UNINSTRUCTED HUMAN REPONDING: SENSITIVITY TO RATIO AND INTERVAL CONTINGENCIES[1]

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College students' presses on a telegraph key were occasionally reinforced by light onsets in the presence of which button presses (consummatory responses) produced points later exchangeable for money. One student's key presses were reinforced according to a variable-ratio schedule; key presses of another student in a separate room were reinforced according to a variable-interval schedule yoked to the interreinforcement intervals produced by the first student. Instructions described the operation of the reinforcement button, but did not mention the telegraph key; instead, key pressing was established by shaping. Performances were comparable to those of infrahuman organisms: variable-ratio key-pressing rates were higher than yoked variable-interval rates. With some yoked pairs, schedule effects occurred so rapidly that rate reversals produced by schedule reversals were demonstrable within one session. But sensitivity to these contingencies was not reliably obtained with other pairs for whom an experimenter demonstrated key pressing or for whom the reinforcer included automatic point deliveries instead of points produced by button presses. A second experiment with uninstructed responding demonstrated sensitivity to fixed-interval contingencies. These findings clarify prior failures to demonstrate human sensitivity to schedule contingencies: human responding is maximally sensitive to these contingencies when instructions are minimized and the reinforcer requires a consummatory response.

Key words: instructions, shaping, yoked VR-VI, FI, point reinforcers, consummatory response, telegraph keys, humans

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Infrahuman organisms such as pigeons and rats are sensitive to the contingencies established by different schedules of reinforcement. For example, ratio contingencies, in which responses are selected for reinforcement on the basis of the number of responses that have been emitted, typically maintain higher rates of responding than interval contingencies, in which responses are selected for reinforcement on the basis of the time at which they occur. Human performance, however, has often been found insensitive to these and related contingencies. For example, Lattal (1974) found that response-dependent reinforcers maintained higher response rates in pigeons than response-independent reinforcers, but Streifel (1972) found no difference in the response rates maintained by response-dependent and response-independent reinforcers with two of three humans. Herrnstein (1970) found that the proportion of a pigeon's total responses maintained by each of two concurrent variable-interval schedules approximately matched the proportion of the total reinforcers provided by each schedule, but Schmitt (1974) failed to obtain such matching with human concurrent responding. In fixed-interval (FI) performances, infrahuman responding is typically characterized by a scallop (i.e., a postreinforcement pause followed by a gradually increasing response rate within individual intervals: Ferster and Skinner, 1957), but the FI performance of humans is commonly characterized by high rates without postreinforcement pauses (e.g., Weiner, 1969, 1970). Yet an organism's sensitivity to schedule contingencies is simply sensitivity to the differential consequences of its own behavior, and it is puzzling that human responding often appears less sensitive than that of other species.

The sensitivity of human performance to schedule contingencies can be manipulated experimentally. Such sensitivity has been modified by arranging prior exposure to schedules that differentially reinforce long interresponse times (Weiner, 1964), by giving instructions and schedule descriptions (Baron, Kaufman, and Stauber, 1969), by adding an exteroceptive clock, a stimulus correlated with the passage of time (Long, 1963), and by arranging response cost or point penalties for responding (Weiner, 1962). Also, unlike procedures in which button presses produce point counts, procedures that use novel stimulus displays as reinforcers (Long, Hammack, May, and Campbell, 1958) or that reinforce observing responses with signal detections (Holland, 1958) seem typically to enhance sensitivity of human performance to schedule contingencies, at least in the sense that they generate scalloping in human FI responding. Further, laboratory procedures commonly used with humans differ in many ways from standard operant protocols. Thus, human insensitivity to contingencies may be attributed to several variables: the types of reinforcers typically provided for humans (*e.g.*, point counts *versus* food); the topographical properties of responses (*e.g.*, high *versus* low force); the details of reinforcer delivery (*e.g.*, presence *versus* absence of a consummatory response); and the method of initiating responding (*e.g.*, instructions *versus* shaping).

It may be that points delivered on a counter do not serve as reinforcers for some subjects, or that points are such weak reinforcers that their effects are masked by other variables operating in the experimental setting. Human responding therefore may sometimes be maintained by instructional control or by "demand characteristics" (Orne, 1962), rather than by point deliveries. Such a possibility exists because many studies of human operant performances have not assessed reinforcer efficacy.

Response force is another variable that may contribute to the relative insensitivity of human performance. Force requirements with human subjects are typically low relative to body weight; lever pressing, on the other hand, is a high-force response relative to the body weight of a rat. Thus, it may be argued that human responding is sensitive to schedule contingencies to the extent that responding requires gross postural adjustments, high force, or some other form of "response cost" (Mat-

thews and Shimoff, 1974). Although the potential role of response force finds some support in the literature (Azrin, 1958; Long, 1963), its effects have not been systematically analyzed. In addition, data seem contradictory. Key pecks in pigeons are presumably low-force responses, but their sensitivity to schedule contingencies is well known. Conversely, Holland (1958) reported FI scalloping in human performances with low-effort observing responses. Thus, for the range of force requirements typically encountered in the laboratory, sensitivity to schedule contingencies appears relatively independent of response force.

The present research assumed that differences between infrahuman and human operant performances stem in part from typical procedural differences in establishing responding and delivering reinforcers. First, with infrahuman subjects, responses (*e.g.*, key pecks) are established through shaping; with humans, however, responses (*e.g.*, button presses) are established through verbal instruction or demonstration. Second, with infrahuman subjects, the reinforcement cycle usually includes both highly discriminable visual and auditory stimulus changes and a distinct consummatory response (*e.g.*, eating) that interrupts ongoing operant behavior; on the other hand, the point deliveries that presumably maintain human responding usually involve less marked stimulus changes (*e.g.*, the flash of a light next to the point counter) and no consummatory response is required. The present research established responding through shaping, rather than through instruction, and used a reinforcement cycle that was highly discriminable and that required an explicit consummatory response.

EXPERIMENT I

The yoking of variable-ratio (VR) and variable-interval (VI) schedules provides a test of the effects of these procedural changes on the sensitivity of human performance to schedule contingencies. In research with pigeons, sensitivity to contingencies is demonstrated when higher response rates are maintained by ratio than by interval schedules (Killeen, 1967; Zuriff, 1970). The present procedure was analogous to that of Ferster and Skinner (1957, p. 399), in which one pigeon's pecks were reinforced according to a VI schedule in which successive interreinforcement intervals were de-

termined by those produced by the VR pigeon. In such a yoking procedure, differences in response rate between the two organisms must be attributed to differences in the ratio and interval contingencies, because the temporal distributions of reinforcers are virtually equivalent for the two organisms over the range of response rates that are typically maintained by these schedules. Human performances generated by these yoked schedules were examined when responding was established either by shaping or by demonstration and when reinforcers either required or did not require an explicit consummatory response.

