

Maintenance of fixed-interval responding by conditioned reinforcement in multiple schedules

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Responding was maintained on small fixed-interval schedules by briefly presented stimuli in a multiple-schedule component that provided for no unconditioned reinforcement. The brief stimuli were paired with unconditioned reinforcement in another component of the multiple schedule.

Recent research on positive conditioned reinforcement has shown that brief stimulus presentations that are intermittently associated with unconditioned reinforcement can maintain behavior for considerable time periods in the complete absence of unconditioned reinforcement (Thomas, 1969; Zimmerman & Hanford, 1967). Thomas demonstrated that responding during small fixed-ratio schedules could be maintained by conditioned reinforcement in a multiple-schedule component that provided for no unconditioned reinforcement. The conditioned reinforcing stimulus was intermittently associated with the unconditioned reinforcer in another component of the multiple schedule. The present experiment extends these results to behavior maintained by small fixed-interval schedules of reinforcement.

METHOD

The Ss were two adult male White Carneaux pigeons maintained at approximately 80% of their free-feeding body weights. The experimental space was a standard pigeon chamber with a single response key available. Programming and recording were accomplished automatically by solid-state programming equipment.

The Ss initially performed on a multiple fixed-interval fixed-interval schedule. In the presence of a red key light, a fixed-interval (FI) 30-sec schedule was in effect. The first response to occur after 30 sec changed the key light from red to flashing white for 0.7 sec. A tone was also introduced through a speaker in the chamber for the 0.7 sec. Following the 0.7 sec of the flashing white key light and tone, there was a 4-sec presentation of mixed grain in the food tray. The houselight was turned off and the grain was illuminated by the feeder light during the 4-sec reinforcement presentation. The

flashing white key light and tone remained on during the 4-sec reinforcement period. In the presence of a green key light, a second FI 30-sec schedule was in effect. In this component of the multiple schedule, the first response to occur after each 30-sec period produced only the 0.7 sec of the flashing white key light and tone but never produced grain reinforcement. The two FI components each lasted for 3.5 min, and a 3.5-min time-out condition, during which all the lights in the experimental chamber were off and responses had no programmed consequences, occurred between the two alternating components. The time out was employed between the two FI components to insure that responding during the brief stimulus component would not be maintained by the production of the FI component associated with grain reinforcement (cf. Thomas, 1969).

Following 50 sessions on the above procedure, the grain reinforcement schedule was increased from FI 30 to FI 90 sec. After stable baselines were obtained, the time-out condition was removed from the procedure for 10 sessions and then returned. A number of experimental manipulations were then performed to elucidate the stimulus functions of the flashing white key light and tone. The FI schedule on which only the brief 0.7-sec stimuli could be produced was reduced from FI 30 to FI 5 sec. The grain reinforcement schedule remained at FI 90 sec. After a number of sessions on the multiple FI 90 sec FI 5 sec, the brief stimulus presentations were removed from the FI 5 sec component so that a multiple FI 90-sec extinction was in effect. Responses in the presence of the green key light had no programmed consequences. The FI 5-sec schedule was then reinstated in the multiple schedule. Following a number of sessions on the reinstated baseline, the flashing white key light and tone were removed from the grain reinforcement component only. The brief 0.7-sec stimuli were still produced on the FI 5-sec schedule in the presence of the green key light, but these brief stimuli were no longer paired with grain reinforcement in the presence of the red key light. After this condition, the brief stimuli were again paired with grain reinforcement on the FI 90-sec schedule as before.

For all experimental conditions, a session lasted for 50 grain reinforcements.

The Ss were exposed to a particular procedure until the daily response rates showed no systematic trends.

RESULTS AND DISCUSSION

The general findings were that responding could be maintained on the small FI schedules by the brief stimulus presentations in the component of the multiple schedule that was not associated with grain reinforcement. The maintained responding, however, was generally weak and variable and rarely gave any indication of FI response patterns.

Figure 1 shows response rates of the two Ss in both FI components of the multiple schedule for all of the experimental conditions. The upper half of Fig. 1 shows response rates in the FI component associated with unconditioned reinforcement (UCR) and the lower half shows response rates associated with brief stimulus presentations (conditioned reinforcement—CR). Each point is the mean of the last five sessions on each condition. Figure 2A shows a cumulative response record of one S from a portion of a session on the multiple FI 30-sec FI 30-sec schedule. Excursions of the recording pen while the bottom event pen is up indicate responding during the red key light (grain reinforcement schedule); excursions while the event pen is down indicate responding during the green key light (brief stimulus schedule). Pips of the recording pen indicate grain reinforcements while the event pen is up and brief stimulus presentations while the event pen is down. The recording pen reset to baseline each time a FI component ended. The recorder motor did not operate during the time outs between the two FI components. Figure 2A shows that the responding on the FI 30-sec schedule of grain reinforcement exhibited FI response patterns appropriate to a small FI schedule (cf. Ferster & Skinner, 1957). The maintained responding on the brief

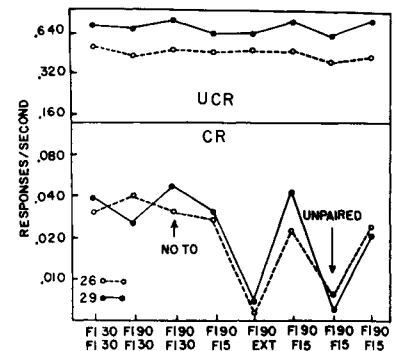


Fig. 1. Response rates of both Ss 26 and 29 on the two fixed-interval components for all experimental conditions. Note log response-rate scale.

