A failure to demonstrate behavioral contrast when the S+ and S- components of a discrimination schedule are separated by about 23 hours*

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In two operant discrimination learning experiments, pigeons' keypecks were reinforced in the presence of one stimulus (S+) on certain days and nonreinforced in the presence of another stimulus (S-) on other days. In neither experiment did responding in the presence of S+ reach a higher rate than occurred when only S+ was presented. Hence, behavioral contrast was not demonstrated. Thus, when S+ and S- are temporally separated, the conditions required for contrast seem much more restricted in scope than when no interval separates S+ and S-.

In discrimination training, responding is reinforced in the presence of one stimulus (S+) and not reinforced in the presence of another (S-). With the S+ and S- presentations in discrimination training being separated by about 23 h, Bloomfield (1967) investigated behavioral contrast (Reynolds, 1961). Three birds pecked at a red key on a variable-interval 1-min (VI 1-min) schedule for 20 days. Forty days of discrimination training then followed. On alternate days, the conditions were the same as in nondiscrimination training—a red keylight correlated with a VI schedule. On the intervening days, the response key was green and no reinforcements were available (extinction). Under these conditions, the pecking rate to the red key (S+) became higher than in nondiscrimination training, demonstrating contrast. The present paper reports some unsuccessful attempts to obtain contrast under conditions similar to Bloomfield's.

EXPERIMENT 1

After reaching stable response rates on a VI schedule, 11 birds were trained on a discrimination schedule in which the S+ and S- components were separated by about 23 h.

Subjects

Eleven adult homing pigeons, locally obtained and experimentally naive at the outset of training, were maintained at about 80% of their free feeding weights.

Apparatus

A standard operant conditioning chamber contained a 19-mm-diam (0.75-in.-diam) response key which could be illuminated from behind by a

dim red light, a bright red light, or a green light. Reinforcement consisted of a 4-sec exposure to a grain magazine centered below the response key.

Sessions were programmed through apparatus contained in an adjoining room.

Procedure

A bird was trained under one of four conditions, A, B, C, or D, differing in the respects mentioned below. Different birds were run at different periods of time in the course of about 1 year. The periods were not systematically related to the training conditions.

After auto keypeck training (Brown & Jenkins, 1968), daily sessions of a VI 1-min schedule were programmed, with the response key being bright red. In Condition A, the houselights were off throughout the experiment. In Conditions B, C, and D, the houselights were always on. The 30-min session began with appropriate illumination (keylight or keylight plus houselights) after 4 min had passed since the placement of a bird in the box.¹

Upon reaching a steady baseline

Fig. 1. Rate of responding as a function of number of sessions. Filled circles indicate sessional rates; open circles indicate rates in the first 10 min.

*This research was supported by a grant from the University of Texas Graduate School under the NSF Graduate Fellowship Program. Reprints may be obtained from R. N. Wilton, Dept. of Psychology, University of Texas, Austin, Tex. 78712.

Table 1
Group Mean Rates of Responding (to the Nearest Response Per Minute) in the First 8 Min of Each S+ Session*

Session	Group			
	D30	D90	C1	C2
1	26	25	35	34
2	28	26	33	37
3	41	42	48	45
4	43	47	51	44
5	42	47	49	44
6	45	41	59	49
8	47	52	52	56
10	50	66	64	59
12	51	61	59	59
13	44	57	54	51
16	53	66	52	57
17	38	61	55	58
19	46	56	57	53
22	59	64	63	56
24	55	51	60	54
26	58	71	65	56
27	55	51	58	66
30	53	63	47	45
31	61	68	52	55
32	55	62	69	60
36	59	72	70	63
39	63	65	67	66
41	61	67	66	63
43	64	69	66	60
45	61	67	67	67

*Discrimination training starts after Day 6.

response rate, a bird was shifted to 30 sessions of discrimination training. On alternate days conditions were as before, a VI 1-min schedule being correlated with a bright red keylight (S+). On intervening days the schedule was extinction, with the keylight (S-) being other than bright red. In Condition A the keylight (S-) was dim red. In Conditions B, C, and D it was green. In Conditions A and B, an S- session lasted 30 min. In Condition C it lasted 60 min, and in Condition D it lasted 10 min. The duration of an S+ session remained at 30 min. For each session, the total number of responses was recorded, and in Conditions C and D, the responses emitted in the first 10 min were separately recorded.

Results

For each bird, the filled circles in Fig. 1 show response rates over the last 15 baseline sessions and the S+ sessions of discrimination training. There is little indication of higher rates occurring in discrimination training.

Bloomfield obtained greatest contrast in the early portions of a session, and his response rates declined over a session. Neither of these effects occurred in the present study; this is shown by examination of the open circles, which represent response rates in the first 10 min of a session.

Figure 1 also shows the total number of responses emitted to S-. Almost every bird responded to S- more frequently than would be

expected following errorless training, and, generally, more responses were emitted than the minimum associated with contrast in Terrace's (1963) experiments. Hence, the absence of contrast can probably not be explained by subsuming the formed discriminations under the classification "errorless." Nevertheless, the emission of so few responses to S- constituted one reason for running a second experiment.

EXPERIMENT 2

Four groups of birds were used. Following preliminary training to respond to a vertical white line, two of the groups received discrimination training, with S+ and S- sessions being separated by about 23 h. The S+ for both groups was a vertical white line illuminating the response key. The S- for one group was a line 30 deg from the vertical; for the other group it was a line 90 deg from the vertical. Two discrimination groups were run to maximize the probability of obtaining a "typical" discrimination—one in which there are more responses to S- than in Experiment 1, but also one in which responding to S+ and S- becomes differentiated.

