Behavioral contrast and type of reward: Role of elicited response topography

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Groups of pigeons were exposed to multiple variable-interval variable-interval and multiple variable-interval extinction schedules of either food or water reinforcement for keypecking. Discriminative stimuli associated with component schedules were located either on the operant key or on a second "signal" key. When the stimuli were projected on the operant key, positive contrast appeared during discrimination conditions with either food or water as the reinforcer. When the stimuli were projected on the signal key, overall responding to the operant and signal keys showed contrast with food, but negative induction with water as the reinforcer. In the latter condition, the signal for the variable-interval schedule of water reinforcement elicited a variety of water-related behavior, only some of which was directed at the signal. Thus, the type of reward and location of discriminative stimuli interacted to determine the presence or absence of behavioral contrast effects. In large part, these results support and extend the autoshaping view of contrast.

A good deal of research suggests that the phenomenon of positive behavioral contrast (Reynolds, 1961) may result from a combination of operant and respondent (or autoshaping, Brown & Jenkins, 1968) factors. Positive contrast appears during multiple-schedule procedures when, for example, a multiple variable-interval variable-interval (mult VI VI) schedule is changed to multiple variable-interval extinction (mult VI EXT). As response rate declines in the EXT component, response rate often increases in the unchanged VI component, and this divergence of response rates is labeled positive contrast. According to the autoshaping view of contrast, a change from mult VI VI to mult VI EXT introduces a stimulus-reinforcer contingency into the discrimination situation. The stimulus correlated with VI may engender elicited, or autoshaped responses, which sum with ongoing operant responses to increase response rate during VI (Gamzu & Schwartz, 1973; Hearst & Jenkins, 1974; Rachlin, 1973; Schwartz & Gamzu, 1977).

Support for the autoshaping account comes from studies showing that variables which determine the frequency or topography of autoshaped responding also influence the magnitude or direction of response rate changes during mult VI EXT. For example, rate of reinforcement and relative duration of components determine the frequency of responding in autoshaping

procedures, and these factors have parallel effects on the magnitude of response rate increase during mult VI EXT (Spealman, 1976). The autoshaping view also accounts for effects on contrast of varying the locus and modality of discriminative stimuli during mult VI EXT. When stimuli are projected on a pigeon's operant key, operant and elicited responses should be directed toward the same location and summate to increase response rate. Contrast is typically large and reliable under such conditions (Rachlin, 1973). When the stimuli are diffuse, or located at some distance from the operandum, elicited responses should not appear on the operandum. Under these circumstances, contrast is attenuated or abolished (Hearst & Gormley, 1976; Hemmes, 1973; Redford & Perkins, 1974; Schwartz, 1975; Westbrook, 1973). However, when the stimuli are projected on another pecking key (to allow recording of signal-directed responses), the sum of operant and elicited responses should synthesize contrast. Several experiments have reported such a result (Keller, 1974; Schwartz, 1974).

The autoshaping view also suggests that the type of reinforcer used to maintain the operant should influence contrast, by determining the topography of elicited responses. In autoshaping, the topography of elicited behavior varies with the type of reinforcer (Jenkins & Moore, 1973; Woodruff & Starr, 1978). In pigeons, a signal for food engenders signal-directed pecking, a highly targeted response form (Zeigler, 1974). A signal for water also elicits signal-directed contact responses, but these "drinklike" responses consist of prolonged pushing motions of the beak on the key ("rooting"), and rapid opening and closing of the mandibles ("mumbling") during contact.

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Several other activities may be released by, but not directed toward, a signal for water, such as "bowing" (a quick, smooth lowering of the head toward the floor) and "rooting" in the empty water magazine (Morrison, 1977; Woodruff, Morrison, & Williams, 1974; Woodruff & Williams, 1976; Morrison, Note 1).

These differences between activities elicited by signals for food and water suggest different outcomes during mult VI EXT. With food reinforcers, elicited responses should be predominantly signal-directed pecks. With water reinforcers, only some of the elicited responses should be directed toward the signal. Consequently, contrast should be less pronounced with water than with food.

