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RESPONDING IN THE SQUIRREL MONKEY UNDER SECOND-ORDER SCHEDULES OF SHOCK DELIVERY[1]

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Lever-pressing responses were maintained in the squirrel monkey when the only consequence of responding was the delivery of a response-produced electric shock, or alternatively, a brief visual stimulus that was occasionally followed by an electric shock. When shock was produced by the first response occurring after 8 min (8-min fixed-interval schedule), a period of no responding at the beginning of the interval was followed by a gradual increase in response rate during the interval. Similar rates and patterns of responding were maintained when a 1-sec visual stimulus was produced by the first response occurring after 8 min and shock delivery followed the brief stimulus. Subsequently, patterns of positively accelerated responding were engendered during individual fixed-interval components when the first response occurring after 4 min produced a 1-sec visual stimulus and shock delivery followed the second, and later the fourth, presentation of the 1-sec stimulus. When the duration of the brief stimulus was varied over a 100-fold range from 0.1 to 10.0 sec (1) mean response rates decreased monotonically as stimulus duration increased, and (2) patterns of positively accelerated responding were least variable and response rates during the initial part of each 4-min interval were lowest at a stimulus duration of 1 sec.

The same type of event can enhance and maintain responding, or suppress responding, depending on the conditions and schedules under which it occurs (Morse and Kelleher, 1970). The presentation of food to a food-deprived subject, for example, can enhance and maintain responding under a variety of schedules and circumstances (*cf.,* Ferster and Skinner, 1957); yet Azrin and Hake (1969) have shown that under some conditions food presentation can also suppress responding. Traditionally, the delivery of electric shock has been stereotyped as an event that suppresses responding when shock delivery is response dependent, and that maintains responding when shock postponement or shock termination is response dependent (Azrin and Holz, 1966; Kimble, 1961; Sidman, 1953, 1966). Recent reports have shown, however, that in subjects trained according to certain procedures the delivery of response-dependent electric shock, like the presentation of food, can engender and maintain responding. Responding has been maintained in the cat (Byrd, 1969) and in the squirrel monkey (Kelleher and Morse, 1968; McKearney, 1968, 1969, 1970; Morse, Mead, and Kelleher, 1967; Stretch, Orloff, and Dalrymple, 1968; Stretch, Orloff, and Gerber, 1970) under a variety of schedules when the only consequence of responding was the delivery of a response-dependent shock.

The present experiment was undertaken to provide additional data on the conditions under which response-dependent electric shock can maintain responding in the squirrel monkey, and to evaluate the performances engendered when shock is delivered under second-order schedules. Under a second-order schedule, the responding engendered during each component schedule is treated as a behavioral unit and a designated event occurs after the completion of several components (Kelleher, 1966a). In the present experiment, for example, responding under a 4-min fixed-interval (FI 4-min) schedule was treated as a unit, and electric shock was delivered to the subjects after completion of a fixed number of 4-min components.

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METHOD

Subjects

Two mature, male squirrel monkeys (*Saimiri sciureus*) were housed in individual cages where food and water were always available. The monkeys (SM-158 and SM-562) were handled in the manner described by Kelleher, Gill, Riddle, and Cook (1963).

Apparatus

The experiment was conducted in a ventilated refrigerator shell containing a Plexiglas restraining chair of the type described by Hake and Azrin (1963). When seated in the chair, the monkey faced a wall supporting a response key (Lehigh Valley Electronics, LVE #1352) and a rectangular stimulus panel of translucent Plexiglas. The 1.25 by 1.75 in. (3 by 4 cm) stimulus panel was transilluminated by 6-w ac colored bulbs. The response key was 4 in. (10 cm) above the waist plate of the chair and 3.75 in. (9 cm) below the bottom of the display panel. Each depression of the key with a force of at least 20 g (0.19 N) registered a response and operated a feedback relay. Beneath the monkey, a small stock held the tail motionless so that an electric current could be passed through two brass plates resting on a shaved area approximately 2.25 to 5 in. (6 to 12 cm) from the tip of the tail. Electrode paste (EKG Sol) applied to the shaved area minimized changes in resistance between the monkey and a 650-v ac, 60-Hz, shock source. A 25-w houselight (GE #101F) was located on the ceiling to the rear of the monkey. Continuous white noise and an exhaust fan masked extraneous sounds. Electromagnetic relay equipment in a remote room arranged the experiments and recorded data.

Procedure

Responding (lever pressing) was initially engendered according to procedures described previously (Byrd, 1969; McKearney, 1968, 1969). In brief, after responding had stabilized under a schedule in which each response postponed shock delivery for 65 sec (SM-158) or 30 sec (SM-562), electric shock was delivered at fixed periods of time (16 min for SM-158; 12 min for SM-562) independently of responding and concurrent with the schedule of shock postponement. Subsequently, the schedule of shock postponement was omitted and the delivery of shock was made dependent on the first response occurring after 16 min (SM-158) or 12 min (SM-562). Responding was maintained thereafter under fixed-interval schedules at interval durations ranging between 4 and 16 min.

Phase I. The present procedures are summarized in Table 1. At the beginning of the experiment, an FI 8-min schedule of shock delivery was in effect. In the presence of a red light on the stimulus panel, the first response occurring after 8 min was followed by a 200-msec, 6-mA electric shock. The red stimulus light was on continuously for the duration of each session; the houselight was never on. After 10 sessions, a 30-sec timeout was added to the fixed-interval schedule so that after each shock delivery, the red stimulus light was off for 30 sec and responses had no scheduled consequences. After 32 sessions, the schedule arranged a 1-sec delay between the first response occurring after 8 min and the delivery of a shock. In the presence of the red light, the first response occurring after 8 min activated a clock and shock was delivered at the end of 1 sec. The red light remained on during the 1-sec delay, but terminated with shock delivery and remained off during the 30-sec timeout. During Sessions 50 to 65, a blue light was associated with the period preceding shock delivery. The first response occurring after 8 min initiated a 1-sec period during which a blue stimulus light was on, and shock was de-

Table 1

Schedules of shock delivery and the sessions each was studied during the three phases of the experiment.

