DOCUMENT RESUME

ED 205 732 CE 029 719

AUTHOR	Shimoff, Eliot H.; Matthews, Byron A.
TITLE	Instructional Influence on Human Performance: Insensitivity to Contingencies. Interim Report September 1, 1979 through August 31, 1980.
INSTITUTION	Maryland Univ., Baltimore. Dept. of Psychology.
SPONS AGENCY	Army Research Inst. for the Behavioral and Social Sciences, Alexandria, Va.
REPORT NO	ARI-TR-482
PUB DATE	Aug 80
CONTRACT	MDA-903-79-C-0544
NOTE	43p.
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Adjustment (to Environment); *Behavior Modification; Behavior Patterns; Cognitive Style; Conditioning; *Contingency Management; *Feedback; Generalization; *Instruction; Learning; *Learning Processes; Learning Theories; Motor Reactions; Performance Factors; Psychomotor Skills; Reinforcement; Responses; *Skill Development; Task Analysis; Teaching Methods; Transfer of Training; Verbal Operant Conditioning; Verbal Stimuli

ABSTRACT

Five experiments were conducted to determine whether properties inherent in some training procedures may subtly influence the adaptability of skilled performance of complex tasks. The first two experiments assessed the insensitivity of low-rate performances. Examined in the third experiment was the issue of whether instructions that focus attention on the contingencies can engender responding under the control of the contingencies. The fourth experiment involved developing a more efficient procedure for assessing the sensitivity of responding to natural contingencies, while the fifth experiment addressed the effects of verbal guesses about the contingencies on motor behavior under the control of the contingencies. Results indicated that instructionally induced insensitivity is a basic behavioral phenomenon, rather than a by-product of behavior that does not make contact with contingencies. If instructed insensitive behavior makes contact with contingencies, it appears likely that sensitivity to those contingencies will eventually develop. If training procedures explicitly call attention to natural consequences, instructionally induced insensitivity may be avoided. Thus, partial training where trainees are allowed to develop personal styles based on contingency contact would be beneficial. The fifth experiment reinforced the distinction between verbalization and motor performance and pointed to the need for further research on their potential interaction. (MN)

Technical Report 482

INSTRUCTIONAL INFLUENCE ON HUMAN PERFORMANCE: INSENSITIVITY TO CONTINGENCIES

Eliot H. Shimoff and Byron A. Matthews
University of Maryland Baltimore County

George Lawton, Contracting Officer's Representative

Submitted by:
Robert M. Sasmor
Director, Basic Research

Approved by:
Joseph Zeidner
Technical Director

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333

Office, Deputy Chief of Staff for Personnel
Department of the Army

August 1980

Army Project Number
2Q161102B74F

Organizational Structure and Leadership

ARI Research Reports and Technical Reports are intended for sponsors of R&D tasks and for other research and military agencies. Any findings ready for implementation at the time of publication are presented in the last part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

3

U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the Deputy Chief of Staff for Personnel

JOSEPH ZEIDNER
Technical Director

FRANKLIN A. HART
Colonel, US Army
Commander

Research accomplished under contract
for the Department of the Army

University of Maryland Baltimore County

NOTICES

DISTRIBUTION Primary distribution of this report has been made by ARI. Please address correspondence concerning distribution of reports to: U. S. Army Research Institute for the Behavioral and Social Sciences, ATTN: PERI-TP, 5001 Eisenhower Avenue, Alexandria, Virginia 22333.

FINAL DISPOSITION This report may be destroyed when it is no longer needed. Please do not return it to the U. S. Army Research Institute for the Behavioral and Social Sciences.

NOTE The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER Technical Report 482	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INSTRUCTIONAL INFLUENCE ON HUMAN PERFORMANCE: Insensitivity to contingencies		5. TYPE OF REPORT & PERIOD COVERED Interim Report 1 Sept 1979 - 31 Aug 1980 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Eliot H. Shimoff and Byron A. Matthews		8. CONTRACT OR GRANT NUMBER(s) MDA 903-79-C-0544
9. PERFORMING ORGANIZATION NAME AND ADDRESS University of Maryland Baltimore County Psychology Department Baltimore, MD 21228		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q161102B74F
11. CONTROLLING OFFICE NAME AND ADDRESS Army Research Institute 5001 Eisenhower Avenue Alexandria, VA 22333		12. REPORT DATE 31 Aug 1980 13. NUMBER OF PAGES 39
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Reinforcement, operant behavior, instructions, verbal behavior, contingency, learning

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

To the extent that behavior is under the influence of instructions, it is insensitive to other consequences of the behavior. This phenomenon, termed instructionally-induced insensitivity, was investigated with monetary reinforcement for button-pressing by undergraduates. The data suggest that insensitivity is independent of response rate, and may occur despite contact with contingencies, although precluding contingency-contact may delay the development of sensitivity. Instructions that the task involved problem-solving did not

necessarily induce insensitivity. Attempts at using multiple schedules suggested the role of verbal behavior even when responding was uninstructed. When subjects were required to make written guesses of the contingencies, accurate written reports usually preceded contingency-sensitive button-pressing, but contingency-insensitive button-pressing often persisted even after written reports were accurate.

6

FOREWORD

The research described in this Technical Report, "Instructional Influence on Human Performance: Insensitivity to Contingencies" was performed under Army Project Number 2Q161102B74F by Eliot Shimoff and Byron Matthews from the University of Maryland, Baltimore County.

The research deals with the phenomenon of instructionally-induced insensitivity. Basically, this occurs when a person, under the influence of instructions, exhibits a behavior which makes them insensitive to other consequences of the behavior. The data from these experiments suggests that insensitivity is independent of response rate and may occur despite contact with contingencies.

I would like to extend my appreciation to Dr. George Lawton from the Personnel Utilization Technical Area here at ARI for acting as the COR for this research.

JOSEPH ZEIDNER
Technical Director

7

INSTRUCTIONAL INFLUENCE ON HUMAN PERFORMANCE: INSENSITIVITY TO CONTINGENCIES

BRIEF

Requirement:

The development of technologically advanced weapons systems has generated increased demands for similarly advanced training procedures for military personnel. Research is needed which adopts a behavioral or functional approach to this problem, and which deals with the implications of recent studies suggesting that properties inherent in some training procedures may subtly influence the adaptability of skilled performance on complex tasks.

Procedure:

Five experiments were conducted which addressed theoretical issues with potentially significant practical implications. The first two experiments assessed the insensitivity of low-rate performances, and indicate that the mechanism of instructionally-induced insensitivity is not simply the extent to which instructions preclude contact with the natural contingencies. The third experiment assessed whether instructions that focus attention on the contingencies can engender responding under the control of the contingencies. The fourth experiment represented an attempt at developing a more efficient procedure for assessing the sensitivity of responding to natural contingencies, while the fifth experiment addressed the effects of verbal guesses about the contingencies on motor behavior under the control of the contingencies.

Findings:

Experiments 1 and 2 indicate that instructionally-induced insensitivity is a basic behavioral phenomenon, rather than a by-product of behavior that does not make contact with the contingencies. If instructed insensitive behavior makes contact with the contingencies, it appears likely that sensitivity to those contingencies will eventually develop; on the other hand, instructions which engender performance patterns that preclude contingency contact may remain permanently insensitive. This information about the mechanism of insensitivity has implication for training programs. In those instances in which the transition from instructional to contingency control is desirable, training procedures should be devised to maximize contact with the natural contingencies. If; on the other hand, resistance to the natural consequences of behavior is preferred, training programs and maintenance procedures should be designed to eliminate (as much as possible) natural contingencies.

The results of the third experiment suggest another general principle useful for the development of training programs; instructionally-induced insensitivity may be avoided if the training procedures explicitly call for attention to the natural consequences. This might be of particular significance if sensitivity is desired but the trainee's performance is unlikely to make contact with the natural contingencies. The detailed application of this principle depends, of course, on the specific training task. The focus on contingencies could be verbal, as in instructions which remind the student to try for the most efficient performance; under such conditions, it might even be advantageous to provide only partial training, with each trainee developing idiosyncratic, personal "styles" based on contingency contact. Alternatively, training protocols might include "problem-solving" tasks which encourage contact with the natural consequences.

Finally, the fifth experiment focussed attention on the significance of verbal behavior about the contingencies. Clearly, uninstructed performance need not be free of verbalization; if the trainer does not verbalize, the trainee might. The presence and nature of these verbalizations will depend on the task. Some tasks with complex motor components may be free of verbalization; for other tasks, this seems unlikely. The verbalizations may focus on the response, the consequences, or the relation between the two. While the present results suggested that verbalization of the response-reinforcer contingency generally appeared before the rate differences indicative of sensitivity, there were instances of accurate verbalizations with insensitive button-pressing. This should alert us to the distinction between the verbal and motor performances; while both are at least partially determined by the contingencies on button-pressing, they are different behaviors and need not correspond. The design of training procedures should take into account these differences. Verbalizations and motor activities are different and may be independent; verbalizations may be accurate while performance remains inefficient. Training procedures which focus on appropriate verbal behavior may not always engender efficient performance. Further studies of the interactions of contingency-guesses and motor performance are planned, and may shed further light on the nature of these potentially important interactions.

INSTRUCTIONAL INFLUENCE ON HUMAN PERFORMANCE: INSENSITIVITY CONTINGENCIES

CONTENTS

FIGURES

Page

11

INSTRUCTIONAL INFLUENCE ON HUMAN PERFORMANCE: INSENSITIVITY TO CONTINGENCIES

General Introduction

The development of technologically advanced weapons systems has placed increased demands for similarly advanced and technologically sophisticated training procedures to prepare military personnel. As performance requirements are made more stringent, new training procedures become mandatory, with increased emphasis on cost-effective, hands-on performance assessments which accurately assess skills, job proficiency and combat readiness.

One of the critical features of skilled performance on complex tasks is sensitivity to subtle changes in the interactions between task performance and the outcomes or consequences of that performance. In fact, skilled performance may be defined as the ability to adjust or modify activity according to subtle or changing feedback so that behavior remains closely adapted to current environmental demands. Skilled personnel adapt readily while their lesser-skilled counterparts are more likely, especially under stressful conditions, to persevere with maladaptive rules and show functional fixedness.

In many respects, in fact, adaptability rather than topographical smoothness is the best indicator of proficiency. Consider the case of a weapons assembly task; skill and proficiency are better defined in terms of performance under adverse battlefield conditions than by effortless assembly in a classroom. Similarly, tactical and leadership skills are indicated most vividly under idiosyncratic or shifting conditions rather than in routine circumstances where "rules of thumb" provide adequate guides for action.

Many theoretical approaches. in a variety of formats and vocabularies have addressed the development of such adaptability (often under the rubrics of creativity or problem-solving). Personality theories, motivational analyses, social-psychological principles have all focused on this issue in one form or another. The present proposal adopts a behavioral or functional approach and focuses on the implications of recent studies suggesting that properties inherent in some training procedures may subtly influence the adaptability of skilled performance on complex tasks. We will start by outlining the theoretical considerations that support the possibility that training may induce insensitivity to environmental feedback, then summarize some of the basic research supporting the theoretical analysis, and finally describe some initial experiments of theoretical significance with practical implications.

