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THE EFFECTS OF MAGNITUDE AND SCHEDULE OF REINFORCEMENT ON INSTRUCTION-FOLLOWING IN HUMAN SUBJECTS WITH VERBAL AND NONVERBAL INSTRUCTIONS

by Bobby Newman

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

1996

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Abstract

THE EFFECTS OF MAGNITUDE AND SCHEDULE OF REINFORCEMENT ON INSTRUCTION-FOLLOWING IN HUMAN SUBJECTS WITH VERBAL AND NONVERBAL INSTRUCTIONS

by

Bobby Newman

Advisor: Professor Nancy S. Hemmes

Three experiments are reported that analyze instruction-following in human subjects. In Experiment 1, two individuals with autism served as subjects. Magnitude of reinforcement and accuracy of instructions were manipulated across phases, and both subjects showed sensitivity to the changing contingencies for instruction-following and illuminating a red or green light. In Experiment 2, college students served as subjects. In this experiment, the schedule of reinforcement was varied across subjects, and the accuracy of instructions was varied across phases. Subjects who were exposed to continuous reinforcement (CRF) were sensitive to the changing contingencies for instruction-following, but subjects who were exposed to leaner schedules (Fixed Ratio 2 and Fixed Ratio 3) were not. In Experiment 3, groups of college students were exposed to one of the three conditions of Experiment 2, but were given either verbal instructions or nonverbal instructions (white or black cards). While all subjects were sensitive under CRF, subjects in the nonverbal instruction conditions showed more sensitivity than the subjects in the verbal conditions under the two leaner schedules of reinforcement. Implications of the findings for the rule-governed behavior literature are discussed.

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Acknowledgements

Stanley Sham of the Queens College Psychology Department designed and built the apparatus used in Experiment 1. Special appreciation is extended to Dr. Nancy S. Hemmes for her supervision and to Dawn M. Buffington and Dana R. Reinecke for their assistance with this study and its written preparation.

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The Effects of Magnitude and Schedule of Reinforcement on Instruction-Following in Humans Subjects with Verbal and Nonverbal Instructions

"Insensitivity," the failure of human subjects to choose the most densely reinforced response option when given inaccurate instructions regarding programmed schedules of reinforcement, has been repeatedly documented over the past two decades (e.g., Buskist, Bennett, & Miller, 1981; Cerutti, 1991; Hayes, Brownstein, Haas & Greenway, 1986; Hayes, Brownstein, Zettle, Rosenfarb & Korn, 1986; Higgins & Morris, 1984; Joyce & Chase, 1990; Lippman & Meyer, 1967; Matthews, Catania, & Shimoff, 1985; Matthews, Shimoff, Catania, & Sagvolden, 1977; Shimoff, Catania, & Matthews, 1981; Shimoff, Matthews, & Catania, 1986). In these experiments, subjects have complied with inaccurate instructions, even though the programmed consequences for the response options (e.g., pressing a button quickly or slowly) did not support such a response pattern. Using inaccurate instructions, several researchers (e.g., Kaufman, Baron, & Kopp, 1966; Weiner, 1970) found strong instructional control over responding even during programmed extinction conditions. Subjects in these experiments were said to be insensitive to "collateral" consequences

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(Cerutti, 1989), the actual programmed schedule of reinforcement for the response options, as distinct from the social consequences of instruction-following.

In an attempt to explain insensitivity within the radical behavioral paradigm, Hayes et al. (1986a) suggested that instructions reduce sensitivity to contingencies attached to individual response options (as opposed to the contingencies for instruction-following), possibly by substituting rule-governed for contingency-shaped behavior. The interaction between rule-governed and contingency-shaped behavior may be difficult to tease apart, however, because when instructions accurately describe the contingencies for the response options, "Behavior under the control of a rule may occur in the same form as schedule-sensitive behavior and yet be purely an instance of rule-following not controlled by the particular programmed consequences" (Hayes et al., 1986a, p. 144).

In another attempt to explain insensitivity within the radical behavioral paradigm, Baron and Galizio (1983) described instruction-following as an operant response class, and suggested that inaccurate instructions will continue to control responding only if they allow the individual to come into contact with the densest schedule of

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available reinforcement. They assert that the individual's responding will continue to be instruction-based only as long as (s)he does not come into contact with a greater source of available reinforcement, or the instruction-based responding does not lead to reinforcer loss. When instruction-based responding did result in the loss of reinforcers, instructional control was lost (Galizio, 1979).

Such a conception has not satisfied all researchers. Hayes et al. (1986a), for example, found that (p. 145): "In some of the subjects...contact with the contingencies transferred control of responding from the given rule to the point contingency. In other subjects this did not occur, and control over responding stayed with the rule."

In view of such findings, Hayes et al. (1986a) have suggested that Baron and Galizio's conception is incomplete (not necessarily inaccurate). The reinforcement history of the instruction-following response must also be taken into account. When inaccurate, instructions provide a competing source of control, and may lead to entirely different behavior (Catania, Shimoff, & Matthews, 1989). The interaction of the programmed consequences for the response options and the individual's reinforcement history for rule-following must be taken into account.

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While it is not possible to manipulate the lifelong history of reinforcement for subjects, it is possible to manipulate factors within the experimental situation that will make insensitivity more or less likely. The three experiments presented here attempt to explore insensitivity and attempt to demonstrate the effects of three (of these many) variables: magnitude of reinforcement, schedule of reinforcement, and verbal versus nonverbal instructions (see Appendix 1 for additional suggestions for experimental manipulations from the rule-governed behavior literature).

Experiment 1

The studies cited above that claimed to show insensitivity are complicated by the fact that the potency of reinforcers used in many of the studies could be questioned. Hayes et al. (1986a), for example, used points that served as chances in a lottery for two $20 cash prizes to be awarded at the end of a semester. Other researchers have also used small monetary reinforcers, e.g., Galizio (1979), who awarded up to a total of $2 for a 50 minute session, and Matthews, Shimoff, Catania, and Sagvolden (1977), who awarded a reinforcer of .1 cent per response. Because the subjects in these studies were college students, the potency of such reinforcers as compared to the potential

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influence of the experiment administrators is questionable. Baron and Galizio (1983) argued that such social situations lead to expectations of scrutiny by the experimenter and therefore greater instruction-following than would ordinarily be observed. A more potent reinforcer would be needed to override the subject's concern regarding disapproval from the authority figures conducting the experiment. To sum up the heart of the objection, it hardly makes sense to talk about insensitivity to reinforcement if the monetary rewards are merely consequences, but not reinforcers (in the technically correct sense).

In Experiment 1, I investigated insensitivity with two individuals with autism. These subjects were chosen for two reasons. The first reason was the data of Mullins and Rincover (1985). Mullins and Rincover established steady-state performance in two groups of children, one group of children with autism and one normally developing children, using intermittent schedules of reinforcement. Mullins and Rincover then changed the schedule of reinforcement without informing the subjects about the change. Only the normally developing children changed response patterns in keeping with the new schedule. The children with autism maintained the established response pattern.

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Mullins & Rincover (1985) suggested that one of the key deficits of individuals with autism may be their tendency to perseverate on a particular response pattern and, therefore, failure to sample alternative schedules or sources of reinforcement. If this is indeed the case, it should be very easy to demonstrate insensitivity in students with autism.

The second reason for the use of subjects with autism was the relative ease of establishing potent reinforcers with this population, and thus to avoid the problems of weak reinforcer strength noted above.

The magnitude of a pre-established potent reinforcer was differentially manipulated across three response classes, instruction-following and turning on a red or a green light. Instructions, which varied in their accuracy, were presented before each trial. Consequences for turning on red or green and for instruction-following were varied across phases, and were presented after each trial.

Method

Subjects

Two teenagers with autism, independently diagnosed by an outside agency and known hereafter as Ron and Don, served as the subjects for Experiment 1. Ron and Don both had IQs

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in the moderately retarded range (as determined by the Stanford-Binet Intelligence Scale, Fourth Edition), and had developed verbal abilities (i.e., tacts and mands were spontaneously and appropriately emitted). Both were students at an afterschool program for students with autism where the experiment was conducted.

Apparatus

The experimental apparatus consisted of two components; a control box that was connected to a box with lights (colored red or green). The control box had a dial that allowed the subject to choose which light would be illuminated on the light box. In addition, there was a button in the middle of the control box that activated a bulb on the light box when depressed. To illuminate a particular bulb on the light box, the control box dial had to be set to that color setting, and the button had to be depressed. The boxes were placed in front of the subject, the control box on the left of the light box. The dimensions of the control box were 10 x 18 cm., and the dimensions of the light box were 13 x 15 cm. The light bulbs were .5 cm. in diameter. The apparatus is represented in Figure 1.

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General Procedure

The experiment was carried out over seven phases for Ron and ten phases for Don. Blocks of trials were conducted independently for the two subjects. Contingencies for three operant responses; turning on a red light or a green light, and instruction-following, were varied across phases (see Table 1 for summary).

Two blocks of ten trials were conducted each day. At the beginning of each experimental session, each subject was led into a room in which the apparatus was placed on a circular table. The subject sat at the table, with the apparatus directly in front of him and in easy view. The maximum number of tokens that could be earned in one block (15 tokens in Phases 2 & 7, six tokens in Phase 9, and 20 tokens in the remaining phases) was laid out on the table. The subject was asked to count them. The subject was then asked to "make the red light go on three times, and the green light go on three times." After each response, the appropriate number of tokens (1 or 2 tokens, dependent upon the contingencies specified by the phase) for each light for that session were presented. After the completion of these practice trials, the experimenter turned the control dial to one randomly chosen color setting. After this placement,

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the day's blocks were begun.

Subjects earned tokens for their responding during the experiment. The tokens were pennies, which were also used in the token economy in existence in the subjects' afterschool program. The trading in of tokens and the consumption of reinforcers separated the two blocks of trials conducted each day. In all phases, the maximum number of available tokens (in this phase 20 tokens) was exchangeable for a commodity of the subject's choice (e.g., a can of soda or a package of M & M's), or 20 minutes in an activity of the student's choosing (e.g., time in the gymnasium or access to a Walkman with a favorite music tape). For Ron, when fewer than the maximum number of available tokens were earned, they were exchangeable for an equal number of minutes in an activity of his choosing, except in the final phase. During the seventh phase for Ron, and during the entire experiment for Don, the subject was required to earn the maximum number of available tokens to trade in his tokens. Any number of tokens fewer than the maximum number available was not redeemable (i.e., an "all or nothing" contingency).

Inter-observer agreement

Inter-observer agreement was taken on both independent

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and dependent measures for approximately 75% of the blocks. Agreement on all measures was 100% throughout all phases, calculated using a point by point method (agreements divided by agreements plus disagreements).

Design and Procedure

In Phase 1, the subject was instructed to "make the lights go on." Turning on the red light produced two tokens; turning on the green light produced one token. After ten lights had been lit in total, the subject was allowed to trade in his tokens. This first phase was conducted to verify that the tokens would function as reinforcers, and would control behavior in the absence of instructions. This phase, and all others, was terminated when response patterns appeared stable.

In Phase 2, the experimenter presented an instruction before each trial. Instructions were read from a pre-arranged random order of five instructions to turn on the red light, and five instructions to turn on the green light. Instructions were phrased, "Turn on the (color) light and you'll get the most tokens you can," in keeping with Glenn's (1987) conception of rules as descriptions of operant relations, in this case a relation between the required response and a consequence. During this phase,

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turning on the red light when instructed led to the delivery of two tokens. Turning on the green light when instructed led to the delivery of one token. No tokens were delivered if the instruction was not followed (i.e., the wrong light was turned on). If the subject did not respond after the first instruction, it was repeated a maximum of two more times. If a response did not occur following the second repetition, the next scheduled instruction was delivered. This phase was conducted to demonstrate that the subjects were capable of following instructions, provided the contingencies supported instruction-following.

Phase 3 was identical to Phase 2, except there were no differential consequences for compliance versus noncompliance. Whenever the subject turned on the red light, regardless of instructions, two tokens were delivered. Whenever the subject turned on the green light, regardless of the instructions, one token was delivered. This phase was conducted to demonstrate that responding would be controlled by the consequences for the light-illuminating responses rather than the instructions if instruction-following did not lead to maximum earning of reinforcement.

Phase 4 was identical to Phase 3, with the exception

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that turning on either light was equally reinforced (two tokens for red and two for green). This phase was conducted to examine the response pattern when compliance and noncompliance were not differentially reinforced.

Phase 5 was identical to Phase 4, with the exception that turning on the green light led to the delivery of two tokens, and turning on the red light led to the delivery of one token. This phase was conducted to establish that the response pattern would shift away from the previously established bias towards the red option, if supported by the consequences for light illumination.

Phase 6 was identical to Phase 4.

Phase 7 was a replication of Phase 2, with differential consequences for instruction-following reinstated. Turning on the green light when so instructed produced two tokens; turning on the red light when so instructed produced one token. Noncompliance with instructions produced no tokens. This phase was conducted to establish that the response class of instruction-following could be reinstated when supported by the consequences for instruction-following.

Phase 8 was identical to Phase 7, except that turning on both the red and green lights led to the presentation of two tokens. This phase was instituted as a control for the

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fact that 15 tokens was the maximum number of tokens that could be earned in previous accurate instruction phases, as opposed to the 20 that could be earned during the no instruction and inaccurate instruction phases.

In Phase 9, regardless of instructions, both response options led to the intermittent delivery of only one token. The red option, however, was reinforced according to a fixed ratio (FR) 5 schedule. The green option was reinforced according to an FR 10 schedule. Because of the intermittency of the reinforcement, each block of this phase contained 30 trials to allow for effective contact with the consequences for the light illuminating responses and for instruction-following.

Phase 10 was identical to Phase 3.

Results

As can be seen in Phase 1 of Figure 2, both subjects earned all available reinforcers with no instructions. The filled circles represent percentage of red chosen. The open circles represent percentage of available reinforcers earned. After initially alternating between the two choices, Ron earned all available reinforcers on the third block, and again on the fifth through tenth blocks, by responding exclusively on the red light alternative. Don

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earned all available reinforcers on the first, and then on the fourth through tenth blocks.

As is visible in Phase 2, both subjects also earned all available reinforcers with accurate instructions. Despite an initial bias towards the red light, Ron earned all available reinforcers on the seventh through tenth blocks of this phase by following instructions on all trials. Don earned all available reinforcers on the second, and then on the fourth through tenth blocks.

In Phase 3, Ron initially failed to earn all available reinforcers, complying with all instructions (the first four blocks of this phase). Subsequent performance was variable, finally stabilizing with all reinforcers being earned during the ninth block of the phase, and continuing to the end of the phase. Don also failed to earn all available reinforcers early in the phase, following instructions on the first five blocks of the phase and following nine out of ten instructions during the sixth block. Don then earned all available reinforcers twice, resumed instruction-following for two blocks, and then earned all available reinforcers on the 11th through the 18th blocks of the phase.

In Phase 4, Ron tended to choose red. Because both

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choices were equally reinforced regardless of instructions, pressing any combination of buttons resulted in earning all available reinforcers during this phase. During the first two blocks, Ron sampled green on 40% of the trials. During the remaining eight blocks, however, the green light was chosen only once. Don followed instructions for the first six blocks of this phase, but then chose the red alternative during the final six blocks of the phase.

In Phase 5, Ron again earned all available reinforcers. The phase began with Ron concentrating responses on the red light, and gradually shifting over to the green light. During the final five blocks of the phase, Ron earned all available reinforcers by concentrating responses exclusively on the green light alternative. Don chose the red option on the first two blocks of this phase, but then earned all available reinforcers by concentrating responses on the green alternative for the final eight blocks of the phase.

In Phase 6, responding was variable. In some blocks Ron concentrated responses on one light, in some blocks on the other. Ron tended to stay with whichever light he chose initially, changing the light setting within a block only once. Don began the phase by choosing green for three full blocks. He then gradually changed his responding towards

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instruction-following. Earning of all available reinforcers during all blocks was again necessitated by conditions of this phase.

In Phase 7, Ron again earned all available reinforcers with accurate instructions. Responding was variable, with Ron often failing to earn all available reinforcers after two or more consecutive blocks of such responding. During the final six blocks of this last phase, however, Ron failed to earn all available reinforcers only once. Don began to earn all available reinforcers by the third block of the phase, and continued to earn all available reinforcers by following instructions for the remainder of the phase.

Only Don completed Phases 8 through 10. During Phase 8, an accurate instruction phase, Don earned all available reinforcers in all blocks.

During Phase 9, Don failed to earn all available reinforcers during any block of the phase, following all instructions for a total of 300 trials across ten blocks.