	Schedule	*Sessions*
Phase I	FI 8-min	1-10
	FI 8-min (timeout 30 sec)	11-42
	FI 8-min: 1-sec delay (timeout 30-sec)	43-49
	FI 8-min: 1-sec S (timeout 30-sec)	50-65
	FI 8-min: 1-sec S	66-80
Phase II	FR2 (FI 4-min: 1-sec S)	81-144
	(FI 4-min: 1-sec S) (FI 4-min)	145-185
	FR2 (FI 4-min: 1-sec S)	186-212
Phase III	FR4 (FI 4-min: 1-sec S)	213-248
	FR4 (FI 4-min: 3-sec S)	249-257
	FR4 (FI 4-min: 10-sec S)	258-272
	FR4 (FI 4-min: 1-sec S)	273-303
	FR4 (FI 4-min: 0.3-sec S)	304-328
	FR4 (FI 4-min: 0.1-sec S)	329-342
	FR4 (FI 4-min)	343-355

livered at the termination of the blue light. A 30-sec timeout followed shock delivery. After Session 65, the 30-sec timeout was omitted from the procedure and the red light appeared immediately after each shock delivery. Responding was maintained without the timeout during the remainder of the experiment.

Phase II. Beginning with Session 81, shock was delivered under a second-order schedule consisting of two FI 4-min schedules. In the presence of a red stimulus light, the first response occurring after 4 min produced a brief stimulus (1-sec blue light). After every second presentation of the brief stimulus a 200-msec, 6-mA electric shock was delivered. After 36 sessions under this second-order schedule, the houselight was added to the brief stimulus. For the remainder of the experiment, the brief stimulus comprised presentation of both the houselight and blue stimulus light.

Beginning with Session 145, the brief stimulus no longer preceded shock delivery. The 1-sec stimulus continued to be presented at completion of the first FI 4-min schedule, but only shock was delivered at completion of the second FI 4-min schedule. After 41 sessions, the 1-sec brief stimulus was again scheduled for presentation at completion of each FI 4-min schedule, and shock delivery followed every second presentation of the brief stimulus.

Phase III. During Sessions 213 to 355, shock was delivered after every fourth presentation of the brief stimulus. Each component of the second-order schedule was an FI 4-min schedule; the first response occurring after 4 min presented the houselight and the blue stimulus light briefly. A 200-msec, 8-mA electric shock was delivered after every fourth presentation of the brief stimulus. The duration of the brief stimulus was varied systematically during the 142 sessions this schedule was in effect, and at various times the stimulus duration was 0.0, 0.1, 0.3, 1.0, 3.0, or 10.0 sec. The order and the number of sessions each duration was studied are summarized in Table 1. All daily sessions were of approximately 80-min duration and were conducted Monday through Friday. Schedule changes were usually made only when performance had been stable for at least four successive sessions.

RESULTS

Phase I. Performance under the FI 8-min schedule of response-produced electric shock in effect at the beginning of the experiment was characterized by patterns of positively accelerated responding (Figure 1A) and mean rates of 0.4 to 0.5 response per second. There was little responding during the first part of each 8-min period, but subsequently, responding increased gradually to a moderately high rate that persisted until the first response occurring after 8 min produced an electric shock. Quarter life, a measure of the distribution of responses under the fixed-interval schedule (Gollub, 1964; Herrnstein and Morse, 1957) was 55 to 60%. If responses had been distributed uniformly throughout the interval, quarter life would have been 25%; a quarter life of 60% indicates that most of the responses occurred during the last few minutes of the interval.

The addition of a 30-sec timeout after each shock delivery did not affect the patterns of positively accelerated responding maintained under the fixed-interval schedule (Figure 1B). Quarter life changed little in either monkey, but mean response rate, which did not change in SM-158, decreased slightly in SM-562 (Figure 2).

When a 1-sec delay intervened between the first response occurring after 8 min and the subsequent delivery of a shock, mean response rates decreased but patterns of positively accelerated responding persisted. During the last four sessions, quarter life was 60 to 75%. In addition to a decrease in mean response rates, response rates during successive fixed intervals in a session were more variable (Figure 1C). Response rates during the 1-sec period preceding shock delivery were 0.7 to 0.8 response per second.

Overall mean response rates increased when a blue light was present during the 1-sec period preceding shock delivery, and in addition, response rates during the 1-sec period preceding shock delivery increased to 2.6 to 2.9 responses per second (Figure 1D). The patterns of positively accelerated responding maintained during the 8-min periods were reflected in a quarter life of 65 to 75% (Figure 2). Responding was less variable than when there was no stimulus change during the 1-sec period preceding shock delivery.

Omission of the timeout during Sessions 66 to 80 produced hardly any change in performance (Figure 1E). Responding was maintained at overall mean rates of 0.55 (SM-158) and