METHOD

Subjects and Apparatus

Thirty-eight students, whose participation was an option in satisfying Introductory Psychology course requirements, were paired according to time of mutual availability. Each member of a pair was seated in an individual sound-attenuating cubicle and faced a console containing a reinforcement button 15.0 cm below an earnings counter that was mounted between two red reinforcement lamps. Presses of at least 15.0 N on the 2.4-cm diameter red reinforcement button produced counts on the earnings counter when the red reinforcement lamps were lit. Between the reinforcement button and the earnings counter were an amber lamp labelled "WAIT" and a green lamp labelled "SESSION ON". The operandum, a telegraph key requiring 1.9 N for operation, was mounted on the table directly in front of the console. The frame and contacts of the telegraph key were covered by a 10.0- by 12.5- by 8.0-cm aluminum Minibox, so that only the 2.7-cm diameter black key was visible. Each press on the key caused the SESSION ON lamp to blink off for approximately 30 msec and, according to the schedules described below, occasionally lit the reinforcement lamps for 2 sec. White noise was presented through headphones to eliminate auditory cues from the scheduling apparatus, located in an adjacent room. Participants could not see each other during the session, but could be observed by the experimenters through one-way windows.

Procedure

Instructions. After being escorted into the cubicles, participants were asked to read the following instructions mounted on the wall above the console (the bracketed sentence was deleted for the no-consummatory-response procedure described below):

> Please read carefully. Do not ask for additional information about what you are to do.
>
> Your task is to earn as many points as you can. Points are shown on the counter at the center of the console. Each point is worth .1¢. For example, if you earn 2000 points, you will be paid $2.00. [Whenever the RED LIGHTS beside the counter are on, each press on the RED BUTTON will add one point to your total.]
>
> The YELLOW LIGHT above the red button is a "wait" light: while the yellow light is on, the equipment is temporarily disconnected.
>
> The session will begin when the GREEN LIGHT comes on. Put on the headphones now and do not remove them until the session is over.

Shaping. The reinforcement cycle consisted of a 2-sec illumination of the reinforcement lamps beside the counter, during which each press on the reinforcement button produced a point. The reinforcement cycle was initiated by presses on the telegraph key or, during shaping, by an experimenter-observer. All subjects began pressing the reinforcement button within the first few reinforcement cycles; thus, rate and latency of button pressing were not used as criteria for advancing to subsequent stages of the procedure.

Responding on the telegraph key was established by reinforcing successively closer approximations to a key press; two experimenters were present so that shaping could proceed simultaneously with both participants. In most cases, key pressing was shaped within 10 min. After the first reinforcement cycle, some participants sat motionless with a finger on the reinforcement button (perhaps analogous to head-in-feeder behavior sometimes encountered during preliminary training with pigeons). In such cases, movements away from the button and downward toward the telegraph key were reinforced. In a few cases, reinforcement of visual orientation toward the key appeared to be effective. When 25 successive key presses were reinforced for one member of the pair, that member's WAIT light

was lit while shaping continued with the other member. Because it was necessary to shape key pressing, it may be assumed that participants had little information about experimental procedures before entering the laboratory.

Reinforcement schedules. Once both members had completed 25 reinforced presses, their reinforcement schedules were yoked for the remainder of the session. One person was assigned to the VR schedule; whenever a key press was reinforced, reinforcement was also arranged for the next key press by the other (yoked) member of the pair. Thus, key pressing by the yoked member was reinforced according to a VI schedule in which interreinforcement times were determined by and approximately equal to those of the VR member. For the yoked VI member, reinforcers could be accumulated, *e.g.*, if six VR reinforcers occurred before a VI key press occurred, each of the next six key presses by the VI member was reinforced.

The ratio requirement began at VR 5 and was gradually increased to VR 25 over 50 reinforcements according to a predetermined sequence. After a brief interruption (signalled by the WAIT light), a VR 30 schedule was put into effect for the final 64 min. In two pairs (8 and 16), a fixed-ratio (FR) schedule was used in place of the VR 30 schedule.

Procedural variations. For seven pairs (2, 3, 6, 11, 14, 1NC, 3NC), the 64 min of VR 30 were followed by 16 min of extinction, during which the reinforcement cycle was never initiated. In three pairs (4, 12, 13), the VR and yoked VI schedule assignments were reversed for the two members during the 64-min session. For five pairs (4, 10, 11, 12, 1NC), key pressing for one of the two pair members was established by a demonstration (D) procedure rather than by shaping because time constraints precluded extensive preliminary training. After brief attempts at shaping the key press, an experimenter entered the cubicle and pressed the key, producing the reinforcement lights; no vocal interaction took place. In each instance, this demonstration procedure rapidly established key pressing.

Finally, for five pairs (1NC through 5NC), no consummatory response was required. For these pairs, the reinforcement button was disconnected; in the nonconsummatory (NC) procedure, the key press was reinforced by the addition of a point to the counter accompanied by a 1-sec illumination of the red lights. In addition, the red pushbutton was eliminated from the instructions (see bracketed section), and the value of a point was increased to 0.5¢ to maintain comparability of earnings (typically in a range from $2 to $4 per session).

RESULTS

Response rates for the first and last 16-min segments of the final 64 min of the session are shown in Table 1; the table does not include data for Pairs 4, 12, and 13, for whom schedule reversals were introduced. In Pairs 6 and 7, rate changes developed during the final 16 min, and the session was therefore extended an extra 16 min; response rates during this additional period are shown in parentheses.

For the consummatory-response version of the procedure (all but Pairs 1NC through 5NC), terminal ratio rate exceeded the corresponding yoked VI rate in every pair. No correlation was found between number of consummatory responses during reinforcement cycles and telegraph-key rate. Initial and terminal rates show that, except in Pairs 2, 6, and 11, ratio rate either increased or remained stable over the session; VI rate declined in all but Pairs 1 and 2, in which rates were initially very low, and Pairs 10 and 11, for whom key pressing had been demonstrated.

Figures 1 through 3 show cumulative records that bracket the entire range of performances obtained when the consummatory response was required and the key press was shaped: a median or "typical" pair, the pair with the highest VI rate, and the pair with the lowest VR rate. Pair 3 represents a median case: a high, steady VR rate (Figure 1, top record), with a substantially lower rate maintained by the yoked VI schedule (Figure 1, bottom record). In this pair, rates became different even during the transition from VR 5 to VR 25.