The present experiment compared one- and two-key multiple schedules with pigeon subjects, keypecking as the operant, and food or water as the reinforcer. In the standard one-key procedure (Reynolds, 1961), visual discriminative stimuli were projected on the operant key. In the two-key procedure, stimuli were projected on a separate signal key, in order to identify the individual contributions of signal- and operandum-directed responses to changes in overall response rates (Keller, 1974). In addition, observers recorded non-signal-directed behavior for birds receiving water reinforcers.

METHOD

Subjects

Sixteen experimentally naive adult White King pigeons were maintained at 80% of free-feeding body weight throughout the experiment. Eight birds were deprived of water and eight of food. In the home cages, water-deprived birds had continuous access to grain and grit and food-deprived birds had continuous access to water and grit.

Apparatus

The experimental space was a Lehigh Valley operant conditioning chamber for pigeons, measuring 31 × 35 × 35 cm. The front wall contained three response keys, each 2.6 cm in diameter, positioned 8.3 cm apart and 25 cm above the metal grid floor. A magazine aperture was centered 13 cm below the center key. A houselight was positioned 6 cm above the center key and partially surrounded by an aluminum shield, which deflected the white light toward the ceiling of the chamber. White noise was presented continuously through a speaker covered by a 7.5-cm-diam grid located on the lower left side of the front wall, 12 cm below the left key. The right-hand wall contained a one-way observation window measuring 16 × 19 cm. Programming equipment was located in an adjacent room.

Only the center and left response keys were used, and both required a force of 15 g (.15 N) to operate a microswitch and record a response. A displacement transducer (Hewlett-Packard Model 24 DCDT-250) was attached to the rear edge of the center key and provided continuous recordings of key displacement by means of an eight-channel Beckman Dynograph (Type 506RA; Serial No. 17251).

Visual stimuli were presented with IEE multistimulus projectors mounted behind the keys. The center key could be transilluminated by a white spot, 1 cm in diameter and surrounded by a red or green light. The left key could be transilluminated by homogeneous red or green light.

A solenoid-operated hopper delivered reinforcers. The hopper was filled with mixed grain and elevated into the magazine aperture when food was to be delivered. For delivery of water, a metal plate covered the horizontal opening of the hopper and a polyethylene tube protruded .5 mm through a hole drilled in the center of the plate. The tube led out of the chamber housing to a solenoid valve and water reservoir suspended 30 cm above the level of the hopper. When the hopper was raised into the magazine aperture and the valve opened, water flowed at a rate of 10 cc/min into a slight depression in the metal plate. When the hopper was lowered, any residual water drained off the plate. Thus, the magazine was empty during interreinforcement intervals.

Two observers made informal observations of all subjects throughout the experiment. In addition, the observers shared duties of recording bowing and rooting responses for birds receiving water reinforcers, by means of hand-operated microswitches and timers. During each session, one or the other observer monitored the birds through the one-way window in the door of the chamber. The presence of the observer produced no obvious disruption of any bird's performance. During one session late in the first phase of the experiment, both observers recorded behavior of each bird. Interobserver reliability scores ranged from 84% to 98%.

Procedure

Food- and water-deprived birds were trained to approach and consume food or water, respectively, from the hopper in one session. All birds then were trained to approach and press the center key transilluminated by the white spot (surrounded by black), by the method of successive approximations. Key-contact responding was shaped and maintained after two or three 30-min sessions in which every response was reinforced. Each set of eight food- and water-deprived birds was then unsystematically divided into two groups of four subjects.

For the remainder of the experiment, a two-component multiple schedule of reinforcement was in effect during daily 30-min sessions. Component 1 (the constant component) was a variable-interval 30-sec (VI 30-sec) schedule throughout the experiment. Component 2 (the changed component) was either an identical VI 30-sec schedule or an extinction (EXT) schedule, during which no reinforcers were delivered. Correlated with each component was a red or green light, projected either on the center key (surrounding the white spot) or on the left key. The color associated with component 1 was red for two birds in each group and green for the other two birds. The alternate color was associated with component 2 in each case. Components 1 and 2 were always 15 and 45 sec in duration, respectively, and were presented 30 times per session in regular alternation, beginning with component 2.

