JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1997, **68,** 349–356 NUMBER 3 (NOVEMBER)

PIGEONS' PREFERENCE FOR FREE CHOICE: NUMBER OF KEYS VERSUS KEY AREA

DANIEL CERUTTI AND A. CHARLES CATANIA

DAVIDSON COLLEGE AND
UNIVERSITY OF MARYLAND BALTIMORE COUNTY

In concurrent-chains schedules, pigeons prefer terminal links that provide two keys correlated with reinforcers (free choice) over those that provide only one key (forced choice), terminal-link reinforcement rates being equal. With same-size keys, free choice provides a larger area available for pecking. Preferences were examined using terminal links that differed in key number only (one or two) or key size only (small and medium or medium and large), or that equated the area of the two free-choice keys with that of the forced-choice key. Medium (standard) keys were typically preferred to small keys, but indifference was typically obtained between medium and large keys. The size preference usually overrode free-choice preference with one medium key pitted against two small keys, but free-choice preference was reliably observed with one large key pitted against two medium keys. In other words, preferences were a joint function of key number and key area, implying that free-choice preference is not reducible to preference for larger key areas. Free-choice preference requires separate keys rather than larger areas; the relevant behavioral units are the discriminated operants correlated with each terminal-link key rather than classes defined by topographical features such as area or perimeter.

Key words: concurrent-chains schedules, free and forced choice, preference, key number, key area, key peck, pigeons

To examine whether one situation is preferred to another, conditions must be arranged in which one response produces one of the situations and a second response produces the other. For example, a pigeon's pecks on a left key may occasionally produce one stimulus in the presence of which some schedule operates, and its pecks on a right key may occasionally produce a second stimulus in the presence of which another schedule operates. The magnitude of the preference for one or the other schedule is then given by the deviation of the relative left-key and right-key response rates from those during baseline conditions with equal schedules produced by each key. This is the rationale for concurrent-chains procedures (Herrnstein, 1964b), in which concurrent responses during initial links each occasionally produce separately operating terminal links. In such procedures, relative response rates maintained by initial-link schedules are studied as a function of different terminal-link conditions.

Within concurrent-chains procedures, preferences have been demonstrated for free-choice conditions over forced-choice conditions, with free choice defined as the availability of two or more operant classes maintained by reinforcers and forced choice defined as the availability of only a single such class (Catania, 1980; Catania & Sagvolden, 1980; Cerutti & Catania, 1986). For example, if pecks on either a green or a yellow key produce food at the end of a fixed interval and pecks on a red key never produce food at the end of the same fixed interval, a pigeon will prefer a green and a yellow key over a green and a red key, even if total responses on the two keys and time until food delivery (i.e., reinforcement rate) are essentially identical in the two conditions; the former consists of the two reinforced classes, pecks on green keys and pecks on yellow keys, whereas the latter consists of only one reinforced class, pecks on green keys. A variety of procedures have shown that free-choice preferences are not reducible to stimulus variables such as key colors or key locations.

Pigeon keys are typically of equal size, so when two or more keys are present in free-choice conditions a larger area is available for

Research supported by NSF Grant BNS82-03385 and PHS Grant MH-37256 to the University of Maryland Baltimore County. We thank Melissa Hanrahan, Rachel Burchard, and Deisy G. de Souza for their helpful contributions to the research.

For reprints write to the second author at the Department of Psychology, University of Maryland Baltimore County, Baltimore, Maryland 21250 (E-mail: catania@umbc.edu).

pecking than when only a single key is presented in forced-choice conditions. Thus, terminal links that pit free choice against forced choice ordinarily confound number of keys with key area. In a short study that attempted to separate the effects of key size from those of number of keys (Catania & Reich, 1982), a metal mask over the standard key aperture reduced the diameter of the accessible key surface (for details, see the Apparatus section under Method, below). For 3 pigeons, preferences were variable with a single key of standard size in one terminal link and a single key of reduced size in the other, but with two keys in one terminal link and a single key in the other, two keys were preferred to a single key both with all keys of standard size and with the two keys reduced in size so that their area roughly equaled that of the single key.

