Delayed stimulus control of behavior¹

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Behavior in the terminal component of a two-component chained schedule of reinforcement was shown to be controlled by the exteroceptive stimulus associated with the initial component of the schedule as well as by stimuli generated by the S's own behavior.

The present paper presents a paradigm for investigating behavior under delayed stimulus control. Recent procedures for investigating the control of behavior by preceding stimuli have usually involved some form of delayed matching tasks (e.g., Blough, 1959; Cumming & Berryman, 1965; Pliskoff & Goldiamond, 1966). The present technique attempted to control behavior in the terminal components of a chained schedule of reinforcement by stimuli associated with the early components of the chained schedule.

Method

The Ss were three adult male homing pigeons maintained at approximately 80% of their ad lib body weights. The experimental space was a single-key pigeon chamber similar in design to that described by Ferster & Skinner (1957). Programming was accomplished automatically by a system of switching relays and timers. Data were recorded on a cumulative response recorder.

The Ss performed on a two-member multiple schedule of reinforcement. One member consisted of a two-component chained schedule, chain (fixed ratio) (fixed ratio). The first component of the chained schedule was such that in the presence of a red key light, the 50th response produced a green key light, which was associated with the second component. In the presence of the green key light the 80th response produced food reinforcement. The schedule is technically chain FR 50 FR 80. The other member of the multiple schedule also consisted of a two-component chained schedule, chain (fixed ratio) (differential reinforcement of low rate). In the presence of a white key light which was associated with the first component, the 50th response produced a green key light. In the presence of the green key light, which was associated with the second component, the first response after a 6-sec period of no responding produced food reinforcement. The schedule is technically chain FR 50 DRL 6. Thus, the exteroceptive stimuli associated with the first components of the two chained schedules were different (red or white key lights) while the response requirements of the first components (FR 50) were identical. The exteroceptive stimuli associated with the second components of the two chained schedules were identical (green key light)

while the response requirements of the second components were different (FR 80 or DRL 6). The two chained schedules alternated unsystematically during a session such that each schedule appeared approximately half the session.

Daily experimental sessions lasted for two hours or 50 reinforcements, whichever occurred first. Reinforcements consisted of a 4-sec presentation of the grain tray. During reinforcements, the key light and the house light were off and the grain was illuminated by the magazine light. A blackout period, during which all lights in the chamber were off, preceded and followed each session. The Ss were run on the procedure for 64 to 72 sessions.

Results and Discussion

Behavior in the terminal components of the chained schedules was under the control of two sources of stimuli. Behavior in the terminal components was controlled by the stimuli associated with the first chain component and by the stimuli associated with the Ss' own behavior. Presented in Fig. 1 are selected segments of cumulative records for one S showing the types of behavior observed during the terminal steady state performances. In Fig. 1A are performances on the chain FR DRL schedule which show control over the terminal component behavior by the preceding first component stimulus. In the records of Fig. 1A, the high response rates of the first component change rapidly to the appropriate DRL rate with the onset of the second component stimulus. In Fig. 1B are examples of performances on the chain FR DRL schedule where the first component stimulus does not appropriately control behavior in the terminal component. In these examples, following intermediate rates, the S produces ratio-like runs of responses in the terminal component that are appropriate to the other chained schedule with a ratio requirement in the terminal component. The runs then eventually change to the DRL rates. When the chain FR DRL schedule was presented, the type of performances presented in Fig. 1A occurred about 80% of the time and the type of performances presented in Fig. 1B occurred about 20% of the time.

Presented in Fig. 1C are performances on the chain FR FR schedule which show control over the behavior in the terminal component by the stimulus associated with the preceding first component. The high response rates, appropriate to the FR 80 schedule, appear immediately with the onset of the terminal component stimulus. Pre-ratio pauses rarely occurred in the terminal components. Figure 1D shows per-

Fig. 1. Selected cumulative response records showing performances on the two-component chained schedules. Pips indicate the completion of the first component and the recording pen resets each time a food reinforcement occurs. A and B show performances on the chain FR 50 DRL 6 schedule and C and D show performances on the chain FR 50 FR 80 schedule.

performances on the chain FR FR schedule in which behavior in the terminal FR component is not appropriately controlled by the first component stimulus. In these records, lower response rates persist for some time following the onset of the terminal FR component stimulus and then are followed by a change to the ratio behavior. The type of performances shown in Fig. 1C occurred about 20% of the time when the chain FR FR schedule was presented and the type of performances shown in Fig. 1D occurred about 80% of the time.

When the two chained schedules were compared to identical response requirement two-component tandem schedules, during which a single exteroceptive stimulus was present during both components, the terminal component performances seen in Fig. 1, A and C, almost never occurred. The performances shown in these records appear to be directly under the exteroceptive stimulus control of the previous chain component stimulus. The type of performances observed with the tandem schedules were more like those terminal component performances shown in Fig. 1, B and D. The terminal component performances presented in Fig. 1, B and D, are typical of mixed schedule performance (Ferster & Skinner, 1957) and presumably

represent control over responding by the stimuli generated by the organism's own behavior.

All three Ss showed a bias toward initially emitting intermediate response rates in the terminal components. The bias was not simply due to a pre-ratio type pause at the beginning of the terminal components as such pauses rarely occurred. The low rate bias was probably related to the relatively high reinforcement frequency associated with the DRL 6 schedule compared to the FR 80 schedule.

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