The behavioral approach taken here articulates with a large and rapidly expanding body of theory and methodolcgical technique of demonstrated utility over a wide range of behaviors, settings, and subjects. The assumption is that a functional analysis can result in a consistent and parsimonious account of clear and direct practical applicability. The approach of choice for the investigation and manipulation of behavioral adaptability will ultimately depend of course upon which proves to deal most effectively with the subject matter. In the meantime, paradigm clashes and theoretical closure are premature, and a variety of approaches and formulations should be pursued.

Theoretical Considerations

A behavioral analysis focuses on contingencies--that is, the relation between a response and its outcomes--as major (although not necessarily sole) determinants of performance. In examining the contingencies involved in training procedures, it is important to note that there are two general classes of contingencies in effect: those intrinsic to the task and those prescribed by the training setting. The "natural contingencies" are inherent to the task, and remain operative even outside the training setting. Contingencies arranged by the training setting are most commonly in the form of instructions (either implicit or explicit), and a primary goal of training is compliance with the instructions.

The distinction between the effects of natural contingencies and instructional effects is suggested in the traditional continuum of training procedures from on-the-job training to classroom activity. Clearly, the significance of this distinction is not in the physical location of the training, but on characteristics of the training process: in on-the-job training, there is maximal exposure to the natural contingencies, while classroom activities are more likely to emphasize instructions.

Under what conditions are instructions preferable to contact with the natural contingencies encountered in on-the-job training? Instructions seem most useful under three conditions: If the task is complex, if the natural consequences for errors are dangerous or costly, or if the natural consequences for the trainee are inadequate to maintain performance. In the first case, a weapons assembly task may be so complex that instructions are necessary; a trainee might never succeed in reassembling a weapon by trial and error. The operation of expensive equipment provides an instance of the second case in which instructions are useful; one could hardly allow driving students to learn safety rules by exposure to the natural consequences of reckless driving. Finally, we instruct some performance primarily because there are minimal consequences for the trainee (although consequences to the organization might be very important); the necessity for instruction in military protocol reflects the fact that protocol is important to the organization, but may not be for the trainee. That is, the inherent consequences to the trainee of his protocol behavior would not maintain that behavior.

This latter instance focuses attention on an important feature of instructions and contrived consequences; instructions may maintain performance even in the absence of supportive inherent consequences. People have extended training histories of following instructions, and may do so to the point that performance becomes relatively insensitive to natural contingencies. A task is executed in a particular way not because of the inherent consequences of those behaviors, but because one was told to perform the task in that way.

In brief, then, it appears that instructions are often useful precisely because instructed performance may be relatively insensitive to natural consequences. However, to the extent that sensitivity to natural consequences is important in skilled (adaptable) performance, instructionally-induced "trained insensitivity" may inhibit the development of behavioral flexibility.

Several theorists have indicated the potential significance of the distinction between natural and contrived consequences. Most notably, Fitts (1962) has described three stages in learning perceptual-motor skills; his initial "cognitive phase" involves extensive instructional influence (primarily self-instruction), while the terminal "automation phase" seems best characterized as primarily dependent on natural consequences. In the context of artificial language learning, Reber (1976) has presented evidence that implicit learning is more efficient than learning after instructions to search for grammatical rules. Skinner (1969) has drawn a similar distinction between rule-governed and contingency-controlled behavior, noting that since the controlling variables in each case are different, "the behaviors will not necessarily change in the same way in response to other variables."

Establishing responding: Two general classes of procedures have been used to initiate responding: contingency-based methods and instructional control. Contingency-based methods are most frequently used with infrahuman subjects and include shaping, autoshaping, and a variety of related procedures (e.g., Foree and Lolordo, 1974). The unifying feature of these procedures is that they are based on elementary behavioral phenomena and do not demand a verbal repertoire on the part of the subject. With humans, contingency-based procedures have thus been used in instances where the subject is unable to follow instructions (e.g., retardates: Wolf, Risley, & Mees, 1964) or when the nature of the response precludes the use of instructions (e.g., responses of which the subject is unaware: Hefferline & Keenan, 1963).

Investigations with human subjects have typically used instructions to establish responding, presumably because instructions work quickly and appear efficient. Strictly speaking, instructions are simply verbal discriminative stimuli that specify more or less explicitly the response and its consequences; as instances of verbal behavior (Skinner, 1957), instructions include vocal and written modalities, as well as gestural communication (e.g., modeling).

Instructional effects: Very few comparisons of instructed responding with performance initiated by shaping have been made, perhaps because of a tacit assumption that training method has no systematic effects on terminal maintained responding (but see Skinner, 1969). One indication of such effects, however, is that human operant performance (usually established under instructional control) frequently differs from infrahuman performance (generally established by shaping). In particular, human performance is often found to be relatively insensitive to contingencies. For example, response patterns (scallops) maintained by fixed interval (FI) schedules are characteristic of many species (e.g., Schoenfeld, 1970) over a wide range of parametric values (e.g., Ferster and Skinner, 1957). In the absence of special procedures, however (e.g., prior exposure to schedules which differentially reinforce low rate responding: Weiner, 1964; verbal descriptions of the schedule: Baron, Kaufman, and Stauber, 1959; an exteroceptive clock: Long, 1963; response cost: Weiner, 1962; unusual reinforcers: Long, Hammack, May and Campbell, 1958; signal detection tasks: Holland, 1958), human performance under FI schedules is typically characterized by high, steady rates for a substantial proportion of the subjects (Weiner, 1969; 1970). In addition, human performance often appears insensitive to substantial changes in reinforcement rate; Weiner (1969) found that response rates remained unchanged when the schedule was changed from fixed ratio (FR) 40 to FI schedules from 10 to 600 sec, or from DRL 20 sec to FI 600 sec. Similarly, while Lattal (1974) found that, with animals, response-independent schedules maintained lower response rates than did equivalent response-dependent schedules, Streifel (1972) found no differences in response rates for two of three human subjects.

Rather than assuming that such differences between human and infrahuman performance reflect a phylogenetic discontinuity (with the consequent ramifications for the applicability of basic animal research), we have demonstrated that at least some of these differences are attributable to training method, that is, the fact that human performance is established through instruction, while infrahuman responding is shaped. Our first experiments (Matthews, Shimoff, Catania, and Sagvolden, 1977) used yoked variable-interval (VI) variable-ratio (VR) schedules with pairs of subjects run simultaneously. On ratio schedules, reinforcement depends on the number of responses, so that increased response rates produce increased reinforcement rates. On VI schedules, the first response after varying time intervals is reinforced; so long as response rate is high enough to guarantee one response per interval, increased response rates have no effect on reinforcement rates. Thus, although both schedules provide for intermittent reinforcement, only the VR contingency differentially reinforces high response rates. For one subject, responding was reinforced according to a VR; whenever the VR subject's response was reinforced, the next response of the yoked member of the pair was reinforced. Thus, responding of the yoked member was reinforced according to a VI, with the intervals determined by the interreinforcement times generated by the VR subject. Therefore, because reinforcement density and distribution were substantially identical, the only difference between the members of a pair was the contingency (VR versus VI). Results showed that when responding was established by shaping, the VR schedule maintained rates considerably higher than rates maintained by the yoked VI. However, when the response was established by a minimal instruction (response demonstration with no vocal instruction), there were no systematic differences in responding maintained by the two schedules. Thus, while shaped responding showed good sensitivity to contingencies, responding established through instruction did not.

In short, this experiment provided a procedure for distinguishing instructed from uninstructed performance, and demonstrated that the instructed responding was in fact insensitive to the "real" consequences.

Potential Applications

Both theoretical analysis and empirical evidence presented above support the suggestion that instructions may induce insensitivity to natural consequences. Such instructional effects appear directly relevant to a wide range of training issues in the domain of ARI interest. First, there are numerous situations in which such insensitivity is undesirable. These include instances in which individual initiative or creative activity are important, even if this requires actions not specified in standard operating procedures; such instances are of particular importance in leadership training. In other cases, instructional influences may be far more subtle, but may nevertheless conflict with natural consequences; training may subtly instruct certain patterns of scanning information displays, but special situations may make other scanning patterns more efficient. For such tasks, training procedures must be developed which increase sensitivity to natural consequences.

In other instances, insensitivity to natural contingencies may be more valuable, and it is often preferable to have trainees follow instructions than come under the influence of natural consequences. Instructions, as noted above, are often successful in minimizing the effects of natural consequences, but the significance of these natural consequences may be reasserted, as when one takes a "short cut." In other instances, skills are normally acquired under natural contingencies, and it may be difficult to institute instructional influence; this may be particularly common in the analysis of some forms of social behavior, when military expectations conflict with natural contingencies encountered in civilian settings.

Ideally, within the context of ARI's mission, investigations should bear directly on military problems, and the proposed research should adopt, as a model, particular task performances that relate to current military applications. A number of militarily-significant tasks might be chosen, including, for example, weapon-assembly tasks, signal-detection performance, as well as any of numerous specific training problems. In all of these cases, however, analysis of the effects of instruction would be complicated by interactions with details of the instruction sets, as well as with task-specific features of the performance.

Rather than focus on a specific training setting, these proposed experiments address more general training problems and, as such, will use a more general model of performance. Such a general model is particularly important when, as in the present case, one must bridge the gap between basic research and application; the intermediate step is critical to the extension from the laboratory to "real-life."

The model task for the proposed experiments must meet several criteria. It must be relatively simple to allow for analysis. On the other hand, it must be sufficiently complex so that performance generated by instruction must be different than contingency-generated performance; that is, there must be a ready distinction between skilled and unskilled performance. As a first approximation, the button-pressing task seems adequate. Although it appears on the surface to be excessively simple, it can readily be made more complex. In principle, the button-press may be taken as an analog for any psychomotor task, for the topographical detail of the response is for present purposes irrelevant; the crucial questions concern the relations between the performance, the consequences of the performance, and the instructions about the performance. Later experiments may examine more complex tasks beginning with sequences of button-presses, and gradually extend the findings and focus to tasks of more direct military significance.

The five experiments reported here address theoretical issues with potentially significant practical implications. The first two experiments assess the insensitivity of low-rate performances, and indicates that the mechanism of instructionally-induced insensitivity is not simply the extent to which instructions preclude contact with the natural contingencies. The third experiment asks whether instructions that focus attention on the contingencies can engender responding under the control of the contingencies. The fourth experiment represents an attempt at developing a more efficient procedure for assessing the sensitivity of responding to natural contingencies, while the fifth experiment addresses the effects of verbal guesses about the contingencies on motor behavior under the control of the contingencies.