The present study extended the findings of Catania and Reich (1982) by using similar parameters but arranging additional conditions that involved standard and reduced-size keys and by adding a sequence of conditions involving standard and larger keys. One sequence of procedures examined concurrent chains in which the terminal links pitted two small keys (roughly half the area of standard keys) against one small key, two small keys against one standard key (thereby roughly equating key areas), or one small key against one standard key. A second sequence examined concurrent chains in which the terminal links pitted two standard keys against one standard key, two standard keys against one large key (roughly twice the area of the standard keys, thereby again roughly equating key areas), or one standard key against one large key.

METHOD

Subjects

Three male Silver King pigeons were maintained at about 80% of free-feeding weights. Pigeon 94 was experimentally naive at the start. Pigeons 2 and 4 had served in other concurrent-chains procedures, including a pilot study on key area described below.

Apparatus

Daily sessions were conducted in a six-key chamber described by Catania and Sagvolden (1980). Terminal links were arranged on a horizontal row of four keys at the top of the experimental panel; 6-W lamps behind each key allowed the two upper left keys to be lit green and the two upper right keys to be lit red. Two bottom keys, one centered below the two top left keys and the other centered below the two top right keys, served as the initial-link keys; these keys could both be lit white.

All keys were translucent (milk-white) Gerbrands keys matched to operate with a minimum force of about 0.20 N, but it should be noted that the distance between the key fulcrum and the location of a peck can vary more with a larger key than with a smaller one and therefore may allow greater variability in the minimum effective force. In some procedures, the standard 19-mm diameter key opening was modified as described below. The reinforcer was a 3-s operation of a Gerbrands feeder, during which the feeder was lit and keylights were off. Scheduling and recording were arranged by electromechanical equipment in an adjoining room.

In a pilot study with Pigeons 2 and 4, key area in a free-choice terminal link had been reduced by attaching aluminum masks with smaller openings over the two keys in that terminal link while the single forced-choice key in the other terminal link remained unmasked. Pigeon 2 tended to peck at the edges of the masks rather than at the key surfaces and injured its beak on the inside edges of the masks.

To address this problem, key areas were modified by replacing the Bakelite faces of the keys with faces that had openings of different sizes and on which the edges of the openings were beveled to match those of standard Gerbrands keys. Keys with 13-mm diameter openings (small keys, each about 133 mm^2) were built to about one half the area of a standard or medium key (284 mm^2); a key with a 27-mm diameter opening (large key, 572 mm^2) was built to about twice the area of a standard or medium key (568 mm^2).

In typical pigeon-key mountings, the opening in the panel is a millimeter or two larger than that in the Bakelite front surface of the fixed portion of the key. Thus, the Bakelite shows as a thin black rim behind the aluminum panel and in front of the translucent key surface. To accommodate the different key sizes, the panel openings behind which the modified keys were mounted were either reduced in size by an aluminum insert or enlarged by drilling a larger round opening. In

either case, the opening was designed so that the visible Bakelite rim of any modified key was similar in appearance to that of any standard key in the chamber.

The small keys could be arranged in any of the four upper terminal-link key positions; the large key could be mounted only in the upper leftmost or the upper rightmost terminal-link key position (terminal-link key arrangements are shown schematically as part of the *y*-axis labels of Figures 1 and 2). Initial-link keys were always of standard size.

Procedure

Sessions for Pigeons 2 and 4 were immediately preceded by the pilot study described above. Sessions for Pigeon 94 were preceded by shaping of key pecks in a chamber with a single white key, after which nine sessions were devoted to establishing its terminal-link performances. In those sessions, fixed-interval (FI) schedules were arranged for the top left green key or for the top right red key by two independent random-time schedules that operated while all keys were dark (RT 40 s, t = 1 s, p = .025); with this arrangement, temporal distributions of green and red terminal links approximated those that would occur in the subsequent concurrent-chains schedules. During green or red, the first peck on the lit key after 30 s operated the feeder (FI 30 s).

In order to maintain 80% of free-feeding weights with minimal postsession feeding, sessions were ended after 30 min of initial links for Pigeon 2 and after 15 min of initial links for Pigeon 4. For Pigeon 94, sessions began with 30 min of initial links but were reduced to 20 min after the first 24 sessions.