During Phase 10, Don began to earn all available reinforcers with the third block, and continued to earn all available reinforcers for the remainder of the phase.

Discussion

In Experiment 1, subjects earned all available

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reinforcers under conditions of no instructions, accurate instructions, and inaccurate instructions. These results differ from those of Mullins and Rincover (1985). Ron and Don both earned all available reinforcers under a number of conditions, some of which required responses contrary to previous requirements and contrary to the instructions preceding each trial. In view of the current data, it seems that individuals diagnosed with autism can change their response patterns and therefore earn all available reinforcers, given the appropriate structured environment.

Both Ron and Don completed Phases 1 through 7. Only Don, however, completed Phases 8 through 10. Ron had to drop out of the experiment following the seventh phase due to hospitalization caused by medication difficulties. Further, he became less responsive as a result of medication changes during Phase 6. Although Ron never failed to respond in any phase, it was during this phase that it became necessary to occasionally repeat instructions. It was to solve this problem that token exchange was allowed only after earning of all available reinforcers within a given block during Phase 7. Because the all or nothing procedure maintained responding with Ron, the same contingency was instituted with Don, the second subject.

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Little insensitivity to the programmed contingencies for both the light-illuminating responses and instruction-following was observed in Experiment 1. This coincides with the predictions of Baron and Galizio (1983) and replicates the results of DeGrandpre and Buskist (1991).

Experiment 2 differed from many previous studies comparing rule-governed and contingency-shaped behavior in that prior studies have often used reinforcers of dubious strength. The present study established the potency of the reinforcer before proceeding with the remainder of the experiment. Even with the potent reinforcers, however, insensitivity may have been seen at two points; in the beginning of the third phase (in which there were several full blocks of trials where instructions were followed precisely and all available reinforcers were thus not earned), and in the ninth phase.

There are two plausible explanations for the insensitivity. The first is the response class conception of instruction-following, which fits well within the traditional operant framework (Vaughan, 1989) as an acquired function (Reese, 1989). The way in which responding shifted from instructional to contingency control in Phase 3, only after behavioral variability had allowed for effective

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contact with the consequences for both light illumination and instruction-following (e.g., Galizio, 1979), supports this response class conception. Alternatively, it could be said that in each phase, rule-governed responding was observed. Responding might have been governed by internally stated rules (e.g., "I have to pick red during this phase in order to earn all available reinforcers," the language hypothesis) rather than the programmed consequences for the response options. Such a conception adds nothing here, however, being entirely post-hoc (Vargas, 1988) and far from parsimonious. Invoking such explanations also leads to potential tautologies.

Phase 9, however, raises a methodological issue. Much research in the rule-governed behavior literature has been conducted by giving instructions regarding how to earn the greatest number of available reinforcers, and then varying schedules of reinforcement without giving any new instructions (Vaughan, 1989). Under these conditions, human subjects have generally failed to show behavior consistent with the new schedule of reinforcement (Hayes, Zettle, & Rosenfarb, 1989; Inesta & Sanchez, 1990). When consequences were continuous, Don showed no insensitivity. He showed insensitivity when reinforcement was intermittent, but his

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responding quickly came under contingency control when consequences were once again made continuous.

Insensitivity may therefore be, in part, an artifact of the difficulties humans seem to have with schedules of reinforcement in general, and may or may not be related to the unique linguistic abilities of the human species. I theorize that the intermittent nature of the consequences and their varied order of presentation allowed for adventitious reinforcement of both response options, and precluded one option being favored during Phase 9. To study the effects of more intermittent schedules of reinforcement, I conducted Experiment 2.

Experiment 2

Insensitivity has generally been studied by examining human performance when inaccurate instructions are provided regarding a prevailing intermittent schedule of reinforcement, often after first establishing steady-state performance (Hayes, Zettle, & Rosenfarb, 1989). This is a somewhat curious fact, given Michael's (1984) observation that many experimental studies of rule-governed behavior were inspired by the accumulation of evidence that schedule control of behavior in human subjects is much more difficult to achieve than in infrahumans (Cerutti, 1989; Hayes et al.,

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1989; Vaughan, 1989).

The empirical studies cited above that showed insensitivity generally used a fairly lean intermittent schedule of reinforcement. To take several examples, Random Ratio (RR) 20 and Random Interval (RI) 10-second schedules were used by Matthews, Catania, and Shimoff (1985). Shimoff et al. (1981) used a RI 15-second schedule, with a superimposed DRL 3-second schedule. Shimoff et al. (1986) used a RR 40/RI 5-second multiple schedule, with an additional RI 10-second schedule programmed in as well. Hayes et al. (1986a, 1986b) used a DRL 6s/FR 18 multiple schedule.

Not every study in the area has used an intermittent reinforcement procedure, however. The classic Ayllon and Azrin (1964) study, which first showed the clinical utility of instructions paired with operant reinforcement, used a continuous schedule of reinforcement. Experiment 1 of the present report investigated instruction-following within the operant paradigm, but manipulated magnitudes of continuous reinforcement as opposed to the intermittently scheduled consequences used in the studies mentioned above. Subjects showed more collateral consequence control than is generally reported in the rule-governed behavior literature. When a

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subject was exposed to concurrent FR 5 and FR 10 schedules, however, the collateral consequence control was lost.

Another experiment in which little or no insensitivity was observed was reported by DeGrandpre and Buskist (1991). They conducted an experiment in which the accuracy of instructions was systematically varied across phases. Two groups of subjects were tested. One group was exposed to accuracy levels (expressed in percentages) of 100-50-0-50-100, while a second group ran at 0-50-100-50-0. DeGrandpre and Buskist provided reinforcers ("points") after every fifth response. The reinforcers provided information regarding the points earned by all five prior responses. The schedule of feedback might be considered a CRF schedule. Once initial feedback had begun, subjects were able to systematically sample responding strategies (e.g., compliance, noncompliance, choice biases) and determine the most heavily reinforced strategy. As will be discussed below, the DeGrandpre and Buskist procedure allows for a cleaner demonstration of insensitivity with a smaller number of trials necessary. It is also more appropriate to our new subject group, normally developing college students, subjects who are used to longer delays of reinforcement. It also allowed a particular number of trials to be run per

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subject, rather than merely testing how long it would take for each subject to begin to display sensitivity.

I hypothesized that it is the continuous nature of the schedule of reinforcement that led to the different results obtained by DeGrandpre and Buskist (1991) and Experiment 1 compared to much of the rest of the rule-governed behavior literature. This hypothesis is based on multiple conceptions of insensitivity, especially the argument of Baron and Galizio (1983) that insensitivity may often be due to failure to effectively contact contingencies for noncompliance. A denser schedule of reinforcement makes it more probable that subjects will make effective contact with the consequences for the response options and for instruction-following. It is unlikely that a subject will fail to discriminate a shift in reinforcement for a behavior being reinforced according to a CRF schedule. The same cannot be said for a RR-20 schedule.

In Experiment 2, therefore, I attempted to follow up on the data and methods of DeGrandpre and Buskist (1991) and Experiment 1. The percentage of accurate instructions was systematically varied across phases within subjects, and the schedule of reinforcement (both for instruction-following and noncompliance) was systematically varied between groups.

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With our first group of subjects, I used DeGrandpre and Buskist's arrangement but provided feedback after each response. With subsequent groups, I systematically made feedback more intermittent, to FR 2 and FR 3 in separate groups. My object was to show that the schedule of reinforcement is a potent variable governing instruction-following.

Method

Subjects

The subjects of Experiment 2 were 18 undergraduate students taking an introductory psychology course at Queens College. Subjects volunteered for the experiment to satisfy the research participation requirement of the course. All subjects received credit for having participated in the experiment, regardless of their performance. All subjects were debriefed after the experiment.

Setting and Apparatus

The setting was a large office on the campus of Queens College. A table was placed in the middle of the room. The subject and experimenter sat across from one another, with a Battleship (TM: Milton-Bradley Co.) board game open on the table between them. The Battleship game is a 10x10 slot peg grid enclosed in plastic.

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Design and Procedure

A two choice experiment was conducted. Taking pegs from the left or right side of the Battleship game was the behavior of interest, with compliance with instructions being our dependent measure. Instructions were provided to the subject, in the form of "Take a peg from the (left or right) side of the board to earn tokens." Tokens (pennies) were delivered according to the contingencies described below. Each instruction and the response that followed it constituted a single trial.

At the outset of the experiment, the following instructions were read to the subject:

> Welcome to the learning lab of Dr. Nancy Hemmes. In this experiment, you will be given instructions to perform simple tasks, taking pegs from the left or right side and placing them at random on the playing board. The instructions will vary in their accuracy. You will receive tokens (pennies) for participation in this experiment. The tokens will each be worth one ticket in a lottery to be held at the end of the semester for a $100.00 prize. Sometimes the best way to earn tokens will be to follow instructions. Other times the best way to earn tokens will be to do the

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opposite of what you are instructed. You should try to earn as many tokens as you can. It will be possible to earn 150 tokens. You can take breaks when you desire. Completing this experiment will satisfy a portion of the department's research participation requirement.

Three subjects were randomly placed into each of the six groups listed in Table 2. Subjects therefore were exposed to the percentage of accuracy of instructions in one of two orders, either 100-50-0-50-100 or 0-50-100-50-0. For each sequence of instructional accuracy, one group ran at a CRF schedule, one group ran at FR 2, and one group ran at FR 3. Each phase in the CRF groups lasted for 30 trials, for 60 trials in the FR 2 groups, and for 90 trials in the FR 3 groups.

During the 100% accuracy phases, the only way to earn reinforcers was to comply with instructions. For the CRF groups, reinforcers were delivered after each response. For the FR 2 groups, every second compliance led to reinforcement. For the FR 3 groups, every third compliance led to reinforcement.

During the 50% accuracy phases, half of the reinforcers were delivered after compliance responses and the other half were delivered after noncompliance responses. A randomized

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list of "compliance" or "noncompliance" trials was used to determine whether compliance or noncompliance responses would be reinforced. For the CRF subjects, one half of the reinforcers were delivered after compliance responses, and one half after noncompliance responses. For the FR 2 groups, one half of the reinforcers were delivered after the second compliance response, and one half after the second noncompliance response. For the FR 3 groups, one half of the reinforcers were delivered after the third compliance response and one half after the third noncompliance response.

During the 0% accuracy phases, the only way to earn reinforcers was to do the opposite of what one was instructed to do. For the CRF groups, each instance of noncompliance led to the delivery of a reinforcer. For the FR 2 group, every second noncompliance response led to reinforcement. For the FR 3 groups, every third noncompliance response led to reinforcement.

Results

Data for all subjects are shown in Figures 3-8. In each figure, the percentage of instruction-following (compliance) is plotted across trials. Each point represents the percentage of compliance for five trials. As

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a particular number of trials were conducted for each subject rather than waiting for stability, the trends displayed by each subject in each phase will be discussed.

Figures 3-4 depict the data for subjects in the CRF conditions. During both of the 100% accurate instruction phases, responding stabilized with subjects following all instructions. During both of the 50% accurate phases, responding was variable, with instruction-following varying between 50-100%. No consistent trends can be discerned. During both of the 0% accurate instruction phases, responding stabilized with subjects disobeying all instructions.

Figures 5-8 depict the data for subjects in the FR 2 and FR 3 conditions. The systematic trends observed with the CRF schedule are not visible. Atypically high insensitivity was shown by five subjects in the FR 2 and FR 3 conditions, all of whom failed to even sample noncompliance once. Three other subjects in these conditions sampled noncompliance less than ten times over a total number of 300 (FR 2) or 450 (FR 3) trials. Highly variable responding (although generally above 50% compliance) was shown by the other subjects in these conditions. No shifts in response pattern with the changing

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of the accuracy of the instructions were visible.

Discussion

The data of Experiment 2 suggest that instruction-following is a function of the schedule of reinforcement that either supports or rejects instruction-following. With CRF, subjects were able to earn all available reinforcers across a number of conditions of accuracy of instructions. When the schedule was made more intermittent, however, subjects demonstrated loss of collateral consequence control and followed instructions at a greater rate than with the denser schedule. This loss of collateral consequence control is similar to that observed in many studies of human performance when subjects are exposed to schedules of reinforcement and given inaccurate instructions. The order effects reported by DeGrandpre and Buskist were not observed, however. The contingencies in effect in prior phases did not influence responding in subsequent phases.

From post-session interviews, it seems that discriminability of schedules was the crucial difference. At the leaner schedules, subjects were unable to discriminate the favored response strategy, and the role of the instructions. This lack of feedback made the self-generation of rules (Lowe, 1979; Rosenfarb, Newland, Brannon

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& Howey, 1992) extremely difficult. Subjects reported that they would attempt to formulate hypotheses regarding, for example compliance or noncompliance, or patterns of responding. With CRF, it was relatively easy to test these hypotheses and to discover the appropriate response strategy. With the leaner schedules it was demonstrably more difficult. With greater exposure to the schedules (as suggested by Wanchisen, Tatham, & Hineline, 1992), perhaps earning of all available reinforcers would eventually have been seen. Regardless, the more intermittent schedules do seem to result in far greater difficulty in earning all available reinforcers. I therefore postulate that the phenomenon of insensitivity may be partly the result of the fairly lean schedules used in most studies of rule-governed behavior, and not the result of any inherent properties of the instructions themselves (as suggested by Shimoff et al., 1981). Subjects who ran at lean schedules demonstrated loss of consequence control, despite the fact that all subjects were told that noncompliance was going to be the appropriate strategy during certain portions of the experiment (in an attempt to remove fear of disapproval for noncompliance). Such insensitivity was not observed with the CRF subjects, and thus I conclude that the schedule of reinforcement was

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the crucial variable governing compliance and noncompliance.

These data are generally consistent with the view of rule-governed behavior advanced by Baron and Galizio (1983), that instruction-following can be conceptualized as a response class. Instructions can serve as discriminative stimuli that lead to behavior (instruction-following) that is susceptible to the same laws of consequential relations as behavior occasioned by nonverbal antecedents. The conditions under which most studies of rule-governed behavior have been conducted, however, preclude effective contact with these consequences.

In Experiment 2, I identified the schedule of reinforcement as one variable that can affect whether verbal instructions will be followed. In Experiment 3, I investigated the role of the nature of the instruction, i.e., the difference between a verbal and nonverbal instruction.

Experiment 3

The results of Experiment 2 do not explain why subjects exposed to the leaner schedules showed insensitivity. At least two theories may be important. Researchers such as Shimoff et al. (1981) have suggested that insensitivity is a defining characteristic of instructional control. According

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to this view, insensitivity is due to the fact that instructions inherently lead to insensitivity, perhaps due to the long reinforcement history subjects have for instruction-following (Reese, 1989).

As mentioned above, Baron and Galizio (1983) and Galizio (1979), in contrast, suggest that insensitivity can be explained as a failure to effectively contact prevailing contingencies for compliance and noncompliance. The relatively lean schedules used in the studies cited above do not allow a subject to determine the best responding strategy for earning the greatest number of available reinforcers. Insensitivity is seen here as being caused by the schedule of reinforcement, and not by the instructions. If the schedules were denser, if the subjects came into greater contact with the contingencies for compliance and noncompliance, the insensitivity would not be seen.

Experiment 3 attempts to determine the model that best explains the data observed in Experiment 2, particularly the insensitivity observed in the FR 2 and FR 3 conditions. In the current study, the procedure of Experiment 2 was replicated, but additional groups of subjects were tested. Two additional groups were exposed to FR 2 and FR 3 with nonverbal, arbitrarily chosen stimuli serving as

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instructions. As no order effects were seen in Experiment 2, and since the order effects are not essential to the question at hand, I ran all subjects with the accuracy of instructions at 100-50-0-50-100%.

The purpose of Experiment 3 was to test the two models of insensitivity presented above. The pattern of responding demonstrated by the FR 2 and FR 3 subjects with the nonverbal stimuli allowed me to conclude whether the insensitivity displayed in the prior study was caused by some inherent property of the instructions, or caused by the more intermittent schedule of reinforcement. If subjects show insensitivity with the nonverbal instructions then it can be concluded that the insensitivity seen in Experiment 2 was due to the schedule and the failure of subjects to make effective contact with the contingencies for the response options and for instruction-following (Baron & Galizio, 1983). If no insensitivity is observed with the nonverbal instructions, but is seen with the verbal instructions, then I will conclude that the insensitivity seen in the prior study was indeed caused by some property of the verbal instructions provided.

