

*THE EFFECTS OF A VARIETY OF INSTRUCTIONS ON
HUMAN FIXED-INTERVAL PERFORMANCE*

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College students were instructed to press a button for points under a single reinforcement schedule or under a variety of reinforcement schedules. Instructions for a single schedule were either specific or minimal. Instructions on a variety of schedules involved specific instructions on eight different schedules of reinforcement. Subsequent to the varied training, responding under a fixed-interval schedule occurred at a low rate. Both the minimal and specific instruction training led to fixed-interval responding that was similar to the responding exhibited during training. These findings suggest that under certain conditions instructed behavior is sensitive to changes in contingencies.

Key words: variety of training, instructed behavior, contingency-shaped behavior, response history, efficiency of responding, reinforcement schedules, button press, adult humans

Theoretical and empirical developments in behavior analysis have suggested that behavior acquired by following an instruction may be less sensitive to changes in prevailing contingencies than behavior acquired by shaping (Baron & Galizio, 1983; Baron, Kaufman, & Stauber, 1969; Galizio, 1979; Harzem, Lowe, & Bagshaw, 1978; Matthews, Shimoff, Catania, & Sagvolden, 1977; Skinner, 1966, 1969; Vaughan, 1985). For example, subjects who have been instructed to respond under one schedule of reinforcement continue to respond as instructed even when the schedule of reinforcement has changed (Baron et al., 1969; Harzem et al., 1978). Insensitivity to changing contingencies is less likely to occur when behavior is shaped by successive approximations, or when instructions are used that do not describe the specific schedules (i.e., minimal instructions; Matthews et al., 1977; Shimoff, Catania, & Matthews, 1981).

These findings give rise to the question of which variables determine the sensitivity of human behavior to various and varying contingencies. Weiner (1969, 1970a) showed that

specific histories of responding under schedules of reinforcement were necessary to bring about sensitivity to fixed-interval (FI) schedules. Training under a differential-reinforcement-of-low-rate (DRL) schedule was sufficient to bring about sensitive performance under FI schedules even when the subjects had a history of responding at high rates under fixed-ratio (FR) schedules. When either no response history or a high-rate response history was provided, high rates occurred under the FI schedule. Weiner's studies, however, did not examine the interaction of reinforcement histories and instructions.

Galizio (1979) suggested that under instructed conditions sensitivity occurs only when behavior comes into contact with the change in contingencies. When avoidance behavior was instructed under a point-loss procedure and a schedule was then introduced in which the loss contingency was no longer in effect, behavior did not change. However, when continued responding as instructed resulted in a loss of points, performance quickly adjusted to these conditions. Under the first condition, responses did not contact the change in contingencies but in the latter condition they did. However, Shimoff et al. (1981) found that instructions to respond at a low rate yielded low response rates that did not subsequently increase when a higher frequency of reinforcers became available. Also, in some cases, although instructed high rate responding decreased when a DRL 6-s schedule was implemented, the rate decrease was not sufficient to yield reinforcement

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under that schedule (Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986). Data from both studies suggested that contingency contact was made by responses, but in a different way than in the experiment by Galizio (1979) where not responding resulted in removal of points. Apparently, when behavior contacted a punitive contingency, it changed more quickly than when it contacted other types of contingencies.

Hayes *et al.* (1986, Experiment II) noted that instructions add social contingencies that may compete with the schedule of reinforcement in effect, thus reducing sensitivity to the schedule. To investigate this, a green light was paired with an instruction to respond quickly and a red light was paired with an instruction to respond slowly. Some subjects received one instruction light, other subjects received both instruction lights alternating every minute. The critical comparison, however, was between subjects who received instruction lights for one of three sessions versus those who received instruction lights for all three sessions. All subjects responded under DRL and FR schedules that alternated every 2 min. The subjects who were presented with the lights alternately in the first session only engaged in contingency-sensitive responding in Sessions 2 and 3 when the schedules continued to alternate. This finding suggests another factor that may affect sensitivity to changing contingencies: the range of behavior that has been instructed. This is consistent with Weiner's (1969, 1970a) findings, and with the literature on transfer of learning that indicates that test performance on a novel task is facilitated by training on a variety of tasks (Callantine & Warren, 1955; Carson & Wiegand, 1979; Crafts, 1927; Dashiell, 1924; Duncan, 1958; Ellis, 1965; Ellis, Parente, Grah, & Spiering, 1975; Johnson & Stratton, 1966; Kelso & Norman, 1978; McCracken & Stelmach, 1977; Naylor, 1977; Newell & Shapiro, 1976). Perhaps instruction on a variety of schedules produces responding that changes when the contingencies change. A test of this would be to instruct responding under a variety of schedules and then to observe responding when a novel schedule is presented. In the present study, responding under an FI reinforcement schedule followed training under a variety of instructions, training under a specific instruction, and training under a minimal instruction. Response rates under the FI schedule were compared with those under training.