Experiment 1: Low rate interval contingencies

Human operant behavior should by definition be sensitive to its consequences. But sometimes human responding is insensitive to such differences in contingencies as those between fixed-interval (FI) and fixed-ratio (FR) schedules (e.g., Weiner, 1969, 1970), or even those between response-dependent and response-independent schedules (e.g., Streifel, 1972). If sensitivity to contingencies is fundamental to adaptive behavior, it is puzzling that human behavior should sometimes be insensitive. (This view does not require that human behavior show sensitivity to contingencies in precisely the same way as the behavior of other species: cf. Lowe, 1980; Lowe, Harzem, & Hughes, 1978.)

Sensitivity of human operant behavior to contingencies has been assessed within pairs of variable-ratio (VR) and yoked variable-interval (VI) schedules. When responding was established by instructions high rates were maintained by both schedules, but when it was shaped the ratio schedule maintained rates consistently higher than those maintained by the yoked interval schedule. Thus, instructed responding was insensitive to contingencies and shaped responding was sensitive (Matthews, Shimoff, Catania, & Sagvolden, 1977). Human behavior therefore is sometimes insensitive to contingencies when responding is initiated by instructions. In fact, such insensitivity must be a defining property of instructional control.

The insensitive instructed performances reported by Matthews et al. and by others (e.g., Baron, Kaufman, & Stauber, 1969; Harzem, Lowe, & Bagshaw, 1978; Kaufman, Baron, & Kopp, 1966) were characterized by high, steady rates. The present research asks whether low rates can also be insensitive to contingencies. This question is important for several reasons. First, sensitivity to contingencies must be determined by experimental analysis. For example, a history that includes differential reinforcement of low rates (DRL) can produce low-rate FI responding (Weiner, 1964); would such low-rate FI performances be sensitive to a transition to other contingencies (e.g., ratio scheduling, which typically maintains high-rate responding)? Similarly, low rates can be generated with observing responses (Lowe, Harzem and Hughes, 1978). Do these rates depend on contingency sensitivity or on some aspect of the instructions? To assume that low rates are prima facie evidence of contingency sensitivity implies that explicit testing for sensitivity is sometimes unnecessary; on the other hand, if low rates can be insensitive, the effects of instructions must be assessed even with low-rate performances.

The question of low-rate sensitivity may also be relevant to the design of procedures for producing contingency-sensitive responding. If low-rate responding is always sensitive to contingencies, shaping may be circumvented by instructing the response and then reducing rates by introducing a lowrate requirement. Low-rate insensitivity, however, would preclude such a procedure.

More important, the contingency-sensitivity of low-rate responding may help us to understand insensitivity induced by instructions. One account of insensitivity (Galizio, 1979) is that instructions often produce high rates that preclude contact with contingencies. For example, if the low rates maintained by interval relative to ratio schedules are produced by the differential reinforcement of long interresponse times inherent in interval schedules, instructions might induce insensitivity by producing high rates with no long interresponse times available to be reinforced. Alternatively, insensitive responding might remain insensitive despite contact with the contingencies. Investigating sensitivity explicitly by manipulating contingencies and comparing shaped versus instructed responding will not allow these possibilities to be assessed if instructed responding is characterized by high-rates.

Experiments 1 and 2 examined sensitivity of low-rate responding using a within-subject design less cumbersome than the earlier yoked-control procedure (Matthews et al., 1977). Low rates were maintained by either random-interval (RI) or random-ratio (RR) schedules with a superimposed differential-reinforcement-of-low-rate (DRL) requirement, so that only responses terminating interresponse times longer than those required by the DRL contingency were eligible to produce points exchangeable for money. Sensitivity was tested by relaxing the DRL requirement; responding would increase if it were sensitive to the contingencies, but not otherwise.

In this experiment, low rates were maintained by superimposing a DRL requirement on an RI schedule, and sensitivity was assessed by a mid-session removal of the DRL requirement. With this change in contingencies, increased response rates would not substantially increase point earnings. Thus, while even weak instructional control might maintain low rates of instructed responding, an increased rate of responding after removal of the DRL contingency would be a convincing demonstration of contingency sensitivity.

Method

Subjects and apparatus. Twenty-one students participated as an option in satisfying Introductory Psychology course requirements. In sessions at two- to four-day intervals, each was seated in a sound-attenuating cubicle facing a console that contained a red button 15 cm below an earnings counter mounted between two red lamps. Presses of at least 15.0 N on the 2.4 cm diameter red button when the red lights were lit produced counts on the earnings counter. Between the red button and the earnings counter were an amber lamp labelled "WAIT" and a green one labeled "SESSION ON." The operandum, a black telegraph key requiring 1.9 N for operation, was mounted on the table directly in front of the counter. The frame and contacts of the telegraph key were covered by a 10 x 12.5 x 8 cm aluminum Minibox, so that only the 2.7 cm diameter black key was visible. Also mounted on the Minibox, directly above the key, was a small lamp that blinked off for approximately 30 msec after each response. White noise was presented through headphones during sessions to eliminate auditory cues from the standard electromechanical scheduling apparatus located in an adjacent room.

Procedure. After being escorted into the cubicle, each participant was asked to read the following instructions mounted on the wall above the console:

> 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 cent. For example, if you earn 200 points, you will be paid $2.00. Whenever the RED LIGHTS beside the counter are on, each press of the RED BUTTON will add one point to your total.
>
> The blue light above the red button is a "wait" light; while the "wait" light is on, the equipment is temporarily disconnected. The session will begin when the blue "EXPERIMENT ON" light comes on. Put on the headphones now, and do not remove them until the session is over.

When a response met the schedule requirements, the light above the telegraph key was turned off and the red lights next to the earnings counter were lit; a press of the red button added one point to the earnings counter, turned off the red lights, and reinstated the light above the key.

For eleven participants, successively closer approximations to presses on the telegraph key were shaped. For ten others, the key press was established by the following additional instruction, inserted above as the next-to-last paragraph:

> To make the RED LIGHTS come on, you must press the BLACK BUTTON. You must press slowly; pressing too rapidly will not work.

When the instructions had been read by these participants, the experimenter demonstrate" " pressing by producing two or three IRTs of about 3 sec, and then left the cubicle.

Once responding was established, either by instructions or shaping, the RI and DRL requirements were gradually introduced, with the terminal schedule values usually attained within 15 minutes. Sessions lasted 50 min each. The RI schedule (Farmer, 1963) arranged consequences for the first response after a variable duration determined by selecting with a probability of .10 pulses generated at a rate of one per 1.5 sec; this defined an RI 15-sec schedule, with t=1.5 sec and p=.10. The DRL requirement was 3 sec, so that 15 sec (on the average) after each collection of a point the first response terminating an interresponse time greater than 3 sec turned on the red lights. The RI DRL schedule remained in effect until the tenth min of a subsequent session (usually the third), when the DRL contingency was eliminated; no stimulus changes accompanied the removal of this contingency.

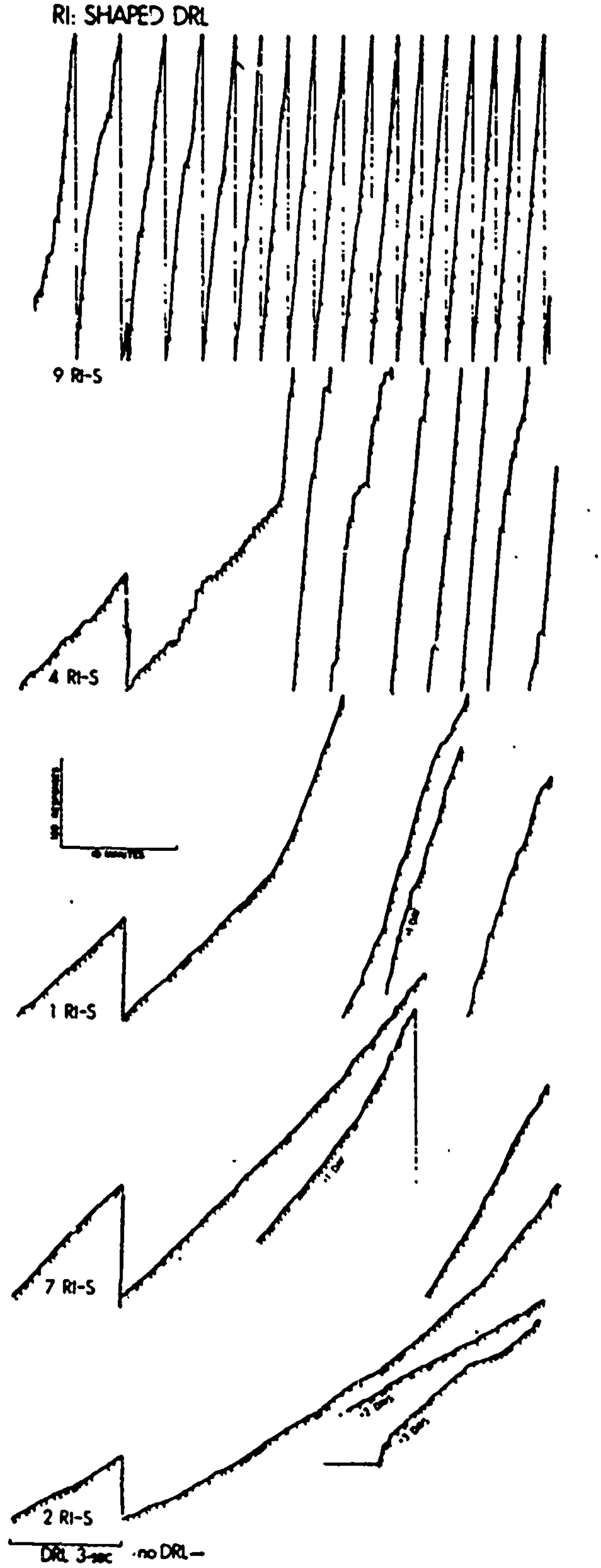
Results

Figures 1 through 4 show cumulative records for the session in which the DRL contingency was removed; after the first 10 min (at reset) responding was maintained by the RI schedule with no DRL requirement. Sessions are shown in their entirety; in some cases, additional sessions were run, and representative samples of these sessions (marked as +1, +2, or +3) are also shown.

Five records of performances established by shaping are shown in Figure 1. In the first three, response rate increased within about 15 min after the DRL contingency was removed. For 7 RI-S, the increase came toward the end of the session and was maintained in the next session. For 2 RI-S, the increase toward the end of the session was transient; rates were lower in the next two sessions, while performance in a third session (+ 3) was erratic and marked by extended periods of non-responding. Observation through a one-way window suggested 2 RI-S was asleep during part of some sessions.

Records of six other shaped performances are shown in Figure 2. The response rate of 10 RI-S increased when the DRL requirement was removed whereas that of 11 RI-S decreased slightly. In the case of 3 RI-S, several brief high-rate episodes followed removal of the DRL contingency, but only in the following session were high rates maintained for substantial periods of time. For 5 RI-S, 6 RI-S and 8 RI-S, response rates with the DRL contingency were so low that typical sessions included only one or two inter-response times shorter than the DRL requirement; when the DRL contingency was eliminated, rates remained low. For two of these three cases, it was possible to schedule an additional session (+1), but low rates continued even into that session.