Reinforcers were always dependent upon a response to the center key (hereafter referred to as the operant key). Responses to the left key (hereafter referred to as the signal key) were recorded, but had no other scheduled consequences. Reinforcers were always 3 sec access to either .5 cc water for water-deprived birds or mixed grain for food-deprived birds. During reinforcement, the houselight and keylights were extinguished and the hopper was illuminated by a clear 28-V dc bulb. Reinforcers not collected by the end of a component were cancelled.

The four groups of birds were labeled F1, F2, W1, and W2; the letter denotes the type of reinforcer (F indicates food, W indicates water) and the number the type of procedure (1 indicates the one-key procedure with stimuli localized on the operant key, 2 indicates the two-key procedure with stimuli located on the signal key). The experiment proper consisted of three phases. In Phase 1, all birds were exposed to mult VI VI for a minimum of 25 sessions. Thereafter, when response rates stabilized for an individual subject (i.e., when response rate deviated by no more than 10% from the previous four-session mean and showed no visible increasing or decreasing trend), the next phase was initiated. In Phase 2, component 2 was changed to EXT (mult VI EXT). In

Phase 3, component 2 was returned to VI (mult VI VI). Phases 2 and 3 were continued for a minimum of 10 sessions, even when response rates appeared stable earlier.

RESULTS

Most subjects required more than the minimum of 25 sessions to reach stable baseline response rates in Phase 1. Response rates gradually increased for at least 20 sessions, and for up to 40 sessions for P15 in Group W2. In later phases, stable response rates generally were achieved more rapidly than in Phase 1. Table 1 presents the number of sessions in each phase of the experiment for each subject.

Asymptotic levels of operant-key responding (and signal-key responding for birds in the two-key procedure) were calculated for each subject from daily response rates over the last five sessions of each phase, and are presented in Figure 1. Mean response rates varied considerably between subjects in baseline Phases 1 and 3 (mult VI VI conditions), but there was no systematic effect of either the signal location or the type of reinforcer on baseline levels of responding.

During mult VI EXT in Phase 2, mean response rate in the EXT component decreased for 14 of 16 subjects, and showed relatively little change for the remaining two birds (P6 in Group F2 and P10 in Group W1). All subjects showed an increase in mean response rate during component 2 upon return to baseline conditions in Phase 3 (mult VI VI). Thus, signal location and type of reinforcer had no differential effect on levels of responding in the EXT component during Phase 2 either.

On the other hand, type of reinforcer and location of discriminative stimuli interacted to determine the

Figure 1. Mean response rates in the constant component 1 and the changed component 2 during the last five sessions of Phase 1 (mult VI VI), Phase 2 (mult VI EXT), and Phase 3 (mult VI VI).

magnitude or direction of response rate changes in the constant VI component during Phase 2. To facilitate comparison of the results for each group, a measure of percentage change in response rate was calculated for each bird. Response rates from the last five sessions of Phases 1 and 3 (mult VI VI) were averaged and compared with mean response rates over the last five sessions of Phase 2 (mult VI EXT). The results of these calculations are shown in Table 2. Each percentage indicates the magnitude and the sign indicates the direction (+ = increase, - = decrease) of response rate changes during Phase 2 relative to baseline levels averaged across the preceding and following phases. The results of a *t* test applied to the same data are also presented in Table 2 for each bird.

All subjects in the one-key procedure with either food (Group F1) or water (Group W1) reinforcers showed a response rate increase in component 1 and decrease in component 2 (positive contrast). However, the magnitude of response rate increase in the constant VI component tended to be larger for birds with water reinforcers. Only one bird in Group F1 (P1) showed a percentage increase in VI responding as great as those observed for birds in Group W1.

The two-key procedure yielded response rate changes that differed qualitatively with the type of reinforcer. All subjects in the two-key procedure initiated and maintained signal-key responses during Phase 2, and these responses occurred almost exclusively during the VI component (Figure 1). Upon return to baseline conditions in Phase 3, signal-key responding declined and disappeared for most birds.