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Method

Subjects

The subjects of Experiment 3 were chosen in the same manner as those for Experiment 2. Queens College students volunteered for the experiment in order to satisfy the research participation requirement of an introductory psychology course. All subjects received credit for having participated in the experiment, regardless of their performance. All subjects were debriefed after the experiment.

Setting and Apparatus

The setting and apparatus of Experiment 3 were identical to that of Experiment 2.

Design and Procedure

As in Experiment 2, a two choice experiment was conducted. Taking pegs from the left or right side of the Battleship game was the behavior of interest, with compliance with instructions being the dependent measure. For subjects who received verbal instructions, instructions were provided to the subject, in the form of "Take a peg from the (left or right) side of the board to earn tokens." Instructions were delivered by experimenters who were unaware of the purpose of the experiment or the

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controversies in the rule-governed behavior literature. Tokens (pennies) were delivered according to the contingencies described below. Each instruction, the response that followed it, and either the delivery or non-delivery of a reinforcement constituted a single trial. For subjects who received nonverbal instructions, instead of a verbal stimulus, either a black or a white index card was held up at eye level by the experimenter. Experimenters in the nonverbal instruction condition said nothing while presenting the black and white cards. In all other ways, the procedures were exactly the same for subjects receiving verbal and nonverbal instructions. Procedurally, the black card corresponded to a verbal instruction to take a peg from the left side, and the white card corresponded to a verbal instruction to take a peg from the right side. For the rest of this paper, it will be understood that the experimenter holding up a white card is procedurally equivalent to a verbal instruction to take a peg from the right side and that the experimenter holding up a black card is procedurally equivalent to a verbal instruction to take a peg from the left side.

Before the experiment, the subjects in the verbal instruction conditions heard the same instructions as the

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subjects of Experiment 2. Subjects who received nonverbal instructions were told this before the experiment:

> Welcome to the learning lab of Dr. Nancy Hemmes. In this experiment, you will be shown black and white cards. These cards will be your cue to take a peg from either the left or the right side of the board. The relation between card and the correct side from which to take a peg may change during the experiment. You will receive tokens (pennies) for correct responding. The tokens will each be worth one ticket in a lottery to be held at the end of the semester for a $100.00 prize. Sometimes the best way to earn tokens will be to perform the same behavior that earned tokens before. Other times, the best way to earn tokens will be to do the opposite of what previously led to tokens. You should try to earn as many tokens as you can. It will be possible to earn 150 tokens. You can take breaks when you desire. Completing this experiment will satisfy a portion of the department's research participation requirement. If you have any questions about what is expected of you during this experiment or how to earn tokens, you may ask questions now.

Three subjects were placed randomly into each of the

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six groups listed in Table 3. Each phase lasted for 30, 60, or 90 trials for the CRF, FR 2, and FR 3 groups, respectively.

During the 100% accuracy phases, the only way to earn reinforcers was to comply with instructions (or, in the case of the subjects in the nonverbal instruction groups, to take from the right when shown a white card and from the left when shown a black card). For the CRF groups, reinforcement was delivered after each response. For the FR 2 groups, every second compliance led to reinforcement. For the FR 3 groups, every third compliance led to reinforcement.

During the 50% accuracy phases, half of the reinforcers were delivered after compliance responses and the other half were delivered after noncompliance responses. A randomized list of "compliance" and "noncompliance" trials was used to determine whether compliance or noncompliance responses would be reinforced. For the CRF subjects, one half of the reinforcers were delivered after compliance responses, and one half after noncompliance responses. For the FR 2 groups, one half of the reinforcers were delivered after the second compliance response, and one half after the second noncompliance response. For the FR 3 groups, one half of the reinforcers were delivered after the third compliance

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response and one half after the third noncompliance response.

During the 0% accuracy phases, the only way to earn reinforcers was to do the opposite of what one was instructed to do. For the CRF groups, each instance of noncompliance led to the delivery of a reinforcer. For the FR 2 group, every second noncompliance response led to reinforcement. For the FR 3 groups, every third noncompliance response led to reinforcement.

Results

Data for all subjects are shown in Figures 9-14. In each figure, the percentage of instruction-following (compliance) is plotted across trials. Each point represents a percentage for five trials. For the subjects in the verbal instruction conditions, the points represent compliance. For the subjects in the nonverbal instruction conditions, the points represent "compliance" with the original "white card means pick from the right, black card means pick from the left" condition of the first phase of the experiment (referred to hereafter as the "original contingency"). As in Experiment 2, a particular number of trials were conducted for each subject rather than waiting for stability. Therefore, the trends displayed by each

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subject in each phase will again be discussed.

Figure 9 depicts the data for the subjects in the verbal CRF condition. Across subjects, sensitivity to the consequences of instruction-following was observed. Subject VHM followed all instructions across the first two phases. During the third phase, when noncompliance was reinforced, there is a steep decrease in instruction-following. Responding became variable during the next phase, the 50% accuracy condition, with instruction-following varying from 20-100%. During the second 100% accurate instruction condition, VHM followed all instructions.

Subject ABF also followed all instructions during the first 100% accurate instruction condition. During the initial 50% accurate instruction condition, however, her responding became variable, ranging from 20-80% instruction-following. During the final 100% accurate instruction condition, her instruction-following again rose, finally reaching 80%.

Subject LZM followed all instructions during both 100% accurate instruction phases. During both 50% accurate instruction conditions, she showed a greater tendency towards instruction-following, with instruction-following in the first 50% accurate instruction condition ranging from

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80-100%, and from 40-100% during the second 50% accurate instruction condition. During the 0% accurate instruction condition that separated these two 50% conditions, however, her instruction-following dropped rapidly from 100% to 0% instruction-following.

Data for the nonverbal CRF instruction condition are shown in Figure 10. Subject CDF followed the contingencies in the first phase, following the original contingency 100% of the time in five out of six blocks. Responding varied from 60-100% during the next phase (random relationship between side choice and card color), and dropped steadily from 100-0% during the third phase when the contingencies regarding the relationship between card color and side had reversed completely from the first phase. Following of the original contingency rose from 20% to 60% during the next phase (random relationship), and finally back up to 100% during the final phase, when contingencies were precisely as they had been in the first phase.

During the first phase, subject TLF followed contingencies 100% in four out of five blocks. During the next phase, when contingencies were random regarding card color and side choice, following of the original contingency dropped to 80-40%. When the contingencies totally reversed

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in the next phase, following of the original contingency dropped further, falling to between 0-20%. During the next phase, random relationship between card color and side choice, following of the original contingency rose, varying between 20-100%, stabilizing at 60%. When the original contingencies were reinstated in the final phase, following of the original contingencies rose back to 100%.

Subject DBM showed variable following of the original contingency in the first phase, with following of the contingency originally decreasing from 80-20%. Her subsequent contingency-following increased during the phase, with her last two blocks of trials showing 100% contingency-following. During the next phase, random relationship between card color and side choice, following of the original contingency decreased, ranging from 80-40%. When the original contingency was fully reversed in the next phase, following of the original contingency decreased and stabilized at 0%. When the contingencies were once again made random, following of the original contingency increased, ranging from 20-60%. In the final phase, when the original contingency was reinstated, following of the original contingency was 100%.

The data for the three subjects in the verbal

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instruction FR 2 condition are shown in Figure 11. All three subjects showed no real changes in response patterns across phases. Subject YZM followed every instruction given, never sampling noncompliance once. Subject MCM sampled noncompliance in three of the five phases, but never lower than 40% instruction-following, and never consistently. Subject NHF showed nonsystematic responding across phases, with no real pattern evident.

Figure 12 displays the data for the subjects in the nonverbal instruction FR 2 condition. Subject GMF showed no real changes in response pattern across phases. Her responding varied from 0-100% following of the original contingency in two phases, from 20-80% in two phases, and from 20-100% in the last phase.

Subject DRF, however, changed response patterns across phases. In the first phase, contingencies were followed 100% of the time. In the second phase, following of the original contingency became predictably variable. In the third phase, when the original contingency was reversed, following of the original contingency reduced to 0-20%. When contingencies again became random, following of the original contingencies increased, stabilizing around 40%. In the last phase, when the original contingency was

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reinstated, following of the original contingency was 100%.

Subject DLM showed response patterns similar to those of subject DRF. In the first phase, following of the original contingency ranged from 40-100%, with most of the blocks being 60% or above. Similar response patterns were observed during phase two, the random phase. During Phase 3, however, following of the original contingency decreased, with the last several blocks being either 0% or 20%. Following of the original contingency increased during the return to the random phase, and even more so when the original contingencies were reinstated (all blocks were between 80-100% in the final phase).

Figure 13 shows the data for subjects in the verbal instruction FR 3 condition. Neither subject CBF nor subject BTM showed any real changes in response patterns across phases. Subject BTM showed more variable performance than did subject CBF. His compliance ranged from 0-100%, but with no discernible pattern. Subject CBF never dropped below 60% compliance.

Subject AAM, in contrast, showed changes in response patterns across phases. During the 100% accurate instruction phase, compliance stabilized at 100% instruction-following. During the 50% phase, responding was

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more variable, ranging from 20-100%. During the 0% accurate instruction phase, although responding still varied between 0-80%, a greater concentration of blocks saw 40% or less compliance. During the 50% accurate instruction phase, instruction-following rose, with the majority of the blocks being 40% or above. In the last 100% accurate instruction phase, the majority of the blocks were 60% compliance or above.

Figure 14 shows the data for subjects in the nonverbal instruction FR 3 condition. Subject CZF showed little change in response patterns across phases. Her following of the original contingency never dropped below 60%, and only in one phase did she deviate at all from that response pattern.

Subjects JIF and MOM, in contrast, showed large degrees of change in response pattern across phases. In the first phase, neither subject dropped below 60% following of the original contingency. In Phase 2, JIF's following of the original contingency varied from 20-100%, with most blocks falling in the 40-60% range. During Phase 2, MOM never dropped below 60% following of the original contingency. During the reversal of the original contingency phase (Phase 3), JIF followed the original contingency 0-20% of the time

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in the majority of blocks. MOM showed slower change in response pattern, but the final four blocks were 20% following of the original contingency or below. Both subjects' following of the original contingency ranged from 0-80% during the second random phase (Phase 4). For both subjects, when the original contingency was reinstated, following of the original contingency concentrated in the 80-100% range.

Discussion

During both the verbal and nonverbal instruction conditions with CRF, all subjects showed sensitivity to the changing contingencies for instruction-following. This responding is no different from what was observed during the CRF conditions of Experiment 2.

During the verbal instruction FR 2 condition, no subject showed sensitivity to the changing contingencies for instruction-following. This response pattern, again, is no different from what was observed in Experiment 2. Two of the three subjects in the nonverbal instruction FR 2 condition, however, showed sensitivity to the changing relationship between card color and side choice.

Subject BTM of the verbal instruction FR 3 condition was arguably sensitive to the changing contingencies for

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instruction-following. The other two subjects, however, showed insensitivity to these changing contingencies. In contrast, two of the three subjects in the nonverbal instruction FR 3 condition showed strong sensitivity to the changing relationship between card color and side choice.

These results suggest that there is an interplay between schedule of reinforcement and verbal versus nonverbal instructions. At CRF, feedback was constant enough that no subject showed insensitivity. This result supports Baron and Galizio's (1983) suggestion that insensitivity may be partially explained as a failure to effectively contact collateral contingencies.

As the schedule was made more intermittent, however, subjects in the verbal instruction conditions showed more insensitivity than did subjects in the nonverbal instruction conditions. Because sensitivity was shown at CRF, we cannot simply state that insensitivity is a defining characteristic of instructional control. A more plausible alternative was suggested by Reese (1989), who, as stated above, suggested that human subjects come to the experimental situation with a long reinforcement history for instruction-following, thus making instruction-following probable. Without the long reinforcement history for the relationship between card

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color and side choice, the subjects showed more sensitivity to the changing contingencies regarding card color and side choice.

General Discussion

From Experiments 2 and 3, it is apparent that inaccurate instructions do not automatically lead to insensitivity. Subjects who were tested under CRF showed no insensitivity in either Experiment 2 or 3, regardless of the type of instruction. In Experiment 3, four of six subjects who were tested with nonverbal instructions under FR 2 and FR 3 showed sensitivity. Although no subject in either FR 2 or FR 3 in Experiment 2 showed sensitivity, one subject in Experiment 3 who was tested under FR 3 with verbal instructions showed what could arguably be called sensitivity. The remainder of the subjects of Experiments 2 and 3 who were tested under the leaned schedules of reinforcement showed insensitivity.

The exposure subjects received to the schedules was fairly brief (150, 300, or 450 trials). While obvious trends are visible in the data of Experiments 2 and 3, it could be argued that, given time, the insensitive subjects would have begun to earn all available reinforcers. While this may be true (see the argument of Hayes et al. 1986a

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below), it is nonetheless apparent from the data of Experiments 2 and 3 that the more intermittent schedules and verbal instructions were associated with less sensitivity.

Glenn (1987) has suggested that rules be defined by their topography, without any reference to their behavior-altering function. A rule is an event in the environment: a verbal statement of a behavior to be performed and the consequence that will follow this response. The three experiments presented here support this view. If rules are defined as events in the environment, defined by their topography, then it is possible to systematically study the variables of which instruction-following is a function. Here I have identified magnitude of reinforcement, schedule of reinforcement, and verbal versus nonverbal instructions as three such variables. From the three experiments reported here and the rule-governed behavior literature, it is possible to suggest several such variables that will determine whether instructions or consequences for the response options will determine the topography of responding.

First, as demonstrated by DeGrandpre and Buskist (1991), the immediate history with accurate or inaccurate instructions can determine the source of control for

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behavior. According to DeGrandpre and Buskist, variability in instruction-following is related to how reliable the previous instructions had been. This conception closely mirrors the conclusions of Galizio (1979). Galizio suggested that experience with the fact that instruction-following does not lead to earning the greatest number of available reinforcers will decrease the tendency to follow instructions. Further, prolonged exposure to collateral consequences may change behavior that was originally instruction-based to collateral consequence-shaped (Catania et al., 1989; Hayes et al., 1986a), assuming that effective contact with the collateral consequences is made (e.g., Galizio, 1979).

As described by Catania et al. (1989), instructions must also be sufficiently plausible and convincing if instruction-following is to occur. This raises the additional point that subjects must understand instructions in order to follow them. Compatibility between the forms of instructed and consequence-shaped behavior may also be important (Baron & Galizio, 1983). If the behavior described by rules does not allow for effective contact with consequences for compliance and noncompliance, then behavior may appear to be instruction-based. To cite an earlier

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example, some inaccurate rules allow for responding that leads to some reinforcement (as in the Kaufman et al., 1966 variable interval/variable ratio study). If the rules and collateral consequences are not compatible, however, instruction-following is less likely (provided collateral consequences are potent). If the instructions and collateral consequences both shape behavior in the same direction there will be no conflict. It will not be possible, however, to determine the source of control of behavior (Hayes et al., 1986a). The form of response required by the instructions may also determine whether the instructions are followed or not. Hayes et al. (1986a) and Joyce and Chase (1990) suggest that general instructions may allow for more behavioral variability, leading to more contact with collateral consequences, and therefore more collateral consequence control.

Cerutti (1989) has suggested that collateral consequences are likely to control responding when the consequences are potent. The pennies, or tenths of pennies, or chances in a lottery mentioned above may not be potent enough to override instructional control. Experiment 1 assessed the potency of reinforcers before assessing the instruction/collateral consequence interplay and found

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strong collateral consequence control. Continuous schedules of reinforcement for these collateral consequences, as opposed to intermittently scheduled consequences, may facilitate control by collateral consequences (Experiment 2).

Finally, verbal instructions lead to more insensitivity than do nonverbal instructions (Experiment 3). This is in all probability due to the extensive reinforcement history subjects have for following verbal instructions.

One major objection may be raised against the methodology used in Experiments 2 and 3. In the DeGrandpre and Buskist (1991) study upon which Experiments 2 and 3 were based, consequences were delivered solely on the basis of responses to instructions. There were no collateral consequences attached to the individual response options that were separate from the instructions provided. Since there were no collateral consequences that were separate from the instructions, it could be suggested that the DeGrandpre and Buskist (1991) study did not really make contact with the insensitivity literature. We believe that this conception is false.