In Pair 14 (Figure 2), VI rate exceeded VR rate for most of the session: this terminal VI rate was the highest observed. Nevertheless, the grain of the records shows that differences in local response variability and patterning developed under the two schedules, with VI rate decreasing toward the end of the session. The differential effects of interval and ratio contingencies were also evident during extinction in this pair. After a ratio history, extinction responding was marked by a high rate interrupted by pauses ("break and run"); ex-

Table 1

Rates of key pressing (responses per minute) in the first and fourth 16-min segments of yoked ratio and interval schedules. All schedules are variable (VR or VI), unless fixed ratio (FR) is indicated. Numbers in parentheses show rates in a fifth 16-min period. The response was demonstrated (D) for the VI members of Pairs 10 and 11, and for the VR member of Pair 1NC. For pairs labelled NC, no consummatory response was required. Data are omitted for pairs with schedule reversals. Additional details in text.

Pair	Ratio Schedule		Yoked Interval Schedule	
	First 16 min	*Fourth 16 min*	*First 16 min*	*Fourth 16 min*
1	77.1	162.7	13.5	22.9
2	125.3	78.0	15.8	30.1
3	210.5	225.0	31.9	21.2
5	108.2	257.0	126.2	44.4
6	439.5	264.6 (252.8)	327.3	164.8 (38.3)
7	114.7	107.5 (115.7)	269.8	150.9 (11.4)
14	237.1	257.6	278.3	145.4
10	227.6	278.7	220.0 (D)	257.8
11	257.4	239.0	124.7 (D)	208.0
8	198.8 (FR)	251.5	66.1	12.1
16	348.5 (FR)	386.3	182.9	66.8
1NC	259.4 (D)	229.0	76.8	194.8
2NC	207.7	228.4	15.8	23.9
3NC	132.1	334.1	117.9	142.4
4NC	133.8	129.9	136.6	224.9
5NC	191.4	154.2	253.4	35.8

tinction after VI reinforcement was characterized by a more gradual rate decline, although occasional high-rate runs appeared.

The lowest ratio rate was observed in Pair 2 (Figure 3, top record). The break-and-run pattern of responding by the VR subject both dur-
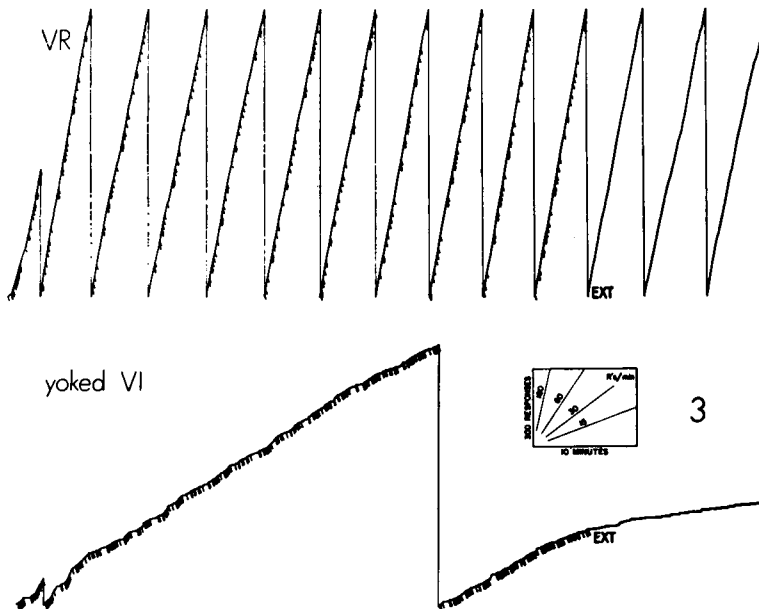

Fig. 1. Cumulative records of key pressing maintained by the VR 30 and yoked VI schedules for Pair 3. Reinforcement cycles required consummatory responses. Both pens were reset after preliminary training, when the VR 30 and yoked VI schedules were first introduced. The responding of this pair was characterized by a high, steady VR rate and a lower yoked VI rate; rates also differed in extinction (EXT).
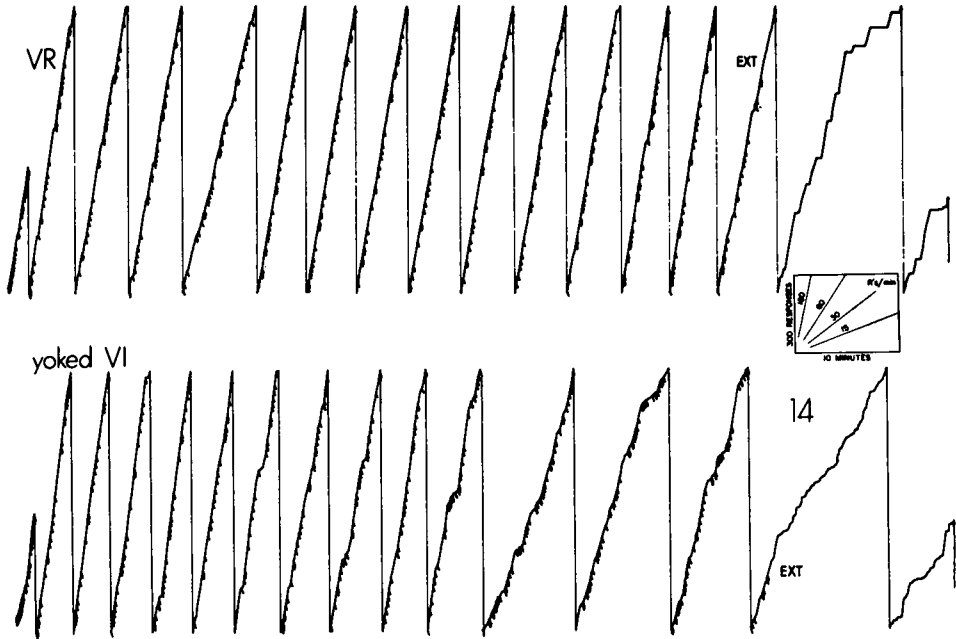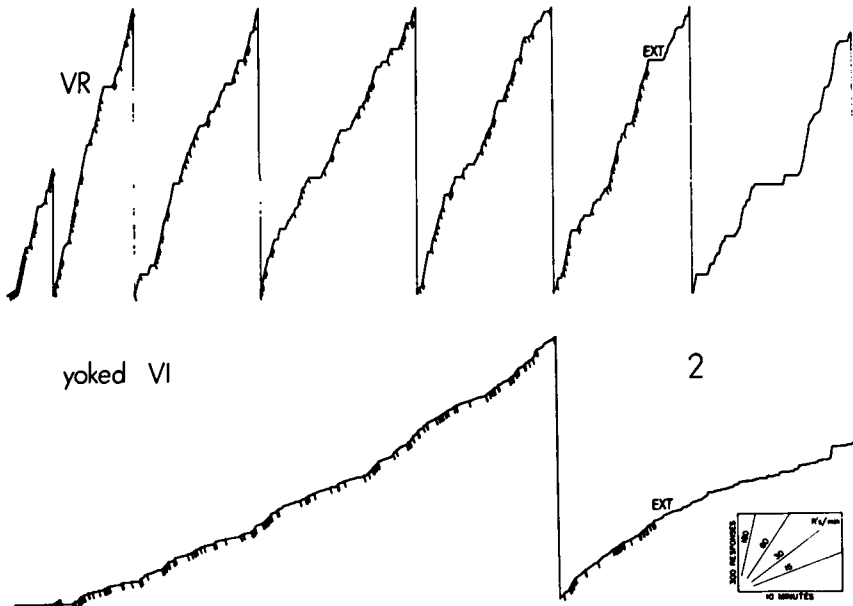
Fig. 2. Cumulative records for Pair 14. The terminal VI rate in this pair was the highest obtained when a consummatory response was required.