Table 1
Number of Sessions in Each Phase of the Experiment

Group	Subject	Phase		
		1	2	3
F1	P1	39	10	15
	P2	29	10	17
	P3	29	10	34
	P4	25	14	20
F2	P5	31	14	21
	P6	26	13	44
	P7	30	18	11
	P8	36	15	24
W1	P9	26	14	18
	P10	27	12	15
	P11	32	11	19
	P12	28	10	31
W2	P13	43	12	25
	P14	29	18	10
	P15	45	18	32
	P16	28	15	13

Table 2
Mean Operant-Key Response Rates (and, in Parentheses, Signal-Key Response Rates) in the Last Five Sessions of Baseline
Phases 1 and 3 (Column A) and Phase 2 (Column B). Column C Shows Percentage Change in Phase 2 Relative to Baseline
Levels of Operant-Key Responding (and in Parentheses, Combined Operant- and Signal-Key Responding).
Also shown are Results of a t-Test for a Significant Difference Between A and B (Column D).

Group	Subject	Component Number	A	B	C	D
			Mean Responses Per Minute in Phases 1 & 3	Mean Responses Per Minute in Phase 2	Percentage Change in Response Rate [(B-A)/A] × 100%	t Ratio, 13 df, All ps < .05
F1	P1	1	71.6	165.0	+177	13.50
		2	70.7	30.6	- 57	
	P2	1	62.2	71.7	+ 15	2.49
		2	58.6	33.7	- 42	
	P3	1	65.1	99.8	+ 53	7.08
		2	52.9	23.1	- 56	
	P4	1	73.6	97.8	+ 33	4.08
		2	83.6	60.5	- 28	
	P5	1	102.6(0)	128.0(17.3)	+ 25(+ 42)	7.98(12.95)
		2	98.7(0)	32.2(0)	- 67(- 67)	
F2	P6	1	62.6(0)	76.5(11.8)	+ 22(+ 41)	2.77(5.26)
		2	62.6(0)	55.3(0)	- 12(- 12)	
	P7	1	83.0(0)	49.0(73.0)	- 41(+ 47)	3.98(4.41)
		2	82.6(1.4)	45.3(1.0)	- 45(- 45)	
	P8	1	38.9(0)	53.7(31.7)	+ 38(+120)	5.04(15.11)
		2	39.4(0)	28.9(0)	- 27(- 27)	
W1	P9	1	50.7	119.3	+135	12.40
		2	49.5	24.1	- 51	
	P10	1	115.7	251.9	+118	7.35
		2	123.3	93.8	- 24	
	P11	1	37.0	174.2	+371	14.03
		2	42.6	16.0	- 62	
	P12	1	70.6	216.3	+206	19.25
		2	71.5	44.6	- 38	
W2	P13	1	129.7(0)	55.7(12.6)	- 57(- 47)	13.15(10.15)
		2	131.2(0)	84.3(0)	- 36(- 36)	
	P14	1	117.0(0)	64.2(9.6)	- 45(- 37)	6.07(4.91)
		2	120.8(0)	47.9(0)	- 60(- 60)	
	P15	1	73.0(3.4)	58.6(39.9)	- 20(+ 29)	5.92(6.07)
		2	74.1(0)	18.3(0)	- 75(- 75)	
	P16	1	73.7(0.8)	49.2(12.5)	- 33(- 17)	4.10(2.20)
		2	70.3(0)	36.8(0)	- 48(- 48)	

When responses to the operant and signal keys were summed, all birds with food reinforcers (Group F2) showed positive contrast, whereas only one bird (P15) with water reinforcers (Group W2) showed contrast. Three of four subjects in Group W2 showed a decrease in overall responding during both VI and EXT components (negative induction). Furthermore, operant-key response rates considered alone showed the same general pattern of results. Three birds in Group F2 showed small contrast effects, while all birds in Group W2 showed negative induction of operant-key responding.

Thus, the overall results were considerably more complex than expected. Although the two-key procedure produced substantial contrast with food and

negative induction for most birds with water as the reinforcer (in keeping with the autoshaping hypothesis), contrast was not always attenuated or abolished with water. The largest contrast effects observed in the present experiment were for birds in the one-key procedure with water reinforcers (Group W1).