The initial links of the concurrent-chains schedules consisted of independent random-interval schedules (RI 40 s, t = 1 s, p = .025) arranged for pecks on the two bottom white keys. During initial links, terminal-link keys were dark, and the first peck on one initial-link key after a peck on the other could not produce a terminal link. Once a terminal link had been set up for a subsequent eligible initial-link key peck, no further setups could be accumulated for that key.

During terminal links, initial-link keys were darkened and appropriate terminal-link keys were lit. Single-key or forced-choice terminal links produced by left initial-link pecks were always arranged on the upper leftmost key, which was lit green; those produced by right initial-link pecks were always arranged on the upper rightmost key, which was lit red. Two-key or free-choice terminal links produced by left initial-link pecks were always arranged on the two upper left keys, which were both lit green; those produced by right initial-link pecks were always arranged on the two upper right keys, which were both lit red.

An FI 30-s schedule operated in all terminal links. In terminal links with a single key, the first peck on that key after 30 s operated the feeder. In terminal links with two keys, the first peck on either key after 30 s operated the feeder. In both cases, feeder operation was followed immediately by a return to the initial links of the concurrent chains.

One sequence of procedures examined preferences for terminal links that included small and medium keys. Terminal-link conditions in this sequence pitted two small keys against one small key, two small keys against one medium key of about the same total area, and one small key against one medium key. Another sequence examined preferences for terminal links that included medium and large keys. Conditions in this sequence pitted two medium keys against one medium key, two medium keys against one large key of about the same total area, and one medium key against one large key. Left-right reversals of terminal-link contingencies were arranged over blocks of sessions within each condition (the first three over 10-day blocks, the next four over 14-day blocks, and later ones over 7-day blocks). The detailed order of conditions and the number of sessions of each condition are summarized schematically along the *y* axes of Figures 1 and 2.

RESULTS

Preferences and terminal-link responding across conditions are summarized for each pigeon in Figure 1 (small and medium keys) and Figure 2 (medium and large keys). Successive changes in terminal-link conditions are shown schematically along the left *y* axis; the last session number of each condition is shown along the right *y* axis. In the presentation of data, an experimental condition will sometimes be referred to by the session number on which it ended (e.g., the first condition may be referred to as the Session 10 condition).

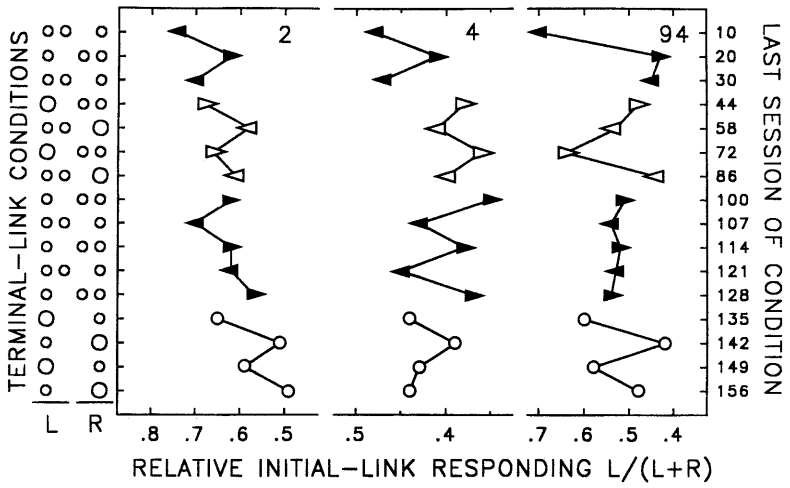

Fig. 1. Relative initial-link response rates (left divided by left plus right) over successive conditions for 3 pigeons. Keys available during left and right terminal links are shown schematically along the left *y* axis, with the smaller circles representing small keys and the bigger ones medium or standard keys; the right *y* axis provides the session number at which each condition ended. Triangles with apex pointing left or right, respectively, indicate the location of free-choice terminal links. Circles show relative initial-link response rates with forced choice in both terminal links. Data from conditions involving different keys sizes are shown by open symbols, and those from conditions involving a single key size are shown by solid symbols. All data are arithmetic means over the last five sessions of a condition.

