JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1997, **67,** 311–322 NUMBER 3 (MAY)

EFFECTS OF HISTORIES OF DIFFERENTIAL REINFORCEMENT OF RESPONSE RATE ON VARIABLE-INTERVAL RESPONDING

KOICHI ONO AND KEIKO IWABUCHI

KOMAZAWA UNIVERSITY AND
YOKOHAMA CITY PUBLIC HEALTH BUREAU

Three pigeons were exposed first to multiple differential-reinforcement-of-high-rate and differential-reinforcement-of-low-rate schedules that were correlated with green and red keys, respectively, and then were shifted to a variable-interval schedule arranged on a white key. In subsequent test sessions, the variable-interval schedule continued to operate, but green and red keys replaced the white key in alternate sessions. In Part 1 of the experiment, the variable-interval schedule correlated with the white key was introduced immediately after the multiple-schedule condition, and the test condition began 15 days later. This sequence was repeated twice, with a reversal of the correlation of the key colors with the components of the multiple schedule at the start of each new cycle. Part 2 added a 6-month break between the multiple-schedule history and the white-key variable-interval schedule followed by test sessions. The procedure was then repeated with a reversal of the correlation between key colors and multiple-schedule components. In the test sessions of Part 1, all pigeons consistently responded faster in the presence of the key color most recently correlated with the differential-reinforcement-of-high-rate contingency than during the color most recently correlated with the differential-reinforcement-of-low-rate contingency. Similar but smaller effects were observed in Part 2. The effects of the reversals in these two parts of the experiment showed that only the most recent contingency exerted an influence on subsequent responding. The data suggest that this effect of the most recent history continues to operate on behavior under current contingencies even after a long lapse of time.

Key words: schedule history, stimulus control, multiple schedules, differential-reinforcement-of-high-rate schedules, differential-reinforcement-of-low-rate schedules, key peck, pigeons

Current behavior is affected by both current contingencies and past experience with contingencies. Whenever we consider the effects of successive procedures over time, we are studying effects of history. For example, experiments about extinction are concerned with how the effects of a history of reinforcement continue even after the reinforcement contingencies that created that history no longer operate. Thus, historical variables, the effects of past contingencies, are assumed to play an important role in the analysis of an organism's current behavior.

The present research deals with the effects of behavioral history on current responding maintained by variable-interval (VI) schedules of reinforcement (a VI schedule arranges a reinforcer for the first response after a variable time has elapsed since some event, usually the previous reinforcer). The terms *behavioral history* and *conditioning history* are widely used outside the operant literature, as in, for example, the complexity of the psychosocial and behavioral history of clients (Fors & Rojek, 1991), conditioning history as initial attitudes (Pierce & Belke, 1988), and natural behavioral history (Parker, 1985). Conditioning history can include such Pavlovian-type conditioning histories as the effects of preexposure to a conditioned stimulus (Kasprow, Schachtman, & Miller, 1987; Swartzentruber & Bouton, 1992). Given the variety of terms and usages, it may be most convenient for the present article to use terms such as *operant history, reinforcement history,* or *schedule history.*

The effects of schedule history were investigated with humans as subjects during the 1950s and 1960s (Long, Hammack, May, & Campbell, 1958; Weiner, 1964). Since then, many experiments have been conducted with rats, and fewer have been conducted with pigeons or monkeys. A basic procedure in these studies is to expose subjects to a certain schedule of reinforcement and then to eval-

---

We thank the members of the pigeon staff of Komazawa University for their contributions to the conduct of experiment. We are also grateful to A. Charles Catania for his very helpful comments and suggestions on an early version of this manuscript.

Reprints may be obtained from Koichi Ono, Department of Psychology, Komazawa University, 1-23 Komazawa, Setagaya-ku, Tokyo 154, Japan.

uate the effects of the exposure on subsequent responding under a different schedule of reinforcement. Weiner (1964), for example, first exposed human subjects to either a fixed-ratio (FR) 40 or a differential-reinforcement-of-low-rate (DRL) 20-s schedule and then exposed both groups to identical fixed-interval (FI) 10-s schedules. Fixed-ratio schedules arrange for the last of a constant number of responses to produce a reinforcer, and FI schedules arrange for the first response after a fixed period of time to produce a reinforcer; DRL schedules arrange for a response to be reinforced only if at least *t* seconds have elapsed since the last response. Preexposure to FR schedules generated high response rates in FI schedules, and preexposure to DRL schedules generated low response rates in FI schedules. Weiner (1965, 1969) found that humans showed effects of history even when the response rates were maladaptive in the sense that they produced reinforcement loss.

Similar effects of schedule history on FI responding have been reported with nonhuman subjects under many experimental parameters (Baron & Leinenweber, 1995; Freeman & Lattal, 1992; Johnson, Bickel, Higgins, & Morris, 1991; LeFrancois & Metzger, 1993; Tatham, Wanchisen, & Yasenchack, 1993; Wanchisen, Tatham, & Mooney, 1989). In a pharmacological study, the effects of schedule history on a drug's effects on FI performance (Urbain, Poling, Millam, & Thompson, 1978) and on VI performance (Nader & Thompson, 1987; Poling, Krafft, & Chapman, 1980) were also demonstrated, suggesting possible latent history effects, in which history shows its effect only under special circumstances. Several studies examined the effects of various kinds of operant histories on responding under schedules other than FI and VI (Alleman & Zeiler, 1974; Cohen, Pederson, Kinney, & Myers, 1994; Messing, Kleven, & Sparber, 1986) and on the effects of drugs on punished responding (Barrett, 1977; Tatham, Gyorda, & Barrett, 1993).