The two other groups received no discrimination training. One group responded to S+ every day; the other responded to S+ on the same days as the discrimination groups, receiving no training on the other days. The two nondiscrimination groups were used for controls. It was felt that if a particular discrimination training condition was conducive to the production of contrast, this would be indicated by the occurrence of a higher rate of responding in that group than in one of the nondiscrimination groups. If this had happened, further experimentation, with the appropriate discriminative stimuli, would have followed. But, as it did not, experimentation went no further.

Subjects

Twenty-four adult homing pigeons, locally obtained and experimentally naive at the outset of training, were maintained at about 80% of their free feeding weights.

Apparatus

Two operant conditioning chambers similar to the one used in Experiment 1 were used. White line angles of about 3 mm width could be projected on the keys.

Procedure

The birds were divided randomly into four groups of six birds each. Three birds in each group were run in each box. Each bird was autottrained (Brown & Jenkins, 1968) to peck at the response key when a vertical white line was projected on it. Two days of training on a VI 15-sec schedule and 2 days of training on a VI 30-sec

schedule followed. Six days of training on a VI 1-min schedule followed this. The groups were then scheduled differently. For Groups D30 and D90 a session consisted sometimes of a VI 1-min schedule correlated with a vertical line (S+) and sometimes of extinction correlated with another line (S-). The angle of the line correlated with extinction was 30 deg for Group D30 and 90 deg (horizontal) for Group D90. Groups C1 and C2 were trained under the S+ conditions of the discrimination groups. Group C1 ran every day. Group C2 ran only on those days in which the discrimination groups were run on the S+ schedule. On the other days, they remained in their home cages and were fed an amount sufficient to make their weights comparable to those of the birds in the other groups. Throughout the experiment the duration of a session was 24 min, and a session was initiated 5 min after a bird was placed in a chamber. Forty discrimination training sessions were given. For the most part, S+ and S- sessions alternated from day to day, but occasionally up to three S+ and S- sessions were given in succession. The ordering of the sessions is indicated in Table 1 of the results section.

Results

Mean response rates were calculated separately for a complete session and for its first 8 min. Table 1 shows the mean rates for each group over the first 8 min of each S+ session; data are provided from this time period because Bloomfield's data showed that contrast appears most strongly in the earlier portions of a session. (In the present study, the rates for the session were very similar to those for the first 8 min.) At no point in training are the response rates of either discrimination group appreciably higher than those of either control group. [Table 1 shows that at the beginning of the experiment, the control groups respond at a higher rate, but this effect largely disappears before the onset of discrimination training (Session 7).]

Figure 2 shows response rates in each 8-min portion of a session, averaged over the last five S+ sessions. Over the course of the session, changes in response rates differ little between the groups. In particular, the rates of the discrimination groups do not differentially decline during the session. Indeed, they show little, if any, absolute decline. (Note the ordinate scale.) Hence, the data yield the same picture as the data from the first experiment. Analysis of variance on the data summarized in Fig. 2 supports the above conclusions. Neither the main effect of groups ($F = .36$, $df = 3$ and 20) nor the interaction of Groups by Portions of

the Session ($F = 1.23$, $df = 6$ and 40) is significant. The main effect of portions of the session is also insignificant ($F = 2.00$, $df = 2$ and 40).

The birds in Group D90 emitted a mean total of 2,051 responses to S—, while the birds in Group D30 emitted 5,227 responses to S—. Generally, the birds in both discrimination groups emitted more responses to S— than the birds in Experiment 1.

DISCUSSION

When only a very short interval separates S+ and S—, behavioral contrast is very easy to demonstrate (e.g., see Terrace, 1966). Almost every bird shows contrast, and in our laboratory it is not unusual for response rates to S+ to be almost double those obtained in baseline training. Nevin & Shettleworth (1966), Terrace (1966), and Wilton & Clements (1971) showed that contrast increases when S+ is immediately preceded by S—. And Pliskoff (1963) and Wilton & Gray (1969) showed that contrast increases when S+ is consistently and immediately followed by (signals) S—. If these adjacency effects depend on temporal parameters, as seems reasonable to suppose, then smaller contrast might be expected when a large interval separates S+ and S— presentations. Bloomfield comments that the contrast in his 23-h study was smaller than the contrast he usually obtained when no interval separated S+ and S—. Bower (1966, p. 516) also reports that contrast can occur when S+ and S— are temporally separated. However, he gives no details concerning his procedure or the magnitude of the effect.

Our conclusion from the experiments presented here is that contrast is very much less readily demonstrated when S+ and S— presentations are temporally separated. No indication of contrast was obtained, and it seems clear that the conditions required for its demonstration are much more restricted in scope than those required when S+ and S— follow each other

Fig. 2. Mean rates of responding in each 8-min period of an S+ session, averaged over the last five S+ sessions.

with no intervening interval (cf. Amsel, 1971; Scull, Davies, & Amsel, 1970). What these conditions are is not at all obvious. Perhaps the parameters of reinforcement magnitude and/or the duration of an S— session are important. Bloomfield used a reinforcer of very small magnitude and S— sessions which lasted for 1 h each. None of our birds were trained with a very small magnitude of reward, and only three were trained with a duration of an S— presentation as great as 1 h (Experiment 1).

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NOTE

1. Bloomfield also began his sessions in this way (personal communication).