Methodologically, the DeGrandpre and Buskist (1991) procedure actually allows for a cleaner demonstration of

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insensitivity. Baron and Galizio (1983) argued that the inaccurate instructions of some of the studies in the area are not incompatible with the programmed schedule of collateral consequences. Baron and Galizio provide the example of an experiment in which subjects were told that they were responding under a VR schedule of reinforcement, when the schedule of collateral consequences was in fact VI. Subjects showed responding characteristic of the VR schedule. Baron and Galizio suggest that, rather than insensitivity being demonstrated, the subject's VR-like responses were actually being reinforced (and thus maintained) by the programmed VI schedule. In DeGrandpre and Buskist's 0% accurate instruction condition, the influence of the instruction-following history described by Reese (1989) was set against the collateral consequences programmed into the laboratory tasks. This is no different from what is traditionally done in the insensitivity literature. The accidental partial reinforcement effects described by Baron and Galizio, where instruction-following may be accidentally reinforced because the collateral consequences and the supposedly inaccurate instructions occasionally run parallel, are avoided, however.

In the traditional insensitivity literature,

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insensitivity is said to be observed when subjects continue to follow instructions and do not respond as one would expect if there were no instructions present (Baron & Galizio, 1983; Joyce & Chase, 1991). Thus, when subjects whose behavior had been shaped shifted responding to earn the greatest number of available reinforcers, and subjects who had been instructed about prevailing contingencies did not (Shimoff et al., 1981), this was called insensitivity. To return to the more general definition, insensitivity is said to exist when one observes responding not supported by the programmed collateral consequences. If instruction-following does not lead to a maximum rate of reinforcement relative to another response strategy, we would expect instruction-following to extinguish (as it did in DeGrandpre & Buskist, 1991; Galizio, 1979; Experiment 2 and 3). According to these conceptions, instruction-following is a response class that can be sensitive to consequences. We can therefore proceed as did DeGrandpre and Buskist (1991) and examine insensitivity to the consequences of instruction-following itself. In other words, if subjects continued to follow instructions in DeGrandpre and Buskist's 0% accurate instruction phases, we would be observing insensitivity. This is indeed what I saw with four of six

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subjects in the FR 2 and FR 3 conditions of Experiment 2 and seven (possibly eight) of the 12 subjects in the FR 2 and FR 3 conditions of Experiment 3.

Rule-governed behavior will in all probability continue to be one of the most controversial areas within behavior analysis. It is here that behavior analysis most closely contacts other schools within psychology (Zettle, 1990). As argued by Schlinger (1991), it is also an area that can rapidly degenerate into tautologies and redundancies. Catania's (1989) suggestion that rules are merely verbal discriminative stimuli, defined by their behavior-altering properties, seems to confirm Schlinger's fears. If research proceeds in the fashion suggested by Glenn (1989), however, the term rule-governed behavior can be as precise and useful as any other term in behavior analysis. A rule is a verbal stimulus that is presented prior to an opportunity to respond. The factors that determine whether or not that verbal stimulus will influence behavior are the proper area of study for the experimental analysis of rule-governed behavior.

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Appendix 1: Rule-governed Behavior is a Useful Term

Rule-governed behavior refers to behavior control by verbal stimuli antecedent to the behavior (Catania, 1989; Cerutti, 1989; Glenn, 1987; Schlinger, 1990; Skinner, 1969; Vargas, 1988; Zettle, 1990). Recent interest in rule-governed behavior has been so intense that Hayes, Zettle and Rosenfarb (1989) have suggested that concern with instructions and other forms of verbal behavior is the defining characteristic of the modern era of operant research. Other researchers, however, have argued that the term, rule-governed behavior, does not add anything new to the behavior analytic vocabulary and should be eliminated (e.g., Vargas, 1988; Schlinger, 1990).

Those who claim a need for the term are quick to point out that the traditional three-term contingency does not convincingly explain some common human behavior. There are many examples of everyday responses that almost certainly involve some degree of antecedent verbal stimulus control in the absence of actual consequences. Catania (1984) suggests that there are many responses learned by humans that are almost exclusively verbally mediated. Learning to find a friend's home by trial and error rarely occurs. There are also some responses that must be performed correctly on the

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first attempt, based solely on verbal instructions that may have been delivered some time previous to the opportunity to respond, e.g. driving a car through a red light (Hayes & Hayes, 1989). Malott (1986) and Braam and Malott (1990) have further suggested that environmental collateral consequences cannot be invoked to explain the genesis or maintenance of responses that lead to collateral consequences that are temporally distant or improbable (such as tooth flossing or helmet wearing), nor "self-directed" behavior (e.g., eating sensibly). Finally, many researchers have found that human subjects, exposed to operant schedules of reinforcement, often fail to demonstrate schedule control when presented with inaccurate instructions regarding collateral consequences (e.g., Buskist, Bennett, & Miller, 1981; Higgins & Morris, 1984; Lippman & Meyer, 1967; Lowe, 1979; Matthews, Shimoff, Catania, & Sagvolden, 1977; Shimoff, Catania, & Matthews, 1981).

In this appendix I will attempt to demonstrate that the term, rule-governed behavior, does add to the explanatory power of the behavior analytic system. I will first trace the history and proposed definitions of rule-governed behavior, and then consider models of how rules control behavior. I will then analyze the research claiming to show

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"insensitivity" to reinforcement contingencies for individual response options when inaccurate instructions are presented. Finally, I will review specific experimental parameters that have been shown to influence rule-following.

To analyze the interplay of rules and collateral consequences, I will use the terminology of Cerutti (1989). The consequences for following instructions (including the reinforcement history for same) will be called "instructional contingencies." The actual consequences of the given behavior, distinct from the social consequences regarding instruction-following, will be called "collateral" consequences. Although they will not be used here, a related set of terms suggested by Zettle and Young (1987) are also in common use and merit mentioning. When a rule describes a relationship between behavior and consequence that is not socially mediated, e.g. the relationship between putting your hand into a fire and being burned, this is known as a "track." When a rule describes a relationship between behavior and consequence that is only socially mediated, e.g. the relationship between making your bed and receiving praise, this is known as a "ply."

How should rules be defined?

In this section, I will review theories regarding the

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functional properties of rules. I will suggest a definition that will increase the scope of the behavior analytic system, while not introducing the tautologies and redundancies feared by some. The opening portion of this section will merely describe the different functions for rules that have been suggested. Later in the section I will attempt to integrate the proposed definitions.

The first explicit use of the term "rule-governed behavior" was made by Skinner (e.g., 1969, pp. 121-125 and pp. 146-152). As Skinner meant the term, rule-governed behavior is defined as responding controlled by an antecedent verbal stimulus (a "rule," often in the form of a verbal instruction). This description of rule-governed behavior is sufficiently vague to allow for two highly related, but slightly different, descriptions of the means by which rules control behavior. The first means by which rules control behavior is by altering the functions of stimuli within a three-term, antecedent stimulus -> response -> consequence, contingency (the stimulus we might call a conditional discriminative stimulus if the function-altering stimulus was nonverbal). In this case, the rule is known as a contingency-specifying stimulus. An example of a contingency-specifying stimulus would be a verbal warning

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regarding the significance of a red warning light on a car dashboard. After the delivery of the contingency-specifying verbal stimulus, this previously neutral red light becomes a discriminative stimulus that occasions pulling off to the side of the road. The second means by which rules can control behavior is by having the antecedent verbal stimulus itself serve as the discriminative stimulus in the three-term contingency, in which case no special term beyond "discriminative stimulus" is required.

As will be demonstrated, Skinner was not always consistent, sometimes referring to the contingency-specifying function of rules and sometimes referring to the discriminative stimulus function of rules. Adding to this confusion, as mentioned above, terms already exist to describe nonverbal stimuli that serve these same functions (i.e., conditional discriminative stimulus and discriminative stimulus), leading to questions about whether or not introducing the term "rule" adds anything not already adequately described within the behavior analytic vocabulary. To make matters even worse, Schlinger (1991) has also described widespread confusion regarding a distinction between a discriminative stimulus and a contingency-specifying stimulus. Schlinger asked the

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editors of several major behavioral journals to score examples of antecedents provided by him. He found low rates of agreement, and widespread disagreement regarding the temporal and functional properties of contingency-specifying and discriminative stimuli. Making a distinction between the two may therefore, in some instances, be very difficult.

In Skinner (1988), the contingency-specifying function of a rule is demonstrated via a "fable." In this narrative, an individual is instructed regarding how to operate a car (e.g., "press down the clutch") and this alters the significance of the clutch (a discriminative stimulus). According to this use of the term "rule," the rule does not directly occasion a response, but rather alters the function of antecedents and collateral consequences that will be present at the time of the response. The verbal antecedent may be quite temporally distant from the opportunity to respond.

According to Skinner, a rule could also, however, serve discriminative stimulus functions. The verbal antecedent may itself evoke a response much as would any nonverbal stimulus in whose presence prior responding had been reinforced. This verbal antecedent takes on response-evoking properties precisely as would a nonverbal stimulus.

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As stated by Skinner (1969): "As a discriminative stimulus, a rule is effective as part of a set of contingencies of reinforcement. A complete specification must include the reinforcement which has shaped the topography of a response and brought it under the control of the stimulus" (p. 148). According to this conception, the rule is provided at the time of the opportunity to respond and directly occasions the response.

Modern conceptions of rule-governed behavior have emphasized one or the other of these two uses of the term "rule." Schlinger (1990) and Schlinger and Blakely (1987) have emphasized the contingency-specifying properties of the rule, as has Malott (1988). As noted above, contingency-specifying rules function as would conditional discriminative stimuli in a nonverbal organism. Malott (1988) also notes that contingency-specifying rules are also related to setting events and establishing operations in that they alter the function or potency of stimuli (both antecedents and consequences) which might be quite temporally distant to the opportunity to respond. With so many terms to serve the same function, it is small wonder that many have been skeptical of the need for a new term.

Other theorists (the vast majority, according to

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Schlinger, 1990) have emphasized the discriminative function of rules. Catania (1989), for example, argues that the discriminative function is a necessary component of the definition. A rule is a rule only if, when presented antecedent to a response, a reliable behavioral effect of the rule can be observed. To make his suggestion concrete, Catania (1989) offers an example: "Just as we do not call a stimulus discriminative if it has no behavioral effect on an organism, we should not call a verbal antecedent a rule if it has no behavioral effect on a listener" (p. 50). According to Catania, rules are defined in terms of functional relations, much as are other behavioral terms (e.g., reinforcement and punishment).

While agreeing that rules may serve as discriminative stimuli, Glenn (1987, 1989) has attempted to avoid a definition of rules in terms of function. Such a definition merely adds one more tautology into the behavior analytic vocabulary (i.e., a reinforcer is a stimulus that reinforces; a punisher is a stimulus that punishes). Glenn (1989) characterizes the danger of a functional definition: "Thus Mr. Smith's classroom rules, which are written on the blackboard, are not rules unless the kids obey them" (p. 51).

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To avoid this difficulty, Glenn (1987) has, instead, advocated defining rules as objective environmental events. A given rule exists and is defined by its topography, not by the individual's response to this antecedent verbal stimulus. Reese (1989) speaks of functional and nonfunctional rules, capturing both Catania's and Glenn's conceptions. Allowing for such contradictory properties is unlikely to help resolve the present confusion, however.

According to Glenn's analysis, a rule consists of two equally important components, a statement of the behavior that must be performed and a statement of the consequences that will follow the performance of this behavior. By defining rules in terms of topography, Glenn suggests that we can more easily investigate the ways in which antecedent verbal stimuli govern behavior. As stated by Glenn (1989), "The experimenter is then in a position to manipulate various parameters of the verbal stimulus (as well as other environmental events of interest) to observe if the stimulus control is maintained (i.e. if the rule continues to "govern" the behavior)" (p. 51).

To summarize, following Skinner's precedents, rules have been defined both as contingency-specifying stimuli and as discriminative stimuli. Schlinger (1990) has advocated

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using "rule" only when referring to contingency-specifying stimuli. In his view, referring to antecedent verbal discriminative stimuli as rules is unnecessary (i.e., why have a special term just because the antecedent stimulus is verbal?) and confusing (Schlinger, 1990): "I....suggest that continued adherence to the rules-as-discriminative stimuli interpretation may be one cause of the confusion over how we should interpret verbal stimuli we call rules" (p. 77).

Schlinger notes that verbal antecedents may be presented any length of time before a response actually occurs, and may not have any training history that is associated with the response. The evoking or occasioning effect that is generally considered to be the hallmark of a discriminative stimulus is therefore often absent. Schlinger (1990) thus notes that "the use of the term 'discriminative stimulus' does not appear to be consistent with its use in the animal literature" (p. 79).

Despite Schlinger's suggestions, the evoking or occasioning effect that he considers the hallmark of a discriminative stimulus is often observed when a verbal antecedent stimulus is presented, and one would have no problem calling the antecedent verbal stimulus

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discriminative. A teacher tells students "Now begin your math examples, and when you're done you can go to gym." The temporal and behavior-evoking properties of a discriminative stimulus seem to be present here. The verbal stimulus not only specifies contingencies, it occasions a response (exactly as a nonverbal stimulus might signal the availability of reinforcers). Thus, the discriminative stimulus conception of rules also seems to hold in some cases. At the risk of introducing another set of terms into this area, perhaps one can consider these as Type 1 (contingency-specifying) and Type 2 (discriminative stimulus) rules. A rule is always a contingency-specifying verbal stimulus. Type 1 rules change behavior by altering the function of antecedents or consequences, and may be quite temporally distant from the behavior they describe. Type 2 rules evoke behavior at the time of their delivery by describing the immediate behavior/consequence relationships.

With the function of the rule thus outlined, the defining characteristics remain to be established. Defining rules in terms of their function seems to lead to tautologies and redundancies. If rules were nothing more than verbal discriminative stimuli, then there would be nothing of interest to discuss, and the term "rule-governed

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behavior" would be superfluous (the argument of Vargas, 1988). This difficulty can be avoided by accepting Glenn's suggestion that rules should be defined by their topography, consisting of a statement regarding the response to be performed and the consequence(s) that will follow this response. This verbal stimulus may (through training) alter the functions of particular antecedents or consequences or evoke a behavior at the time of delivery. Accepting this definition will allow us to look more clearly at the insensitivity literature (discussed below). With our definition of a rule set in this way, the factors that determine whether a rule will have any behavioral effect can be studied without confusion regarding any "inherent" behavior-altering properties of the verbal stimulus.

How do rules become effective?

In this section, I will examine two models of how rules acquire their behavior-altering properties: stimulus equivalence and differential reinforcement. The current literature does not allow us to choose between these models. Both may be important, and an understanding of each conception will be essential prior to discussion of the most controversial aspect of rule-governed behavior research, insensitivity (our next section).

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Noting that stimulus equivalence and rule-governance are two phenomena that have yet to be demonstrated with nonverbal organisms, models by which nonverbal stimuli can enter into relationships with verbal stimuli (including rules) via equivalence relations have been suggested by Catania (1986), Devaney, Hayes and Nelson (1986) and Hayes and Hayes (1989). According to these models, rules evoke behavior because the nonverbal stimuli that they describe have entered into equivalence relations with the verbal stimuli of the rules. Hayes and Hayes (1989, p. 179) provide the example of an organism who has formed equivalence classes such that the word classes "bell", "cake", "get", "go to" and "oven" have entered into relational frames with the sounds of actual bells, actual cakes, the act of getting, the act of going, and actual ovens. According to the model, "the temporal relation between the bell and the function of going to the oven specified in the rule transfer to actual bell and actual oven...When the bell rings, it actualizes the go to function established verbally with regard to the oven" (p. 79). While this model may be a departure from radical behavioral theory, and may not as yet be fully developed (Vaughan, 1989), at the very least it provides a model with a great

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deal of supporting experimental evidence that suggests the means by which the verbal stimuli come to be regarded as equivalent to the nonverbal stimuli they describe.

Another model that has been proposed to explain the genesis and maintenance of rule-following is differential reinforcement. In keeping with the idea of rules as discriminative stimuli, it has been suggested that rules are followed because behaving in accordance with rules has led to reinforcer delivery in the past (Vaughan, 1989). Rules can thus be acquired verbally, as the individual follows novel instructions because past instructions have led to their promised consequences. This can occur even if the rules promise consequences that are actually highly improbable (e.g., "don't do that or you'll go blind"). Rules may also be acquired by experiencing the actual consequences promised by the rule (e.g., actually touching a hot stove you had been warned not to touch). It has been experimentally demonstrated that rule-following can be created in this manner (e.g., studies in the clinical literature regarding the effectiveness of instructions with treatment populations, e.g., Ayllon & Azrin, 1964; Baer, Rowbury, & Baer, 1973; Koegel, Dunlap, & Dyer, 1980; Rincover & Koegel, 1975; Whitman, Zakaras & Chardos, 1971).