Some limitations of the procedures in most of the experiments with humans and nonhumans described above have been pointed out by Freeman and Lattal (1992). One limitation is that comparisons of different histories were limited to those between different groups of subjects: Different groups of subjects were provided different histories, thereby permitting only across-subject comparisons. In typical procedures on schedule history, each of two groups was first exposed to different schedules (FR or DRL) and then both were shifted to the same FI schedule (Weiner, 1969). Recent studies have improved procedures so that more appropriate comparisons can be made, for example, by introducing control groups (Baron & Leinenweber, 1995; Cohen et al., 1994; LeFrancois & Metzger, 1993; Tatham, Wanchisen, & Yasenchack, 1993).

Freeman and Lattal (1992) argued that a technique for comparing the historical effects of different reinforcement schedules within individual subjects is preferable because it is difficult to separate differences in history from individual differences in response rate across groups. Freeman and Lattal arranged parallel histories with two different reinforcement schedules (FR and DRL) for each pigeon, with each schedule correlated with a different stimulus. In Experiments 1 and 2, parallel exposures to the different schedules were established in two daily sessions, each with a different schedule, 6 hr apart. Three pigeons showed different response rates in subsequent performance on FI and VI schedules. In Experiment 3, histories of high-rate and low-rate responding were established by using a multiple schedule. During a subsequent multiple VI VI schedule in which the components were correlated with the different stimuli from the baseline schedule, different response rates occurred.

Another limitation of the previous studies, including Freeman and Lattal's (1992), is that they all examined the influence of prior schedules on current responding only when test conditions closely followed the schedule histories. Insofar as two schedules are consecutive, the effect of past contingencies on present behavior can be regarded as a kind of transition state (Sidman, 1960) in which the organism's behavior gradually adapts to the current contingency. This adaptation can be regarded as the result of the diminishing effects of the prior schedule and the increasing effects of the current schedule correlated with a particular discriminative stimulus. It might be interesting, then, to examine the effects of prior contingencies on current responding when periods of time away from the experimental setting or periods of exposure to new contingencies in the presence of different discriminative stimuli intervene between the relevant exposure to a contingency and the later test for its persisting effects under a new contingency.

The present study examined the effects of high-rate and low-rate schedule histories established within the two components of a multiple schedule on later multiple VI VI performance. The experiment included two procedural features that were intended to address the limitations mentioned above. One improvement was that the effects of different reinforcement histories were measured within an individual subject. Another was that the schedule history and the test of its effects were separated by a number of sessions of VI baseline training in the presence of a different discriminative stimulus. The major focus of the present experiment was first to examine the effects of successive reversals of the correlation between discriminative stimuli and schedule history in the multiple schedule, and second to compare the effects of a short intervening period (immediate transition from multiple schedules to VI baseline) or a long intervening period (6 months between the multiple-schedule training and the VI baseline).

The differential-reinforcement-of-high-rate (DRH) schedule (a DRH schedule arranges a reinforcer for the response that follows a preceding response by less than *t* seconds) was selected instead of an FR schedule to generate high response rates within short schedule components. Furthermore, although FI schedules were assumed to be more sensitive to history effects than VI schedules are (Poling et al., 1980), the VI schedule was selected as the contingency under the test conditions because it provides a relatively constant response rate: The postreinforcement pauses and systematic rate changes within intervals in FI performance might have made it more difficult to evaluate the effects of histories of high-rate and low-rate responding.

Part 1 of the experiment investigated the effects of prior multiple DRH DRL history on subsequent multiple VI VI responding, in which the schedule training and the history test sessions were separated by 15 days of VI baseline sessions. Part 2 investigated the effect of a long intervening period, in which experimental sessions were not conducted for 6 months, on behavior in the history test sessions.

METHOD

Subjects

Three homing pigeons, maintained at about 80% of their free-feeding weights, were individually housed with free access to water in a facility with a 12:12 hr light/dark cycle. All pigeons had an experimental history in which FI schedules had been in effect in the presence of a green keylight, extinction had occurred in the presence of a red keylight, and VI schedules had been in effect in the presence of blue and white keylights. Pigeons had been free feeding for a year and a half since the previous experiment ended, and weight reduction began 3 weeks before the start of the experiment.

Apparatus

A one-key chamber for pigeons was enclosed in a Gerbrands sound-attenuating enclosure containing an exhaust fan that provided ventilation and masking noise. A response key, 2.5 cm in diameter, was located in the center of an aluminum panel (30 cm by 34 cm) 25 cm above the floor. A force of approximately 0.14 N was required to operate the key. The key could be transilluminated red, green, or white. During 3- to 5-s deliveries of hemp seeds, the feeder was illuminated and the keylight was off. Electromechanical control and recording equipment was located in an adjacent room.

Procedure

In Part 1 of the experiment, the cycle of multiple-schedule training, VI baseline, and tests of history effects was repeated three times, with a reversal of the correlation between the key colors and the multiple DRH DRL components at the start of each new cycle. The three components of the cycle will be referred to as phases. In all phases, a session ended after a specified number of reinforcers. This number, ranging from 50 to 70, and the duration of feeder operation, ranging from 3 s to 5 s, were varied, usually across pigeons but also occasionally across sessions, to minimize the amount of postsession feeding. Sessions were conducted 7 days a week.

Phase 1: Multiple-schedule training. Each pigeon was exposed to a multiple DRH DRL schedule. In the first cycle, the DRH schedule was assigned to the green key and the DRL schedule was assigned to the red key. This assignment was reversed in the second cycle and returned to the original assignment in the third cycle.