Response Topography

Observations of response forms over the course of the experiment revealed at least part of the basis for the present pattern of response rate changes. Early in Phase 1, response topographies clearly varied with the type of reinforcer. With food, key contacts were ballistic pecking motions. With water, key contacts were prolonged pushing movements of the beak on

the key (rooting) and rapid opening and closing of the mandibles (mumbling) during contact. These observations were consistent with those of previous investigations of the pigeon's food- and water-related key-contact topographies (Jenkins & Moore, 1973; Moore, 1973; Wolin, 1968; Woodruff et al., 1974).

Late in Phase 1, response topographies for all birds were quite similar. Rooting motions on the key gradually decreased in frequency and duration, and by the end of Phase 1, responses for birds in Groups W1 and W2 resembled weak pecks. Figure 2 shows a representative key-displacement recording for one bird in Group F1 and one bird in Group W1, made during the final session of Phase 1. Both topographies consisted of brief contacts with the key, although pecks for food were generally more forceful than those for water.

Response forms for birds with food reinforcers showed no change over the course of the experiment. In contrast, response forms for birds with water reinforcers showed striking changes in Phase 2. However, the nature of the change in form was not the same for birds in the two groups (Groups W1 and W2).

Key contacts changed from pecking to rooting and mumbling, as observed early in training, for birds in Group W1 during Phase 2. These subjects tended to maintain contact with the operant key (and/or the signal projected on the operant key) throughout VI components. During contacts, rapid mumbling motions operated the microswitch at extremely high rates. Figure 2 shows an example of this type of topography for a bird in Group W1. Upon return to

Figure 2. Representative key-displacement recordings showing the form of operant-key responses for P9 in Group W1 (top row) and P1 in Group F1 (bottom row). Each key-contact response produced an upward deflection of the recording pen proportional to the horizontal displacement of the key. The left column shows the topography of responses for water reinforcers (top) and food reinforcers (bottom) late in Phase 1. Responses for both reinforcers were brief pecks, although pecks for food were more forceful than those for water. The right column shows response topographies late in Phase 2. For P9 with water reinforcers, contacts changed to virtually continuous "rooting" motions, and "mumbling" motions of the mandibles produced the rapid, irregular pattern of displacement shown here. For P1 with food reinforcers, contacts were more frequent but did not change in form.

baseline conditions in Phase 3, all birds in Group W1 resumed pecking the operant key.

Key contacts did not change in form for birds in Group W2 during Phase 2. Indeed, both signal- and operant-key responses resembled weak pecks for these subjects. However, non-signal-directed bowing and rooting in the empty water magazine increased in frequency for three of four birds. Table 3 shows the mean rate of bowing, and the mean proportion of

Table 3
Mean Rate of "Bowing" and Proportion of Each Component with Head in Magazine ("Rooting") in the Last Five Sessions of Each Phase of the Experiment for Birds with Water as the Reinforcer

Group	Subject	Component Number	Bowing (Responses/Minute)			Rooting in Magazine (Proportion of Time in Each Component)		
			Phase			Phase		
			1	2	3	1	2	3
W1	P9	1	1.4	1.0	2.3	.05	.04	.01
		2	1.3	.9	2.1	.03	.02	.02
	P10	1	2.3	2.4	2.4	.00	.01	.01
		2	2.4	2.0	1.9	.01	.01	.01
	P11	1	.6	.8	3.6	.01	.01	.02
		2	1.1	1.5	2.4	.00	.01	.01
	P12	1	3.4	4.1	2.9	.04	.03	.01
		2	2.5	3.9	.9	.03	.01	.02
W2	P13	1	3.6	10.5	5.7	.04	.31	.10
		2	4.0	4.5	5.4	.04	.11	.09
	P14	1	1.6	3.1	2.5	.02	.25	.03
		2	2.2	4.1	1.8	.02	.22	.02
	P15	1	2.5	2.3	1.9	.02	.02	.02
		2	3.0	3.4	2.6	.03	.01	.00
	P16	2	1.2	14.7	3.7	.06	.12	.04
		2	1.6	3.8	3.7	.01	.11	.02

time spent rooting in the magazine during both components in the last five sessions of each phase. No subject in Groups F1 or F2 showed these responses, and systematic observation of these birds was terminated during Phase 2. Thus, no data are presented in Table 3 for birds with food reinforcers.