METHOD

Subjects

Ninety undergraduates were solicited from psychology classes at West Virginia University. They ranged in age from 18 years to 22 years and were enrolled in a psychology course (e.g., introductory, human development, or social psychology). Subjects were paid 3¢ per point earned and recorded during the session and were given up to a maximum of two percentage points extra credit in their psychology course work.

Apparatus

An Apple II Plus® computer was located on a table in a small windowless and sound-attenuated room that measured 2.4 m by 2.6 m. A subject sat in a chair in front of and facing the keyboard and video screen of the computer. Instructions were presented on the video screen of the computer, schedule responses were made on an "earn" button, and consummatory responses on a "register" button. The earn and register buttons were located in two game control paddles (requiring a minimum force of 3.08 N) that were connected to the game port of the computer and were located on the same table beside the keyboard. When a point was earned, a beep sounded from the computer and a press of the register button registered the point on the video screen of the computer. Until a register response was made, the schedule stopped and earn-button presses were ineffective. A cumulative recorder in an adjacent room was wired to the computer and recorded the earn responses and reinforcers. A ceiling fan was operated throughout each session to mask outside noises.

Procedure

Subjects were assigned randomly to one of six conditions. A group design was used so that each subject would be exposed to only one type of training history before exposure to the test schedule. Two Variety of Instructions conditions (Variety 1 and Variety 2), a Specific Instruction variable-interval (VI) condition, a Specific Instruction variable-ratio (VR) condition, a Minimal Instruction VI condition, and a Minimal Instruction VR condition were used. Within each condition, there was a training phase (32 min), a testing phase (25 min), and an extinction (EXT) phase (10 min). All three phases occurred in one session.

Training conditions. Upon arrival at the laboratory, subjects were greeted and removal of their watches was requested by the assistant. They were told to sit in front of the computer and to read the instructions on the video screen of the computer. Appendix A contains the general instructions presented to all subjects in the study.

In Variety 1 and Variety 2, training consisted of the presentation of an instruction and a different reinforcement schedule every 4 min during the 32-min training phase. The eight schedules of Variety 1 were FR 60, FR 100, DRL 15 s, DRL 45 s, fixed-time (FT) 15 s, FT 45 s, VI 20 s, and VI 40 s. In the event that the DRL responding in Variety 1 might be sufficient to produce efficient FI responding (Weiner, 1969), Variety 2 without DRL schedules was used. The eight schedules in this condition were FR 40, FR 60, FR 100, FT 15 s, FT 45 s, VI 20 s, VI 40 s, and VI 60 s. In both Variety conditions the eight schedules were selected to train responding at high, moderate, and low rates, under different values of fixed and variable parameters, and finally under different contingencies: ratio, interval, and response independent. Immediately before the onset of each schedule, an instruction for responding was presented on the video screen of the computer (see Appendix B). When the eight instructions and schedules had been presented, the training phase ended. In each Variety condition, the schedule presentation was ordered in the three ways shown in Table 1. Each schedule order was assigned at random to 5 subjects.

In the training phase for each Specific Instruction condition, one reinforcement schedule (i.e., VI 30 s or VR 80) was in effect for the 32-min phase. Prior to the onset of the schedule, an instruction for responding under the schedule was presented (see Appendix B).

In the training phase of each Minimal Instruction condition, a vague instruction was given for responding on a VI 30-s or a VR 80 reinforcement schedule. Responding was trained under these conditions for 32 min.