In training during the DRH component, the starting value was 0.5 s (a peck was reinforced only if it followed the most recent peck within less than 0.5 s); this value was gradually decreased to a value ranging from 0.14 s to 0.30 s. The final value varied across pigeons (0.20 s to 0.30 s for Pigeon 6, 0.14 s to 0.16 s for Pigeon 7, and 0.20 s to 0.25 s for Pigeon 8). In training during the DRL component, a starting value of 0.5 s (a peck was reinforced only if it followed the most recent peck by more than 0.5 s) was gradually increased to DRL 3 s for all 3 pigeons. Durations of each component were varied from 10 s to 40 s, not including reinforcement time, over sessions to maintain approximately equal delivery of reinforcers in each component. The two multiple-schedule components randomly alternated with a probability of .5, with the restriction that no component could appear more than three consecutive times. In each cycle, multiple-schedule training lasted 30 (±2) sessions.

Phase 2: VI baseline. Each pigeon was exposed to sessions of VI reinforcement in the presence of a white keylight immediately after the multiple-schedule training. The values of the VI schedules, varying over pigeons and cycles, ranged from VI 6 s to VI 9 s, and were based upon mean interreinforcer intervals over the last 10 sessions of the preceding DRH and DRL schedules. The VI baseline sessions continued for 15 sessions.

Phase 3: Tests of the effects of schedule history. The test phase started immediately after the 15 baseline sessions. During this phase, VI baseline sessions and test sessions were conducted on alternate days. In the test sessions, the baseline VI schedule operated; but instead of remaining white, the key color randomly alternated between green and red as it had in the multiple-schedule phase. Each green or red component continued for 30 s. Thus the 19 sessions in the test phase included nine VI sessions with a white keylight and 10 VI sessions with green and red keylights.

In Part 2 of the experiment, which immediately followed the last test phase of Part 1, each of two cycles again consisted of a schedule history phase (multiple DRH DRL), a baseline VI phase, and a test phase, except that, within each cycle, 6 months intervened between the schedule history phase and the VI baseline and test phases. During the interruption, each pigeon was provided with free feeding in its home cage until 15 days before the start of the VI baseline phase, when restricted feeding began again.

In the first phase of the first cycle of Part 2, which lasted 10 sessions, the DRH schedule was assigned to green and the DRL schedule was assigned to red, as in the third cycle of Part 1. In the second cycle, which began immediately after the test phase of the first cycle, the assignment of schedules to key colors was reversed, and the first phase was maintained for 25 sessions. Other details of procedure were the same as in Part 1.

RESULTS

Response rates (responses per minute) over the three phases (schedule training, VI baseline, and test sessions) of the first cycle in Part 1 are plotted against successive sessions of the cycle in Figure 1. Session time in the rate calculation excluded the duration of reinforcer deliveries.

The differentiation of response rates within the multiple DRH DRL schedule was rapid for all 3 pigeons, and a large rate difference was stably maintained through the end of this phase. An intermediate rate, somewhat lower than the average of the prior DRH and DRL rates, was maintained during the subsequent VI baseline phase; this rate increased slightly during the phase for Pigeons 6 and 8. In the test phase, when all stimuli were correlated with the same VI contingencies as during the VI baseline, all 3 pigeons produced relatively high response rates during green (the former DRH stimulus) and relatively low rates during red (the former DRL stimulus). These rates converged toward the VI baseline rates for Pigeons 6 and 7 during the test sessions, but remained fairly consistently separated for Pigeon 8. Even after 10 test sessions, rates during green (the former DRH stimulus) were higher than those during red (the former DRL stimulus) for all 3 birds.