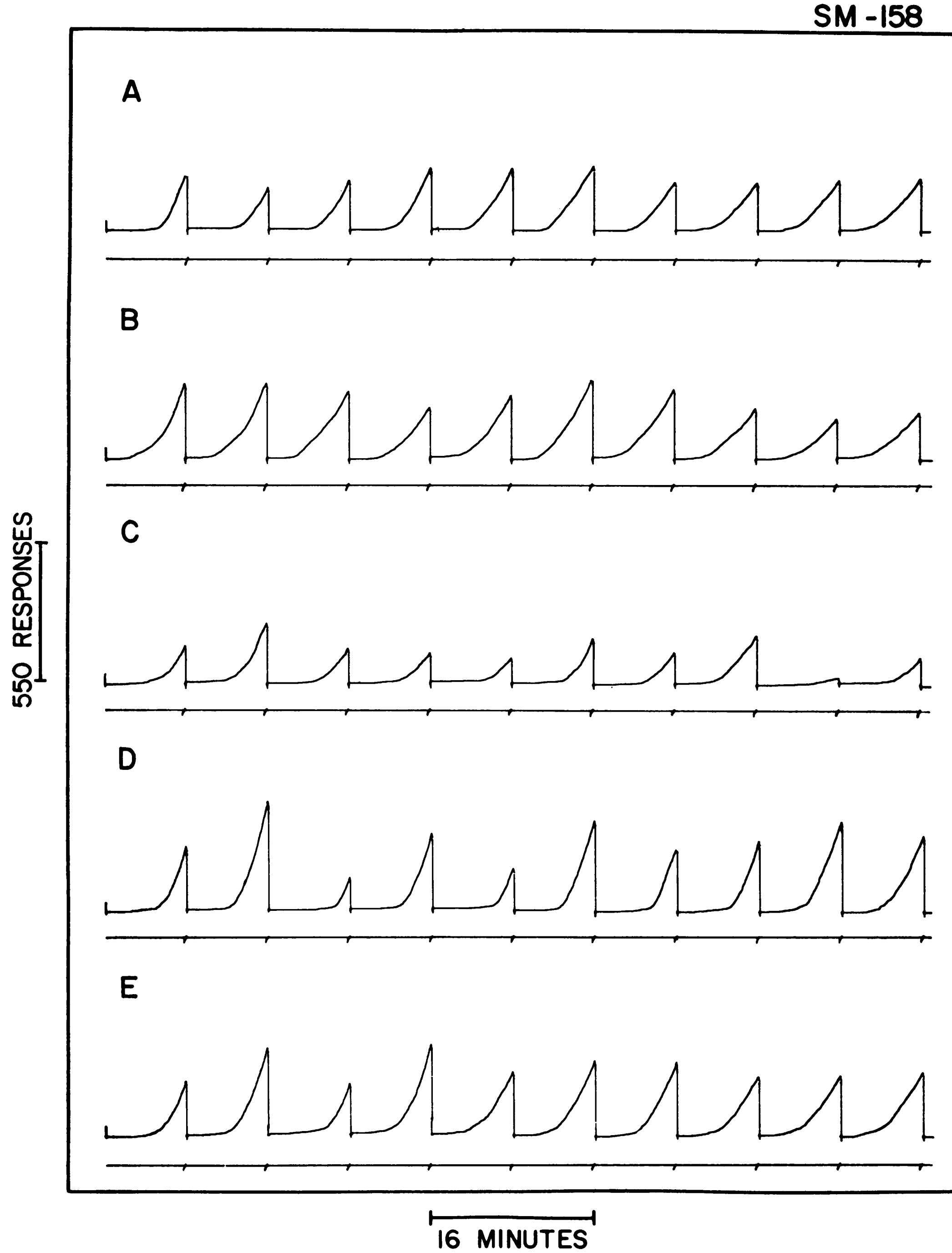

Fig. 1. Cumulative records of responding in SM-158 during final sessions when: (A) the first response occurring after 8 min produced an electric shock; (B) the first response after 8 min produced a shock and a 30-sec timeout followed each shock delivery; (C) a 1-sec delay without a stimulus change intervened between the first response occurring after 8 min and delivery of a shock, and a 30-sec timeout followed shock delivery; (D) the first response occurring after 8 min produced a 1-sec stimulus change, shock delivery followed the 1-sec stimulus, and a 30-sec timeout followed shock delivery; (E) the first response occurring after 8 min produced a 1-sec stimulus change and shock delivery followed the 1-sec stimulus. A mark of the event pen and resetting of the response pen indicate shock delivery.

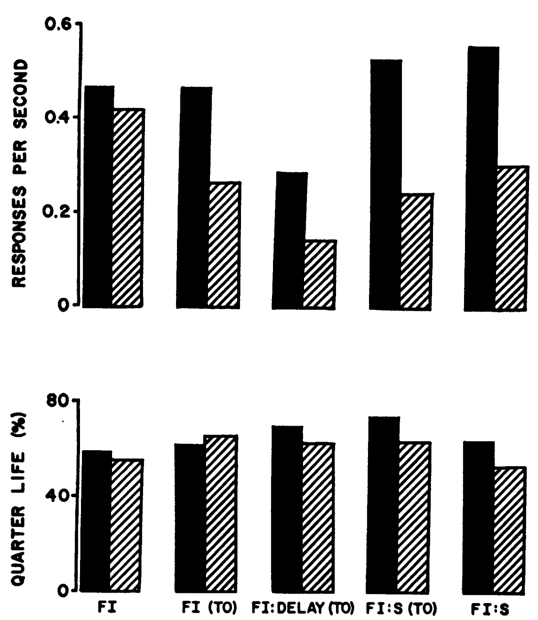

Fig. 2. Mean rate of responding and quarter life in SM-158 (shaded bars) and SM-562 (striped bars) during the last four sessions under an 8-min fixed-interval schedule of shock delivery and variations thereof as described in Figure 1.

0.30 (SM-562) response per second when the first response after 8 min produced a 1-sec stimulus and shock delivery followed the stimulus presentation. Response rates during the brief stimulus were 2.4 to 3.0 responses per second. Performance was characterized by uniform patterns of positively accelerated responding and a quarter life of 55 to 65% (Figure 2). The performance was similar to that maintained under the FI 8-min schedule at the beginning of the experiment.

Phase II. The effect of changing the procedure to a second-order schedule under which the first response occurring after 4-min produced the brief stimulus, and shock delivery followed every second presentation of the brief stimulus was immediate. During the first session under the second-order schedule, patterns of positively accelerated responding were engendered during the individual 4-min periods (Figure 3A). Response rates were generally higher during the second 4-min component than during the first. Responding was less variable during the second session after the schedule change, and rates and patterns of responding were more nearly the same during the first and second components of each sequence (Figure 3B). Responding changed little during subsequent sessions, and after 20 sessions the performance shown in Figure 3C was recorded. During the last four sessions under the two-component second-order schedule, overall mean response rates derived from total session time and total responses were 0.4 to 0.5 response per second. Quarter life derived from the distribution of responses within the components was 55%, and response rates during the brief stimulus were 1.7 to 1.9 responses per second.