Testing conditions. When the training phase ended, an assistant entered the room and initiated the test phase on the computer. This took approximately 2 min, during which time the subjects were asked to look away from the computer. When the test phase instruction appeared on the screen, subjects were instructed to look at the screen and to respond according

Table 1

Order of schedule presentation within the variety of training conditions.

Order 1	Order 2	Order 3
Variety 1		
FR 60	VI 40 s	FT 45 s
VI 20 s	FR 100	DRL 15 s
FT 15 s	DRL 15 s	FR 100
DRL 45 s	FT 45 s	VI 40 s
VI 40 s	FR 60	DRL 45 s
FR 100	VI 20 s	FT 15 s
DRL 15 s	FT 15 s	VI 20 s
FT 45 s	DRL 45 s	FR 60
Variety 2		
FT 45 s	VI 40 s	FR 60
FR 40	FR 100	VI 20 s
FR 100	VI 60 s	FT 15 s
VI 40 s	FT 45 s	VI 60 s
VI 60 s	FR 60	VI 40 s
FT 15 s	VI 20 s	FR 100
VI 20 s	FT 15 s	FR 40
FR 60	FR 40	FT 45 s

to the instruction presented there. The instruction stated: "Now figure out how to best earn points." An FI 30-s schedule was in effect in this phase. After 25 min of testing, the computer calculated response stability by determining the mean response rate of six consecutive FI cycles, determining the mean response rate of the first three of those six FI cycles and the mean response rate of the last three of the six cycles, and comparing each three-cycle mean to the six-cycle mean. The stability criterion was reached when each three-cycle mean was within 5% of the six-cycle mean (cf. Schoenfeld, Cumming, & Hearst, 1956). If this criterion were not reached when the first measure was made, a new calculation was performed each second thereafter and the session continued until stability was reached. Then, a 10-min EXT period was instituted. When the EXT period ended, subjects were paid, were given extra credit for their psychology course work, and were debriefed about the experiment.

RESULTS

Training

In general, earn responses occurred immediately following presentation of the instruction, and register responses occurred immediately when a point was earned. Visual