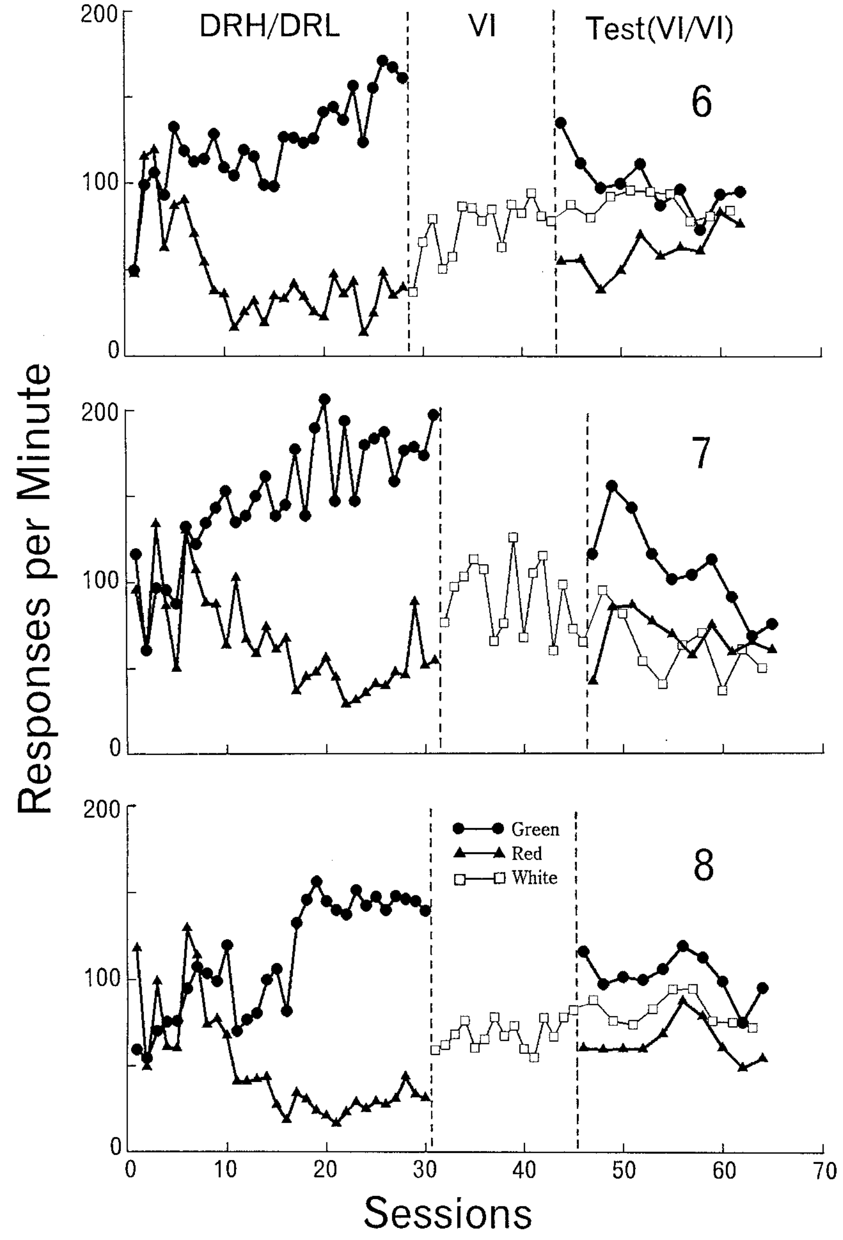

Fig. 1. Response rates over successive conditions of Cycle 1 of Part 1, in the multiple DRH DRL schedule, the VI baseline, and in the test phase for 3 pigeons. In the first phase, the DRH schedule (the final values were 0.20 s for Pigeon 6, 0.14 s for Pigeon 7, and 0.22 s for Pigeon 8) was assigned to the green key and the DRL 3-s schedule was assigned to the red key. In the test phase, VI baseline sessions with a white keylight alternated every other session with sessions in which the keylights were green and red. The values of the VI schedules were 9 s for Pigeon 6, 6 s for Pigeon 7, and 7 s for Pigeon 8.

The data from the second cycle, shown in Figure 2, reveal the rapid reversal of the differentiated response rates with reversal of the assignments of the DRH and DRL schedules to green and to red during the multiple-schedule phase: For all 3 pigeons, rates became high during red and low during green. As in the first cycle, responding in the VI baseline phase began at a rate intermediate to the high DRH and low DRL rates, and rate

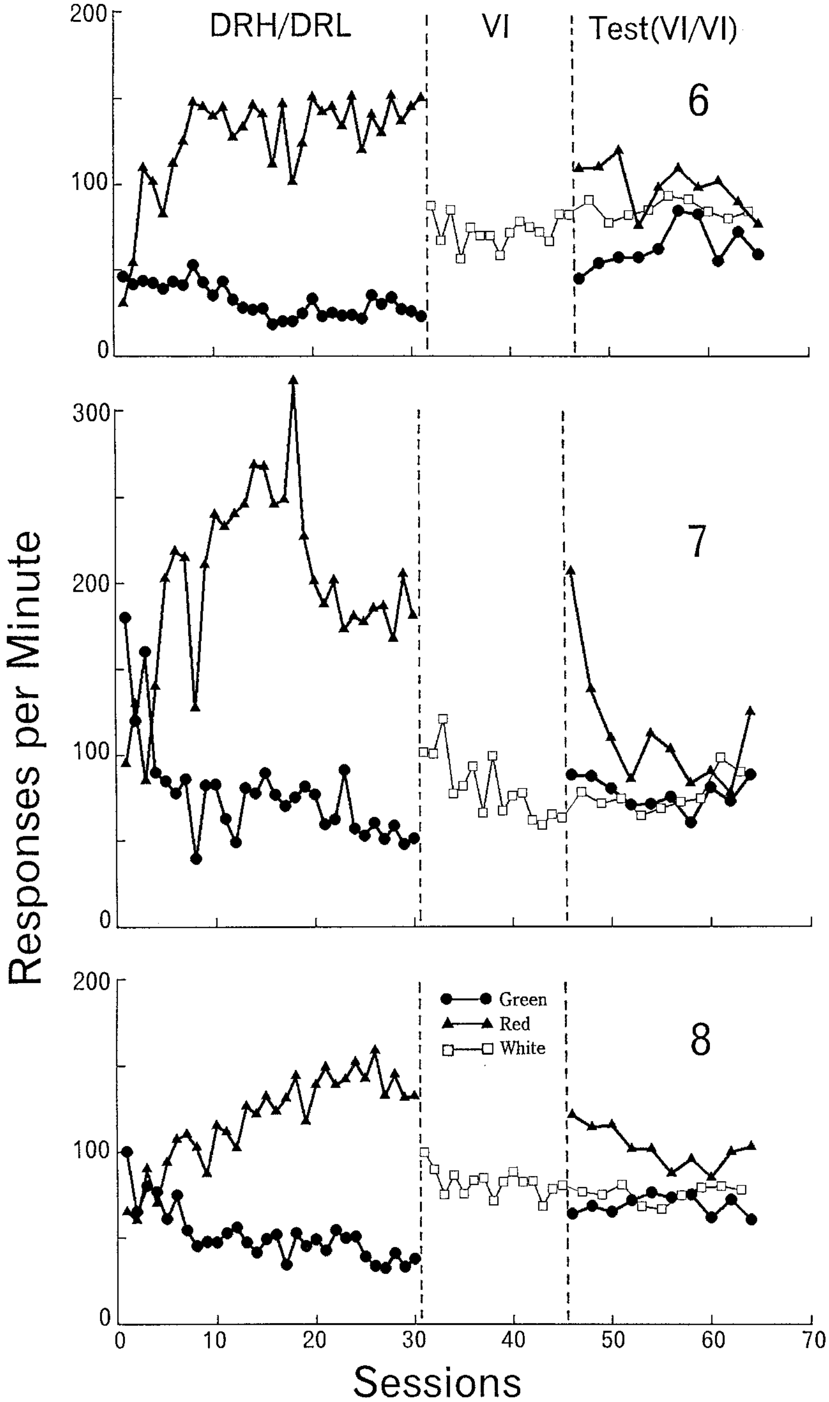

Fig. 2. Response rates over successive conditions of Cycle 2 of Part 1, in the multiple DRH DRL schedule, the VI baseline, and in the test phase for 3 pigeons. In the first phase, the assignment of the key color was reversed from what it had been in Cycle 1: The DRH schedule (the final values were 0.30 s for Pigeon 6, 0.14 s for Pigeon 7, and 0.25 s for Pigeon 8) was assigned to the red key and the DRL 3-s schedule was assigned to the green key. In the test phase, VI baseline sessions with a white keylight alternated every other session with sessions in which the keylights were green and red. The values of the VI schedules were 8 s for Pigeon 6, 7 s for Pigeon 7, and 7 s for Pigeon 8.