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Once the instruction evokes the response, the natural or social consequences of instruction-following maintain the behavior. In this way, a response class of "rule following" is created (called the "instruction response" by Schoenfeld & Cumming, 1963). This conception of a general response class of rule-following fits well within the operant framework (Vaughan, 1989) as an acquired function. People tend to follow rules because this general response class of rule-following has been reinforced in the past. This is somewhat unsatisfying in that such a response class has no particular form (Reese, 1989), being totally dependent upon the form of the instruction. Reese, however, admits "I do not have a better solution, or even an alternative one" (p. 38). Because the relationship between instructions and subsequent behavior can be readily established, however, it seems that we can accept this response class as valid and study its properties (as done by Galizio, 1979, discussed below).

Insensitivity

As described by Michael (1984), interest in the experimental analysis of rule-governed behavior was largely inspired by the accumulation of evidence that schedule control of behavior in human subjects is much more difficult

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to achieve than is the case with infrahumans (Cerutti, 1991; Hayes et al., 1989; Vaughan, 1989). One theory that has been proposed to explain this discrepancy between animal and human behavior is the "language hypothesis" (e.g., Brewer, 1974; Lowe, 1979; Thoresen & Mahoney, 1974). According to this theory, humans do not behave as infrahumans do under schedules of reinforcement because the linguistic abilities of humans come into play. Humans form (possibly false) hypotheses regarding the best way to respond in a given situation, and these hypotheses may direct behavior away from the pattern of responding exhibited by infrahumans. Support for this theory was provided by Matthews, Shimoff, Catania, & Sagvolden (1977). In their study, subjects were taught to press a key either through shaping or through instructions and demonstration. Only subjects whose behavior had been shaped proved to be sensitive to changes in schedules. Inaccurate instructions may therefore function as an impediment to the development of schedule control, with shaped subjects being sensitive to changes in schedules of reinforcement and instructed humans becoming insensitive to the schedules of reinforcement.

Some experiments suggest that inaccurate instructions are able to override the influence of programmed collateral

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consequences (e.g., Buskist, Bennett, & Miller, 1981; Higgins & Morris, 1984; Kaufman, Baron & Kopp, 1966; Lippman & Meyer, 1967; Matthews, Shimcff, Catania, & Sagvolden, 1977; Shimoff, Catania, & Matthews, 1981; Weiner, 1970), possibly by substituting rule-governed for consequence-shaped behavior (Hayes, Brownstein, Haas & Greenway, 1986). Under inaccurate instruction conditions, Kaufman, Baron and Kopp (1966) found strong instructional control over responding even during programmed extinction conditions. Subjects in the Kaufman et al. studies were told they were working on a variable ratio schedule. Subjects responded steadily throughout a three hour extinction period. Weiner (1970) found similar instructional control under extinction conditions. Subjects told that 999 reinforcers could be obtained, when in reality only 700 could be obtained, continued to respond throughout a two hour extinction period. Shimoff et al. (1981) concluded that insensitivity is a "defining property" of instructional control. As we shall see, however, the matter is not so simple. Many factors must be taken into account before deciding whether responding will be controlled by rules or by the programmed collateral consequences.

To understand the apparent interplay between

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rule-governed and consequence-shaped behavior, it will be useful to briefly review the model presented by Skinner (1989). According to Skinner, control over behavior transfers from instructional control to consequence control, as long as instructions are consistent with the actual consequences. The instructions tell the individual what the most efficient means of obtaining reinforcement are. It has been demonstrated experimentally that accurate instructions regarding schedules of reinforcement may enhance schedule control of human behavior (Baron & Galizio, 1983; Perone, Galizio & Baron, 1988). When accurate, instructions evoke behavior in the same form as would the collateral consequences, and the characteristic response patterns associated with infrahuman schedule responding appear. The relationship between control by rules and control by collateral consequences may be difficult to tease apart, because when instructions are accurate "Behavior under the control of a rule may occur in the same form as schedule-sensitive behavior and yet be purely an instance of rule-following not controlled by the particular programmed consequences" (Hayes et al., 1986a, p. 144).

One model of the interplay of instructions and collateral consequences was proposed by Baron and Galizio

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(1983). Baron and Galizio see rules as discriminative stimuli, and rule-following as an operant response class understandable within the three term contingency. They have therefore suggested that inaccurate instructions will continue to control responding only to the extent that they allow the individual to earn the greatest number of available reinforcers. They assert that the individual's responding will continue to be rule-governed only as long as (s)he does not come into contact with a greater source of available reinforcement. Baron and Galizio provide an example: Kaufman et al. (1966) exposed subjects to a variable interval schedule, but instructed the subjects that the schedule was variable ratio. High, steady responding consistent with a variable ratio schedule was observed (and, as a consequence, all available reinforcers were obtained). As with the extinction studies described above, reinforcement was not lost (although much effort was wasted). Available reinforcers were still earned, and thus responding did not shift from being instruction-based to consequence-based.

Baron and Galizio's analysis was based in part upon earlier studies conducted by Galizio (1979). In these studies, several results consistent with an operant response

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class conception for rule-following were obtained. When instruction-based responding resulted in earning the greatest number of available reinforcers, instructions were followed. When instruction-based responding resulted in the loss of reinforcers, instructional control was lost. It was also demonstrated that rule-following could come under discriminative control, and that accurate rules could have reinforcing properties.

The Baron and Galizio conception has been supported by the findings of DeGrandpre and Buskist (1991). DeGrandpre and Buskist tested subjects under conditions of varying instructional accuracy, and found that the degree of instruction-following was highly correlated with the accuracy of instructions. Variability in instruction-following was highest at high levels of unreliability of instructional information. Further, the degree of instruction-following was affected by the accuracy of instructions presented in previous conditions. DeGrandpre and Buskist concluded that their findings supported the three term contingency model of instruction-following, and suggested that the source of instructional control is not within the instructions, but within the collateral consequences. Insensitivity cannot, therefore,

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be spoken of as a "defining characteristic" of instructed behavior.

This model does not, however, explain other findings in the research literature. The Baron and Galizio model suggests that when subjects come into contact with consequences that demonstrate that instruction-following does not lead to maximum reinforcement, they will abandon instruction-following. Hayes et al. (1986a), however, found that exposure to the collateral consequences was not enough to shift responding away from a rule for some subjects (p. 145): "In some of the subjects...contact with the contingencies transferred control of responding from the given rule to the point contingency. In other subjects this did not occur, and control over responding stayed with the rule."

In view of such findings, Hayes et al. (1986a) have suggested that Baron and Galizio's conception is incomplete (not necessarily inaccurate). The reinforcement history of the instruction-following response must also be taken into account. When inaccurate, instructions provide a competing source of control, and may lead to entirely different behavior (Catania, Shimoff, & Matthews, 1989). The interplay of the programmed collateral consequences and the

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individual's reinforcement history for rule-following must be taken into account if we are to determine the extent to which rules will govern behavior.

Methodological issues

In this section, I will examine four of the methodological problems of many studies of rule-governed behavior. Correction of these flaws may lead to clearer conceptions of the behavioral impact of rules.

First, as pointed out by Galizio (1979), the laboratory-based studies of human instructional control are often based on one-time laboratory testing. If it is indeed true that prolonged exposure to collateral consequences shifts control from inaccurate instructions to the programmed collateral consequences, then an experiment that provides extensive exposure to collateral consequences over the course of several weeks might eliminate instructional control (as suggested by Hayes et al., 1986a).

Second, this research has often been conducted by giving instructions regarding how to the greatest number of available reinforcers, and then varying schedules of reinforcement without giving any new instructions (Vaughan, 1989). As previously discussed, the failure to demonstrate schedule control with human subjects was the original

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impetus for the study of rule-governed behavior. In view of the weak evidence for schedule control of human behavior (Todd, 1991), drawing conclusions from a failure to respond to shifts in schedules of reinforcement is problematic. These schedules were also fairly lean. Catania, Shimoff and Matthews (1989) mention typical schedules: Random Ratio (RR) 20 and Random Interval (RI) 10-second schedules, a RI 15-second schedule with a superimposed DRL 3-second schedule, and a RR 40/RI 5-second multiple schedule with an additional RI 10-second schedule programmed in as well. Hayes et al. (1986a) used a DRL 6s/FR 18 multiple schedule.

Third, the studies comparing rule-governed and consequence-shaped behavior have often used reinforcers of dubious strength. Hayes et al. (1986a), for example, used points that served as chances in a lottery for two $20 cash prizes to be awarded at the end of a semester. Galizio (1979) used a monetary reinforcer, up to a total of $2 for a 50 minute session. Matthews, Shimoff, Catania and Sagvolden (1977) also used a monetary reinforcer, awarding .1 cent per response. Invocation of insensitivity to reinforcement when the reinforcing properties of the consequences may be weak, or nonexistent, is pointless. At the very least, the potency of the reinforcers should be demonstrated before it

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is claimed that instructions have made the subject "insensitive" to their reinforcing properties.

Finally, the subjects in these studies were college students, for whom the potency of instructions may be exaggerated. The potency of the reinforcers mentioned in the previous paragraph, as compared to the potential influence of the experiment administrators, is questionable. As pointed out by Baron and Galizio (1983), in such situations individuals feel they are under close scrutiny, and must perform in keeping with expectations (pliance). Such situations seem likely to heighten instruction-following.

These weaknesses have been addressed in a study by Newman, Buffington, and Hemmes (1991). Both Baron and Galizio (1983) and Vaughan (1989) have suggested that some of the difficulties associated with rule-governed behavior research could be eliminated by studying instructional control in subjects who do not have a strong history of instructional control (i.e., young children, the developmentally delayed). The Newman et al. study was conducted with subjects with autism. The potency of reinforcers had been assessed prior to the study. Further, subjects received reinforcers of different <u>magnitudes</u> (not

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probabilities, as with schedule research) according to a continuous reinforcement (CRF) schedule over the course of several weeks.

In the Newman et al. (1991) study, results consistent with the response class conception of Baron and Galizio were obtained: the subjects earn the greatest number of available reinforcers under conditions of both accurate and inaccurate instructions. Instructions were followed when instruction-following led to earning all available reinforcers, and were ignored when following the instruction led to a failure to earn the greatest number of available reinforcers. When one subject was exposed to fixed ratio (rather than CRF) schedules, however, consequence control was lost and the subject followed instructions, despite the fact that this response pattern did not lead to maximum reinforcement.

Interpretation of these results remains in question. One possible explanation is that of Baron and Galizio. Rule-following is an operant response class, and is maintained only to the extent that the greatest number of available reinforcers are earned by rule-following. When rule-following leads to a loss of reinforcers, rule-following extinguishes. An alternate conception is one

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in which rules are central. In each phase of the study, the subject simply learned a new self-generated rule, e.g. "in this phase, no matter what instructions I get, I have to choose the red light in order to earn the greatest number of available reinforcers." The latter conception adds nothing, however, being entirely post-hoc (Vargas, 1988) and far from parsimonious (e.g., Zettle, 1990). Invocation of such explanations also leads to potential tautologies. I suggest that if rules are defined as objects in the environment and rule-following as an operant response class, and carefully define the variables that determine how the rules will exert an influence (the suggestion of Glenn, 1989), then such difficulties can be avoided.

From the current analysis, several such variables that will determine whether instructions or collateral consequences will determine the topography of responding can be described.

1. As demonstrated by DeGrandpre and Buskist (1991), the immediate history with accurate or inaccurate instructions can determine the source of control for behavior. According to DeGrandpre and Buskist, variability in instruction-following is related to the reliability of the previous instructions. This conception closely mirrors the

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conclusions of Galizio (1979). Galizio suggested that experience with the fact that instruction-following does not lead to earning the greatest number of available reinforcers will decrease the tendency to follow instructions.

2. As described by Catania et al. (1989), instructions must be sufficiently plausible and convincing if instruction-following is to occur. This raises the additional point that subjects must understand instructions in order to follow them.

3. Cerutti (1989) has suggested that collateral consequences are likely to control responding when the consequences are potent. The pennies, or tenths of pennies, or chances in a lottery mentioned above may not be potent enough to override instructional control. The Newman et al. study assessed the potency of reinforcers prior to assessing the instruction/collateral consequence interplay and found strong collateral consequence control.

4. Compatibility between the forms of instructed and consequence-shaped behavior may also be important (Baron & Galizio, 1983). If the behavior described by rules does not allow for effective contact with collateral consequences, then behavior may appear to be instruction-based. To cite an earlier example, some inaccurate rules allow for

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responding that leads to some reinforcement (as in the Kaufman et al., 1966 variable interval/variable ratio study mentioned above). If the rules and collateral consequences are not compatible, however, instruction-following is less likely (provided collateral consequences are potent). If the instructions and collateral consequences both shape behavior in the same direction there will be no conflict. We will be unable, however, to determine the source of control of behavior.

5. Prolonged exposure to collateral consequences may change behavior that was originally instruction-based to consequence-shaped (Catania et al., 1989; Hayes et al., 1986a), assuming that effective contact with the collateral consequences is made (e.g., Galizio, 1979).

6. The form of response required by the instructions may also determine whether the instructions are followed or not. Hayes et al. (1986a) and Joyce and Chase (1990) suggest that general instructions may allow for more behavioral variability, leading to more contact with collateral consequences, and therefore more collateral consequence control.

7. Continuous schedules of reinforcement, as opposed to intermittently scheduled consequences, may facilitate

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control by collateral consequences (Newman et al., 1991).

Summary

As described by Skinner (1963), with the evolution of the linguistic abilities of humans (e.g., Skinner, 1957), control by environmental consequences became supplemented by control by verbal descriptions of consequences. The human species thus became capable of rule-governed behavior, behavior controlled by antecedent verbal descriptions of the relationships between given responses and the consequences that reliably follow these responses.

Hayes and Hayes (1989, p. 187) state that "rule-governed behavior is simply behavior controlled by antecedent verbal stimuli." The verbal component of this definition is, in part, responsible for the controversy surrounding the rule-governed behavior concept. Because of the seemingly unique linguistic abilities of humans (e.g., Skinner, 1957), only human behavior may be influenced by rules (e.g., Hayes et al., 1989; Vaughan, 1985). As described by Vaughan (1989), the idea that human behavior (and perhaps only humans with developed verbal skills, e.g. Barnes & Holmes, 1991) might be governed by some species-specific law has not been well-accepted.

To the extent that this characterization ("simply

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behavior controlled by antecedent verbal stimuli") is accurate, the sentiments expressed by Schlinger (1990), Schlinger and Blakely (1987), and Vargas (1988), that there is no need for a special term for such antecedent verbal stimuli must be seriously considered. From what has been discussed, it seems that rules can function either as discriminative stimuli or as establishing operations, both terms already accepted in the behavior analytic vocabulary.

Despite what has been argued, there is no need to exorcise the term rule-governed behavior from the radical behavioral vocabulary. As described above, conceptions of rule-governed behavior fit in well with traditional operant response class conceptions. When researchers in the area of rule-governed behavior speak of insensitivity to programmed collateral consequences, what they are actually looking at is not insensitivity. They are observing the interplay of two responses classes: the behavior that produces the collateral consequences, and the more general response class of rule-following (Inesta & Sanchez, 1990). Difficulties arise because the key assumption of the response class conception of rule-following, that subjects follow rules because they have received reinforcers for such behavior in the past, is untested and therefore possibly unsatisfying

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(Reese, 1989). This is a danger any time reinforcement history is spoken of without an explicit description of same. Nonetheless, there is nothing about rule-governed behavior that goes outside the realm of behavior analytic thinking. Rules are objective events in the environment that, through shaping or equivalence relations, become a particular type of discriminative stimulus or establishing operation (Glenn, 1989). Behavior analysts writing about rules have not suggested anything outside the realm of mainstream behavior analysis. As long as we remember that the following of rules must always return to behavior-consequence relationships, then the concept of rule-governed behavior provides us with a convenient short-hand term for a straight-forward process that can explain some complex human behavior.

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Table 1

Summary of Contingencies Across Experimental Phases of Experiment 1.

Phase #	Trials per Block	Tokens Available	Red Instructed Red	Red Instructed Green	Green Instructed Red	Green Instructed Green
1	10	20	2*	1*		
2	10	15	2	0	0	1
3	10	20	2	1	2	1
4	10	20	2	2	2	2
5	10	20	1	2	1	2
6	10	20	2	2	2	2
7	10	15	1	0	0	2
8	10	20	2	0	0	2
9	30	6	FR 5	FR 10	FR 5	FR 10
10	10	20	2	1	2	1

* No instructions in Phase 1.