ing maintained responding and during extinction was, however, very unlike the smoother, lower-rate performance of the yoked VI member of the pair. For the VI member (bottom record), because reinforcers accumulated during the initial period when no responding occurred, the first few responses were all reinforced; low rates followed for the remainder of the season and decreased further during extinction.

Fig. 3. Cumulative records for Pair 2. The terminal VR rate in this pair was the lowest obtained when a consummatory response was required.
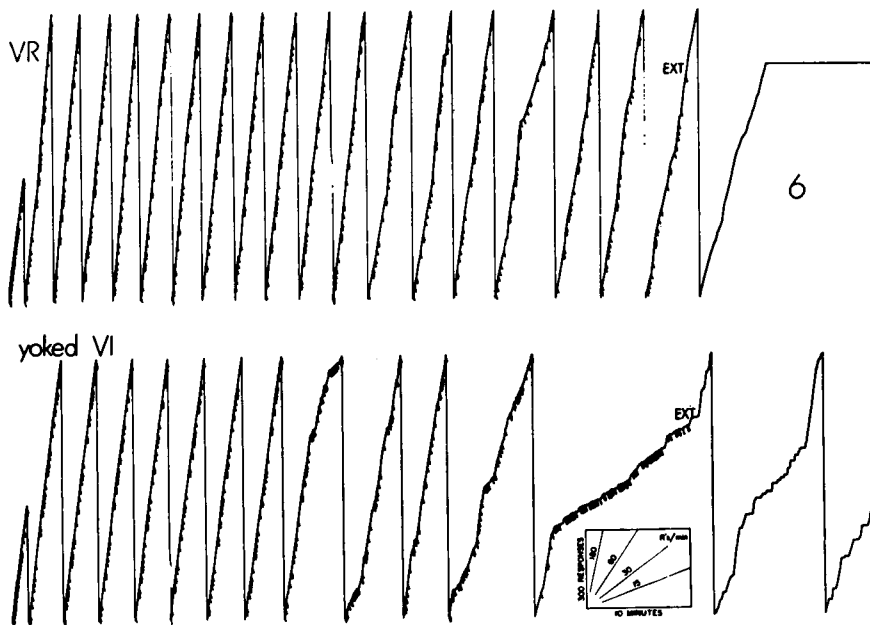
Fig. 4. Cumulative records for Pair 6. The shift from a high to a low VI rate was abrupt and occurred relatively late in the session.

Sometimes, as in Pair 6 (Figure 4), the shift from a high to a low VI rate was abrupt. In that pair, a gradual decrease in VI rate was followed by a sudden shift to a low rate near the end of the session (bottom record). This was the only case in which break-and-run re-sponding was observed in extinction following VI reinforcement with a required consummatory response.

In Pairs 10 and 11, key pressing was established for the VI member by demonstration rather than by shaping (the key press was also
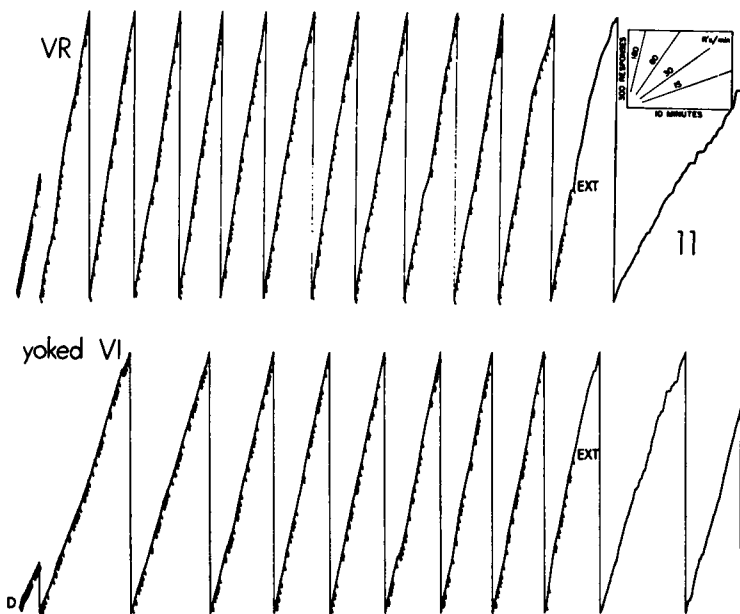

Fig. 5. Cumulative records for Pair 11. Key pressing was established for the VI member by demonstration (D) rather than by shaping, and VI rate increased over the session.
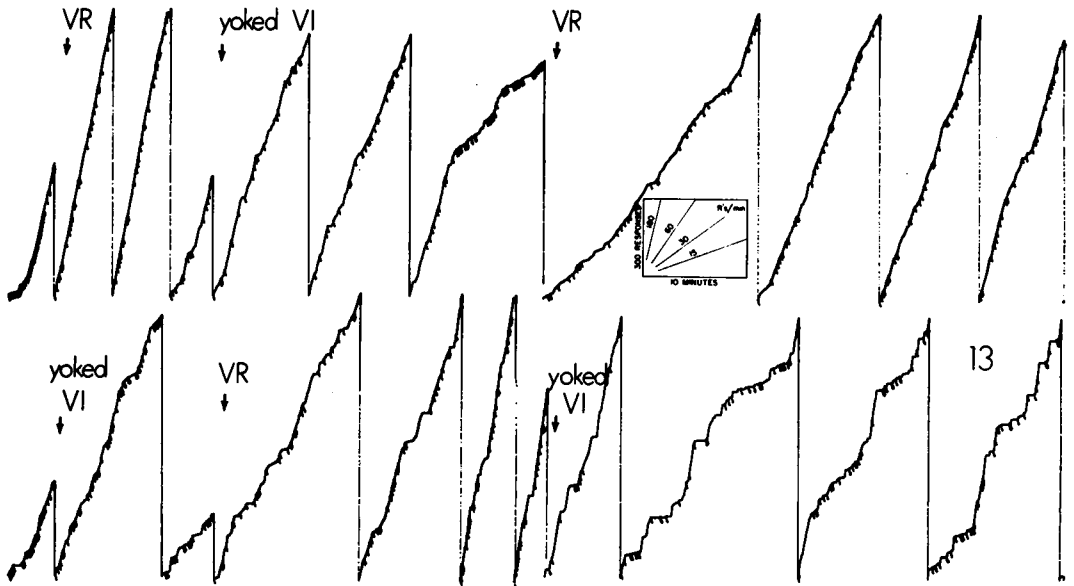
Fig. 6. Cumulative records for Pair 13. Schedules were reversed at the second and third pairs of arrows; response rates changed accordingly for both subjects.