During Sessions 145 to 185, when the brief stimulus no longer preceded shock delivery but was presented at completion of the first FI 4-min component, rates and patterns of responding changed gradually. Patterns of positively accelerated responding during individual fixed-interval components persisted for 20 to 30 sessions, but after 40 sessions, presentation of the brief stimulus at completion of the first component had little effect (Figure 4A, 4B, 4C). During the last four sessions, overall mean response rates had increased to 0.5 to 0.6 response per second, quarter life during the 4-min components had decreased to 40 to 50%, and response rates during the brief stimulus had decreased to 0.8 to 0.9 response per second.

When the brief stimulus was again presented at completion of every FI 4-min component and shock delivery followed every second presentation of the brief stimulus, changes in the patterns of responding were evident during the first session (Figure 4D). Recovery of the rates and patterns of responding maintained during Sessions 81 to 144 was gradual, but during 27 sessions, positively accelerated patterns of responding were engendered and maintained during individual components (Figure 4E). During the last four sessions, overall mean response rates were 0.4 to 0.5 response per second, quarter life during the 4-min components was 50 to 55%, and response rates during the brief stimulus were 1.5 to 2.5 responses per second.

Phase III. Performance during the 143 sessions comprising the final phase of the experiment was a function of the duration of the brief stimulus presented at the completion of each FI 4-min component. When the brief stimulus duration was 0.0 sec, *i.e.*, the stimulus was omitted and there was no stimulus change at the completion of each component but shock was delivered at the completion of

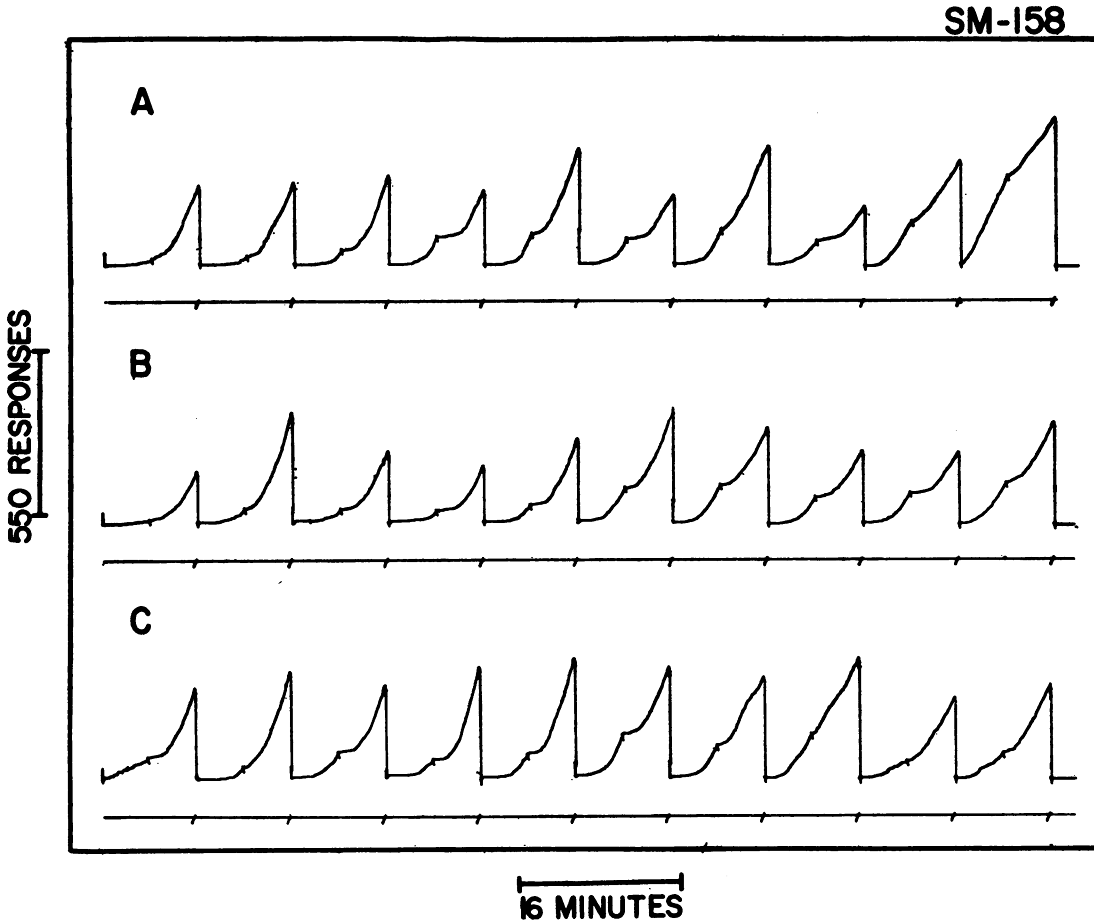

Fig. 3. Cumulative records of responding in SM-158 during the first (A), second (B), and twentieth (C) sessions when the first response occurring after 4 min produced a 1-sec visual stimulus and shock delivery followed every second presentation of the 1-sec stimulus. A diagonal mark of the response pen indicates presentation of the 1-sec stimulus; a mark of the event pen and resetting of the response pen indicate shock delivery.

every fourth component, there was no single response pattern common to performance during individual components. Responding was infrequent during the initial part of the first component; then response rate gradually increased during the first and second components to a moderately high, steady rate that persisted until shock delivery at completion of the fourth component (Figure 5A). Overall mean response rates were 0.7 to 0.8 response per second, and quarter life during the 4-min components was 25 to 30%.

When the brief stimulus duration was 0.1 sec, mean response rates were lower and more uniform patterns of positively accelerated responding were maintained during individual components. Response rates were still lowest during the initial component, but presentation of the stimulus for 0.1 sec engendered and maintained positively accelerated responding during many of the components (Figure 5B). Response rates during presentation of the stimulus were 0.5 to 1.0 response per second.