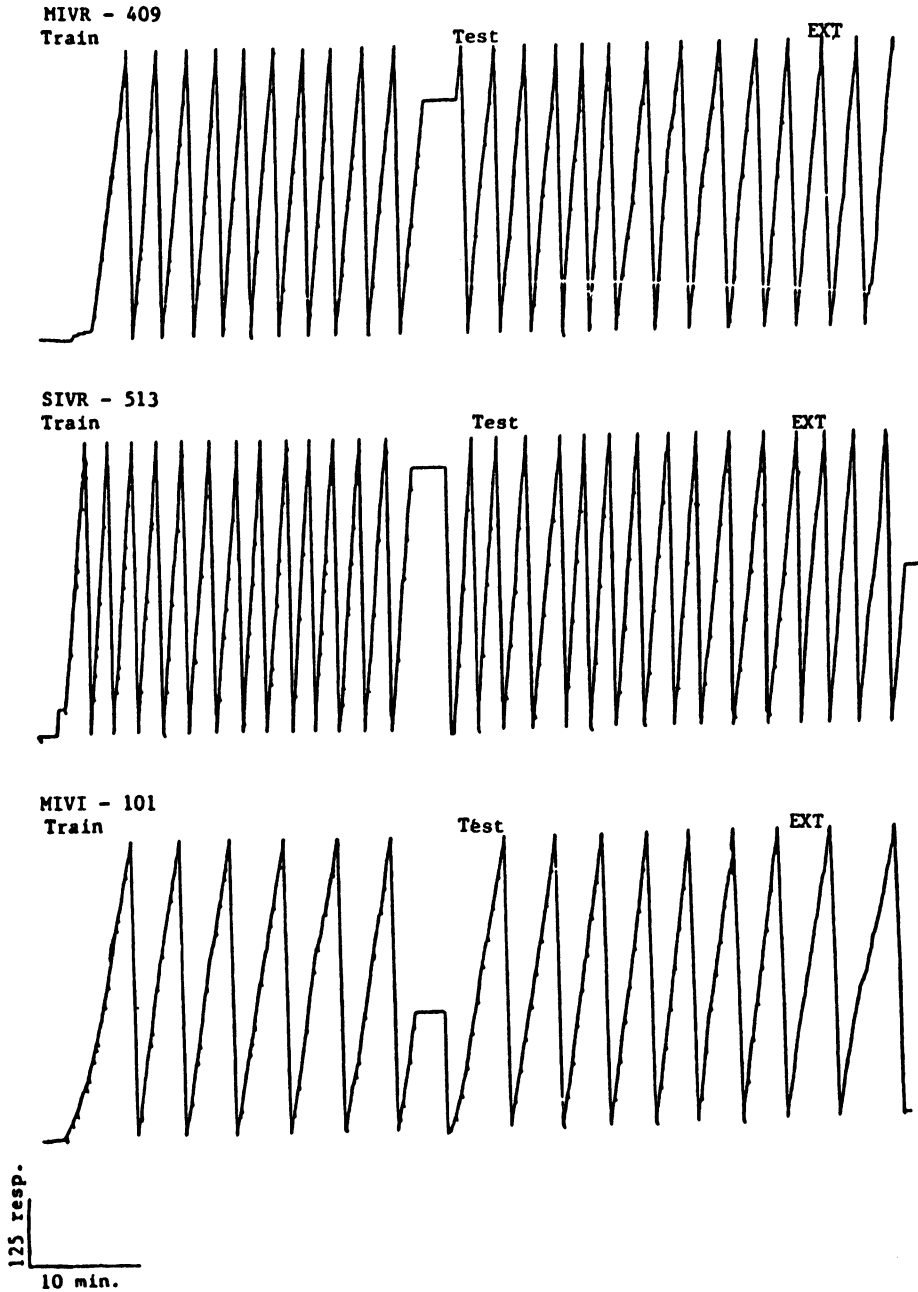


Fig. 1. Representative cumulative records for subjects who were trained by a minimal instruction about a VR 80 schedule (Subject 409), a specific instruction about a VR 80 schedule (Subject 513), and a minimal instruction about a VI 30-s schedule (Subject 101), then tested by an FI 30-s schedule (Test). An extinction (EXT) component followed the test.

inspection of the cumulative records for each subject revealed that training responses quickly stabilized and remained stable as long as the schedule was in effect.

cumulative records of training, testing, and extinction for 1 subject from each group in the study. The records selected show performances of subjects who made the median number of responses per reinforcer during stable FI re-