Four cumulative records of instructed responding are shown in Figure 3. For 6 RI-I and 9 RI-I, rates increased shortly after removal of the DRL contingency, and for 2 RI-I, they increased in the following session. For 8 RI-I, local rates remained low, although episodes of high rate responding began during the transition session and became more frequent in the next session (+1). Cumulative records for the six remaining instructed responders are presented in Figure 4. In none of these cases did rates systematically increase after the DRL requirement was removed.



1. Cumulative records of responding established by shaping and maintained by random-interval (RI) 15-sec scheduling of point earnings. (An interresponse-time contingency (DRL 3-sec) was terminated after the first 10 min of the session. Terminal segments from later records are shown for cases in which addition sessions (+1, +2, +3) were arranged.)

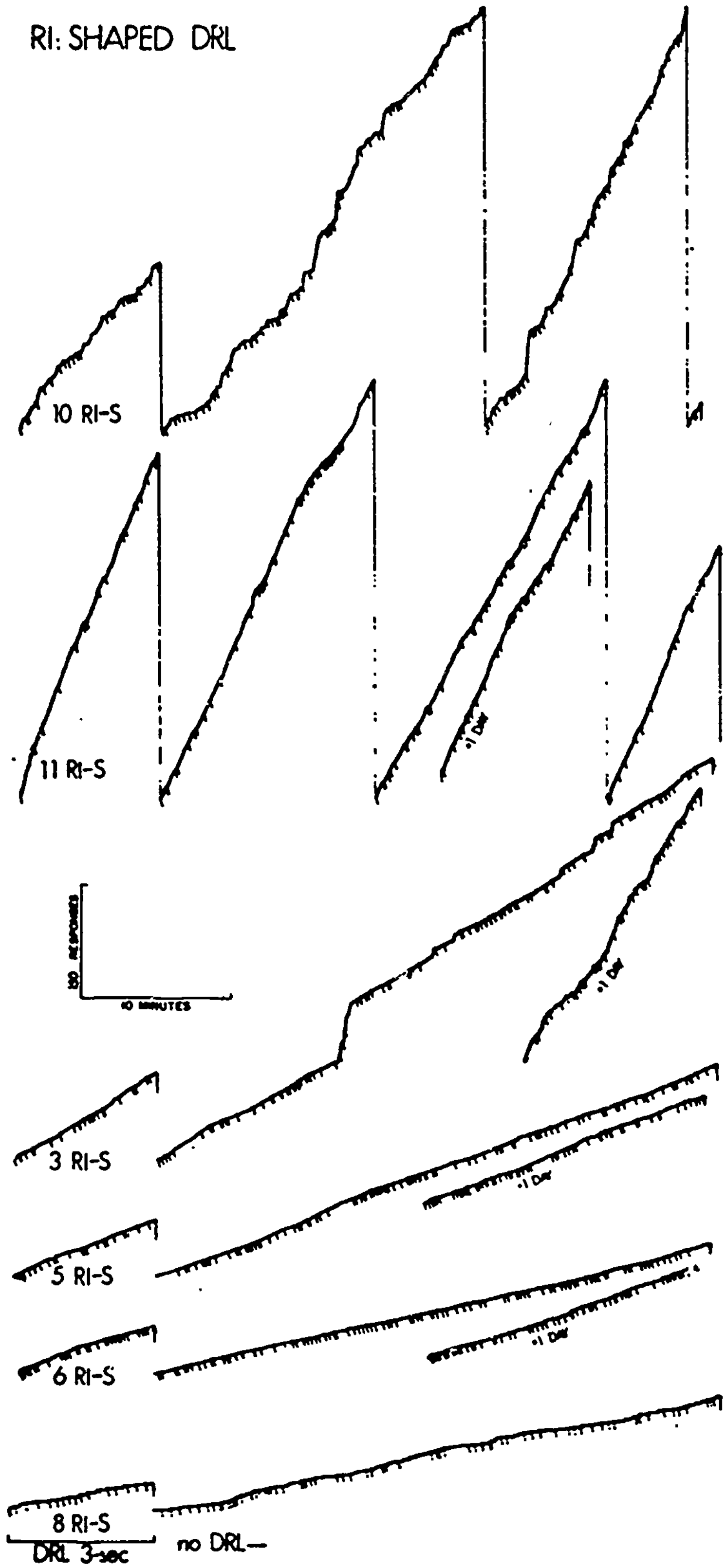


Figure 2. Cumulative records of responding established by shaping and maintained by RI 15-sec scheduling of point earnings. (Details as in Figure 1.)

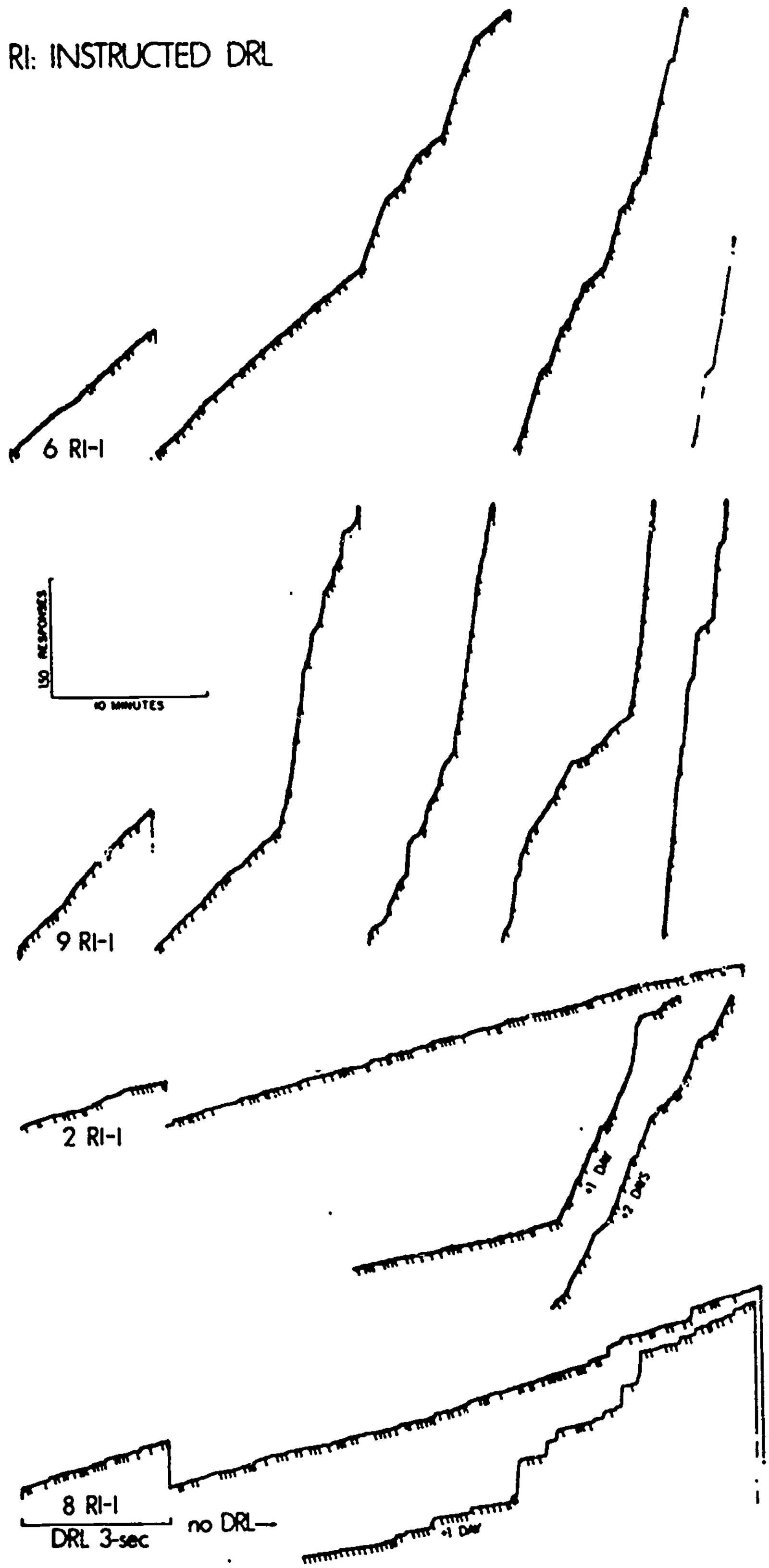


Figure 3. Cumulative records of responding established by instructions and maintained by RI 15-sec scheduling of point earnings. (Details as in Figure 1.)

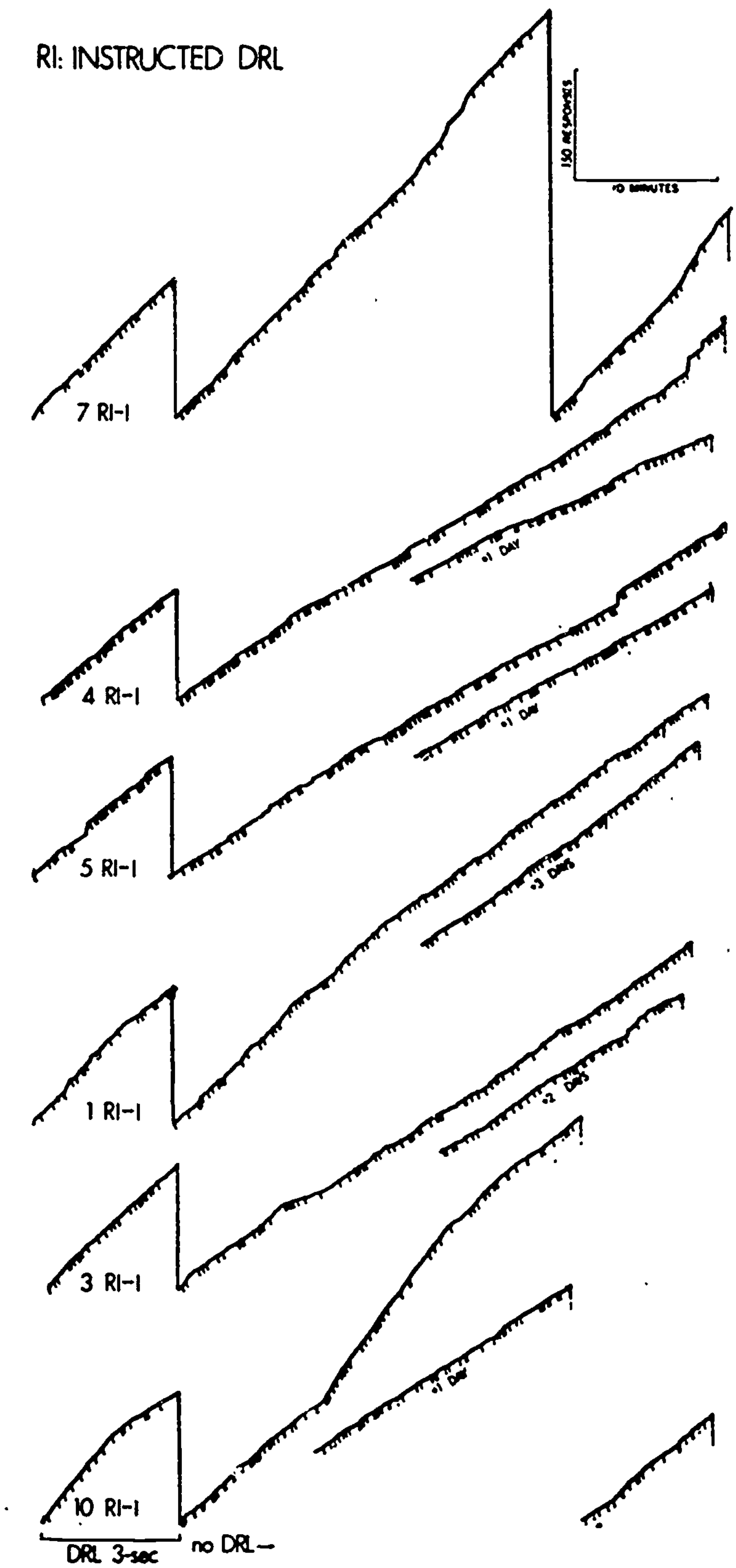


Figure 4. Cumulative records of responding established by instructions and maintained by RI 15-sec scheduling of point earnings. (Details as in Figure 1.)