The *x*-axis scales show relative rates of responding for each pigeon (the scale for Pigeon 4 is doubled relative to that for Pigeons 2 and 94 in both figures). Relative initial-link rates (left divided by left plus right) during free-choice conditions are plotted as apex-left and apex-right triangles corresponding to left and right free-choice terminal links, respectively. Thus, a shift toward the left corresponds to a shift in preference toward the left terminal

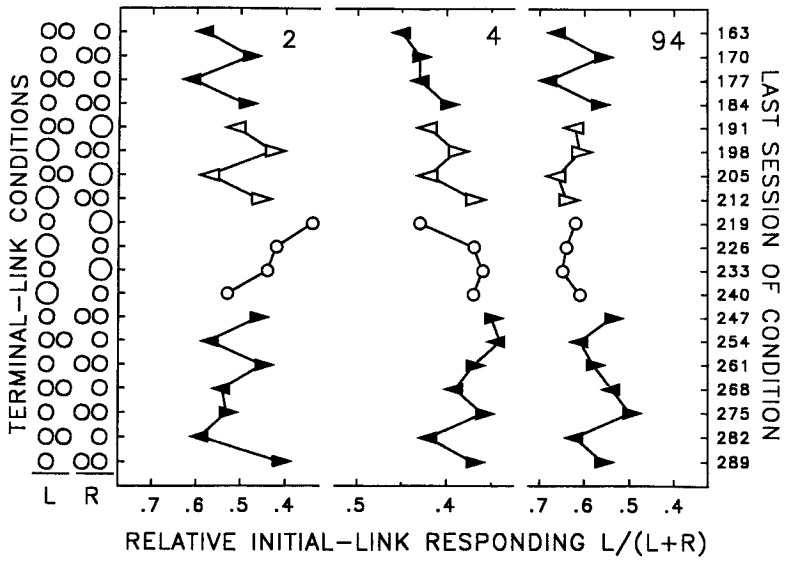

Fig. 2. Relative initial-link response rates (left divided by left plus right) over successive conditions for 3 pigeons. Details are as in Figure 1, except that the conditions involved medium and large keys rather than small and medium keys. Thus, for the key sizes shown schematically along the left *y* axis, the smaller circles represent medium or standard keys and the bigger circles represent large keys.

link, and a shift in relative responding toward the apex of a triangle corresponds to a shift in preference toward free choice. Relative initial-link response rates during conditions involving different key sizes are plotted as open symbols (triangles given free-choice conditions, and circles given only a single key in each terminal link); those during conditions involving keys all of the same size are plotted as solid triangles. Data are means from the last five sessions of each condition.

In free-choice conditions with all keys small (Session 10 through Session 30 and Session 100 through Session 128 conditions), pigeons usually preferred free-choice to forced-choice terminal links, as shown by the shifts in preference. The shift was very small in the Session 121 condition for Pigeon 2 and throughout the Session 100 through Session 128 conditions for Pigeon 94, but the only case in which preference did not follow free choice in the eight conditions and six changes in conditions for the 3 pigeons was in the Session 128 condition for Pigeon 94. Even by very conservative binomial criteria, the free-choice preference is statistically highly significant (shifts in the direction of free-choice preference in 17 of 18 possible cases).

With small free-choice keys roughly equal in area to a single medium forced-choice key, however, preferences varied across pigeons (Session 44 through Session 86 conditions). Pigeon 2 consistently preferred forced choice, Pigeon 4 consistently preferred free choice, and Pigeon 94's preferences were inconsistent.

With a single small key in one terminal link and a single medium key in the other (Session 135 through Session 156 conditions), the pigeons consistently preferred the medium key over the small key, except for Pigeon 4 in the shift to the final Session 156 condition. The size preference apparently overrode the free-choice preference for Pigeon 2 and to a lesser extent for Pigeon 94, whereas the less consistent size preference for Pigeon 4 was apparently overridden by the free-choice preference (Session 44 to Session 86 conditions).