Figures 1 and 2 present representative cu-

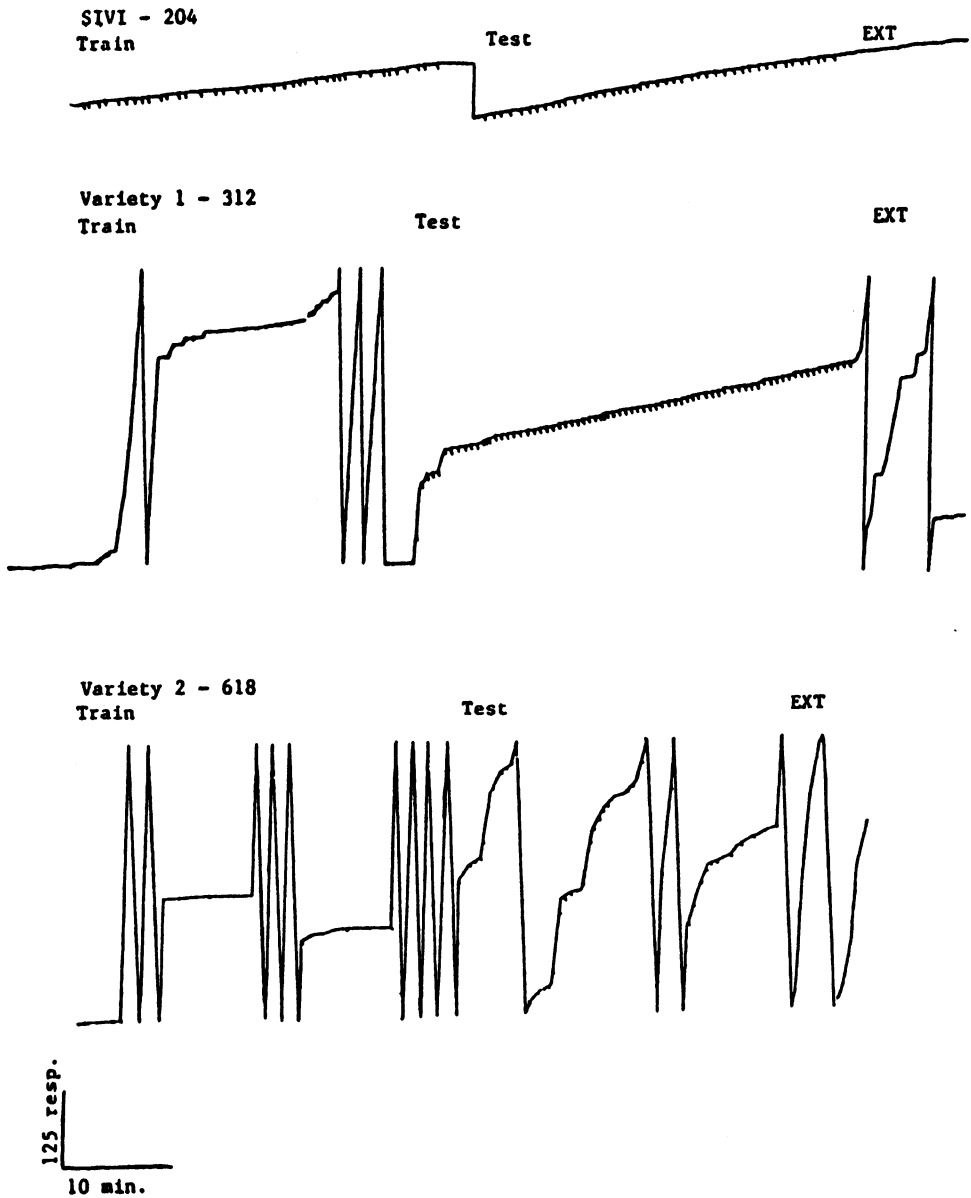


Fig. 2. Representative cumulative records for subjects who were trained by a specific instruction on a VI 30-s schedule (Subject 204) and by a variety of instructions and schedules (Subjects 312 and 618), then tested by an FI 30-s schedule (Test). An extinction (EXT) component followed the test.

sponding. Figure 1 shows that training response rates were relatively high for Subject 101 in the Minimal Instruction VI condition, Subject 409 in the Minimal Instruction VR condition, and Subject 513 in the Specific Instruction VR condition. In contrast, Figure 2 shows low training response rates for Subject 204 in the Specific Instruction VI condition, whereas response rates were high on the FR

schedules and low on the VI, DRL, and FT schedules for the Variety subjects.

Testing

Table 2 presents the average number of responses per minute during training and during stable FI responding for every subject. This comparison revealed that, for 25 of 30 subjects in the Variety groups, responding changed from

Table 2

The average number of responses per minute during the training phase and during stable FI responding for each subject in Minimal Instruction Variable Ratio (MIVR), Specific Instruction VR (SIVR), Minimal Instruction Variable Interval (MIVI), Specific Instruction VI (SIVI), Variety 1, and Variety 2.

MIVR		SIVR		MIVI	
Subject	Train/Test	Subject	Train/Test	Subject	Train/Test
400	263/221	500	210/120	100	64/94
401	230/246	501	338/1	101	98/128
402	35/18	502	220/367	102	72/19
403	185/230	503	133/192	103	179/238
404	255/212	504	213/4	104	134/198
405	150/21	505	128/159	105	247/30
406	125/185	506	210/289	106	227/254
407	185/116	507	213/249	107	33/16
409	185/186	508	268/267	108	274/208
410	138/19	509	238/204	109	165/210
411	103/207	510	288/7	110	8/5
412	35/26	511	* /259	111	68/112
414	118/4	512	260/6	112	5/7
415	145/2	513	230/167	113	133/152
416	115/190	514	258/95	114	35/16
Median:	145/185		230/167		98/112
Range:	35-263/2-246		128-370/1-367		5-274/5-254

* Missing data.

