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The effects of a novel stimulus change on responding in extinction following fixed-ratio training

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The present study assessed the effects of a brief stimulus change not paired with food on the pattern of responding in extinction following fixed-ratio (FR) training. Four pigeons were trained to respond on a FR 100 schedule of food reinforcement. Two of these subjects were then exposed to four extinction sessions in which only this novel stimulus change followed completion of each FR 100. The other two pigeons were exposed to six extinction sessions with the unpaired stimulus change following completion of each FR 100 in odd-numbered extinction sessions. In even-numbered sessions, the stimulus change did not occur. A minimum of five retraining sessions occurred between extinction sessions. The results showed that the unpaired stimulus change controlled the location of pausing. Of the total number of pauses recorded during extinction, a greater proportion of these followed FR 100 schedules with stimulus change than without stimulus change. Consideration is given to the properties of the stimulus change responsible for these pause patterns.

Experiments using conditioned reinforcement techniques have frequently presented brief stimulus changes which are paired with food. The pattern of responding generated by these brief stimulus changes, as well as increases in response rate, have been taken as evidence that the stimuli are conditioned reinforcers. For example, Kelleher (1966) studied second-order schedules in which a white key light was presented briefly following the completion of a fixed-interval (FI) component. Food was delivered following a fixed ratio (FR) of these stimulus changes. Responding generally was positively accelerated within each interval only if a stimulus change paired with food delivery occurred at the completion of each FI component. However, other studies with second-order schedules (Stubbs, 1971; Stubbs & Cohen, 1972) and with percentage reinforcement (Ferster & Skinner, 1957; Neuringer & Chung, 1967) have found either schedule patterning with unpaired stimuli or no difference in patterning with paired or unpaired stimuli. Similarly, even though a paired stimulus change produces appropriate schedule patterning, the stimulus change may not produce more responses in extinction when compared with extinction sessions without a stimulus change (Weissman & Crossman, 1966). Taken together, these results question the pairing hypothesis of conditioned reinforcement.

A difficulty with studies which have compared paired and unpaired stimuli is that food and the unpaired stimuli occur in the same session. Thus, a relationship between food delivery and the unpaired stimuli could exist. One way to avoid this difficulty is to present the unpaired stimulus only in those sessions in which food is not delivered, hence the term "novel." The purpose of the present study was to examine the effects of this novel unpaired stimulus on response patterning in extinction following FR training.

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METHOD

Subjects

Four experimentally naive White King pigeons served. Their age and sex were undetermined. Water was available in the home cage.

Apparatus

Two identical three-key pigeon chambers were used. The front panel was covered during experimental sessions by a paper mask such that only the center key, the food hopper located 10.5 cm directly below the key, and two panel lights (G.E. 1820), which provided illumination during experimental sessions, were exposed. Reinforcement consisted of 3.5 sec access (3 sec for Bird K-12) to an illuminated hopper containing Purina Racing Checkers. White noise was present in the room at all times to mask extraneous sounds. The experiment was controlled and data were recorded by electromechanical equipment housed in an adjacent room.

Procedure

All subjects were maintained at approximately 80% free-feeding weight and shaped to peck a red key. The number of responses required for reinforcement was gradually increased until performance on a FR 100 schedule was established. A relay click followed each response during training sessions except during food delivery. Training remained in effect until the behavior was stable, as determined by visual inspection of cumulative records. During all sessions, subjects were placed in and removed from the test chamber when the key and panel lights were illuminated. The lights remained illuminated at all times except as noted below. Session length during FR 100 session was approximately 100 reinforcers.

Sixty-minute extinction sessions followed training on the FR 100 schedule. During these extinction sessions, each completion of 100 responses was followed by a 3.5-sec cycle (3 sec for K-12), the duration of the food cycle during training. During this cycle, responses did not produce a click from the feedback relay. During some extinction sessions, the response key was darkened during the 3.5-sec cycle. For Subjects K-9 and K-12, a total of four extinction sessions were conducted, with the novel stimulus change following each 100 responses. For Subjects K-17 and K-18, six extinction sessions occurred, with the stimulus change programmed only for the first, third, and fifth of the six sessions. During the other sessions, no stimulus change occurred and the key and panel lights remained illuminated at all times. A minimum of five retraining sessions occurred between each of the extinction sessions for all subjects. The conditions during retraining were the same as those in training.

RESULTS

In extinction, the birds generally ceased responding when the key was darkened after FR 100. Examination of cumulative records showed that, in the stimulus-change extinction sessions, the pause which began at the onset of the stimulus change often continued after the red key light was again illuminated. In extinction sessions without the stimulus change, pauses rarely followed the completion of each 100 responses, but instead occurred at other locations in the ratio.