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Table 2

Percent Accuracy of Instructions across Phases and Schedules of Reinforcement for the Six Groups of Experiment 2.

Group	Sequence of Accuracy	Schedule of Reinforcement
1	100-50-0-50-100	CRF
2	0-50-100-50-0	CRF
3	100-50-0-50-100	FR 2
4	0-50-100-50-0	FR 2
5	100-50-0-50-100	FR 3
6	0-50-100-50-0	FR 3

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Table 3

<u>Type of Instruction, Trials per Phase, and Schedules of Reinforcement for the Six Groups of Experiment 3</u>.

Group	Instruction Used	Trials per Phase	Schedule
1	Verbal	30	CRF
2	Nonverbal	30	CRF
3	Verbal	60	FR [illegible]
4	Nonverbal	60	FR 2
5	Verbal	90	FR 3
6	Nonverbal	90	FR 3

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Figure Captions

<u>Figure 1.</u> Pictorial representation of apparatus from Experiment 1.

<u>Figure 2.</u> This is a graphic representation of responding by Ron and Don during Experiment 1. "N.I." indicates no instructions. "A.I." indicates accurate instructions. "I.I." indicates inaccurate instructions. The "R" represents turning on the red light. The "G" represents turning on the green light. The digit before the "R" and "G" indicates the number of tokens earned for that response.

<u>Figures 3-8.</u> This is a graphic representation of responding by subjects during Experiment 2. The numbers across the tops of the phases indicate percentage of accurate instructions during that phase.

<u>Figures 9-14.</u> This is a graphic representation of responding by subjects during Experiment 3. The numbers across the tops of the phases indicate percentage of accurate instructions during that phase, for subjects in the verbal instruction condition. The numbers across the tops of the phases indicate percentage of original contingency followed in the nonverbal instruction conditions.

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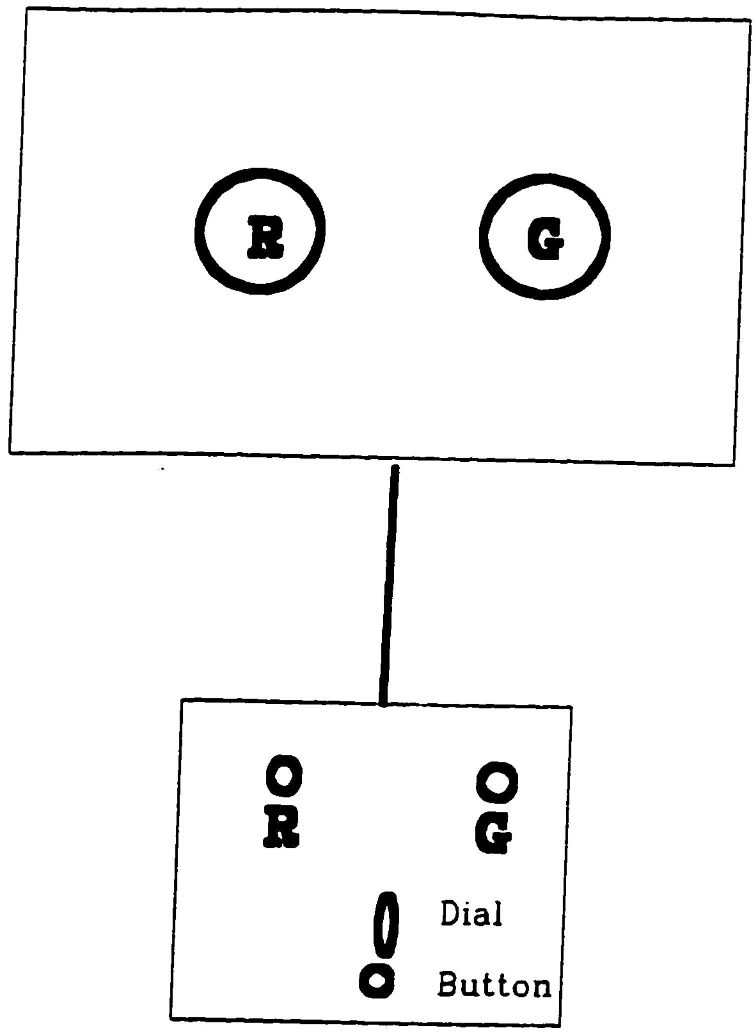

Figure 1

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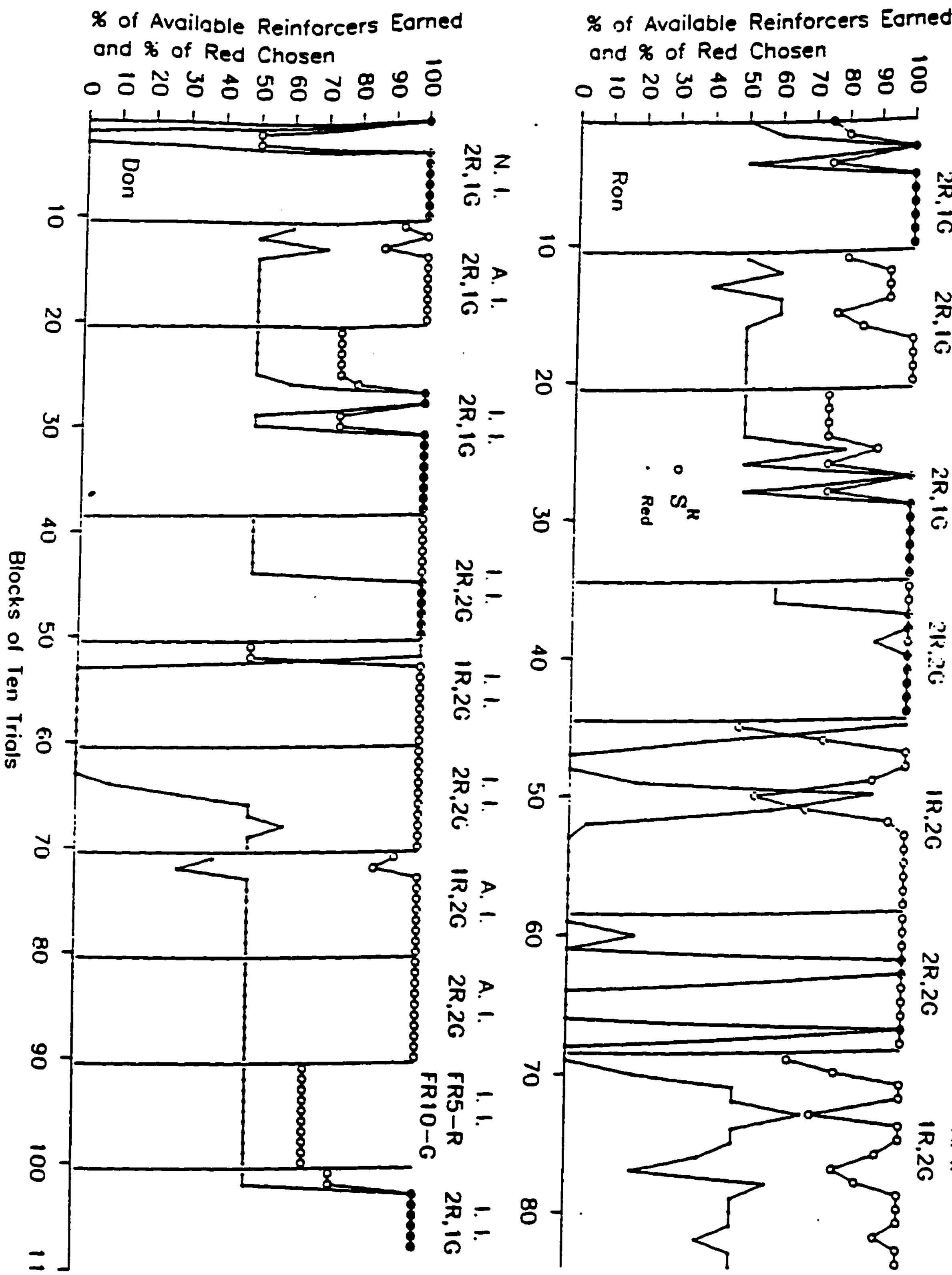

Figure 2

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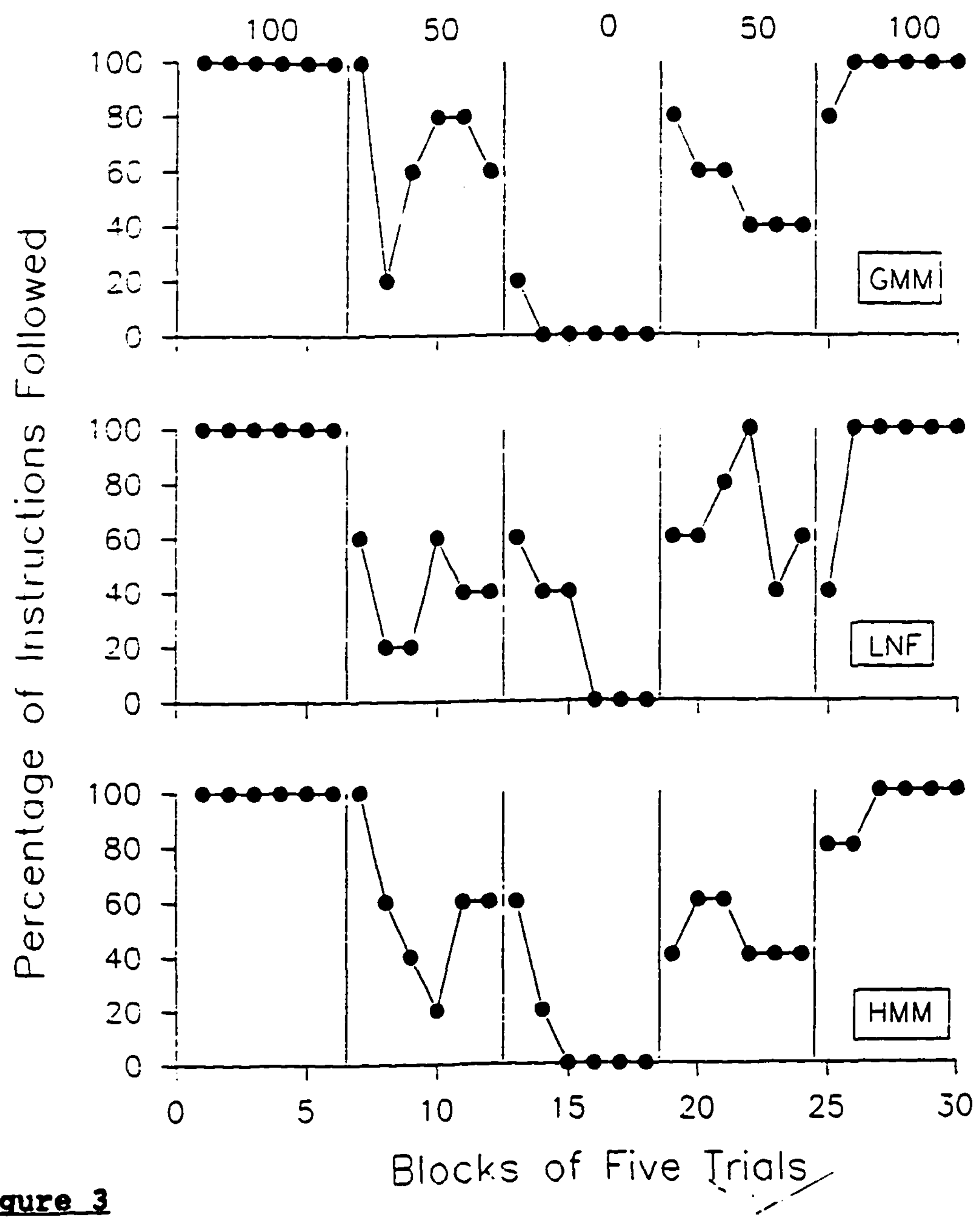

Figure 3

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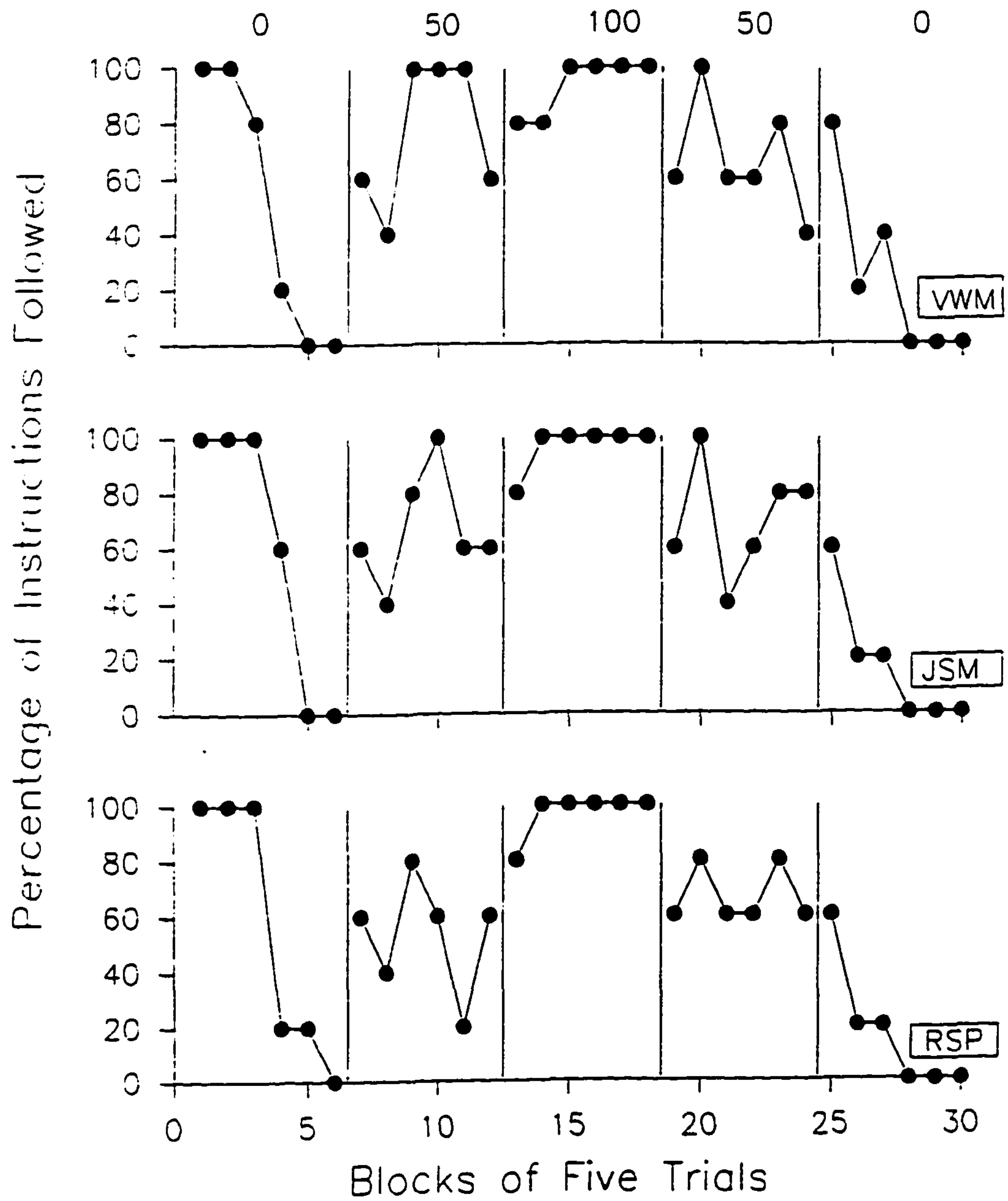