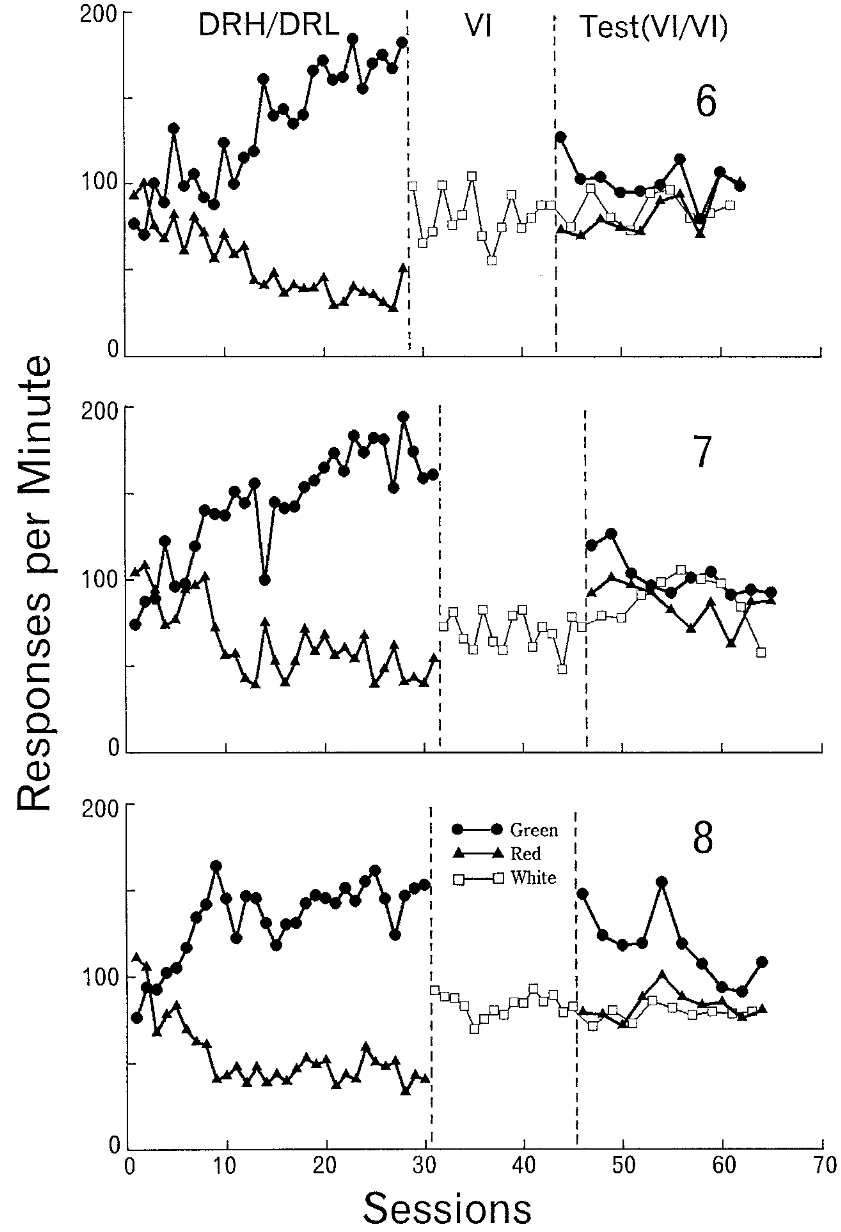

Fig. 3. Response rates over successive conditions of Cycle 3 of Part 1, in the multiple DRH DRL schedule, the VI baseline, and in the test phase for 3 pigeons. In the first phase, the assignment of the key color was reversed from what it had been in Cycle 2: the DRH schedule (the final values were 0.22 s for Pigeon 6, 0.15 s for Pigeon 7, and 0.22 s for Pigeon 8) was assigned to the green key and the DRL 3-s schedule was assigned to the red key. In the test phase, VI baseline sessions with a white keylight alternated every other session with sessions in which the keylights were green and red. The values of the VI schedules were 8 s for Pigeon 6, 6 s for Pigeon 7, and 6 s for Pigeon 8.

differences consistent with the most recent red and green schedule histories appeared at the start of the test phase and decreased over test sessions. Again, even after 10 test sessions, rates during the former DRH stimulus were higher than those during the former DRL stimulus for all 3 birds.