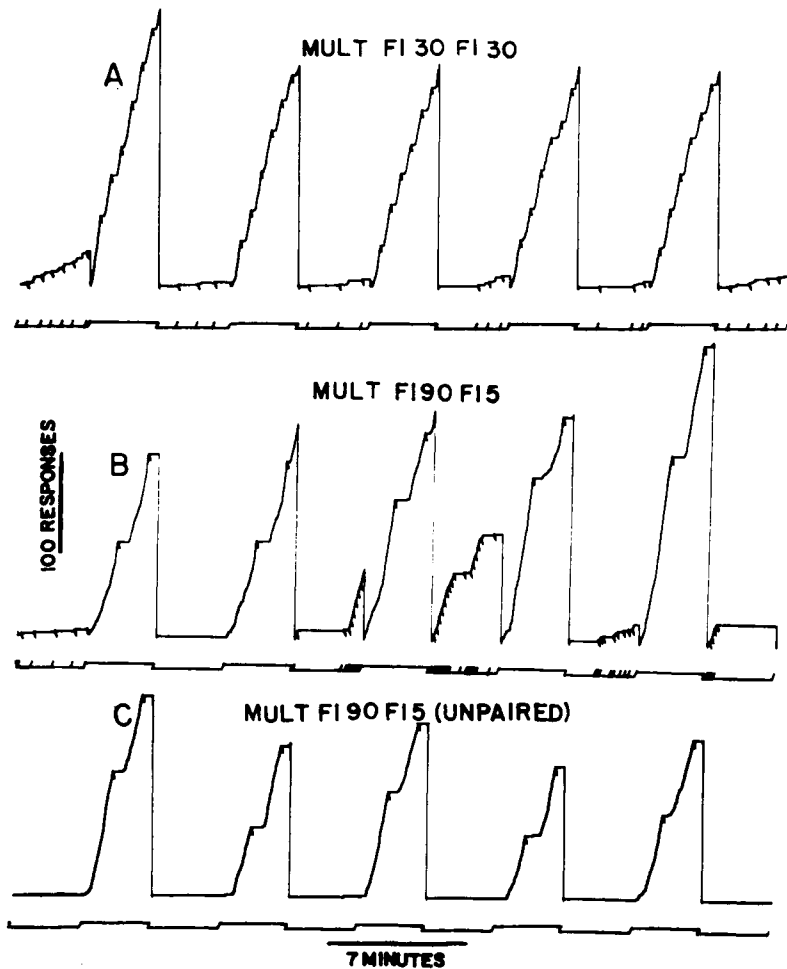


Fig. 2. Cumulative response records of one S on (A) multiple FI 30 sec FI 30 sec, (B) multiple FI 90 sec FI 5 sec, and (C) multiple FI 90 sec FI 5 sec when the brief stimuli were not paired with unconditioned reinforcement.

instituted to insure that responding during the brief stimulus component would not be maintained by the stimulus associated with the grain reinforcement component and to weaken any possible role of chaining maintaining performance. Although removal of the time out (Fig. 1) resulted in an increased response rate in only one animal, the time out was retained for all succeeding conditions with both animals. It is still possible that chaining occurred, which may explain why in the extinction and nonpairing conditions response rate never fell to zero for the component not directly associated with grain reinforcement.

The results of this study are similar to those of Thomas (1969) with fixed-ratio schedules. The decline of responding during the extinction condition indicates that responding was maintained during the green key light component by brief stimulus presentations, which apparently functioned as effective positive conditioned reinforcers. The decline of responding when the stimuli were not paired with unconditioned reinforcement indicates that the conditioned reinforcing function of the stimuli is related to the association of the stimuli with unconditioned reinforcement. The present experiments show that conditioned reinforcing stimuli can maintain responding on fixed-interval schedules over extended time periods in the absence of direct association with unconditioned reinforcement.

stimulus schedule was very low and extremely variable. The variability was very characteristic of responding on the brief stimulus schedule. There was no indication of any FI response pattern in the brief stimulus component; that is, there was no positively accelerated responding (scalping) typically generated by FI schedules of unconditioned reinforcement. The lack of FI pattern of responding when responding is maintained only by conditioned reinforcement has been reported by Zimmerman & Hanford (1966).

Figure 2B shows performance on the multiple FI 90-sec FI 5-sec schedule. The behavior during the brief stimulus component was extremely erratic and occasionally did not occur during a 3.5-min period. When it did occur, responding was often very rapid, alternating with periods of no responding. Several manipulations were made in order to determine the significant variables in the maintenance of responding by conditioned reinforcement.

When responses during the green key light produced no brief stimulus presentations (extinction), responding declined and was almost completely absent during that component (Fig. 1). Responding returned to its former level when the brief stimulus presentations were reinstated. When the brief stimuli were still produced on the FI 5-sec schedule but were not paired with grain reinforcement on the FI 90-sec schedule, responding declined during the brief stimulus component. A segment of a session showing performance on the multiple schedule when the brief stimuli were not paired with unconditioned reinforcement is presented in Fig. 2C. Again, responding during the brief stimulus component returned to its former level when the stimuli were again paired with reinforcement (Fig. 1). There were no major or systematic changes in the maintained behavior when the grain reinforcement schedule was increased to FI 90 sec or when the time out was removed (Fig. 1). The time out was

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