Figure 4

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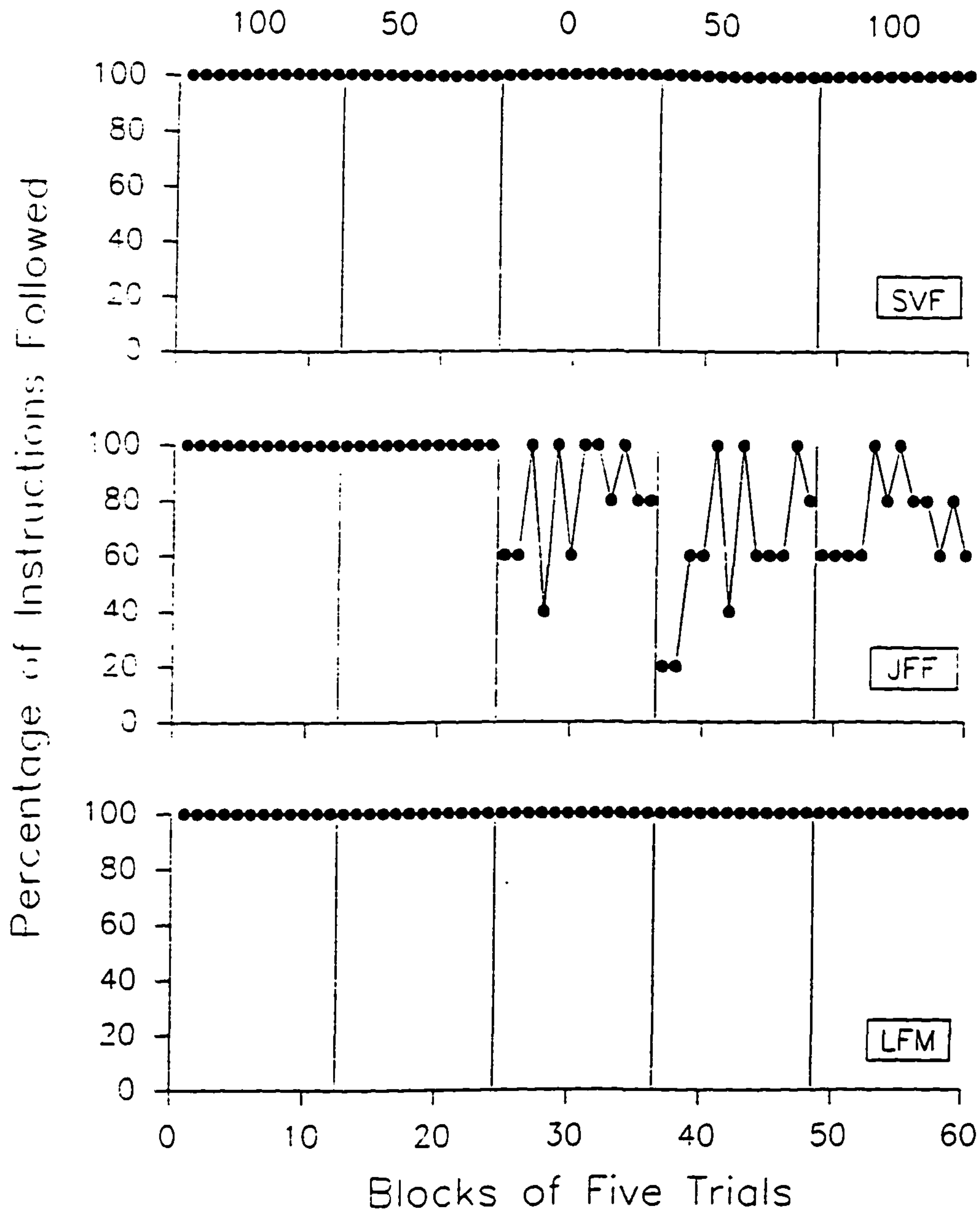

Figure 5

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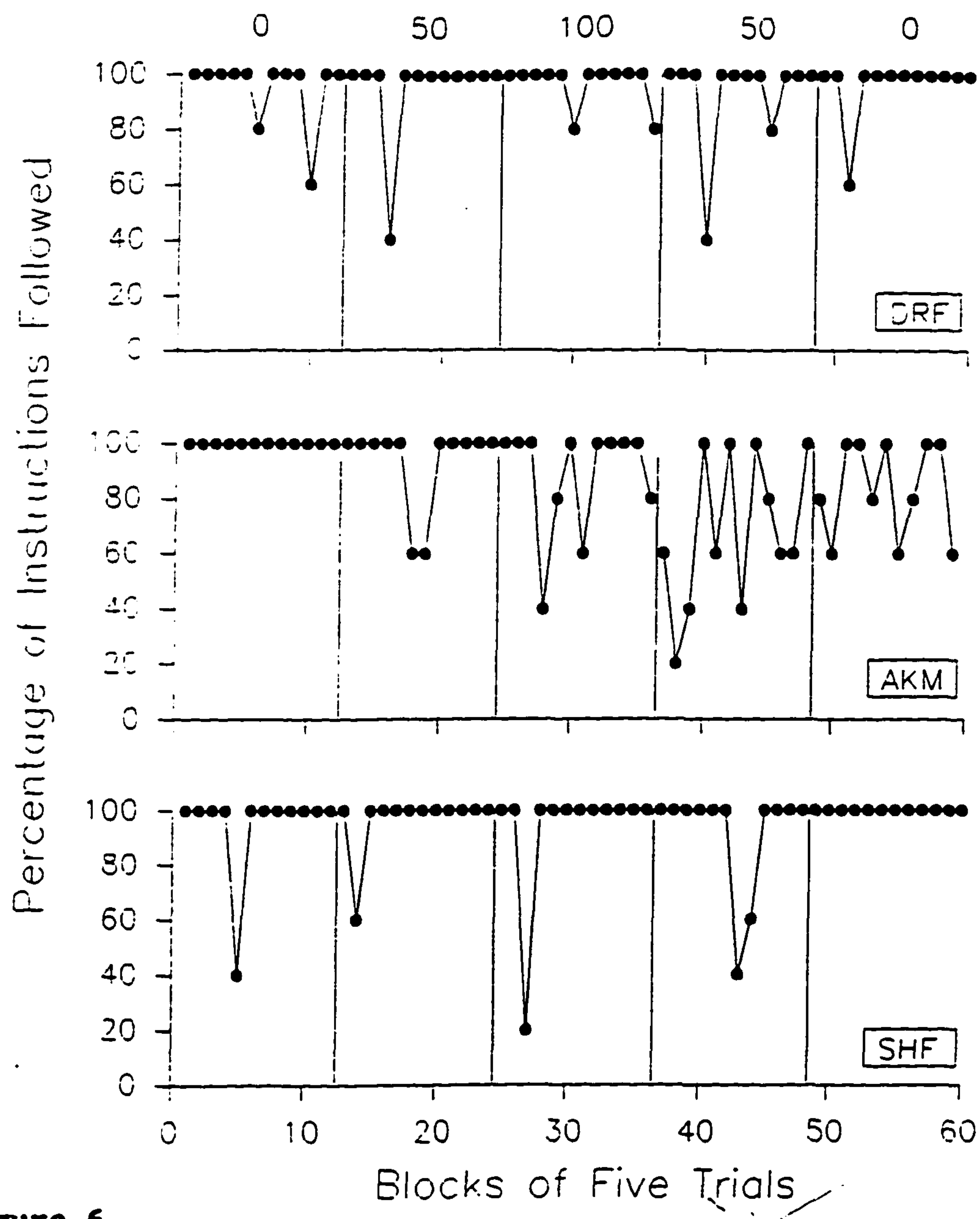

Figure 6

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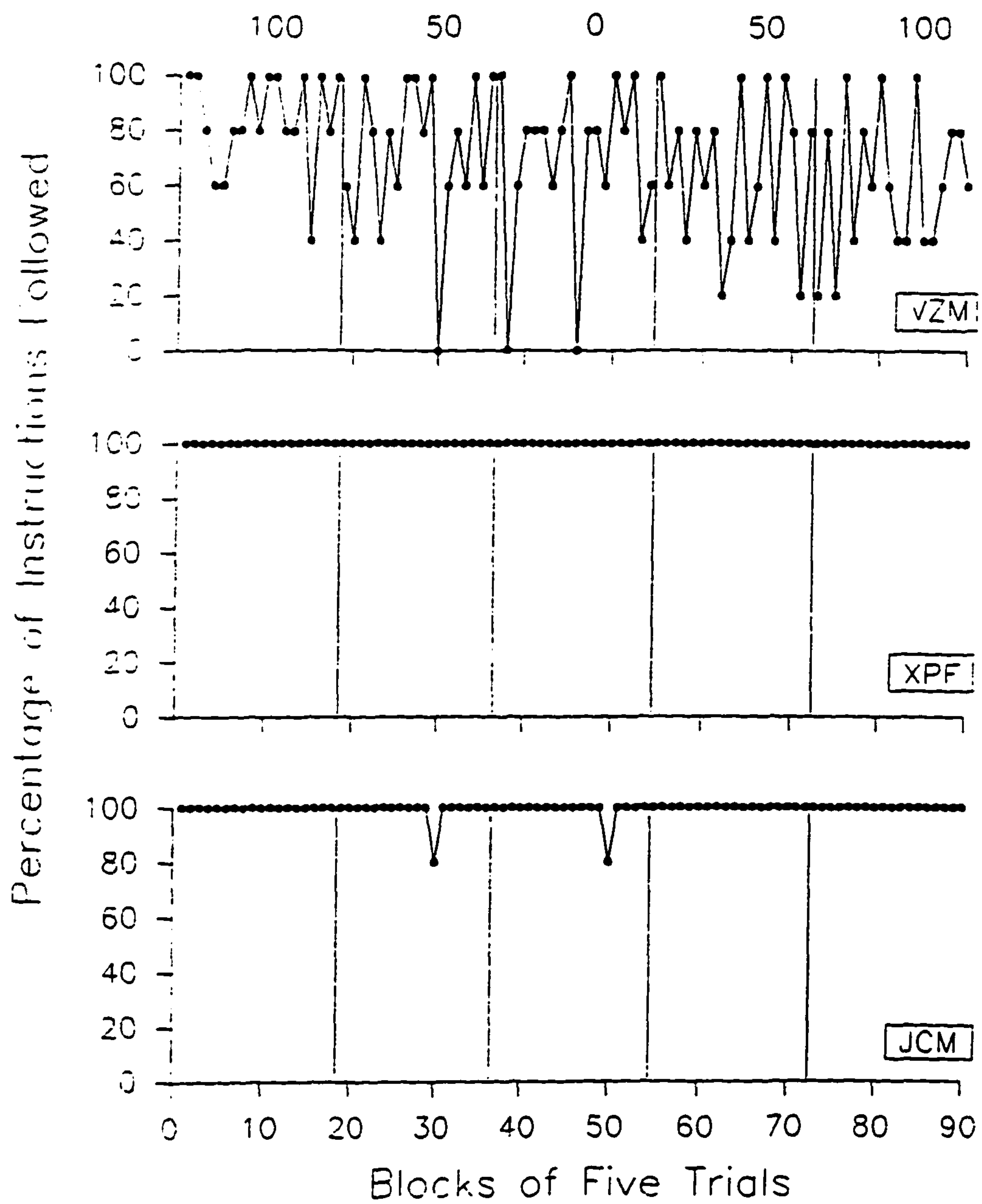

Figure 7

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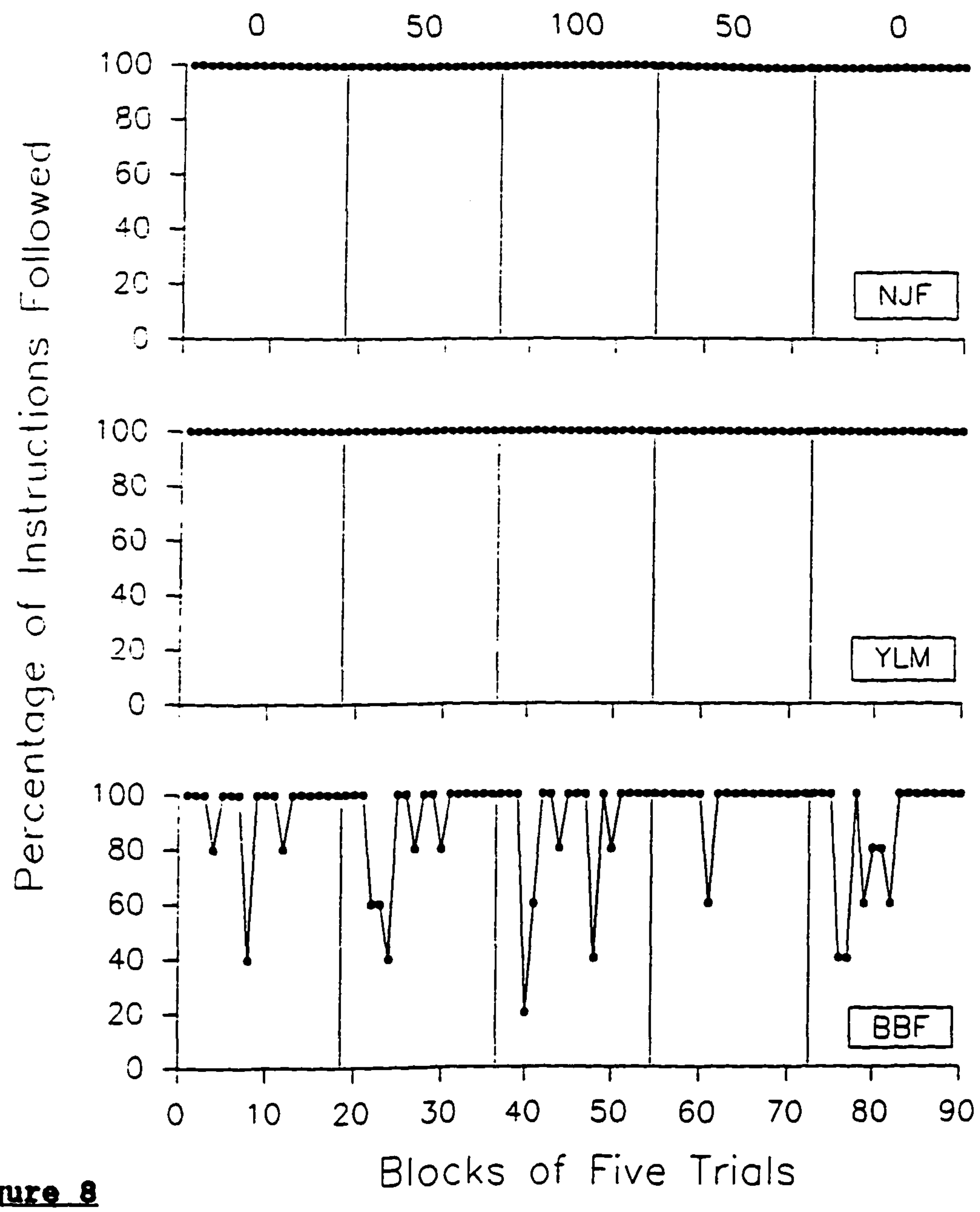

Figure 8

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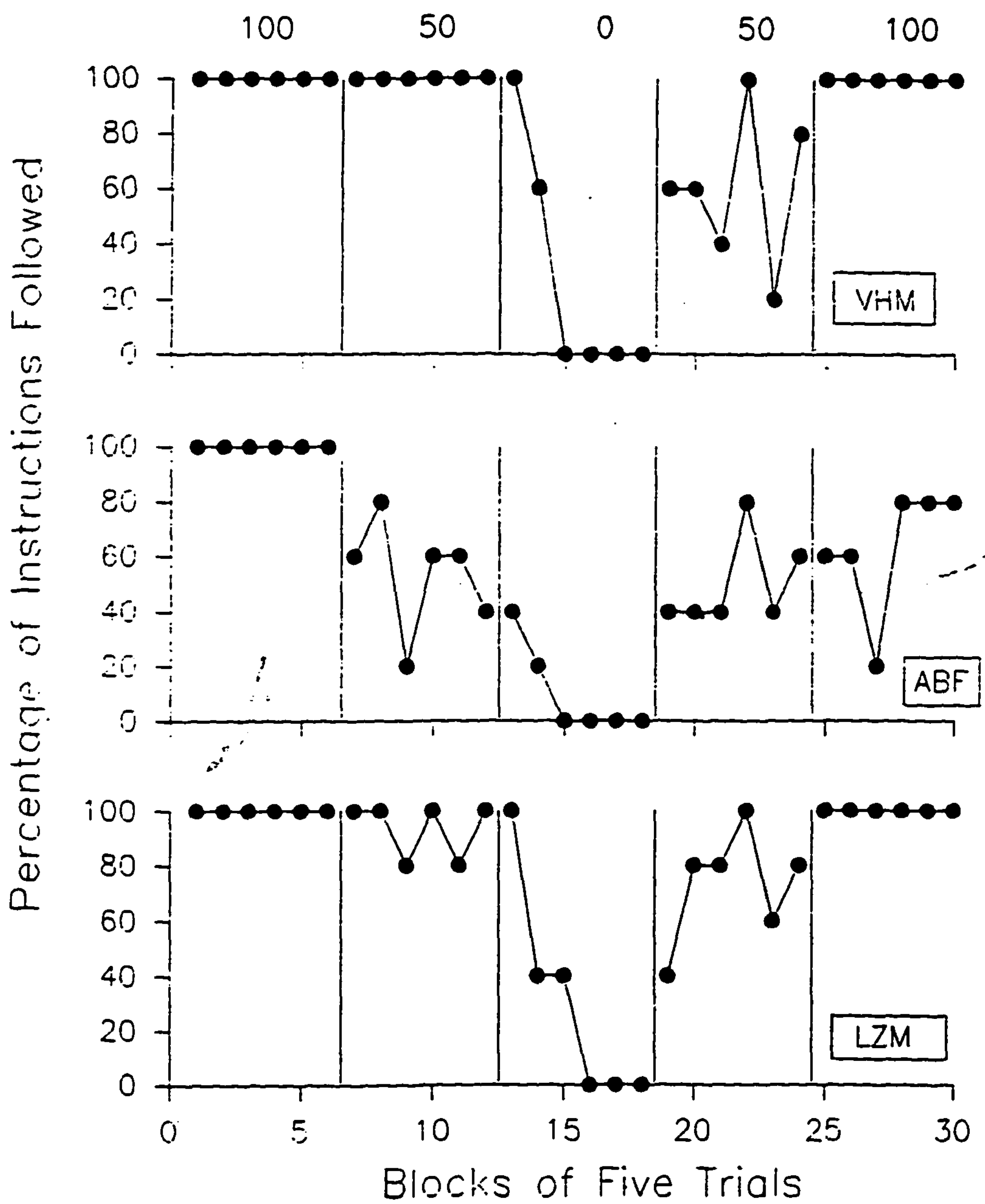