As shown in Figure 3, similar effects of schedule history were obtained in the third cycle after another reversal, back to the orig-

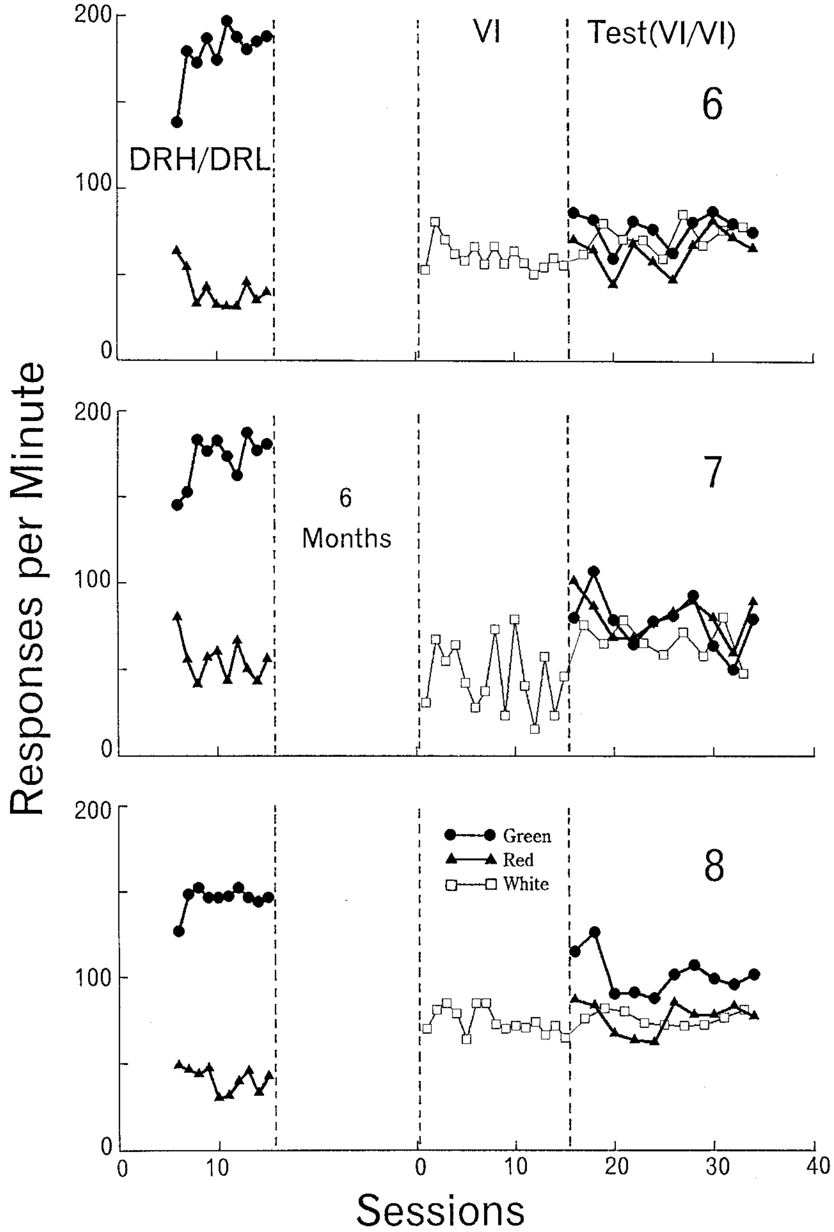

Fig. 4. Response rates over successive conditions of Cycle 1 of Part 2, in the multiple DRH DRL schedule, the VI baseline, and in the test phase. In the first phase, the DRH schedule (the final values were 0.22 s for Pigeon 6, 0.15 s for Pigeon 7, and 0.22 s for Pigeon 8) was assigned to the green key and the DRL 3-s schedule was assigned to the red key. In the test phase, VI baseline sessions with a white keylights alternated every other session with sessions in which the keylights were green and red. The values of the VI schedules were 8 s for Pigeon 6, 6 s for Pigeon 7, and 6 s for Pigeon 8.

inal assignment of DRH to green and DRL to red. These effects were smaller than those of the preceding cycles, and for Pigeon 6 the difference in response rates became negligible by the end of the test phase. It should be noted that the rate differences occurred on almost all test sessions, although the magnitude of response-rate differences tended to diminish across reversals.