Further increases in the duration of the brief stimulus from 0.1 to 10.0 sec produced systematic changes in mean response rates, quarter life value, and response rate during the brief stimulus, as summarized in Figures 5 and 6. Overall mean response rates were highest when the brief stimulus was omitted, then decreased monotonically as the brief stimulus duration increased. The lowest response rates were maintained at a stimulus duration of 10 sec. Response rate during the brief stimu-

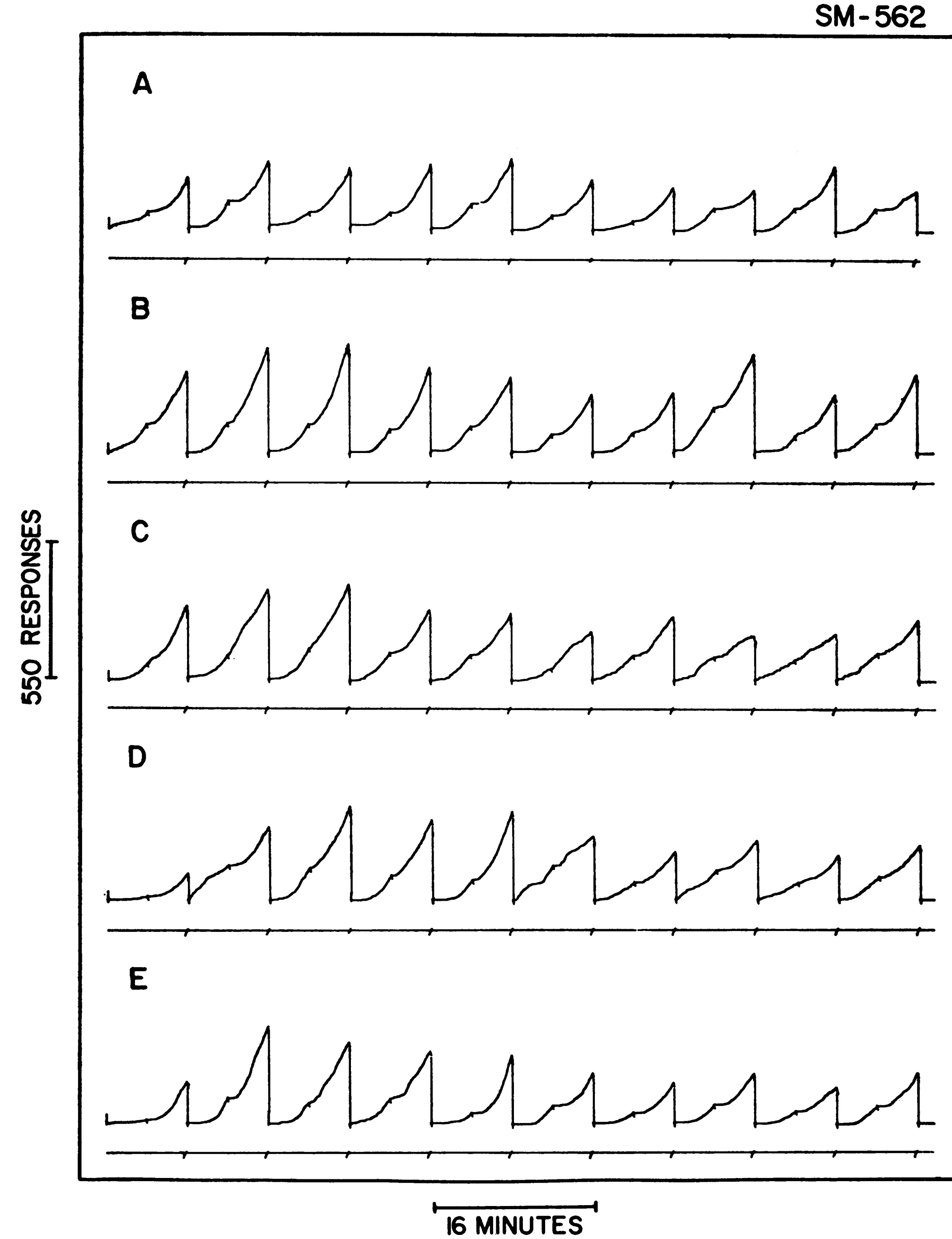

Fig. 4. Cumulative records of responding in SM-562 during: (A) the final session when the first response occurring after 4 min produced a 1-sec visual stimulus and shock delivery followed every second presentation of the 1-sec stimulus; the twentieth (B) and fortieth (C) sessions when the 1-sec visual stimulus was presented at completion of the first 4-min component but shock alone was presented at completion of every second component; and the first (D) and twenty-fifth (E) sessions when the 1-sec stimulus was again presented at completion of every 4-min component and shock delivery followed every second presentation of the stimulus. Recording as in Figure 3.