Table 3 shows that all birds receiving water reinforcers engaged in some bowing and rooting in the magazine throughout the experiment. Only P13, P14, and P16 in Group W2 showed substantial increases in these activities during Phase 2, however. Bowing increased in frequency for P13 and P16, and rooting in the magazine increased in duration for all three subjects. These three birds were also the only ones to show negative induction of overall VI responding during Phase 2 (Figure 1). Thus, non-signal-directed behavior apparently competed with key-directed responding to produce decreases in responding recorded by the keys. It should also be noted that increases in rooting were not always confined to periods in which the signal for VI was present (Table 3), as was the case for signal-directed responses (Table 2). Rooting in the magazine increased in duration during both EXT and VI components in Phase 2. Whether increases in this behavior were engendered by the signal for VI and generalized to the EXT component, or vice versa, cannot be determined from the present data.

DISCUSSION

The present experiment demonstrated an interaction between the type of reinforcer (food vs. water) and the position of localized discriminative stimuli (on vs. off the operandum) in determining response rate changes during mult VI EXT. When the stimuli were projected on the pigeons' operant key, positive contrast appeared for all subjects with either food or water as the reinforcer (Groups F1 and W1). The magnitude of response rate increases during the constant VI component tended to be larger with water than with food. When the stimuli were projected on a separate signal key, signal-key responding emerged and persisted during the constant VI component of a mult VI EXT schedule for all subjects (Groups F2 and W2). The sum of operant- and signal-key responses yielded positive contrast for all birds with food reinforcers, but negative induction for the majority of birds with water reinforcers. Thus, discriminative stimulus location produced little or no differential effect on overall response rate changes during mult VI EXT with food, a result in keeping with prior studies of one- and two-key procedures with food reinforcement (Keller, 1974; Schwartz, 1974). On the other hand, discriminative stimulus location determined the direction of response rate changes during the constant VI component with

water reinforcers. In the one-key procedure (Group W1), all birds showed positive contrast. In the two-key procedure (Group W2), one bird showed relatively weak contrast, whereas most birds showed negative induction.

Observations of response topographies during the experiment revealed that response rate changes for birds with water reinforcers were accompanied by striking shifts in response form. Subjects in Group W1 showed large increases in operant-key response rates during Phase 2 as pecking motions were supplanted by continuous key-contact responses (rooting). During prolonged contacts, mumbling on the key served to operate the microswitch at extremely high rates (see Figure 2). Previous observations and recordings of mumbling have found that this behavior occurs at about 7 responses/sec, with little between-subject variability (Woodruff, et al., 1974; Woodruff & Williams, 1976; Fenner, Note 2). Thus, the large increases in response rate for subjects in Group W1 may have been produced, at least in part, by the shift to a topography with a high natural frequency.

On the other hand, subjects in Group W2 exhibited large decreases in operant-key response rates during Phase 2, as behavior directed toward other locations in the chamber increased in frequency or duration. Weak pecking motions were directed toward the signal for VI, bowing motions were directed toward the floor, and rooting in the empty water magazine increased in duration for several subjects. In contrast to the results for birds in Group F2 with food, signal-key responding formed only a subset of the total elicited response output for birds in Group W2. For birds with appreciable increases in non-key-directed bowing and rooting in the magazine, overall levels of key-contact responding failed to show contrast.

These results support the autoshaping view of contrast by highlighting the importance of the role played by elicited behavior. Variables which affect the frequency (e.g., rate of reinforcement, component durations), direction (locus and modality of discriminative stimuli), and now, the variety of forms of elicited responding (type of reinforcer) must be taken into account by any general theory of the phenomenon.