demonstrated for one member of Pairs 4, 12, and 1NC, discussed separately below). In Pair 11 (Figure 5), the initial moderate VI rate gradually increased to levels approximating those maintained by the VR schedule. Data for Pair 10 were similar (Table 1).

In three pairs, schedule assignments were reversed with no exteroceptive cues in mid-session. Schedules were reversed twice for Pair 13 (Figure 6) and response rates changed as a function of reinforcement schedule. For the VR→VI→VR subject, the high rate initially maintained by the VR schedule decreased under the yoked VI schedule and increased when the VR schedule was reintroduced (top record). For the VI→VR→VI member, the moderate VI rate increased after the change to the VR schedule and decreased when the VI schedule was again in effect.

In Pair 12 (Figure 7), schedule assignments were also reversed twice during the session. No rate differences attributable to schedules were evident for the VR→VI→VR member, for whom the response had been demonstrated (top record). For the VI→VR→VI member, the initially moderate VI rate increased under the ratio contingency and decreased when the yoked VI was reintroduced.

In Pair 4 (Figure 8), schedules were reversed once, and the key press was demonstrated for the VI→VR member. For that subject (bottom record) the moderate rate maintained by the yoked VI schedule increased over the remainder of the session, during which the VR schedule was in effect. This rate increase could indicate control by the ratio contingency, but in this respect the record also resembles those produced by other VI subjects for whom responding had been demonstrated (*e.g.*, Pair 11, Figure 5). For the VR→VI member (shaped key press), the high VR rate decreased when the yoked VI schedule was introduced.

For Pair 16 (Figure 9), the 64-min session began with FR 30 (instead of VR), which was then increased to FR 60 and finally to FR 120. For the ratio member (top record), high steady responding developed quickly and continued through most of the session; postreinforcement pauses occurred toward the end of the session. The constant FR rate produced relatively stable interreinforcement times, so that the yoked VI schedule approximated a fixed-interval schedule. For the interval member (bottom record), the initially high rate decreased by the end of the session to levels similar to those observed in other pairs; scalloping is suggested in some segments of the record. Similar data were obtained for Pair 8 (Table 1).

In Pairs 1NC through 5NC (Table 1), no consummatory response was required. The VR performances in all five pairs including Pair 1NC, in which the key press was demonstrated
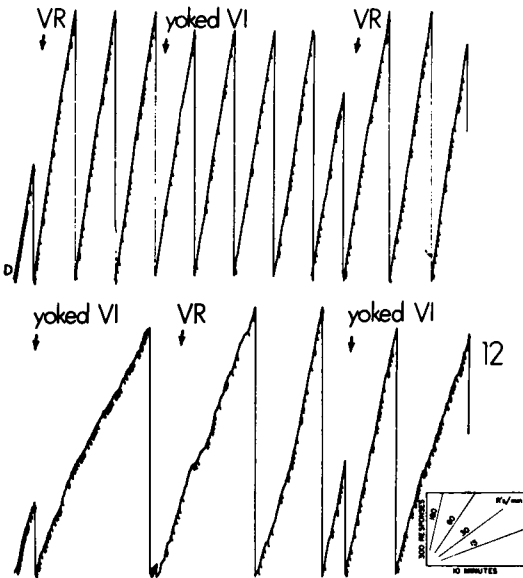
Fig. 7. Cumulative records for Pair 12. Schedules were reversed at the second pair of arrows and again at the third pair. The initial VR subject's responding was established by demonstration (D), and did not vary with changes in schedule.

for the VR member, and the VI performances in Pairs 2NC and 5NC, were similar to those observed in pairs for which the consummatory response was required. In Pairs 1NC, 3NC, and 4NC, however, VI response rates, unlike those

previously discussed, increased rather than decreased over the session (*e.g.*, Figures 10 and 11 bottom records). In the pairs with consummatory responses, such increases in VI rate occurred only when key pressing had been demonstrated (or when rates were already extremely low, as in Pairs 1 and 2). Visual observation indicated that these rate increases were often paralleled by alterations in other behavior: at the start of the session, participants faced the reinforcement counter and appeared to attend to point deliveries; later in the session, however, they often no longer oriented toward the counter and put their heads down while continuing to operate the telegraph key.

DISCUSSION

When responding was established by shaping and a consummatory response was required, ratio schedules maintained higher response rates than did interval schedules with equivalent interreinforcement times. When responding was established by demonstration, schedule sensitivity did not appear; VI rates approximated VR rates (Pairs 10 and 11), and rates did not change when schedules were changed (Pairs 4 and 7). When there was no consummatory response, contingency sensitivity (*i.e.*, low VI rates and high VR rates) was
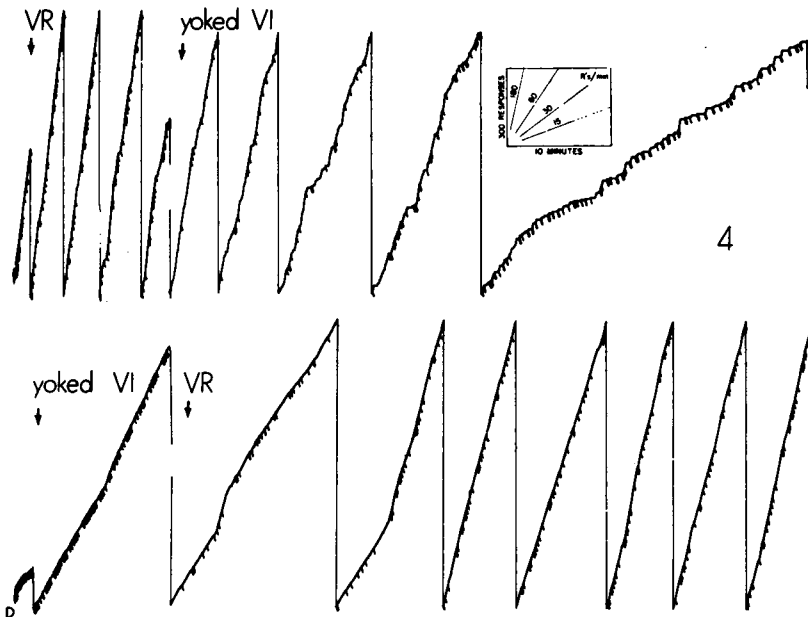