The relationship between the location of pauses and the type of extinction session is shown in Table 1. In this table, the proportion and percentage of pauses after the 3.5-sec cycle to the total number of pauses is shown for each extinction session for each subject. Pauses were measured from cumulative records and a pause was arbitrarily defined as a period of 10 sec or more without a response. The 3.5-sec stimulus-change cycle was excluded from the 10-sec period for both stimulus-change and no-stimulus-change extinction sessions. Table 1 shows that a greater percentage of pauses generally followed the 3.5-sec stimulus-change cycle during stimulus-change sessions than during no-stimulus-change sessions. The only exception to this relationship occurred for Subject K-18 in Session 1, a stimulus-change session, in which a smaller percentage of pauses followed the completion of 100 responses than occurred in Session 6, a session without stimulus changes. No consistent difference in the total number of pauses is evident between the two types of sessions.

Table 1 also shows the number of responses made during each extinction session. Responses during the 3.5-sec cycle were excluded from these totals. In general, there were more responses during no-stimulus-change sessions than during stimulus-change sessions. There were no systematic changes in responding for Subjects K-9 and K-12 across extinction sessions. However, both Subjects K-17 and K-18 emitted more responses in Session 3 than in Session 1, both stimulus-change sessions. This increase did not occur for Subjects K-9 and K-12 where only stimulus-change sessions occurred.

Table 1
Number of Responses for Each Extinction Session and the Proportion and Percentage of Pauses After the Stimulus-Change Cycle Relative to the Total Number of Pauses

Subject	Session	Responses	Proportion of Pauses	Percent of Pauses
K-9	SC	3297	14/29	48.3
	SC	1500	6/14	42.8
	SC	3000	11/28	39.3
	SC	1354	5/16	31.2
K-12	SC	2175	7/36	19.4
	SC	2642	3/11	27.3
	SC	918	3/12	25.0
	SC	1330	5/11	45.4
K-17	SC	495	1/6	16.7
	NSC	5678	2/24	8.3
	SC	3142	13/34	38.2
	NSC	1263	0/9	0.0
	SC	545	1/5	20.0
	NSC	762	0/7	0.0
K-18	SC	1357	2/13	15.4
	NSC	5103	0/8	0.0
	SC	3385	6/11	54.5
	NSC	697	0/2	0.0
	SC	1800	5/7	71.4
	NSC	4943	1/6	16.7

Note–SC = stimulus change, NSC = no stimulus change. Sessions are listed in the order of their occurrence.

DISCUSSION

The present study examined the effects of a novel, unpaired stimulus change on responding in extinction following FR training. The primary finding was that pauses followed 100 responses (FR pause-and-run patterning) in the stimulus-change condition, but not in the absence of the stimulus change. These results indicate that a stimulus change need not be paired with food to produce appropriate schedule patterning. One explanation for the control of pausing by the stimulus change is "that the ability of a stimulus to produce sequences like those occurring with food depends on the power of the stimulus to disrupt behavior" (Zeiler, 1972, p. 187). Since the subjects did not peck the darkened key, the pause after the stimulus change may have resulted from the disruption of responding by the stimulus change.

An alternative explanation is that the stimulus change may have produced pauses by signaling the absence of reinforcement. This explanation has been advanced by Stubbs (1971) to account for patterning in second-order schedules. However, if pausing was controlled by the signaled absence of reinforcement in the present experiment, it is surprising that the subjects continued to respond when responding produced this consequence. In fact, since the stimulus change occurred only during extinction sessions, the stimulus change should signal the ab-

sence of reinforcement for the entire session, not just immediately after the stimulus change. Evidence for a discrimination of extinction sessions based on the stimulus change is provided by the fact that more total responses occurred in the three no-stimulus-change extinction sessions than in the three stimulus-change extinction sessions for Subject K-17 and K-18. However, responding did not decrease systematically over repeated stimulus-change extinction sessions for any subject. A failure to find a decrease in responding over repeated extinctions has been reported previously (Anger & Anger, 1976) but is particularly surprising in the present study, where a stimulus change occurred only during extinction sessions. Since such a decrease might be expected based on discriminative functions of the stimulus, it is unlikely that pausing resulted solely from the discriminative function of the stimulus change.

These findings suggest that when precautions are taken to separate an unpaired stimulus change from food delivery by not presenting the two events in the same session, it is still possible to produce a pattern of behavior which resembles the pattern obtained in training. In many cases, appropriate schedule patterning may depend, not on a pairing operation, but on the properties of the stimulus itself. Thus, the findings may help explain discrepant results in second-order schedule research. As Zeiler (1972, p. 187) has suggested, what may be necessary for a sequence of "behavior to operate as a unitary response is that the completion of each sequence be demarcated by an event that effectively terminates the sequence." Whether this demarcation derives from the disruptive or the discriminative properties of the stimulus change is a question that requires additional research.

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