As shown in Figure 2, a similar pattern of results was obtained in the free-choice conditions with all keys medium (Session 163 through Session 184 and Session 247 through Session 289 conditions). Again, all 3 pigeons usually preferred free-choice to forced-choice terminal links, although again there were exceptions (the small shift at the Session 177 condition and the reversal at the Session 254 condition for Pigeon 4 and the reversal at the shift to the Session 268 condition for Pigeon 94). Despite the reversals, the free-choice preference is statistically highly significant, even by a conservative binomial criterion (shifts in the direction of free-choice preference in 25 of 27 possible cases).

With medium free-choice keys roughly equal in area to a single large forced-choice key, all 3 pigeons preferred free-choice over forced-choice terminal links (Session 191 through Session 212 conditions), although the preference for Pigeon 94 appeared smaller than with all medium keys.

Preferences were inconsistent with a single medium key in one terminal link and a single large key in the other (Session 219 through Session 240 conditions), except that it could be argued that the data for Pigeon 2 imply a large-key preference. If there was such a preference for Pigeon 2, it was not large enough to override free-choice preference in conditions that pitted one large key against two medium keys in terminal links.

Table 1 shows absolute response rates in initial and terminal links for each pigeon across all experimental conditions. It provides no evidence that properties of terminal-link performance affected initial-link preferences. Over a few successive conditions, changes in relative initial-link rates were sometimes correlated with changes in relative terminal-link rates (rates on a forced-choice key or summed across two free-choice keys in one terminal link, divided by rates summed across all keys in both terminal links). But over the experiment as a whole, those correlations were inconsistent in both magnitude and direction (e.g., a positive correlation over the first seven conditions for Pigeon 2, but a negative one over the corresponding conditions for Pigeon 4).

DISCUSSION

This study demonstrated preferences for terminal links that contained two keys over terminal links that contained a single key or, in other words, preferences for free choice over forced choice. It also demonstrated preferences for terminal links that contained a single medium key over terminal links that

Table 1

Response rates (responses per minute) in initial and terminal links for 3 pigeons.