Several aspects of the data for subjects in the two-key procedure seem inconsistent with the autoshaping view of contrast, however. All subjects in Groups F2 and W2 displayed substantial signal-key responding during the constant VI component in Phase 2, and signal-key response rates showed no marked differences between groups (Figure 1). At the same time, operant-key response rates showed positive contrast for three of four birds with food reinforcers, and negative induction for all birds with water reinforcers (see Figure 1 and Table 2). The locus of the difference in key-contact response rate changes between groups was found on the operant key, not the signal

key, contrary to expectations. The autoshaping view predicts either negative induction or perhaps no change in operant-key responding during mult VI EXT in the two-key procedure (Schwartz & Gamzu, 1977). Results for Group W2 conformed to this prediction but those for three birds in Group F2 did not.

The present operant-key contrast effects for birds in Group F2 join with other results which show that positive contrast may appear even when discriminative stimuli are diffuse and/or positioned at some distance from the operandum (Farthing, 1975; Gutman, 1977; Gutman, Sutterer, & Brush, 1975; Hearst & Gormley, 1976; Hemmes, 1973; Scull & Westbrook, 1973). At least two possible interpretations (not mutually incompatible) may be suggested. One, elicited responding may not be the sole source of all contrast effects (see Schwartz, 1978). Or the signal for VI may not be the only reinforcer-correlated stimulus which gains control of elicited responding during mult VI EXT. Several authors have speculated about the latter possibility (Gutman, 1977; Hearst & Gormley, 1976), and the suggestion finds support in the fact that a variety of elicited behavior was observed during mult VI EXT for subjects in Group W2. Not only the signal for VI, but also the site of reinforcer delivery, and perhaps the operandum, may attract elicited behavior when the signal for VI is present. In addition, some elicited behavior, such as "bowing" toward the floor by birds with water reinforcers, may be directed independently of the location of reinforcer-correlated stimuli (Craig, 1912; Woodruff, et al., 1974).

A complete understanding of the role of elicited behavior in the phenomenon of positive contrast must await further study of the means by which localized features of the environment come to release and/or direct reinforcer-related species-specific behavior patterns. A case in point is the dramatic difference in behavior observed in Phase 2 during the constant VI component between one- and two-key procedures with water as the reinforcer. When discriminative stimuli and operandum were coextensive (Group W1), virtually all responding was directed toward the signal/operandum configuration. When the stimuli were positioned on a second key (Group W2), responding was directed to a variety of locations (pecking toward the signal and operant keys, bowing toward the floor, rooting in the empty magazine). This effect of the stimulus configuration finds no obvious explanation in terms of associative factors in these procedures.

Other studies have reported different behavioral outcomes with food vs. water reinforcement (Boakes, Poli, Lockwood, & Goodall, 1978; Bolles & Petrinovich, 1956; Petrinovich & Bolles, 1954; Shettleworth, 1972), often in situations which involve withdrawal of reinforcers (e.g., delay of reward,

Logan & Spanier, 1970; the frustration effect, Levy & Seward, 1969; the partial reinforcement extinction effect, MacDonald & de Toledo, 1974). The present study adds positive behavioral contrast to the list. Previous investigators have suggested that different incentive values, frustration levels, or degrees of motivational arousal may account for the behavioral differences found with these reinforcers. Although such factors may have played some role in the present experiment, they do not seem to furnish an account for the overall pattern of results. For example, the magnitude of positive contrast has been shown to vary directly with magnitude of food reinforcers (Gonzalez & Champlin, 1974). Thus, if the incentive value of food exceeded that of water here, one might expect the difference in response rate changes between Groups F2 and W2. However, the generally larger contrast effects with water in Group W1 than with food in Group F1 would remain unexplained. An account of the present data based on frustration or motivational arousal meets with similar difficulty in explaining the overall food-water discrepancy. The present experiment suggests that further study of determinants of the form, direction, and variety of species-specific behavior which develops under different stimulus and reinforcement conditions may reveal the basis for this general phenomenon of behavioral differences in learning situations with food vs. water reinforcement (for further discussions see MacDonald & de Toledo, 1974; Reberg, Innis, Mann, & Eizenga, 1978; Shettleworth, 1972).

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