Figures 4 and 5 show the data from, re-

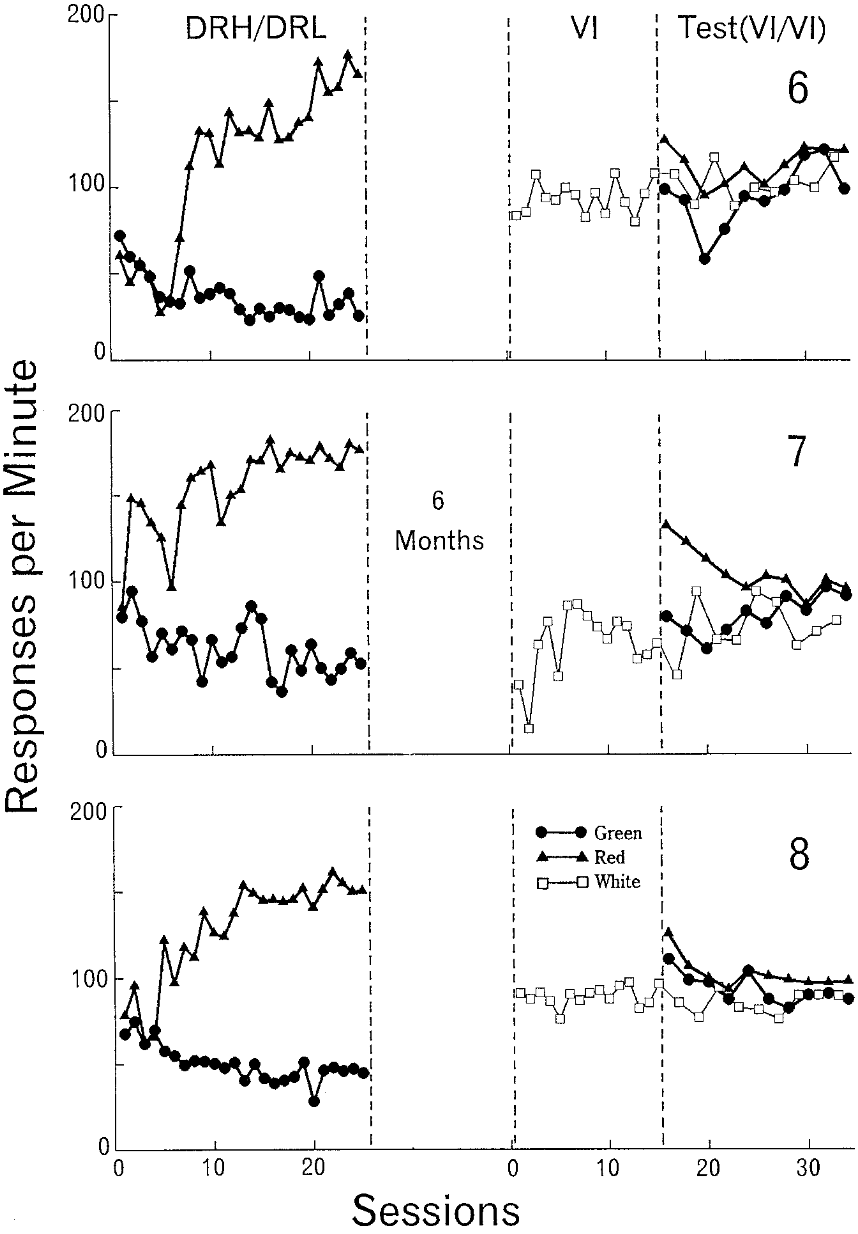

Fig. 5. Response rates over successive conditions of Cycle 2 of Part 1, in the multiple DRH DRL schedule, the VI baseline, and in the test phase. In the first phase, the assignment of the key color was reversed: The DRH schedule (the final values were 0.23 s for Pigeon 6, 0.116 s for Pigeon 7, and 0.20 s for Pigeon 8) was assigned to the red key and the DRL schedule was assigned to the green key. In the test phase, VI baseline sessions with a white keylight alternated every other session with sessions in which the keylights were green and red. The values of the VI schedules were 8 s for Pigeon 6, 6 s for Pigeon 7, and 6 s for Pigeon 8.

spectively, the first and second cycles of Part 2. In the first cycle, the rate differentiation was quickly established in the schedule history phase. Six months later, the effects of those histories were small relative to those found in Part 1. Across all test sessions, only Pigeons 6 and 8 showed reliable rate differences that were consistent with the preceding schedule histories (higher rates during green, the most recent DRH stimulus, than during red, the most recent DRL stimulus). For Pigeon 7, the VI rate during the baseline phase was relatively low and rate differences were inconsistent across the test sessions.

In the second cycle, in which the correlation of rate contingencies with key colors was reversed during the schedule history phase, the rate differentiation with reversal of contingencies was again completed quickly. In the second and third phases 6 months later, history effects were again small, but they were more consistent across all 3 birds than in the first cycle. In almost all test sessions, rates during red, the most recent DRH stimulus, were higher than those during green, the most recent DRL stimulus (the only exception was one test session for Pigeon 8).

DISCUSSION

Previous studies showed that responding maintained by current contingencies was affected by earlier contingencies that immediately preceded them (e.g., Weiner, 1969). Unlike those studies, the present experiments examined the effects of remote past histories on performances on current VI schedules. Part 1 of the experiment showed that different schedule histories in the presence of different stimuli affected current performances in the presence of those stimuli, even though current contingencies in the presence of those stimuli were identical VI schedules. Three aspects of these findings were that, first, the history effects occurred even though the current contingencies were separated from the schedule history by the VI baseline and therefore were not contiguous with it; second, the current responding was strongly affected by the most recent contingency; and third, cumulative exposure to the series of contingencies reduced the magnitude of history effects. Part 2 also demonstrated that schedule history has its effects even when that history has taken place in the remote past (6 months earlier). The relative effects of the most recent and earlier contingencies in Part 2 were similar to those in Part 1.

On the whole, the findings are consistent with those of prior studies. For example, in three experiments, Freeman and Lattal (1992) demonstrated the persisting effect of stimulus control history on behavior maintained by subsequent contingencies (FI or VI schedules). One merit of examining history effects under the same contingencies that are correlated with distinctive stimuli is that within-subject comparisons among the several different contingencies are possible. Experiment 3 of Freeman and Lattal (1992) succeeded in this comparison by using a multiple schedule in which component schedules that controlled high and low response rates alternated several times within each session. Although the schedule parameters were not the same as those used here (they used multiple tandem VI FR 10 tandem VI DRL 5 s for the acquisition phase and VI 100 s or VI 300 s for the test phase), the present experiment also successfully demonstrated the history effects with the same contingencies in different multiple-schedule components within a session.

An advantage of the present experiment was to separate prior exposures to contingencies from exposure to the current contingency by insertion of the VI baseline phase. In general, when one contingency changes to another under the same stimulus setting, the organism's behavior is said to be in a transition state (Sidman, 1960), implying that past contingencies continue to exert transient control over current responding.

One finding of the present study was that pigeons showed distinctive effects of history even after long periods of time and intervening baseline training in the presence of a different discriminative stimulus. Apparently, the passage of time without exposure to the historical contingencies does not weaken their persisting effects. Examination of the present data, however, shows that the magnitude of the history effects became smaller over successive test sessions. In other words, history effects decreased with continued exposure to new contingencies that operated in the presence of the old stimuli (Cohen et al., 1994; Freeman & Lattal, 1992).

A second finding from the present experiments was that with successive reversals of the keylights correlated with each schedule component, the contingency experienced most recently before the test appeared to exert a strong influence on subsequent responding. This was common to history effects after both short and long interruptions. LeFrancois and Metzger (1993) found a similar effect when a remote DRL history had minimal effects upon subsequent FI responding, but an immediately prior FR history had a substantial effect upon FI responding. Those results appear to be inconsistent with findings from similar research with humans, who responded at low rates in FI conditions after a history under DRL followed by exposure to an FR schedule (Weiner, 1969). These discrepant findings regarding the influence of more remote exposure to contingencies may be due to factors that are correlated with the different species of subjects: humans in Weiner's (1969) study and nonhumans in LeFrancois and Metzger's (1993) study and in the present experiment.