		Pigeon 2						Pigeon 4					
		Initial links		Terminal links				Initial links		Terminal links			
Sessions	Conditions	L	R	1	2	3	4	L	R	1	2	3	4
6–10	SS-S	69.3	24.0	20.4	2.3		15.2	25.5	28.0	7.3	10.0		21.0
16–20	S-SS	56.5	34.3	19.1		19.0	0.8	21.3	31.1	17.0		19.1	2.0
26–30	SS-S	70.1	30.2	17.1	4.2		10.5	25.9	28.7	5.0	9.1		22.2
40–44	M-SS	56.8	26.8	22.4		2.3	12.4	17.7	29.3	20.6		11.5	10.5
54–58	SS-M	56.6	40.7	16.2	0.7		19.7	21.7	31.0	14.7	3.9		23.0
68–72	M-SS	49.3	25.1	21.5		8.1	7.8	17.0	30.8	18.9		11.4	6.0
81–86	SS-M	48.3	30.2	10.2	1.2		19.0	19.5	28.8	11.8	2.2		24.4
96–100	S-SS	47.7	29.2	13.9		14.2	1.6	16.9	30.9	13.1		11.6	4.9
103–107	SS-S	52.0	21.8	8.3	1.2		14.7	21.1	28.0	14.0	3.4		20.0
110–114	S-SS	42.6	26.4	11.5		14.2	3.7	19.5	31.2	14.6		16.5	4.8
117–121	SS-S	45.5	28.5	16.8	4.3		15.3	23.2	28.4	12.4	1.6		21.2
124–128	S-SS	42.0	31.5	18.8		15.1	7.1	17.5	30.3	14.0		17.5	3.8
131–135	M-S	55.3	29.3	42.0			15.3	19.8	25.1	23.6			20.1
138–142	S-M	42.1	40.1	21.8			20.6	17.8	27.7	14.2			25.0
145–149	M-S	47.2	33.2	24.3			11.8	22.3	29.9	21.2			17.6
151–156	S-M	40.8	42.5	20.3			27.8	23.4	30.2	15.1			22.6
159–163	MM-M	44.8	32.8	19.3	7.9		21.8	22.7	27.9	15.3	6.1		18.9
166–170	M-MM	43.3	47.0	26.8		19.9	11.1	20.6	27.7	14.5		13.8	6.4
173–177	MM-M	55.6	36.1	20.8	14.9		23.5	21.7	29.3	10.4	10.0		24.5
180–184	M-MM	43.0	44.3	28.3		21.7	10.2	18.7	28.3	19.4		17.4	4.2
187–191	MM-L	41.5	39.4	19.3	23.3		17.5	18.4	25.4	9.3	14.0		23.6
194–198	L-MM	28.4	37.4	26.0		27.2	8.9	18.8	29.9	19.0		21.6	2.2
201–205	MM-L	41.5	31.3	15.5	6.7		17.1	20.4	27.7	5.8	9.0		21.4
208–212	L-MM	30.7	35.3	22.2		19.8	7.8	17.3	29.4	17.3		22.9	1.6
215–219	M-L	24.7	47.1	17.8			18.9	21.9	28.5	15.8			23.3
222–226	L-M	29.4	40.7	25.1			22.0	17.3	29.5	25.0			25.4
229–233	M-L	30.3	37.8	22.3			22.4	17.6	30.9	19.8			23.1
236–240	L-M	35.9	31.8	31.3			18.5	16.5	28.4	23.0			24.4
243–247	M-MM	31.8	37.2	21.3		26.7	8.0	16.9	31.2	17.7		17.5	9.2
250–254	MM-M	46.0	34.3	19.2	8.3		18.8	16.7	32.8	6.4	9.6		25.5
257–261	M-MM	33.2	40.2	20.0		16.7	5.6	18.5	31.8	20.4		10.4	17.0
264–268	MM-M	33.6	28.1	16.8	6.7		20.4	20.0	31.3	6.8	15.0		28.2
271–275	M-MM	34.7	31.0	21.3		13.8	11.8	18.1	32.3	18.0		14.6	10.0
278–282	MM-M	38.2	26.6	17.7	5.0		16.8	20.9	28.9	9.5	8.9		25.5
285–289	M-MM	27.9	39.7	20.8		18.6	6.9	18.4	31.8	17.3		16.2	11.1

Note. S = small; M = medium (standard); L = large. Data are arithmetic means over the last five sessions of an experimental condition.

contained a single small key (although it did not consistently demonstrate corresponding preferences for terminal links that contained a single large key over terminal links that contained a single medium key). Furthermore, preferences obtained when one terminal link was arranged with two keys roughly equal in area to a single key in the other terminal link were reasonably consistent with preferences separately obtained with terminal links that differed only in number of keys or only in key area.

Because both affected preference, key number and key area appear to be orthogonal stimulus dimensions, each separately contributing to preferences for the terminal links of concurrent-chains schedules. In procedures that combine different key numbers and different key sizes in terminal links, preference might go either way depending on the relative magnitudes of each component preference.

The present results might be interpreted in terms of other derivatives of key size besides area. For example, pigeons sometimes peck keys around their perimeters, so it could be argued that circumference is a more relevant dimension than area; presumably other kinds of arguments could be advanced for diameter. But whether the comparisons depend on

Table 1
(*Extended*)