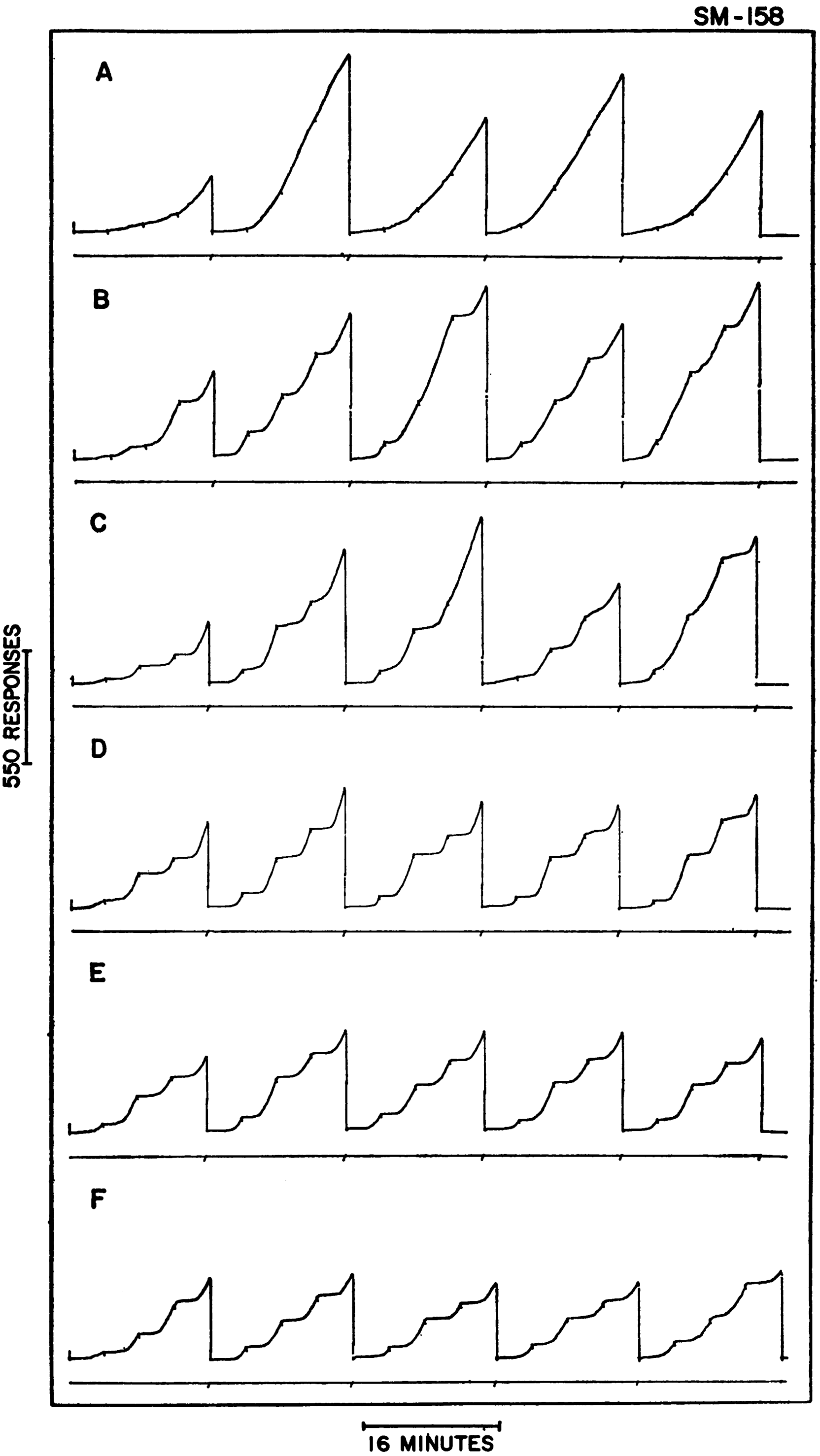

Fig. 5. Cumulative records of responding in SM-158 during final sessions when the first response occurring after 4 min produced a brief visual stimulus and shock delivery followed every fourth presentation of the brief stimulus. Duration of the brief stimulus was 0.0 sec (A), 0.1 sec (B), 0.3 sec (C), 1.0 sec (D), 3.0 sec (E) and 10.0 sec (F). Recording as in Figure 3.

lus was also a function of the duration of the stimulus. As the stimulus duration increased, response rate during the stimulus increased and was maximum when the stimulus duration was 0.3 sec (SM-562) and 1 sec (SM-158). Response rate during the stimulus decreased as the stimulus duration increased beyond 1 sec. Changes in quarter life during the 4-min components were similar to the changes in response rates during the brief stimulus. In SM-158, for example, quarter life was lowest (28%) when the brief stimulus was omitted, was maximum (64%) at 1-sec duration, and decreased at stimulus durations longer than 1 sec. Inspection of the cumulative records showed that variability in the patterns of positively accelerated responding during individual components was lowest at the 1-sec stimulus duration, that the gradual increase in responding during individual fixed-interval components occurred earlier in the 4-min interval at the shorter stimulus durations, and that bursts of responding during the initial period of individual components were engendered at the longer stimulus durations (Figure 5).

The effect of the brief stimulus upon response rates during successive fixed-interval components is illustrated in Figure 7. When the brief stimulus was omitted (upper bars), response rates were lowest during the initial

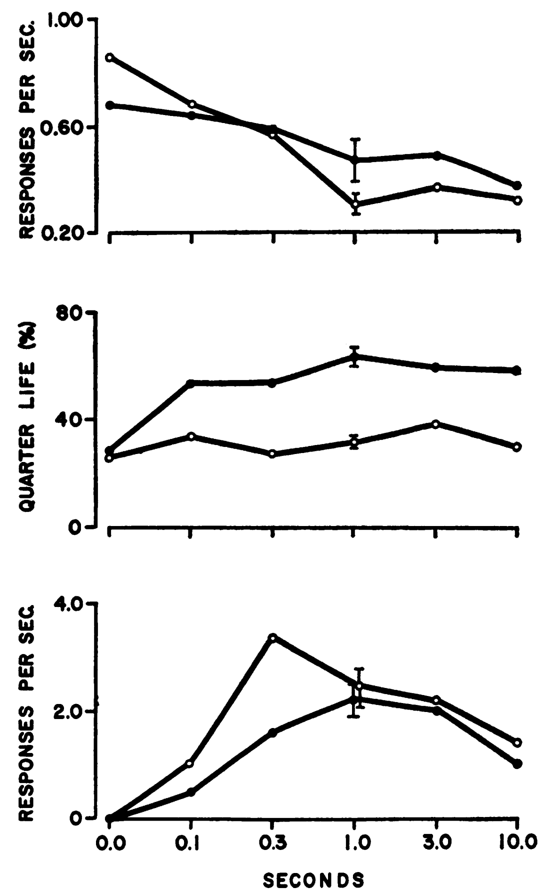

Fig. 6. Mean response rate (top), quarter life (middle), and response rate during the brief stimulus (bottom) in SM-158 (filled circles) and SM-562 (unfilled circles) under a second-order schedule in which the first response occurring after 4 min produced a brief visual stimulus and shock delivery followed every fourth presentation of the brief stimulus. Durations of the brief stimulus studied are indicated along the abscissa. The means of the last four sessions during each of the two times the 1-sec duration was studied are connected by vertical lines. All other data points are means of the last four sessions the respective durations were in effect.

