for more variable responding (e.g., Eckerman & Lanson, 1969; Herrnstein, 1961b; Schoenfeld, Harris, & Farmer, 1966). Would a threefold increase in the area of a green key be equivalent to an increase from one to three green keys?

The preference for free choice over forced choice may have ontogenic or phylogenic origins (cf. Skinner, 1966, 1975). One difference here between free and forced choice was that there were other green keys to peck if a green key became inoperable in free choice, whereas a green-key failure in forced choice left the pigeon with no other green key to switch to.



Free-choice preferences were obtained, however, even before key failures exposed the pigeons to these different free-choice and forced-choice contingencies, and those key failures that did occur were not followed by systematic changes in free-choice preference.

If preferences among several alternatives (e.g., those for particular key positions) change from time to time, a free-choice preference may develop as the organism learns that momentarily preferred alternatives are more likely to be available in free choice than in forced choice. But opposing position preference to free-choice preference by fixing the positions of terminal-link keys in the present study did not have much effect. It might be argued that this manipulation would have been effective if it had been maintained for an extended number of sessions. Even if that happened, however, it would be inappropriate to attribute a preference that develops rapidly to a different preference that develops only slowly.

Whatever the status of these arguments for an ontogenic origin of free-choice preference, the possibility of a phylogenetic origin must not be excluded. Organisms that prefer the availability of different responses or opportunities for more variable behavior may have evolutionary advantages (e.g., Kavanau, 1969, p. 268; Roeder, 1975; Rozin & Kalat, 1971). For example, given that food supplies sometimes may be lost to competitors or may disappear in other ways, an organism that chooses patches of the environment in which two or more food supplies are available will probably have a survival advantage over one that chooses patches of the environment containing only a single food supply. A phylogenetic basis of free-choice preference does not imply that it cannot be overridden by other variables. For example, a forced-choice preference could be established by increasing forced-choice but not free-choice reinforcers or by punishing free-choice but not forced-choice responding. Such procedures, however, would probably involve artificial contingencies, and it is unlikely that they could be maintained for as long a time as the natural contingencies that generated free-choice preference in the first place. If this is so, then even if the free-choice preference were suppressed from time to time, its suppression would be only temporary.

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