Pigeon 94					
Initial links		Terminal links			
L	R	1	2	3	4
31.0	13.1	12.2	23.3		28.1
26.1	34.5	34.0		17.9	12.4
25.8	31.2	9.7	26.3		24.2
26.3	28.8	45.8		6.4	26.8
26.9	24.0	6.3	24.8		40.1
31.2	17.8	115.6		18.1	22.8
23.4	29.3	3.7	26.2		70.3
24.1	23.6	53.8		17.3	15.9
24.6	21.0	9.4	35.4		44.2
23.6	21.7	52.5		16.6	23.1
22.3	19.5	5.6	33.5		41.0
20.1	17.5	43.9		12.1	17.5
26.8	17.7	81.9			32.6
20.1	27.1	31.4			47.8
26.4	19.4	67.9			34.0
21.6	23.0	36.7			41.3
34.4	17.5	8.4	32.6		31.6
27.0	20.8	48.2		19.5	13.6
31.6	15.0	13.7	20.6		27.6
27.5	20.7	43.7		18.8	7.4
27.4	16.8	9.7	24.0		26.4
30.4	19.4	52.1		23.3	9.1
25.7	13.0	14.5	18.2		26.7
29.4	16.9	55.2		14.9	13.2
26.8	16.8	32.8			14.3
30.6	17.0	47.4			30.6
28.7	15.6	32.2			28.5
28.2	17.8	45.9			26.7
21.9	18.6	32.9		18.6	3.8
29.9	19.0	15.6	13.5		36.0
24.5	17.7	30.6		22.7	4.1
21.0	17.7	16.5	10.5		28.9
21.3	21.4	30.6		9.8	12.1
30.1	18.3	17.5	10.5		29.2
25.7	20.2	36.7		24.7	12.1

areas or on measures proportional to square roots of areas (circumference or diameter), the results do not support the reduction of free-choice preferences to preferences based on such key dimensions. An extension of the experimental analysis to such variables (e.g., pitting the small keys of Figure 1 against the large keys of Figure 2) might be of interest in its own right, but it is not clear how it would bear on the issue of determinants of free-choice preference.

The argument for circumference, that pigeons sometimes peck around the edges of keys, suggests a transformation of key size to some dimension that is defined by behavior rather than by physical attributes. For example, variability is a factor in choice (Herrnstein, 1964a), and by providing a larger area a larger key also provides a greater opportunity for variable responding. Given their orthogonal effects, however, the dimensions of key number and key size do not appear to be reducible to a single behavioral dimension that can affect preference. The results are consistent with a large literature on preferences in concurrent-chains procedures (e.g., Davison & McCarthy, 1988) in which temporal and other variables have typically been far more potent than response variables.

In experiments that involve free-choice preference, keys on which pecks do not produce reinforcers are not effective as alternatives. A two-key terminal link in which pecks on either key can produce reinforcers is a free-choice terminal link, but a terminal link in which pecks on only one of the two keys can ever do so is not. This finding has been used to argue that the critical behavioral units are not topographical but are instead functional (e.g., Catania, 1980, 1983). The present results allow the argument to be taken further.

The two halves of the single larger key in the present procedures were not equivalent to the two smaller keys. Instead, the functional units were the several keys, each correlated with particular stimuli and contingencies. In other words, the units were discriminated operants (Skinner, 1938). To demonstrate a free-choice preference is to demonstrate a preference for the availability of two or more operant classes over a single operant class. The findings are therefore one more reminder of the ubiquity of operants as functional units of behavior.

REFERENCES

Catania, A. C. (1980). Freedom of choice: A behavioral analysis. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 14, pp. 97–145). New York: Academic Press.

Catania, A. C. (1983). Is not-responding behavior? *Behavioral and Brain Sciences, 6,* 321–322.

Catania, A. C., & Reich, G. M. (1982). Key area versus number of keys in the pigeon's preference for free choice over forced choice: A preliminary study. *Revista Mexicana de Analisis de la Conducta, 8,* 127–132.

Catania, A. C., & Sagvolden, T. (1980). Preference for free choice over forced choice in pigeons. *Journal of the Experimental Analysis of Behavior, 34,* 77–86.

Cerutti, D. T., & Catania, A. C. (1986). Rapid determination of preference in multiple concurrent-chain

schedules. *Journal of the Experimental Analysis of Behavior, 46,* 211–218.
Davison, M., & McCarthy, D. (1988). *The matching law: A research review.* Hillsdale, NJ: Erlbaum.
Herrnstein, R. J. (1964a). Aperiodicity as a factor in choice. *Journal of the Experimental Analysis of Behavior, 7,* 179–182.
Herrnstein, R. J. (1964b). Secondary reinforcement and rate of primary reinforcement. *Journal of the Experimental Analysis of Behavior, 7,* 27–36.
Skinner, B. F. (1938). *The behavior of organisms.* New York: Appleton-Century-Crofts.

Received January 27, 1997
Final acceptance July 24, 1997