Table 3

Summary of the planned-comparisons analysis of variance for the number of responses per minute under the FI schedule of reinforcement.

Source	SS	df	MS	F
Variety 1 & 2				
x				
SIVI, MIVR,				
MIVI, SIVR	65,052	1	65,052	8.17*
Error	668,901	84	7,963	
Total	733,953			
Variety 1				
x				
SIVR & MIVR	124,382	1	124,382	15.61*
Error	668,901	84	7,963	
Total	793,283			
Variety 2				
x				
SIVR & MIVR	59,070	1	59,070	7.42*
Error	668,901	84	7,963	
Total	727,971			
Variety 1				
x				
SIVI & MIVI	13,204	1	13,204	1.66
Error	668,901	84	7,963	
Total	682,105			
Variety 2				
x				
SIVI & MIVI	28	1	28	.004
Error	668,901	84	7,963	
Total	668,929			

* $p < .01$.

training to testing. Across the other four groups, response rates for 14 of 60 subjects changed from training to testing. Response rates during testing differed between groups. A planned-comparisons analysis of variance indicated that response rates under the FI schedule in the two Variety conditions were significantly lower than FI response rates in the other conditions combined. FI responding that followed Variety 1 training was significantly lower than FI responding that followed VR training. Also, FI responding that followed Variety 2 training was significantly lower than FI responding that followed VR training. There was no statistically significant difference between FI response rates that followed Variety 1 training and those that followed VI training. Likewise, for the same measure, there was no significant difference between Variety 2 and the VI groups. These data are presented in Table 3.

As sample cumulative records show (Figures 1 and 2) FI response rates following VR training and minimal instruction training under the VI schedule were maintained at a high rate throughout exposure to the FI schedule. The low response rates produced by a specific instruction on the VI schedule were maintained throughout the testing phase. In contrast, in the two Variety conditions, response

Table 2 (Continued)

Subject	SIVI Train/Test	Subject	Variety 1 Train/Test	Subject	Variety 2 Train/Test
200	1/2	300	317/1	606	353/185
201	2/2	301	190/2	607	309/7
202	1/1	302	270/2	608	114/10
203	55/185	303	219/2	609	338/213
204	2/2	304	349/8	610	337/189
205	9/3	305	266/229	611	420/252
206	1/1	306	289/4	612	281/2
207	4/2	307	446/2	613	511/11
208	2/66	308	126/2	614	343/51
209	3/2	309	124/2	615	96/4
210	3/2	310	420/34	616	298/2
211	3/5	311	399/2	617	127/2
212	2/4	312	219/3	618	431/4
213	4/46	313	152/1	619	272/35
214	2/4	314	205/167	620	260/14
Median:	2/2		266/2		309/11
Range:	1-55/1-185		124-447/1-229		96-511/2-252

rates and patterns changed when testing began (Figure 2).

Response efficiency under the FI schedule was assessed relative to the fewest number of responses needed to obtain the maximum number of reinforcers (cf. Holland, 1984). In this case, maximal efficiency was one response every 30 s and is represented by a ratio of one response per scheduled reinforcer. The ratio of the average number of responses per scheduled reinforcer during stability, for each subject, is shown in Table 4. The median score for the Variety 1 subjects was 1, for the Variety 2 subjects, 6, and for the Specific Instruction VI subjects, 1. These scores more closely approximate maximal efficiency than do the median scores for the Minimal Instruction VI subjects at 56 responses per scheduled reinforcer, for the Minimal Instruction VR subjects at 93 responses per scheduled reinforcer, and for the Specific Instruction VR subjects at 83 per scheduled reinforcer. A planned-comparisons analysis of variance was performed on these data and indicated a significantly lower number of responses per scheduled reinforcer in the two Variety conditions relative to the other conditions. The FI efficiency scores for responding trained under the Variety 1 condition were significantly lower than those trained under the VR schedule, and the FI efficiency scores of responding trained under the Variety 2 condition were significantly lower than those trained under the VR schedule. No statistically significant differences were found between the

FI efficiency scores of Variety 1 and the VI conditions or when comparing the FI efficiency scores of the Variety 2 condition to the VI conditions. (These data are presented in Table 5.) There was little change in reinforcement frequency from training to testing for each subject.