In short, then, for button-pressing established by shaping, response rate increased after removal of the DRL contingency in 6 of 11 cases, if the transient increase for 2 RI-S is excluded. In these cases, the rate change was evident within the session, i.e., within 40 min after the DRL contingency was removed. In one instance of high-rate responding (11 RS-I), rates decreased after the schedule change. For the remaining three cases, rates were so low that they did not contact the contingencies. When responding was established by instructions, on the other hand, rates increased in the transition session in only three cases (6 RI-I, 9 RI-I and 8 RI-I) and in the next session in a fourth case (2 RI-I). In the remaining six cases, no systematic rate changes occurred.

Experiment 2: Low-rate and ratio contingencies

The first experiment favored instructional control over contingency sensitivy because increases in response rate after removal of the DRL requirement could not substantially increase point earnings. That rates increased despite the constancy of point earnings testifies to the sensitivity of responding established by shaping. Experiment 2 arranged contingencies that would be more likely to override the insensitivity induced by instructions. Responding was maintained by an RR schedule with a 4-sec DRL requirement that was subsequently reduced to 1-sec. In these procedures, increased responding after the DRL requirement is reduced can proportionately increase point earnings, up to a rate of one response per sec. Experiment 1 found that shaped responding increased after a DRL requirement was eliminated. The question addressed by Experiment 2, however, was whether rates of instructed responding would remain low even when an increase in response rate would result in higher point earnings.

Method

Apparatus and procedures were similar to those for the first experiment. For eight participants, responding was instructed; for another six, key-pressing was established by shaping. All participants received the following written instructions:

> 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 cent. For example, if you earn 200 points, you will be paid $2.00. Whenever the RED LIGHTS beside the counter are on, each press of the RED BUTTON will add one point to your total.
>
> When the session begins, the small white light will come on, and you will hear a hissing sound through the headphones. Please put on the headphones now, and do not remove them until the session is over.

Those whose responding was instructed also received a demonstration of two or three 4-sec IRTs and the following inserted as the next-to-last paragraph of the instructions:

To make the RED LIGHTS come on, you must press the BLACK BUTTON. You must press slowly; pressing too rapidly will not work.

Responding was maintained by a random-ratio (RR) schedule with an added DRL requirement. Every response that met the DRL requirement was eligible to produce points with a probability of .25. For the first session, and for the first 25 min of the second session, the DRL requirement was 4 sec. For the remainder of the second session and for any later sessions, the DRL requirement was reduced to 1 sec. (In two cases, 1 RR-S and 6 RR-1, the transition was deferred to the third session).

Results

Cumulative records for the transition session in which the DRL requirement was reduced are shown in Figures 5, 6, and 7. For the first half of the session (up to the reset), responding was maintained by the RR schedule with a 4-sec DRL requirement; the DRL requirement was then reduced to 1 sec. Figure 5 presents data for responses established by shaping. For the top four records, rates increased substantially within 10 min of the reduction of the DRL requirement; in the remaining two cases, rates remained unchanged even in the following session.

Performances after instructions are shown in Figures 6 and 7. In the five records of Figure 6, rates did not increase after the DRL requirement was reduced, and remained unchanged throughout the next 50-min session (no additional session could be arranged for 2 RR-I). Figure 7 presents three records in which response rates did increase. These rate increases, however, were always slower to develop than were those of shaped responding (Figure 5). Thus, response rates for 4 of 6 shaped key-presses increased soon after the DRL requirement was reduced. When key-pressing was instructed, rate increases either did not occur (5 cases) or occurred relatively late (3 cases). Thus, instructions substantially reduced sensitivity to contingencies, even though response rates were positively correlated with point earnings.

Discussion

Both experiments indicated that low-rate responding established by shaping is generally sensitive to changes in contingencies, but that instructions may produce low-rate responding insensitive to contingencies. In Experiment 1, low-rate responding established by shaping and maintained by an RI DRL schedule increased when the DRL contingency was removed, even though rate increases could not substantially increase point earnings. In Experiment 2, instructed responding maintained by an RR DRL schedule remained low when the DRL contingency was reduced, even though increased

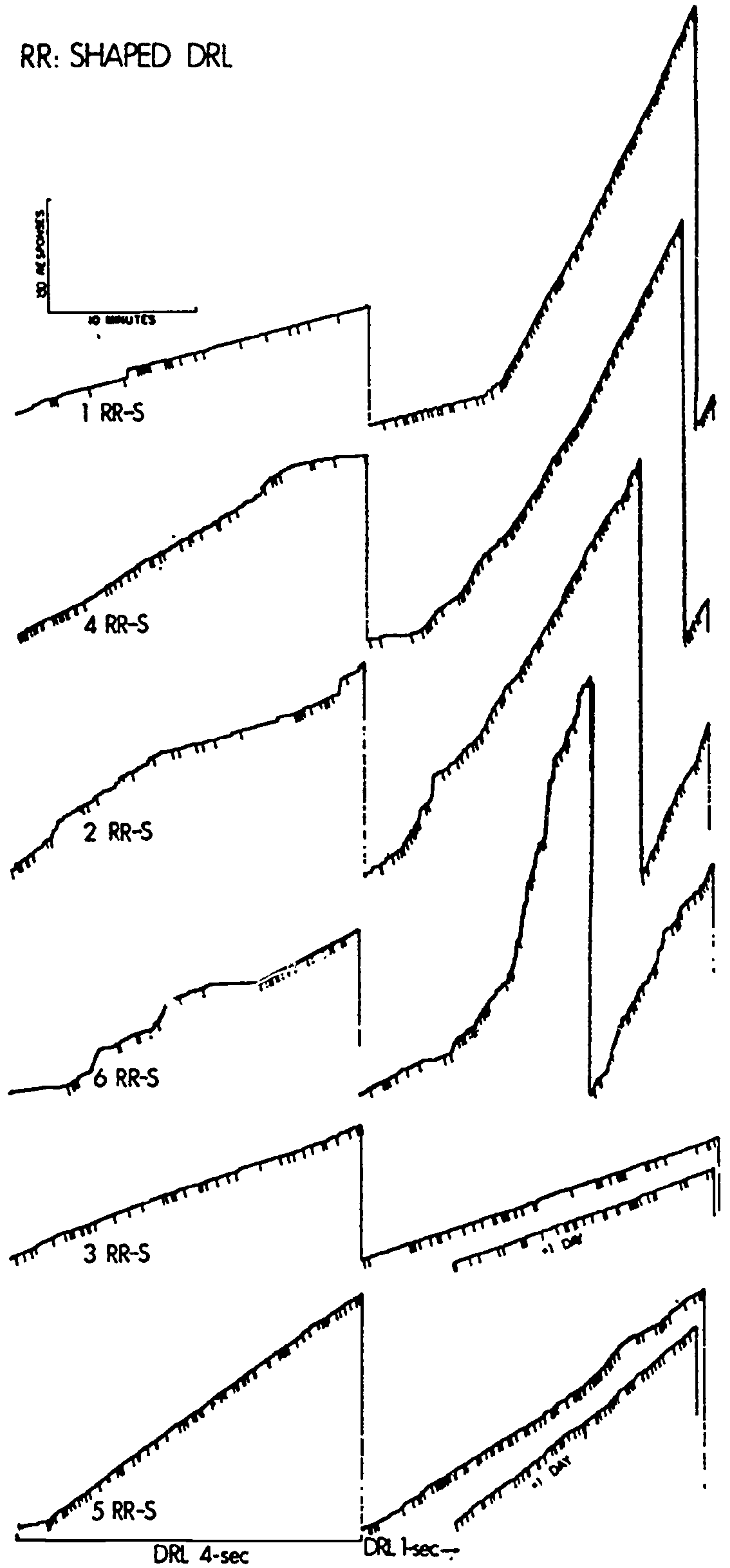


Figure 5. Cumulative records of responding established by shaping and maintained by random-ratio (RR) 4-sec scheduling of point earnings. (An interresponse-time contingency (DRL) of 4 sec was reduced to 1 sec during the second half of the session and in subsequent sessions (+1), for which terminal segments are shown.)