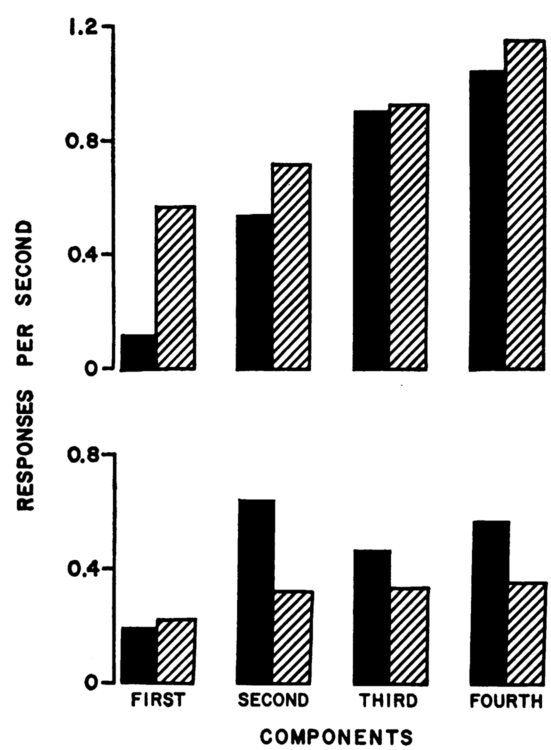

Fig. 7. Mean response rates in SM-158 (shaded bars) and SM-562 (stripped bars) during successive 4-min components of a second-order schedule in which the first response occurring after 4 min produced a visual stimulus of 0.0-sec duration (top) and 1-sec duration (bottom) and shock delivery followed every fourth scheduled presentation of the brief stimulus. Rates were determined from the last four sessions (top), and the last four sessions during each of the two times the 1-sec duration was studied (bottom).

component of the second-order schedule and increased during successive components to a maximum during the component that terminated with shock delivery. When the brief stimulus was presented for 1 sec at completion of each component and shock delivery followed the fourth presentation of the stimulus (lower bars), response rates were also lowest during the initial component. However, response rates during the remaining components did not differ in any systematic way.

DISCUSSION

The present experiment shows that (1) responding can be maintained in the squirrel monkey under second-order schedules of response-dependent shock delivery, and (2) performance under second-order schedules of shock delivery is like that engendered under second-order schedules of food presentation. Previous studies (*cf.*, Kelleher, 1966*a;* Marr, 1969) showed that when a brief visual or auditory stimulus is presented at the completion of individual schedule components, and the stimulus is occasionally followed by or is present during food presentation, patterns of responding during individual components are like the patterns maintained when food is presented at the completion of each component. With the exception of a recent report (Stubbs, 1971), most data further show that when a brief stimulus and food presentation never occur in close temporal contiguity, *i.e.*, the brief stimulus neither precedes nor occurs during food presentation, rates and patterns of responding during the components are not like the rates and patterns engendered when food is presented at the completion of each component. Performances under the second-order schedules of shock delivery studied in the present experiment were generally like the performances reported in other species under similar second-order schedules when food presentation was the terminal event (de Lorge, 1964, 1967; Kelleher, 1966*b;* Marr, 1970). Patterns of positively accelerated responding typical of performance under fixed-interval schedules of food presentation were maintained during individual fixed-interval components when a brief visual stimulus was presented at the completion of each component and shock delivery followed every second (Phase II) or fourth (Phase III) presentation of the brief stimulus. Patterns of positively accelerated responding were not maintained during individual components when the brief stimulus was omitted and shock delivery followed the completion of every fourth component (Phase III), and when the brief stimulus was presented at completion of the first component only and shock alone was delivered at the completion of every second component (Phase II).

An earlier report (Byrd, 1969) showed that responding in the domestic cat can also be maintained under second-order schedules of shock delivery. In that experiment, as in the present one, responding was maintained during fixed-interval components when a brief stimulus did not precede shock delivery but was presented at the completion of other components, and when a brief stimulus was never presented. Responding in the cat decreased, however, when a brief stimulus was presented at the completion of each component and shock delivery followed every third presentation of the brief stimulus.

Since responding in the cat decreased only when a brief stimulus immediately preceded shock delivery, it was of interest to determine whether responding in the squirrel monkey would be affected similarly when an event intervened between the first response occurring after a fixed period of time and shock delivery. The first phase of the present experiment demonstrated that the intervention of a delay between the first response occurring after 8 min and the delivery of an electric shock was not sufficient to result in a marked reduction in responding as observed in the cat. Overall mean response rates were lower when there was no stimulus change during the delay, but response rates increased when a visual stimulus was present during the 1-sec period. Under the latter condition, rates and patterns of responding were like those engendered when shock immediately followed the first response occurring after 8 min.

On the basis of these data, it seems doubtful that the marked decrease in responding observed in the cat was related to the delay imposed by presentation of a brief stimulus preceding shock delivery. A more tenable explanation is that decreased responding in the cat was related to the procedure by which the brief stimulus was initially associated with shock delivery. In the present experiment, the brief stimulus was presented in contiguity with shock delivered under a fixed-interval schedule before being presented alone at the completion of individual components under a second-order schedule. In the experiment with the cat, the brief stimulus was introduced under a second-order schedule without having previously been presented in temporal contiguity with shock delivery. The different performances engendered in the two experiments implicate the history of the subjects as an important determinant of the effectiveness of an event in maintaining responding. Morse and Kelleher (1970) discussed at length the effect behavioral history can have upon subsequent performance.