In the final phase (EXT), cumulative records showed that FI response rates did not change for 10 of 15 subjects in the Minimal Instruction VR group, 11 of 15 subjects in the Minimal Instruction VI group, 10 of 15 subjects in the Specific Instruction VI group, and 9 of 15 subjects in the Specific Instruction VI group. In contrast, only 2 of 15 Variety 1 subjects and 4 of 15 Variety 2 subjects continued to respond as they had during FI in EXT. These differences between groups are illustrated in Figures 1 and 2.

A poststudy questionnaire requested that subjects describe the manner in which points were earned during the test phase. Of the 87% who specified, 69% of the subjects in the two Minimal Instruction groups and in the Specific Instruction VR group said earnings were based on the number of times the earn button was pressed or that points were based on a combination of responses and time passage. These answers were consistent with the findings that most subjects in these groups responded at high rates during the FI schedule. Of the 96% who specified, 76% of the subjects in the two Variety groups and in the Specific Instruction VI group described earnings as based on time

Table 4
Number of responses per scheduled reinforcer during the last 3 min of FI responding.

MIVR		SIVR		MIVI		SIVI		Variety 1		Variety 2	
400	110	500	60	100	47	200	1	300	1	600	93
401	123	501	1	101	64	201	1	301	1	607	4
402	9	502	184	102	9	202	1	302	1	608	5
403	115	503	96	103	119	203	92	303	1	609	107
404	106	504	2	104	99	204	1	304	4	610	95
405	11	505	79	105	15	205	2	305	114	611	126
406	93	506	144	106	127	206	1	306	2	612	1
407	58	507	125	107	8	207	1	307	1	613	6
409	93	508	134	108	104	208	33	308	1	614	25
410	10	509	102	109	105	209	1	309	1	615	2
411	104	510	4	110	2	210	1	310	17	616	1
412	13	511	130	111	56	211	2	311	1	617	1
414	2	512	3	112	3	212	2	312	2	618	2
415	1	513	83	113	76	213	23	313	1	619	17
416	95	514	48	114	8	214	2	314	4	620	7
Median:	93		83		56		1		1		6
Range:	1-123		1-184		2-127		1-92		1-114		1-126

Table 5

Summary of the planned-comparisons analysis of variance for the number of responses per scheduled reinforcer during the last 3 min of FI responding.

Source	SS	df	MS	F
Variety 1 & 2				
x				
SIVI, MIVI, MIVR,				
SIVR	19,354	1	19,354	10.02*
Error	162,292	84	1,932	
Total	181,646			
Variety 1				
x				
SIVR & MIVR	37,353	1	37,353	19.33*
Error	162,292	84	1,932	
Total	199,645			
Variety 2				
x				
SIVR & MIVR	14,807	1	14,807	7.66*
Error	162,292	84	1,932	
Total	177,099			
Variety 1				
x				
SIVI & MIVI	6	1	6	.002
Error	162,292	84	1,932	
Total	162,298			
Variety 2				
x				
SIVI & MIVI	6	1	6	.003
Error	162,292	84	1,932	
Total	162,298			

* $p < .01$.

passage (e.g., "I pressed the earn button about every 30 seconds."). These answers were also consistent with the subjects' nonverbal performance.

DISCUSSION

Instructing button-pressing under a variety of reinforcement schedules was sufficient to bring about sensitivity to changing conditions, whereas training by the other conditions was not. Variety training may, therefore, be effective in generating sensitivity to changing contingencies.

A possible reason for response sensitivity in the variety conditions is that the variety training involved changing response patterns. Then, when confronted with a new schedule, response patterns simply changed. Or, variety training taught specific response patterns that might have been tried out under the FI schedule until the most appropriate one occurred. For 11 of the 30 Variety subjects, FI response rates initially resembled ratio responding but then decreased to interval responding. Alternatively, training by conditions other than Variety 1 and 2 led to apparent insensitivity to changing conditions of the test; response rates established during training were maintained during test and extinction. Responding trained under a variety of instructions resulted in sig-

nificantly lower FI response rates than did responding trained under the other instructions. Failure to find a statistically significant difference between FI response rates under the Variety conditions and the combined VI conditions is not surprising.