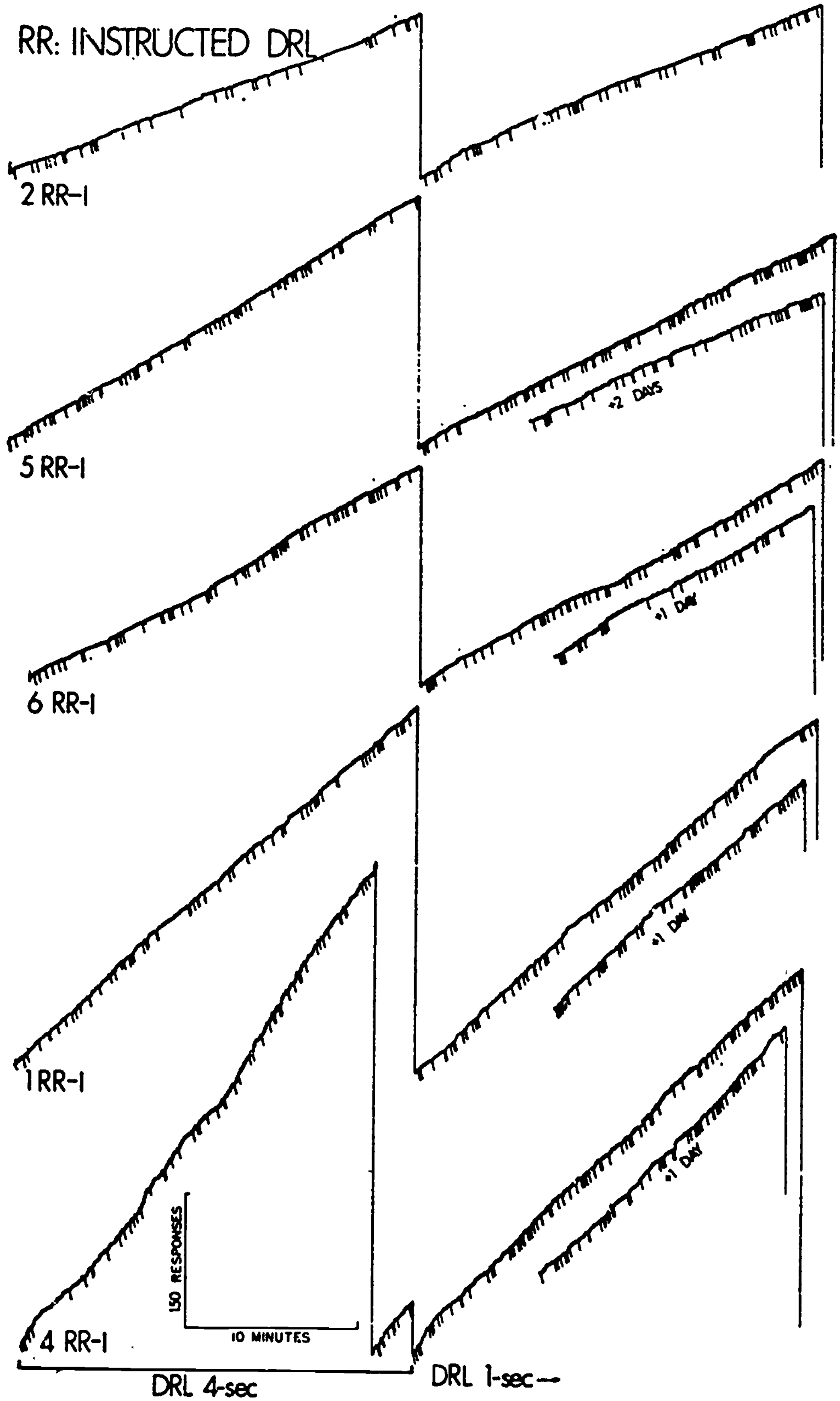


Figure 6. Cumulative records of responding established by instructions and maintained by RR 4-sec scheduling of point earnings. (Details as in Figure 5.)

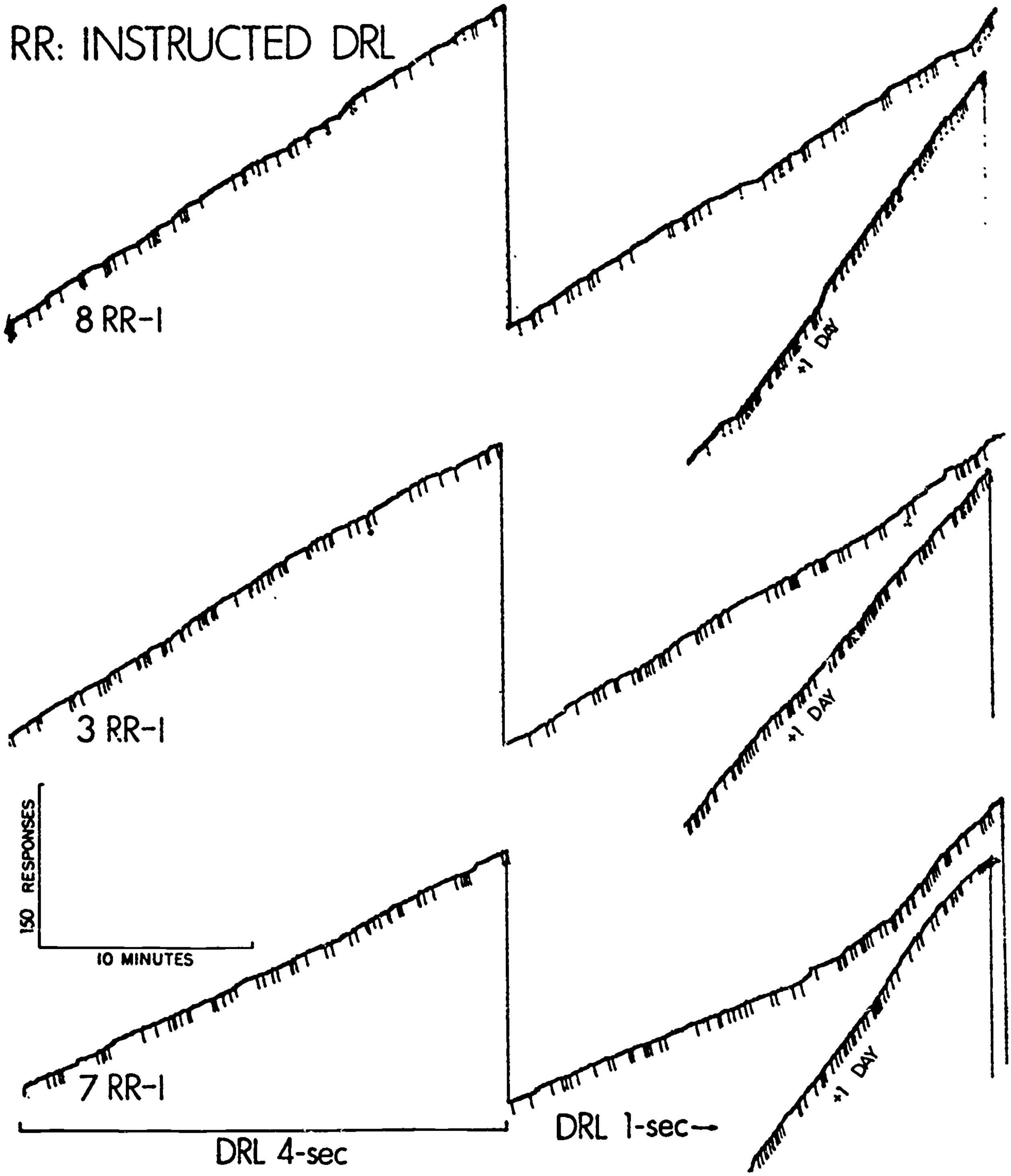


Figure 7. Cumulative records of responding established by instructions and maintained by RR 4-sec scheduling of point earnings. (Details as in Figure 5).

responding proportionately increased point earnings. Thus, the effects of instructions are apparently robust; shaped responding can be sensitive to subtle changes in contingencies, while instructed responding is often insensitive even to major changes in contingencies.

In most cases instructed responding remained insensitive despite contact with the contingencies. This suggests that instructionally induced insensitivity need not operate simply by generating performances that preclude contact with contingencies.

Obviously, instructed responding need not remain immune to contingencies; it would be maladaptive indeed for behavior to remain indefinitely under instructional control. Instructions may delay sensitivity, but need not permanently preclude its development. In Experiment 2, this is evident in the delayed rate increase in three cases of instructed responding. So long as there is some contact with the contingencies, sensitivity may eventually develop. Under some conditions, of course, instructions may exert more long-lasting effects by precluding contact with contingencies.

It is also important to note that uninstructed (shaped) responding need not always be sensitive to contingencies; such was the case for one participant in Experiment 1, and for two in Experiment 2. Covert verbal behavior, for example, may have instructional functions (Lowe, 1980). College students presumably have extensive histories of instructing the performances of others, as well as covertly restating instructions originally presented by others to them, and such verbal behavior may limit sensitivity. Perhaps such verbal behavior is responsible for variations in performances within groups, but it would be premature to speculate about how such behavior is established and how it might have its effects.

An important implication of the present findings is that rate *per se* is not consistently correlated with sensitivity to contingencies; either low rates (as in Experiment 2) or high rates (e.g., Matthews et al., 1977) may be insensitive. It is thus important that studies of human operant behavior test explicitly for sensitivity to contingencies, to ensure that scheduled consequences in fact control responding. In some experiments, internal evidence suggests that instructions controlled performance. In one case, for example, substantial responding was maintained when button-presses earned points according to a VI 171-sec schedule and lost points according to a VI 170-sec schedule, so that responding actually reduced earnings slightly (Bradshaw, Szabadi, & Bevan, 1978). Similarly, the roughly equal rates maintained by avoidance schedules of point-loss postponement with values from 10 to 60 sec (Galizio, 1979) suggest that the minimal instructions used in that procedure had been sufficient to produce insensitivity to contingencies.

It is often difficult to determine whether a particular performance is under the control of contingencies or instructions. Some investigators have suggested the presence of response patterns typical of infra-human performances, such as the fixed-interval scallops, should be the criterion by which we identify schedule-sensitivity. The ultimate criterion for determining sensitivity is whether performance changes appropriately when the contingencies change. The question of schedule-typical performance is orthogonal; one can readily imagine instructionally induced FI scallops which might not be sensitive to changes in contingencies (e.g., to a FT).

Sensitivity to contingencies is a property of a particular response within a particular context, and it would be misleading to suggest that an organism or a behavior class is sensitive or has sensitivity. In fact, it may be important within a given experimental setting to distinguish among contingencies on the basis of the sensitivity of responding to each. For example, instructed response rates in a study of concurrent signalled and unsignalled variable-interval schedules were high and roughly constant across different overall rates of point earnings, but the distributions of responses to the alternative schedules varied with schedule parameters (Bradshaw, Szabadi, Bevan, & Ruddle, 1979). In that instance, instructions seem to have generated a performance in which rate of responding was insensitive to variable-interval contingencies, but allocation of responding was sensitive to differences among the concurrent schedules. It would be of interest to design instructions that would generate concurrent responding the overall rate but not the allocation of which was sensitive to schedule parameters. Such a demonstration would illustrate the specificity of sensitivity to the relation between particular response properties and particular schedule parameters.

Experiment 3: Instructionally-induced sensitivity

In drawing the distinction between contingency-governed and role-governed behavior, Skinner (1969) has used an analogy of a blacksmith and his apprentice, both of whom may operate a bellows to keep a fire hot. The behavior of the blacksmith is under control of the contingencies: his bellow-pumping is maintained by the effects it has on the fire, and, were the fire to extinguish, the smithy would rekindle it. The apprentice, on the other hand, may be in a different room unable to see the fire. His behavior is controlled by the rule "Up high, down low/Up fast, down slow;" if the fire goes out, the apprentice might continue pumping the bellows with undiminished fervor.

What is the difference between the behavior of the blacksmith and that of the apprentice? If the fire burns normally, it might be difficult to distinguish between rule-governed and contingency-governed performances. The differences will become obvious, however, if the contingencies change. The smithy's performance is sensitive to those contingencies relating his behavior and the fire: he will stop pumping if the fire goes out. The apprentice's pumping is sensitive not to the fire (which he may never see), but to the smithy's instructions; if the smithy gives him new instructions, the apprentice's behavior will change regardless of what happens to the fire.

The example of the blacksmith and his apprentice suggests that topographical differences between rule-governed and contingency-governed responding may be inconsequential. The difference between the two types of performance becomes apparent only when there is a change in the contingencies. It is only by changing contingencies that one can determine the relative contributions of rules and contingencies to responding.