Fig. 8. Cumulative records for Pair 4. Schedules were reversed at the second pair of arrows, and response rates changed accordingly. The yoked VI member's responding was established by demonstration (D).
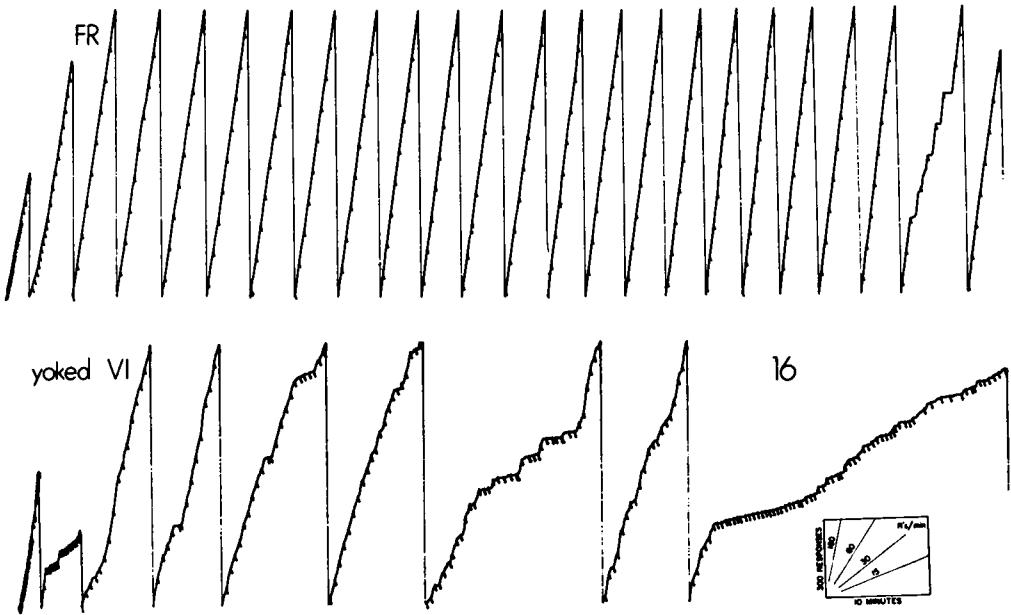
Fig. 9. Cumulative records for Pair 16. For the ratio member, preliminary training was followed by FR 30, then FR 60, and finally FR 120 at the second reset. Late in the session, some ratios included postreinforcement pauses (top record), and some yoked intervals included scalloping (bottom record).
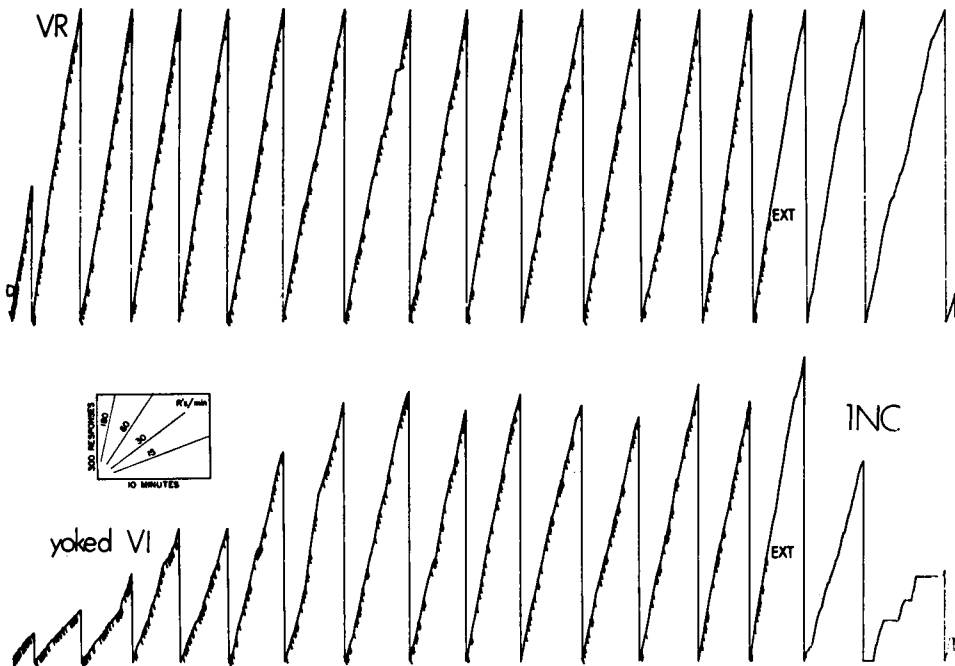

Fig. 10. Cumulative records for Pair 1NC (no consummatory response). The yoked VI pen reset whenever the VR pen reset. The VR response was established by demonstration (D). The rate of the VI response, which was established by shaping, increased over the session.
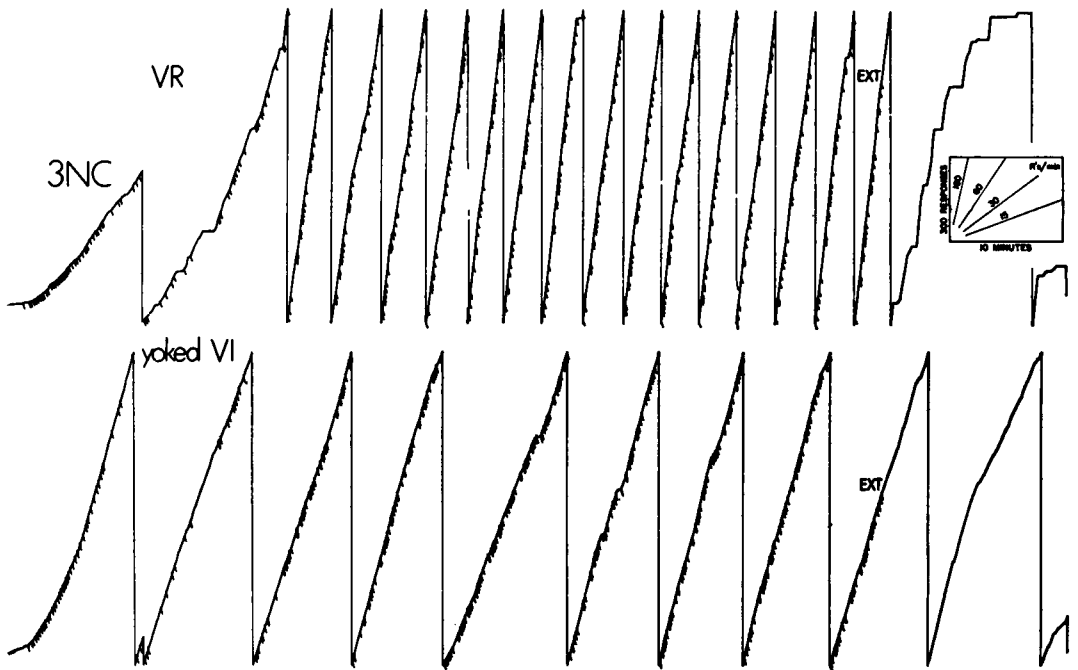
Fig. 11. Cumulative records for Pair 3NC (no consummatory response). Even though VI rate remained lower than VR rate, VI rate gradually increased over the session, and decreased only slightly in extinction.