A third finding was that cumulative exposures to the several contingencies reduced the effects of history. This smaller effect with repeated reversals may be evidence that the earlier contingencies still affected later responding, despite the appearance that current responding was affected mainly by the most recent contingency. In other words, the effect in the second reversal may be smaller because the large effect of the most recent contingencies has combined with a smaller effect of the contingencies from the first cycle, working in the opposite direction from the most recent contingencies. Branch (1991) pointed out that although histories can be arranged or prevented, once they have occurred they can never be eliminated. Older behavior sometimes returns even though it has been absent for a long time, and this means that earlier histories continue to have an effect along with more recent ones.

REFERENCES

Alleman, H. D., & Zeiler, M. D. (1974). Patterning with fixed-time schedules of response-independent reinforcement. *Journal of the Experimental Analysis of Behavior, 22,* 135–141.

Baron, A., & Leinenweber, A. (1995). Effects of a variable-ratio conditioning history on sensitivity to fixed-interval contingencies in rats. *Journal of the Experimental Analysis of Behavior, 63,* 97–110.

Barrett, J. E. (1977). Behavioral history as a determinant of the effects of *d*-amphetamine on punished behavior. *Science, 198,* 67–69.

Branch, M. N. (1991). On the difficulty of studing "basic" behavioral processes in humans. *The Behavior Analyst, 14,* 107–110.

Cohen, S. L., Pederson, J., Kinney, G. G., & Myers, J. (1994). Effects of reinforcement history on responding under progressive-ratio schedules of reinforcement. *Journal of the Experimental Analysis of Behavior, 61,* 375–387.

Fors, S. W., & Rojek, D. G. (1991). A comparison of drug involvement between runaways and school youths. *Journal of Drug Education, 21,* 13–25.

Freeman, T. J., & Lattal, K. (1992). Stimulus control of behavioral history. *Journal of the Experimental Analysis of Behavior, 57,* 5–15.

Johnson, L. M., Bickel, W. K., Higgins, S. T., & Morris, E. K. (1991). The effects of schedule history and the opportunity for adjunctive responding on behavior during a fixed-interval schedule of reinforcement. *Journal of the Experimental Analysis of Behavior, 55,* 313–322.

Kasprow, W. J., Schachtman, T. R., & Miller, R. R. (1987). The comparator hypothesis of conditioned response generation: Manifest conditioned excitation and inhibition as a function of relative excitatory strengths of CS and conditioning context at the time of testing. *Journal of Experimental Psychology: Animal Behavior Processes, 13,* 395–406.

LeFrancois, J. R., & Metzger, B. (1993). Low-response-rate conditioning history and fixed-interval responding in rats. *Journal of the Experimental Analysis of Behavior, 59,* 543–549.

Long, E. R., Hammack, J. T., May, F., & Campbell, B. J. (1958). Intermittent reinforcement of operant behavior in children. *Journal of the Experimental Analysis of Behavior, 1,* 315–339.

Messing, R. B., Kleven, M. S., & Sparber, S. B. (1986). Delaying reinforcement in an autoshaping task generates adjunctive and superstitious behaviors. *Behavioral Processes, 13,* 327–338.

Nader, M. A., & Thompson, T. (1987). Interaction of methadone, reinforcement history, and variable-interval performance. *Journal of the Experimental Analysis of Behavior, 48,* 303–315.

Parker, S. R. (1985). Future directions in behavioral research related to lung diseases. *Annals of Behavioral Medicine, 7,* 21–25.

Pierce, W. D., & Belke, T. W. (1988). Stimulus control of consumer opinion by brand names: A social conditioning analysis. *Psychological Record, 38,* 227–236.

Poling, A., Krafft, K., & Chapman, L. (1980). *d*-Amphetamine, operant history, and variable-interval performance. *Pharmacology Biochemistry and Behavior, 12,* 559–562.

Sidman, M. (1960). *Tactics of scientific research.* New York: Basic Books.

Swartzentruber, D., & Bouton, M. E. (1992). Context sensitivity of conditioned suppression following preexposure to the conditioned stimulus. *Animal Learning & Behavior, 20,* 97–103.

Tatham, T. A., Gyorda, A. M., & Barrett, J. E. (1993). Generalization of behavioral history across responses in the reversal of the effects of cocaine and *d*-amphetamine on the punished behavior of squirrel monkeys. *Behavioral Pharmacology, 4,* 61–68.

Tatham, T. A., Wanchisen, B. A., & Yasenchack, M. P. (1993). Effects of differential-reinforcement-of-low-rate schedule history on fixed-interval responding. *The Psychological Record, 43,* 289–297.

Urbain, C., Poling, J. M., Millam, J., & Thompson, T. (1978). *d*-Amphetamine and fixed-interval performance: Effects of operant history. *Journal of the Experimental Analysis of Behavior, 29,* 385–392.

Wanchisen, B. A., Tatham, T. A., & Mooney, S. (1989). Variable-ratio conditioning history produces high- and low-rate fixed-interval performance in rats. *Journal of the Experimental Analysis of Behavior, 52,* 167–179.

Weiner, H. (1964). Conditioning history and human fixed-interval performance. *Journal of the Experimental Analysis of Behavior, 7,* 383–385.

Weiner, H. (1965). Conditioning history and maladaptive human operant behavior. *Psychological Reports, 17,* 935–942.

Weiner, H. (1969). Controlling human fixed-interval performance. *Journal of the Experimental Analysis of Behavior, 12,* 349–373.

Received February 1, 1996
Final acceptance January 8, 1997