Suppose, however, that the blacksmith, an astute psychologist, wished to avoid the insensitivity-inducing properties of instructions. How might he do so? Perhaps the simplest procedure would be to instruct the apprentice to operate the bellows efficiently: "Up fast/ down slow, but make sure that the fire is still burning."

Put in the context of the present series of experiments, the question reduces to one of whether instructions can induce sensitive performance by focussing attention on the contingencies. Experiment 3 addressed this issue by using the RR DRL procedure described in Experiment 2, with instructions that described the experiment as a "problem-solving" task.

Method

Apparatus was similar to those described in Experiment 2; three undergraduates served as subjects. The standard instructions were modified to indicate that the task of the subject was to solve a problem, specifically to determine what they had to do to earn the maximum number of points. The RR DRL schedule was in effect for the first session. The second session was divided into four 12 min segments; in the first and third segments, the DRL requirement was set at 4 sec, while a 1 sec DRL requirement was in effect during the second and fourth segments. Presumably, sensitive responding would increase in rate when the DRL requirement was reduced, while insensitive performances would be characterized by constant rates regardless of the DRL requirement.

Results

Response rates and point-earnings in successive 12 min segments of the second session are shown in Table 1. The findings for Subject 1 are ambiguous; while extended exposure might have produced evidence of sensitivity, rates in the third and fourth segments do not indicate control by the DRL requirement. In the other two subjects, however, it is clear that rates go up almost immediately after the reduction in the DRL requirement.

Although no data were collected for people whose responding was shaped, a comparison of these data with results from Experiment 2 suggest that responding produced by "problem-solving" instructions was sensitive to the changes in the DRL requirement.

Discussion

Instructions may produce performances sensitive to at least some changes in contingencies; in the present case, instructions that simply identified an experiment as involving "problem-solving" were sufficient to make responding sensitive to changes in the DRL requirement. These findings must, nonetheless remain tentative, primarily because of the limited number of subjects.

These findings do not mean that problem-solving instructions generate responding sensitive to all changes in contingencies. Even behavior under

Table 1

Rates in succession 12 min periods

Subj	DRL Req	Resp/12 min	Reinforcements
1	4	177	16
	1	314	32
	4	349	17
	1	220	39
2	4	174	22
	1	225	43
	4	128	26
	1	255	56
3	4	126	17
	1	293	50
	4	197	21
	1	338	79

contingency control may be insensitive to some features of the environment. Sensitivity is not, after all, a "trait;" it may be specific to a response, or to a response dimension, or to certain kinds of contingencies. Sometimes, insensitivity may be attributed to the interaction of elicited and emitted responding; key-pecking in pigeons often appears insensitive to shock-avoidance contingencies. In other instances, the mechanism of insensitivity is less obvious; in pigeons, response rates appear relatively insensitive to changes in reinforcer magnitude until concurrent schedules are used, when sensitivity becomes apparent (Catania, 1963).

In the present case, the finding that button-pressing established by problem-solving instructions was sensitive to changes in the DRL requirement should not be taken as an index of general sensitivity; such responding might not be sensitive to other changes in contingencies (e.g., from a RR to RI). Furthermore, more detailed instructions may sensitize performance to particular features of a contingency; telling a person to respond at the most efficient rate might sensitize responding to rate contingencies but not to contingencies based on some other dimension of responding (e.g., force).

Experiment 4: Multiple RR RI

In the first three experiments, sensitivity was assessed by an uncued change in a DRL requirement. Compared with the yoking procedures reported by Matthews et al. (1977), these within-subject contingency changes are more efficient in that they do not require pairs of subjects, and allow simpler comparisons (within-subject rather than between-subject). However, the assessment of sensitivity in these experiments remained restricted to "one-shot" probes; sensitivity can be detected only when the contingency is changed, and that occurred only once (Experiments 1 and 2) or three times (Experiment 3) in each session.

Many investigators have shown the advantages of continuous monitoring of behavioral changes (e.g., Sidman, 1960; Shimoff & Matthews, 1975; Matthews, 1977), and such continuous monitoring has become a hallmark of the experimental analysis of behavior. In terms of the present series of experiments, continuous monitoring of sensitivity might uncover several interesting phenomena. Two differing instructions might both generate initially insensitive responding, but one might delay the development of sensitivity more than the other. Under such conditions, the question is not _whether_ sensitivity develops, but _when_ it develops. This fourth experiment represented an attempt at developing a continuous measure of sensitivity to contingencies.

The procedure chosen for the continuous monitoring of schedule sensitivity was a multiple schedule. In multiple (mult) schedules, two (or more) different schedules are presented in alternation, each associated with different discriminative stimuli. On the basis of previous data suggesting the ratio contingencies maintain higher response rates than interval schedules (e.g., Matthews et al., 1977), the schedules chosen were RR and RI; sensitivity to contingencies would be indicated by higher rates during the ratio component than during the interval components.

Method

General procedures were similar to those reported in the first three experiments, but the console was modified for the multiple schedule. Directly beneath the point-counter was a small black button; when the lights next to the counter were lit, a press on the black button added one point to the counter. Under the counter were two large red buttons, similar to the single red button used in previous studies. When the RI schedule was in effect, the left button was inoperative, a light above the right button was illuminated, and presses on the right button were reinforced according to a RI 20 sec (reinforcers available every 2 sec with a probability of .10). When the RR component was in effect, the RI button was inoperative, a light above the left button was illuminated, and every press was eligible for reinforcement with a probability of .05, providing a RR 20. Components alternated every 60 sec, and sessions lasted 50 min. Ten subjects participated; responding was instructed in three cases and shaped in the remaining seven instances.

Results

For three subjects, responding was established by instructions. Responding was insensitive, to the extent that there were no systematic differences in rates between RI and RR components developed over four sessions.

In seven instances, responding was established by shaping. For Subject 1, sensitivity (defined as higher rates during ratio than interval components) was evident within the first session. In the case of Subject 2, however, exposed to the same contingencies, there was no evidence of sensitivity, and rates were high in both interval and ratio components for two sessions. The third session, begun with a mult RI extinction (ext) 10 min period, followed by 10 min of mult RR RI, 10 min of mult RR ext, and 20 min of mult RR RI. there was no evidence of sensitivity in the last 20 min of exposure to the multiple schedule, despite the interpolated extinction periods designed to separate the rates.

At that point, it appeared possible that rates in the two components were "locked together" because of their alternation in the first session. Would rate differences be more likely to appear if the multiple schedule were introduced later in the experimental history? For Subject 3, the first session included only RI components, and schedule-typical RI performances were observed, that is, moderate rates with considerable "grain." In the second session, the multiple schedule was in effect; after 60 sec exposure to the RI component, the RR was presented for the first time. The RR probability was initially set at .25, and was reduced to .05 within the first 60 sec component. For this subject, sensitivity (i.e., rate differences between interval and ratio components) did not appear until the third session (that is, the second session under the multiple schedule).

For Subject 4, the first session included only the RI schedule, and responding was schedule-typical, moderate rates with considerable "grain" in the record. In the second session, the multiple schedule was introduced, and both the RI and RR schedules maintained responding similar to that seen in the first session under RI; the same pattern continued in the third session. In the fourth session, mult RR ext was in effect for the first 40 min; during RR components, rates increased over previous levels, while responding during the extinction components gradually decreased. In the last 10 min of the session, the mult RI RR was reintroduced, and there was some evidence of sensitivity. Unfortunately, the subject was unable to return for further sessions.

In the case of Subject 5, only two sessions were possible; in the first session, the RR schedule was presented alone, and high rates were observed. In the second session, the mult RI RR was introduced; rates during the RR components were relatively low, and RI rates were high, with ratio-like properties (e.g., no grain). For Subject 6, the first session included only exposure to the RI schedule, which generated schedule-typical responding; when the mult RR RI was introduced in the second session, responding in both components was similar to that previously maintained by the RI alone. In a third session, a mult RI ext schedule was used; rates during the extinction component dropped slowly, while interval performances increased in rate, lost grain, and appeared similar to typical ratio performances. Finally, for Subject 7, only the RI schedule was presented in the first session, but rates were high with little grain. In the second session the mult RR RI was in effect, but there was no indication of sensitivity to the difference in contingencies.

Discussion

Even when responding was shaped, there was no evidence of sensitivity to the different contingencies in the multiple schedule. This is particularly puzzling since Matthews et al. (1977) using similar schedule parameters found sensitivity even though there were no exteroceptive stimuli correlated with the change in contingencies, and despite the substantial and frequent shifts in reinforcer density in the present experiment. Although Matthews et al. (1977) used a telegraph key instead of the button used in the present experiment, there is no reason for that difference to induce insensitivity; if anything, the buttons required more force, and might be expected to increase the likelihood of lower rates on the RI button. Nor does it seem likely that responding was "superstitiously chained" because of the fixed 60 sec component duration; insensitivity remained even after responding on one key was extinguished.

Perhaps the most likely explanation is related to unrecorded self-generated verbal instructions. Such verbal behavior might refer to "responding" rather than to differential responding on each key. Unfortunately, such an explanation is entirely post hoc and speculative. It does suggest, however, that instructions focussing attention on the differential contingencies might enhance sensitivity. Such an analysis is based on the premise that shaping does not necessarily eliminate verbal behavior (cf. Lowe, 1980). An empirical assessment of some of that verbal behavior might prove useful in understanding the interactions between instructions and sensitivity, and was the focus of the fifth experiment.

Experiment 5: Contingency Guesses

The previous experiment showed that even shaped responding was not sensitive to the difference between ratio and interval contingencies presented in a multiple schedule. It is possible that the insensitivity might have been generated by self-generated instructions. Although such an explanation is highly speculative, it does suggest that instructions that focus on the contingencies might be effective in inducing sensitivity in much the same manner as the problem-solving instructions (Experiment 3) produced performances sensitive to the DRL contingency.

In the multiple schedules, however, simple problem-solving instructions might not "separate" responding on the two keys. In addition, problem-solving instructions provide no information about the nature of the hypotheses generated by the contingencies. Nor, is there any way of guaranteeing that subjects continue to generate hypotheses; they might assume they have "solved the problem" by responding at high rates. In the present experiment, these difficulties were addressed by having the subjects provide written guesses about the left and right key contingencies.

Method

Apparatus and procedures were generally similar to those reported in Experiment 4. The session was divided into four successive 10 min periods; at the end of each 10 min period, the lights above both keys were extinguished and a buzzing sound was presented through the earphones for 2 min. The subjects were told that, when these 2-min periods began, they were to write down their guesses about what it was about the left and right keys that produced points. A total of seven participants served in this experiment. In four cases, responding was established by instructions. In three other instances, responding was shaped in the first session and the contingency-guessing instructions were given before the second session. In some instances, a response-cost contingency was introduced in which every fiftieth response produced a 1-point decrement in total score.