evident in only two of five pairs. Thus, schedule-sensitive performance depends on both shaped responding and the consummatory response.

EXPERIMENT II

The first experiment assessed contingency sensitivity using a yoked VR-VI schedule. Several previous investigations of human operant performance have focussed on the difficulty of obtaining response patterns (scallops) under FI schedules (*e.g.,* Weiner, 1962, 1969). The second experiment examined fixed-interval performance under the conditions that produced schedule-sensitive performance in Experiment I.

METHOD

Subjects and Apparatus

Ten subjects were recruited from Introductory Psychology classes. The apparatus and instructions were identical to those used in Experiment I. Subjects were asked to leave wristwatches, rings, and bracelets outside, on the pretext that such metal objects might interfere with the operation of the electronic equipment.

Procedures

Shaping of the key press proceeded as in Experiment I. For all 10 participants, each of the first 25 key presses was reinforced. In six cases, this was followed by a variable-ratio schedule in which the ratio gradually increased from five to 25 responses over 50 reinforcers; an FI 60-sec schedule then began. In the other four cases, the initial 25 reinforced key presses were followed by FI schedules in which the interval was gradually increased to 50 sec. In one of the latter four cases, intervals were timed from the end of the preceding interval; in all of the remaining cases, intervals were timed from the end of the preceding reinforcement cycle. Sessions lasted about 90 min.

RESULTS

Terminal response rates of all 10 participants approached one response per interval. Typical cumulative records with ratio and interval histories are shown in Figures 12 and 13 respectively.

For Subject A, the transition from VR to the FI 60-sec schedule occurred at *a*. Scalloping was observed in some intervals (*e.g., b, d, e,* and *f*); in one instance (at *c*), a postreinforce-
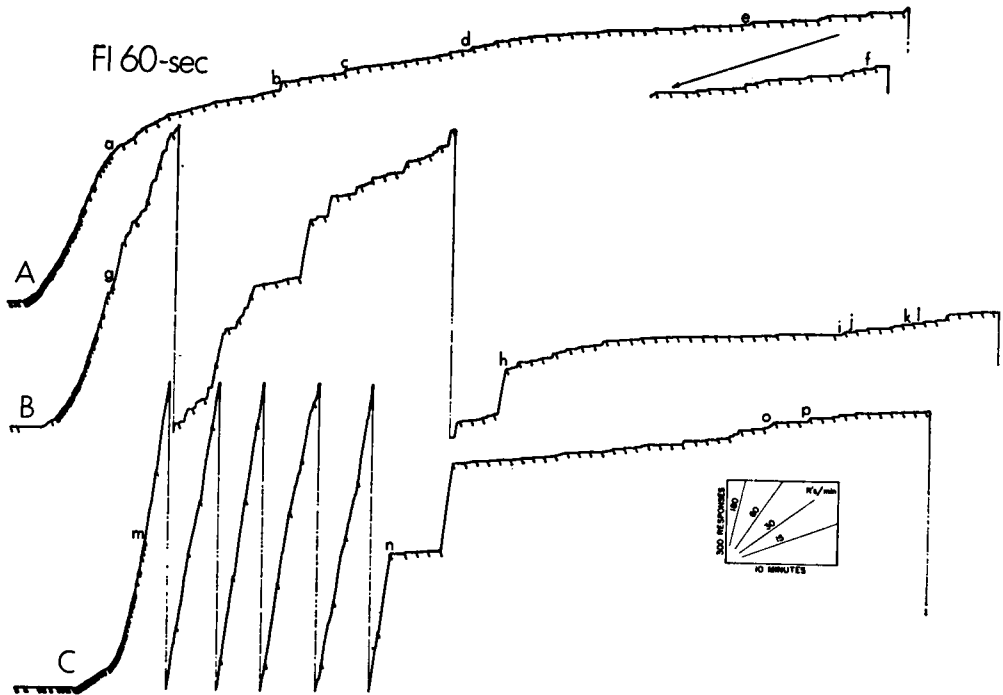
Fig. 12. Cumulative records of fixed-interval key pressing for three participants. Details in text.

ment response burst (*cf.* Ferster and Skinner, 1957, p. 158) occurred. For Subject B, the FI schedule began at *g*; rate changed erratically until *h* (*cf.* Ferster and Skinner, 1957, p. 137), after which low rates and occasional scallops (*e.g., i, j, k,* and *l*) continued for the remainder of the session. For Subject C, the FI schedule began at *m*. Response rates were high until *n*, after which lower rates predominated, with scallops in some intervals (*e.g., o* and *p*). The high rates in this case showed more local variability than those reported by Weiner (1969).