In addition to demonstrating that responses were sensitive to changing conditions following varied training, the present study replicated previous findings on the effects of instructions on behavior (Galizio, 1979; Harzem et al., 1978; Hayes et al., 1986; Kaufman, Baron, & Kopp, 1966; Lippman & Meyer, 1967; Matthews et al., 1977; Shimoff et al., 1981). A specific instruction yielded responding that was insensitive to the changes in schedules of reinforcement. Also, the performance of these subjects during extinction was similar to the performance of subjects in other studies that have shown resistance to extinction (Ellis, Barnett, & Pryer, 1960; Kaufman et al., 1966; Matthews et al., 1977; Weiner, 1970b).

A finer analysis of the results indicated another variable. The median number of responses per scheduled reinforcer under the FI schedule was higher in the Variety 2 condition than in the Variety 1 condition. Possibly, greater exposure to high-rate schedule instructions and contingencies during Variety 2 training yielded higher rates during the FI schedule. Subjects with an extensive response history responded in accordance with that history relative to those without such a response history.

In the present study, variety of training involved exposure to eight different schedules. The necessary conditions of variety can be defined further. Morrisett and Hovland (1959) found accurate performance under each component of the variety conditions to be important to sensitivity. The present results are consistent with this result. Concept-learning studies have indicated that to perform accurately on novel instances, training with instances that covered the range of all possible instances of the concept is necessary (Englemann, 1969). Because the present study involved instructions that produced high, moderate, and low rates of responding, instructions about variable and fixed parameters of the schedule, and instructions about response-independent and response-dependent reinforcement, this requirement is likely to have been met.

This study investigated a variable that may result in instructed behavior being sensitive to schedule changes. Previous findings concerning specific instructions were replicated. Also, the findings extended the generality of the variety-of-training effect (Duncan, 1958). In light of these findings, assumptions concerning instructed behavior should be modified. Instructed behavior may be sensitive to changing conditions if the instructions prompt a range of behavior that overlaps with efficient behavior under the changing conditions. Further studies may reveal other variables that determine sensitivity to changing conditions of behavior that has been primarily generated by verbal instructions.

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APPENDIX A

GENERAL INSTRUCTIONS PRESENTED TO ALL SUBJECTS OF THE STUDY

Introductory

Welcome to the human behavior lab! Get comfortable and when you are ready to read the general instructions, press the space bar.

In order to earn points, you must press the "earn" button. You will hear a beep when you have earned a point. In order to have the point register, press the "register" button. So, as soon

as you have earned a point, register it! Press the space bar to continue.

Here is a practice trial for you. Press the earn button 3 times. Then, when you hear the beep, press the register button. OK begin!

If you want to practice once more, press the "ESC" key.

Press the space bar to continue.

Now you are ready to begin the session. Remember to earn and register as many points as possible. You will be paid 3 cents for each registered point at the end of the session. Press space bar to continue.

Here is an instruction for you to follow:
(The specific schedule instruction was presented.)

Testing Phase

Your training period is over. Now figure out how best to earn points. When you are ready to follow this instruction, press the space bar and begin when you hear the beep.

Final (Both Phases)

Good job! This portion of the session is over. You earned x cents. Please wait here until Jan or one of the assistants comes for you Thanks!

APPENDIX B

Schedule instructions for each condition.

Condition	Schedule	Instruction*
Variety	FR x	Press the earn button x times for each point.
	FT x	You will receive a point every x seconds. Remember to register each point.
	DRL x	Wait x seconds before pressing the earn button for each point.
	VI x	Press the earn button approximately every x seconds for each point.
Specific instruction	VI 30 s	Press the earn button approximately every 30 seconds for each point.
	VR 80	Press the earn button approximately 80 times for each point.
Minimal instruction	VI 30 s and VR 80	It is up to you to figure out how to best earn points.

* Each instruction was followed by: "When you are ready to follow this instruction, press the space bar. Begin when you hear the beep."