The data from the third phase of the present experiment showed that mean response rate, quarter life, and response rate during the brief stimulus are a function of brief stimulus duration. That quarter life was low when the brief stimulus was omitted is consistent with studies of second-order schedules of food presentation. Byrd and Marr (1969), de Lorge (1964, 1967), and Kelleher (1966*b*) reported that patterns of positively accelerated responding were maintained during individual components (*i.e.*, quarter life was high) when a brief stimulus was presented at the completion of each component, but responding was not found to be positively accelerated (*i.e.*, quarter life was low) when the stimulus was omitted.

Performance under second-order schedules can be described in terms of the change in response rate within a component and the change in the mean response rates of successive components. Figure 5 showed that when a 1-sec stimulus was presented at the completion of each component, the change in response rate during a component reflected the influence of the fixed-interval schedule under which the brief stimulus was presented. Figure 7 showed that the change in mean response rates during successive components reflected the influence of the fixed-ratio schedule under which shock was delivered after every fourth presentation of the 1-sec stimulus. Previously, Byrd and Marr (1969), de Lorge (1967, 1971), Kelleher (1966*a*, 1966*b*) and Marr (1969) showed that when a pattern of responding characteristic of the schedule comprising each component was maintained during individual components of a second-order schedule, the change in mean response rates of successive components was indicative of the schedule under which the terminal event occurred.

That the rates and patterns of responding maintained by the brief stimulus in the present experiment were dependent on the temporal relation between the brief stimulus and shock delivery was demonstrated in Phase II. Relatively uniform patterns of positively accelerated responding were typical during the components when the brief stimulus and shock occurred in temporal contiguity at the completion of every second component. The performance changed gradually, however, when the brief stimulus no longer preceded shock delivery at the completion of every second component, and after 30 to 35 sessions presentation of the brief stimulus at completion of the first component had hardly any effect. Subsequently, uniform patterns of positively accelerated responding were again engendered and maintained during the components when the brief stimulus preceded shock delivery at completion of the second component.

Studies of second-order schedules of food presentation have similarly shown that the effectiveness of a brief stimulus in maintaining patterns of positively accelerated responding during fixed-interval components is a function of the temporal relation between the brief stimulus and the terminal event, food presentation (Byrd and Marr, 1969; de Lorge, 1964, 1967, 1969; Kelleher, 1966*b;* Marr, 1965). In general, positively accelerated responding can be maintained during individual fixed-interval components only when the brief stimulus is occasionally contiguous with, *i.e.*, precedes or is present during, food presentation. When a stimulus, due to its occasional contiguity with food presentation, can maintain a pattern of responding like that maintained by food presentation alone, the stimulus is described as a conditioned reinforcer (Kelleher, 1966*a;* Kelleher and Gollub, 1962). In the present experiment, where a stimulus occasionally contiguous with shock delivery engendered and maintained rates and patterns of responding like those maintained by shock delivery alone, the brief stimulus associated with shock delivery had the same effect as a conditioned reinforcer. Presentation of the brief visual stimulus that was occasionally contiguous with shock delivery maintained responding in the same way as a brief visual stimulus that is occasionally contiguous with food presentation.

These data and those reported by Kelleher and Morse (1968), McKearney (1968, 1969, 1970), and Stretch, *et al.* (1970) show that the response-dependent delivery of electric shock can maintain rates and patterns of responding like those reported by Dews (1965), Kelleher and Morse (1964), and Morse and Kelleher (1966) under comparable schedules of response-dependent food presentation. Under the conditions of these experiments, then, the delivery of electric shock engendered and maintained rates and patterns of responding typically maintained by events described as positive reinforcers. Similarities between the rates and patterns of responding maintained in these experiments with response-dependent shock delivery and in other experiments with response-dependent food presentation would indicate that shock delivery can be a positive reinforcer, and a brief stimulus occasionally contiguous with shock delivery can be a conditioned positive reinforcer. Interpretations in terms of elicitation of responding, the adventitious reinforcement of responding, or the selective suppression of elicited responding are not consistent with the data from these experiments and the large body of knowledge that has been generated by the study of schedules of reinforcement.

The present paper began with the observation that some environmental events have been stereotyped in terms of their efficacy in maintaining behavior. According to these stereotypes, electric shock can only maintain responding when responses terminate or postpone shock, and food maintains responding when responses produce food. A number of studies have shown, however, that under appropriate conditions, electric shock can maintain responding when responses produce shock, and response rate can be suppressed by a stimulus associated with the delivery of food (Azrin and Hake, 1969; Byrd, 1969; Kelleher and Morse, 1968; McKearney, 1968, 1969, 1970; Morse, *et al.*, 1967; Stretch, *et al.*, 1968; Stretch, *et al.*, 1970). In addition, the present data show that responding in the squirrel monkey can be maintained under second-order schedules when the only consequence of responding is the delivery of a relatively intense electric shock or the presentation of a brief visual stimulus that is occasionally followed by an electric shock. Together, these findings indicate the inappropriateness of stereotyping environmental events, and instead, support the view that the effectiveness of any event in maintaining responding is dependent on the history of the subject and the schedule and prevailing conditions under which responses produce the event (Morse and Kelleher, 1970). Several experiments have demonstrated the importance of the schedule by showing that performances can be the same whether food presentation, shock delivery, or termination of a schedule complex is the terminal event (Dews, 1965; Kelleher and Morse, 1964, 1968; McKearney, 1969, 1970; Morse and Kelleher, 1966; Stretch, *et al.*, 1970). A comparison of the present data with data generated under similar second-order schedules of food presentation further emphasizes the schedule rather than the terminal event in the maintenance of behavior.

Second-order schedules have become important analytic tools for studying adjunctive behavior (Rosenblith, 1970), for studying the ways in which extended sequences of behavior can be maintained (Kelleher, 1966*a;* Kelleher and Gollub, 1962), and as sensitive procedures for evaluating the behavioral effects of drugs (Marr, 1970). The ability to maintain comparable behavioral performances under second-order schedules whether food presentation or shock delivery is the terminal event permits study of the way in which various interventions can affect extended sequences of behavior independently of any motivational quality attributed to the event maintaining the behavior.

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