Results

For the three subjects whose responding was shaped, there was no evidence of sensitivity in the initial session, and contingency-guessing instructions were given before the start of the second session. For Subject 1, the written guesses of the contingencies were accurate, describing both the differences in reinforcement rate (more points were earned on the ratio than on the interval schedule), as well as the fact that ratio-key responding resulted in proportionate increases in reinforcement density while interval-key reinforcers were temporally-limited and independent of response rate; appropriate rate differences, with higher response rates during ratio than during interval components, appeared, however, only in the third session.

For Subject 2, verbalizations about "what it was about the button-pressing" focussed on topographical dimensions of the button-press and other irrelevant behavior (e.g., position of the earphones), and there were no systematic rate differences between ratio and interval components. In the case of Subject 3, written guesses focussed on the number of responses per reinforcer in the second session, but there were no rate differences.

In four instances, responding was established by instructions. For Subject 4, there were no rate differences in the first three sessions; in the third session, however, the subject correctly verbalized the difference in reinforcement density between the ratio and interval components. Schedule-appropriate rate differences and accurate verbal reports emerged in the fourth session.

For Subject 5, verbal reports remained inaccurate, and there were no systematic rate differences for the first four sessions. In the fifth session, the response cost contingency was introduced; rate differences and a verbal report of reinforcement-density differences appeared rapidly. Even when the response-cost contingency was eliminated, the rate difference remained, indicating sensitivity to the contingencies.

For Subject 6, as with the previous case, neither rate differences nor accurate verbal reports appeared until response-cost was introduced. When the response-cost contingency was eliminated, the rate difference disappeared. In the following session, the rate difference reappeared and, for the first time, verbalizations were accurate. In a final session, however, the rate in the interval and ratio contingencies became approximately equal, although verbalizations remained accurate.

Finally, for a seventh subject, the rate difference and accurate verbalization were evident from the first session. In the third session, the rate difference disappeared, reappeared under response-cost, and disappeared when the response-cost contingency was eliminated; verbalizations remained accurate throughout.

Discussion

Experiment 5 found that verbalizations about contingencies may be independent of performance. In particular, Subjects 6 and 7 provided accurate verbal descriptions of the difference between the two components of the multiple schedule, while their patterns of button pressing remain unaffected by the difference in contingencies. Experiment 5 also found that verbal and nonverbal sensitivity to contingencies was more likely to develop when a response-cost contingency was in effect for button pressing.

Experiment 5 is presently being replicated and refined to further investigate the development of self-instructions and the conditions under which self-instructions control performance.

General Discussion

These five experiments have extended our understanding of the effects of instructions on performance, and tentatively suggest important variables for practical consideration.

Experiments 1 and 2 indicate that instructionally-induced insensitivity is a basic behavioral phenomenon, rather than a by-product of behavior that does not make contact with the contingencies. If instructed insensitive behavior makes contact with the contingencies, it appears likely that sensitivity to those contingencies will eventually develop; on the other hand, instructions which engender performance patterns that preclude contingency contact may remain permanently insensitive. This information about the mechanism of insensitivity has implication for training programs. In those instances in which the transition from instructional to contingency control is desirable, training procedures should be devised to maximize contact with the natural contingencies. If, on the other hand, resistance to the natural consequences of behavior is preferred, training programs and maintenance procedures should be designed to eliminate (as much as possible) natural contingencies.

The results of the third experiment suggest another general principle useful for the development of training programs; instructionally-induced insensitivity may be avoided if the training procedures explicitly call for attention to the natural consequences. This might be of particular significance if sensitivity is desired but the trainee's performance is unlikely to make contact with the natural contingencies. The detailed application of this principle depends, of course, on the specific training task. The focus on contingencies could be verbal, as in instructions which remind the student to try for the most efficient performance; under such conditions, it might even be advantageous to provide only partial training, with each trainee developing idiosyncratic, personal "styles" based on contingency contact. Alternatively, training protocols might include "problem-solving" tasks which encourage contact with the natural consequences.

Finally, the fifth experiment focussed attention on the significance of verbal behavior about the contingencies. Clearly, uninstructed performance need not be free of verbalization; if the trainer does not verbalize, the trainee might. The presence and nature of these verbalizations will depend on the task. Some tasks with complex motor components may be free of verbalization; for other tasks, this seems unlikely. The verbalizations may focus on the response, the consequences, or the relation between the two. While the present results suggested that verbalization of the response-reinforcer contingency generally appeared before the rate differences indicative of sensitivity, there were instances of accurate verbalizations with insensitive button-pressing. This should alert us to the distinction between the verbal and motor performances; while both are at least partially determined by the contingencies on button-pressing, they are different behaviors and need not correspond. The design of training procedures should take into account these differences. Verbalizations and motor activities are different and may be independent; verbalizations may be accurate while performance remains inefficient. Training procedures which focus on appropriate verbal behavior may not always engender efficient performance. Further studies of the interactions of contingency-guesses and motor performance are planned, and may shed further light on the nature of these potentially important interactions.

References

Baron, A., Kaugman, A., & Stauber, K. A. Effects of instructions and reinforcement-feedback on human operant behavior maintained by fixed-interval reinforcement. Journal of the Experimental Analysis of Behavior, 1969, 12, 701-712.

Bradshaw, C. M., Szabadi, E., & Bevan, P. Effect of variable-interval punishment on the behavior of humans in variable-interval schedules of monetary reinforcement. Journal of the Experimental Analysis of Behavior, 1978, 29, 161-166.

Bradshaw, C. M., Szabadi, E., Bevan, P., & Ruddle, H. V. The effect of signaled reinforcement availability on concurrent performances in humans. Journal of the Experimental Analysis of Behavior, 1979, 32, 65-74.

Catania, A. C. Concurrent performances: a baseline for the study of reinforcement magnitude. Journal of the Experimental Analysis of Behavior, 1963, 6, 299-300.

Farmer, J. Properties of behavior under random interval reinforcement schedules. Journal of the Experimental Analysis of Behavior, 1963, 6, 607-616.

Ferster, C. B., & Skinner, B. F. Schedules of reinforcement. New York: Appleton-Century-Crofts, 1957.

Fitts, P. M. Factors in complex skill training. In R. Glaser (Ed.), Training research and education. Pittsburgh: University of Pittsburgh, 1962.

Foree, D. D., & LoLordo, V. M. Transfer of control of the pigeon's key peck from food reinforcement to avoidance of shock. Journal of the Experimental Analysis of Behavior, 1974, 22, 251-259.

Galizio, M. Contingency-shaped and rule-governed behavior: instructional control of human loss avoidance. Journal of the Experimental Analysis of Behavior, 1979, 31, 53-70.

Harzem, P., Lowe, C. F., & Bagshaw, M. Verbal control in human operant behavior. Psychological Record, 1978, 28, 405-423.

Hefferline, R. F., & Kennan, B. Amplitude-induction gradient of a small-scale (covert) operant. Journal of the Experimental Analysis of Behavior, 1963, 6, 307-316.

Holland, J. G. Human vigilance. Science, 1958, 128, 61-63.

Kaufman, A., Baron, A., & Kopp, R. E. Some effects of instructions on human behavior. Psychonomic Monograph Supplements, 1966, 1(11), 243-250

Lattal, K. A. Combinations of response-reinforcer dependence and independence. Journal of the Experimental Analysis of Behavior, 1974, 22, 357-362

Long, E. R. Chained and tandem scheduling with children. Journal of the Experimental Analysis of Behavior, 1963, 5, 459-472.

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

Lowe, C. F. Determinants of human operant behavior. In P. Harzem & M. D. Zeiler (Eds), Advances in analysis of behavior. Volume 1. New York: Wiley, 1980.

Lowe, C. F., Harzem, P., & Hughes, S. Determinants of operant behavior in humans: some differences from animals. Quarterly Journal of Experimental Psychology, 1978, 30, 373-386.

Matthews, B. A. Magnitudes of score differences produced within sessions in a cooperative exchange procedure. Journal of the Experimental Analysis of Behavior, 1977, 27, 331-340.

Matthews, B. A., Shimoff, E., Catania, A. C., & Sagvolden, T. Uninstructed human responding: sensitivity of ratio and interval contingencies. Jounal of the Experimental Analysis of Behavior, 1977, 27, 453-467.

Reber, A. S. Implicit learning of synthetic languages: The role of instructional set. Journal of Experimental Psychology: Human Learning and Memory, 1976, 2, 88-94.

Schoenfeld, W. N. The theory of reinforcement schedules. New York: Appleton-Century-Crofts, 1970.

Shimoff, E., & Matthews, B. A. Unequal reinforcement magnitudes and relative preference for cooperation in the dyad. Journal of the Experimental Analysis of Behavior, 1975, 24, 1-16.

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

Skinner, B. F. Verbal behavior. New York: Appleton-Century-Crofts, 1957.

Skinner, B. F. Contingencies of reinforcement, a theoretical analysis. New York: Appleton-Century-Crofts, 1969.

Streifel, S. Timeout and concurrent fixed-ratio schedules with human subjects. Journal of the Experimental Analysis of Behavior, 1972, 17. 213-219.

Weiner, H. Some effects of response cost on human operant behavior. Journal of the Experimental Analysis of Behavior, 1962, 5, 201-208.

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

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

Weiner, H. Human behavioral persistence. Psychological Record, 1970, 20, 445-456.

Wolf, M., Risley, T., & Mees, H. Application of operant conditioning procedures to the behavior problems of an autistic child. Behavior Research and Therapy, 1964, 1, 305-312.

DISTRIBUTION

1 AIR FORCE HUMAN RESOURCES LAB ATTN: AFHRL/TSR
1 NAVY PERSONNEL R AND D CENTER /
1 OFC OF NAVAL RESEARCH PROJECT OFFICER, ENVIRONMENTAL PHYSIOLOGY
1 NAVAL AEROSPACE MEDICAL RSCH LAB AIRBORNE RANGER RESEARCH
1 USA RESEARCH AND TECHNOLOGY LAB ATTN: DAVDL-AS (DR. R. S. DUNN)
1 NAFEC HUMAN ENGINEERING BRANCH
1 USA RESEARCH AND DEVELOPMENT LABS CHIEF, BEHAV SCIENCES DIV, FOOD SCI LAB
1 NAVAL HEALTH RSCH CEN LIBRARY
1 AIR FORCE HUMAN RESOURCES LAB ATTN: AFHRL/OTS
1 ERIC PROCESSING AND REFERENCE FAC ACQUISITIONS LIBRARIAN
1 NMRDC PROGRAM MANAGER FOR HUMAN PERFORMANCE
1 AFHRL TECHNOLOGY OFC (H)
1 PURDUE UNIV DEPT OF PSYCHOLOGICAL SCIENCES
1 USAFA DEPT OF BEH SCI + LEADERSHIP
1 USA INTELLIGENCE CEN AND SCH ATTN: SCHOOL LIBRARY
1 USA WAR COLLEGE ATTN: LIBRARY
1 US COAST GUARD ACADEMY LIBRARY
1 ORGANIZATIONAL EFFECTIVENESS CEN + SCH ATTN: LIBRARIAN

NUMBER OF ADDRESSEES 18

TOTAL NUMBER OF COPIES 18