For Subjects D and E (Figure 13), the interval requirement was gradually increased to 50 sec. For D, a temporally-defined interval schedule was used: reinforcers were arranged for the first response after every 50 sec, rather than for the first response after 50 sec had elapsed since the last reinforcement (this accounts for the short interreinforcement interval at *t*). The FI 50-sec schedule for this participant began at *q*; high rates continued until *r*, after which low rates and some scallops (at *s* and *u*) predominated. For E, interval values were increased at
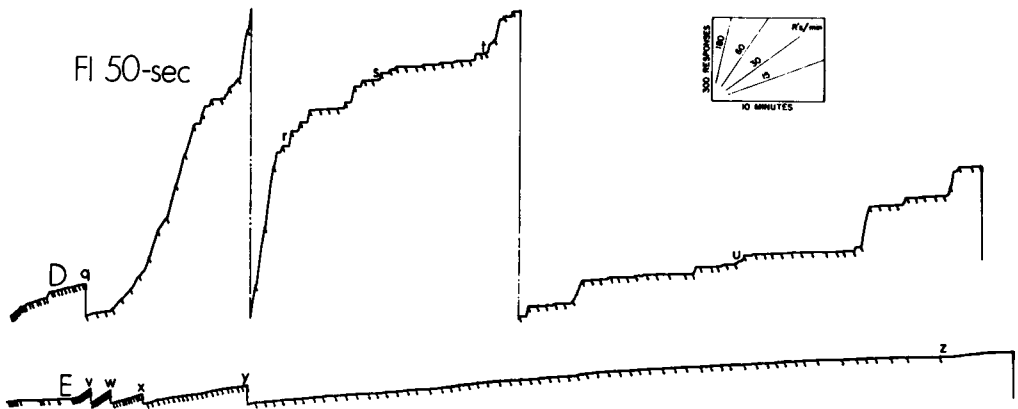

Fig. 13. Cumulative records of fixed-interval key pressing for two participants. Details in text.

v, w, and *x;* the FI 50-sec schedule began at *y,* and low rates were evident until *z,* when extinction began.

DISCUSSION

Fixed-interval schedules maintained low response rates in humans, when the response was established by shaping and a consummatory response was required. Ratio histories were not consistently related to high rates early in exposure to the FI schedules; high rates occurred without ratio histories (*e.g.,* record D), and did not always appear when such histories were provided (*e.g.,* record A). Terminal response rates were lower than those commonly reported, but rates similar to these have been reported for infrahumans (Stebbins, Mead, and Martin, 1959, Figure 2; Reese and Reese, 1962, Figure 5).

The consummatory response also affected FI performances. Postreinforcement pauses can occur only if the organism responds in some way to the reinforcer. In the absence of required consummatory responses, humans often stop looking at point deliveries, and point deliveries not seen cannot serve as discriminative stimuli for postreinforcement pauses. This analysis suggests that shaped responding is required for developing contingency-controlled performance, while consummatory responses are necessary for maintaining such behavior.

GENERAL DISCUSSION

In most investigations of human operant behavior, responding is established through discriminative stimuli called instructions. Instructions may be presented in various ways (*e.g.,* in speech, in written text, or, as in the present experiment, by demonstration), and may vary both in explicitness and in the completeness with which the instructed behavior is specified (*e.g.,* directions are more explicit than suggestions, and either may be more or less detailed). The present study demonstrated that even the minimal instructions provided by a demonstration sometimes generated high-rate responding under conditions that otherwise maintained lower response rates. Insensitivity of human performance to schedule contingencies is not an inevitable consequence of instructions, but subtle and unrecognized aspects of instructional control may be involved in human performances whenever instructions of any kind

are given (Steinman, 1970), and schedule-typical performance may not be a sufficient criterion for contingency sensitivity when performance is instructed. An advantage of the present procedure is that the effects of the natural contingencies are known, therefore providing a baseline against which instructional effects can be assessed.

The usual effectiveness of instructional control over human behavior (*e.g.,* Milgram, 1963) is the product of an extensive history of differential reinforcement for following instructions. Because instructions are often used for supplementing weak environmental contingencies or supplanting counterproductive ones (Skinner, 1969, pp. 166-171), it should not be surprising that instructions may acquire the power to override reinforcement contingencies (*e.g.,* Kaufman, Baron, and Kopp, 1966). The effects of instructions, however, vary with prior history and current circumstances (Hildebrandt, Feldman, and Ditrichs, 1973), and it would be inappropriate to assume that instructional effects are irreversible (in fact, instructions sometimes serve to override other instructions, as when children are told not to do everything their friends tell them to do). The conditions that make instructions effective are uniquely important for the analysis of human behavior; future research must consider the range of variables that modify the effectiveness of instructions as well as the maintenance of human performance by reinforcement contingencies.

Consummatory responses also play a role in maintaining responding that is sensitive to schedule contingencies, although their role has only occasionally been studied explicitly. In infrahuman performance, for example, reinforcement by intracranial stimulation does not produce sensitivity to schedule contingencies unless the stimulation is produced by a consummatory response in the terminal link of a chain schedule (Hawkins and Pliskoff, 1964; the finding that responding characteristic of random-ratio schedules appeared only in monkeys whose eating seemed incompatible with ongoing key pressing may be related: Kelly, 1974). The conclusion that sensitivity to schedule contingencies depends in part on reinforcers that interrupt ongoing responding by setting the occasion for a topographically distinct consummatory response, is consistent with studies that have demonstrated schedule sensi-

tivity in human performances; reinforcers in these studies have involved observing responses (Holland, 1958), novel stimuli (Long et al., 1958), and experimental histories that established discriminative control by reinforcers (Weiner, 1964).

Sensitivity to schedule contingencies is sensitivity to the properties of reinforcing environments, and it has been puzzling that such sensitivity frequently is found lacking in humans. The present research shows, however, that humans are not inferior to infrahuman organisms in this important respect; rather, the sensitivity of human performance to schedule contingencies is reduced by the procedures commonly used with humans. In fact, this reduction of sensitivity is sometimes a criterion for the success of certain procedures, as is evident in laboratory investigations of imitation. Imitation is responding controlled by gestural instruction; i.e., the reinforced response is demonstrated rather than verbally specified. If imitative responses A and B have been reinforced, and nonreinforced imitative response C occurs reliably, it is assumed that response C increases in strength because it is a member of the imitative response class (e.g., Baer, Peterson, and Sherman, 1967). But the reliable occurrence of such nonreinforced imitative responses is precisely what, in other contexts, is referred to as contingency-insensitivity: reinforcers are not contingent on that particular response. By definition, the operations used to demonstrate generalized imitation, if successful, must produce responding that is insensitive to differential reinforcement within the imitative class.

The extent to which the generality of behavioral phenomena can be demonstrated across species often depends on details of methodology (the analysis of behavior has typically examined arbitrary responses in arbitrary settings, so that similarities across species would not be obscured by species-specific characteristics of behavior: Schwartz, 1974). When procedures are equated for humans and for pigeons, by eliminating the special effects of instructions on human behavior and by requiring a consummatory response, humans behave much like pigeons. This should not be taken to imply that humans are to be equated with pigeons: humans can also behave in other ways, of which pigeons are incapable. It is nevertheless reassuring that human behavior is not com-

pletely immune to the effects of schedule contingencies, because such contingencies are clearly part of natural as well as laboratory environments.

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