Figure 9

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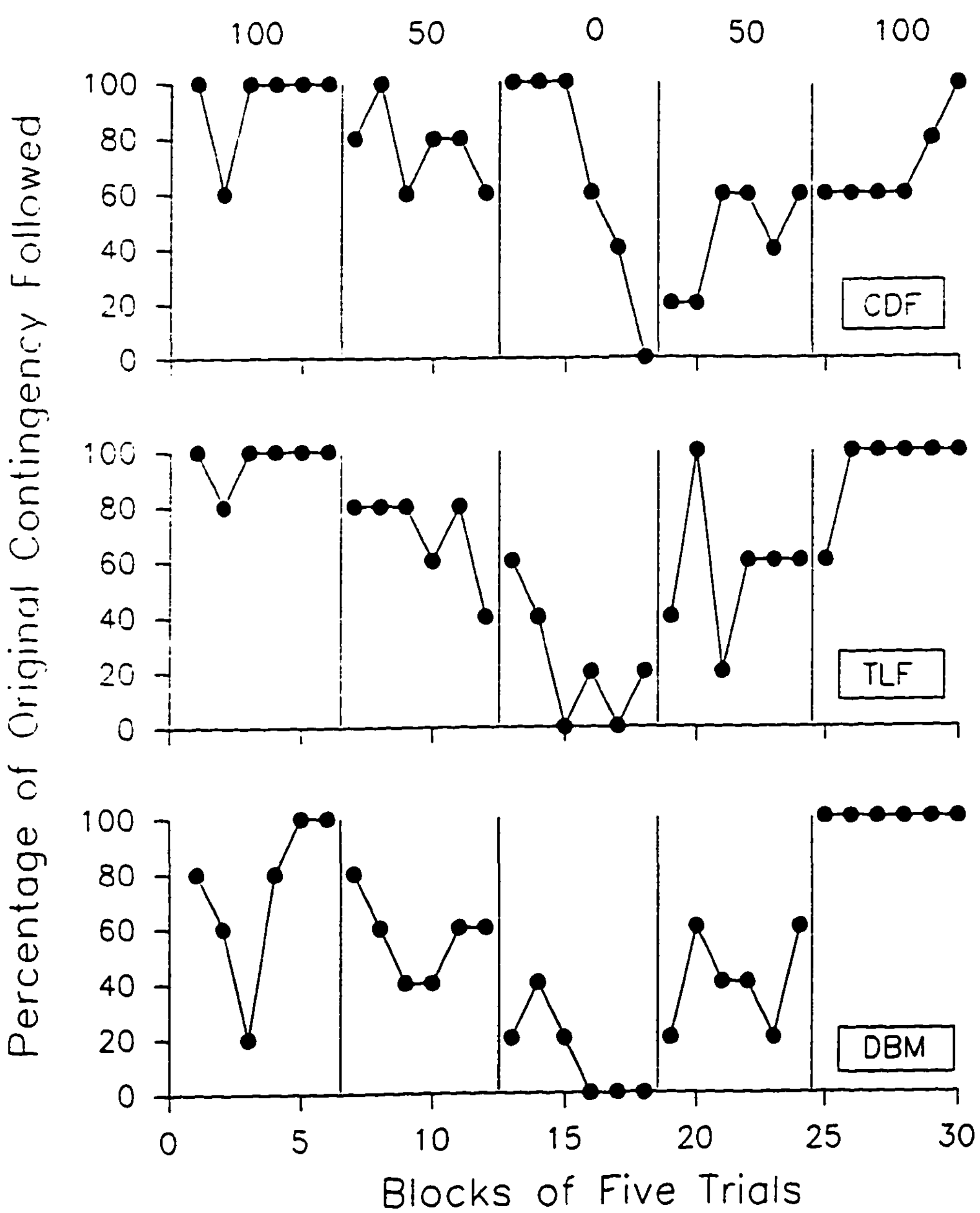

Figure 10

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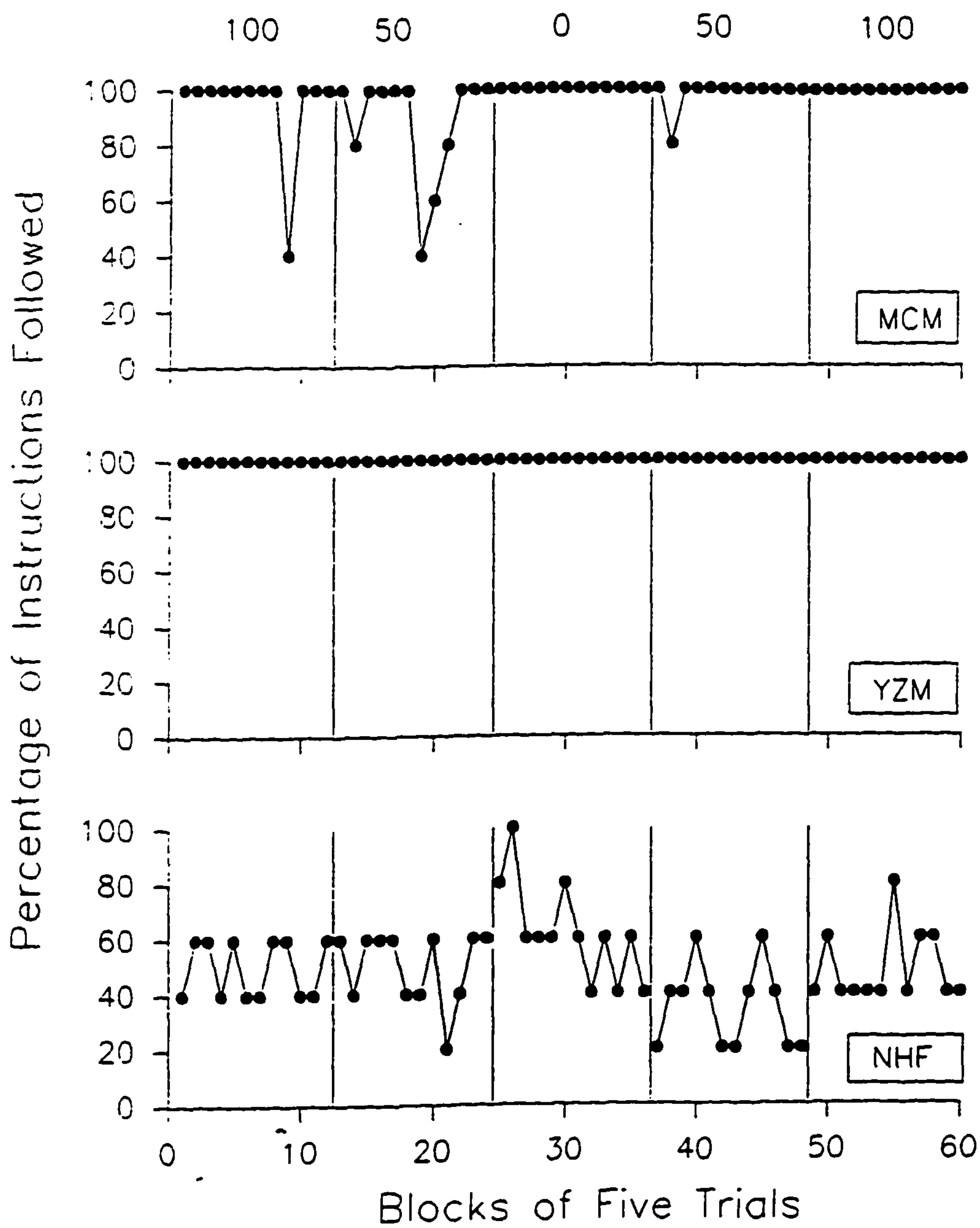

Figure 11

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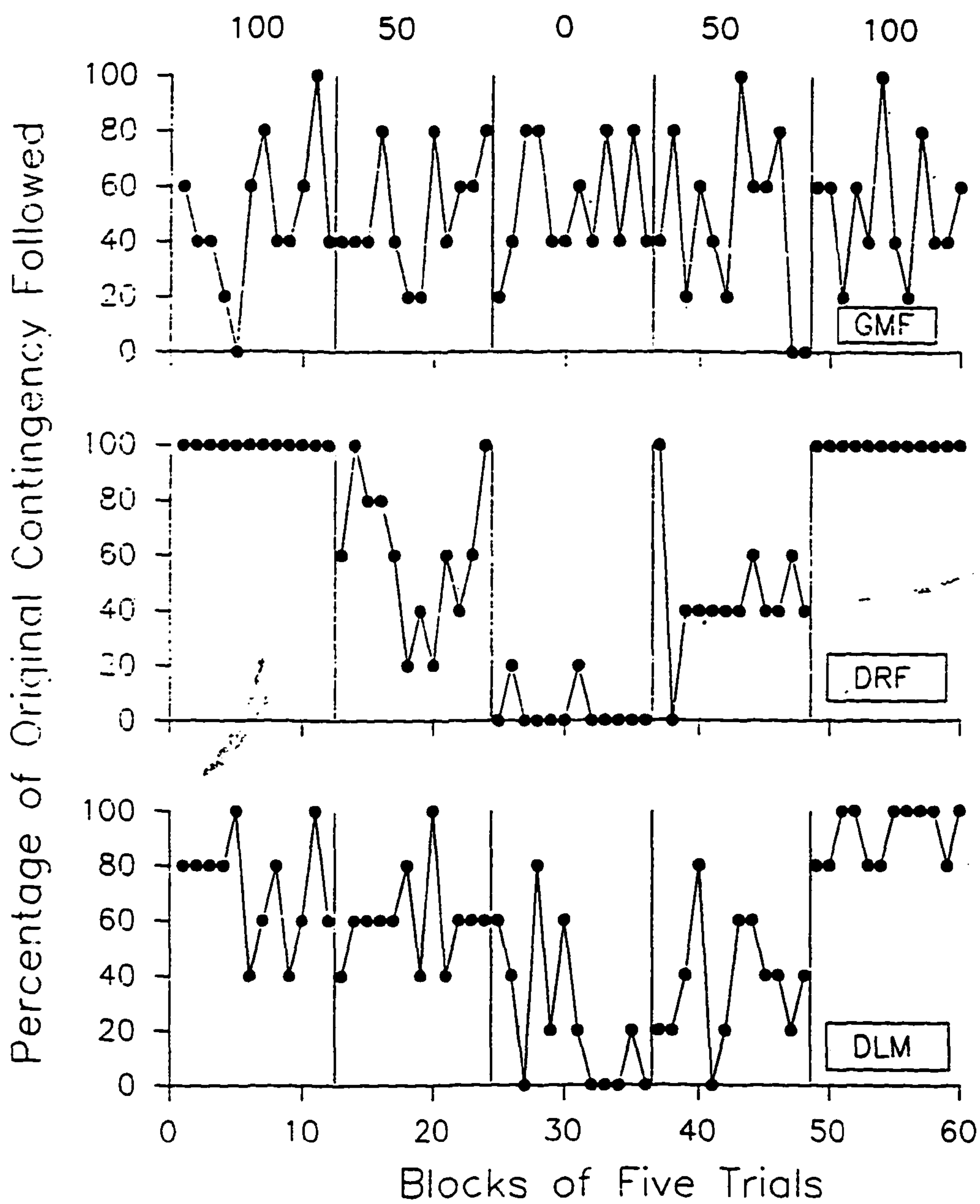

Figure 12

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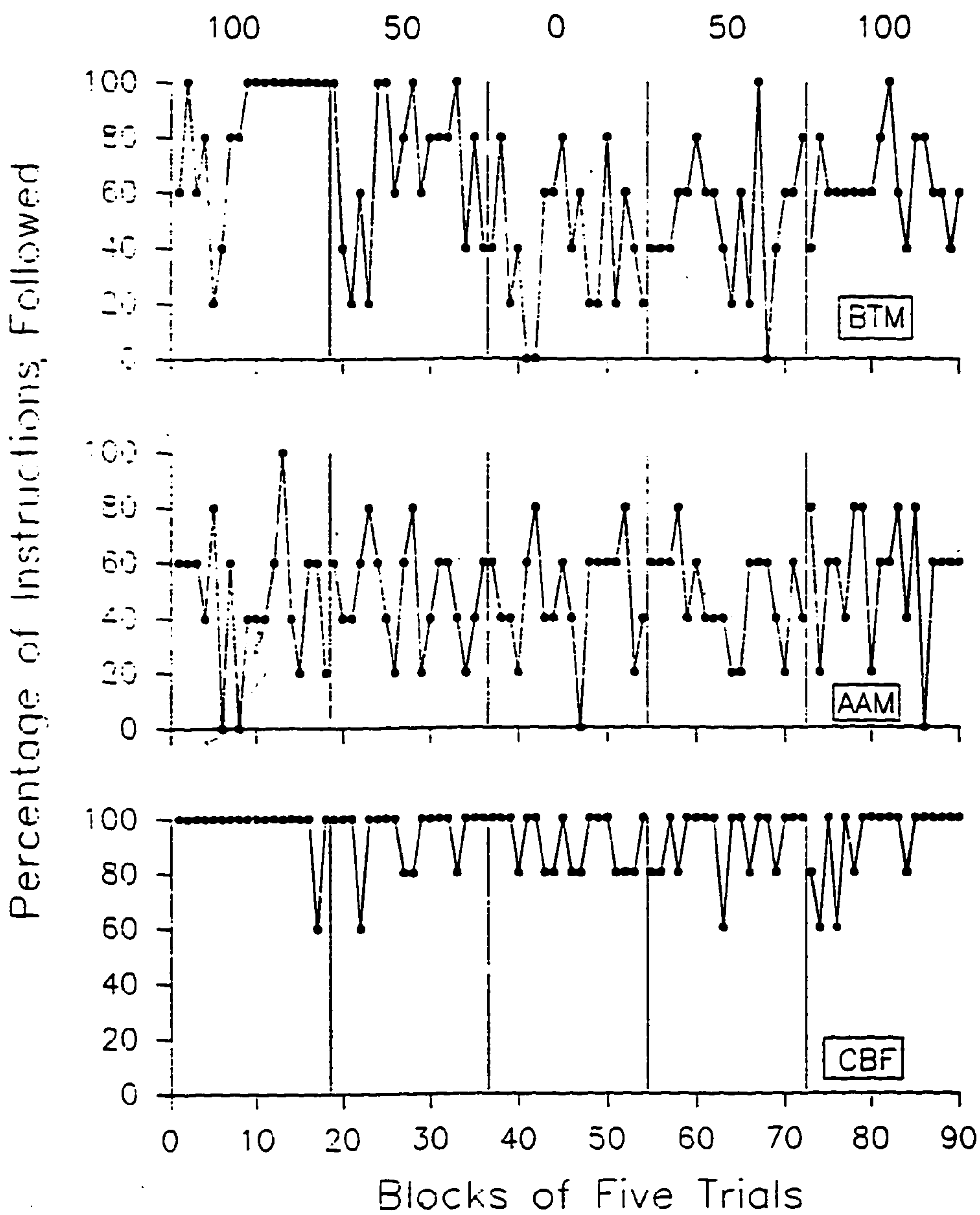

Figure 13

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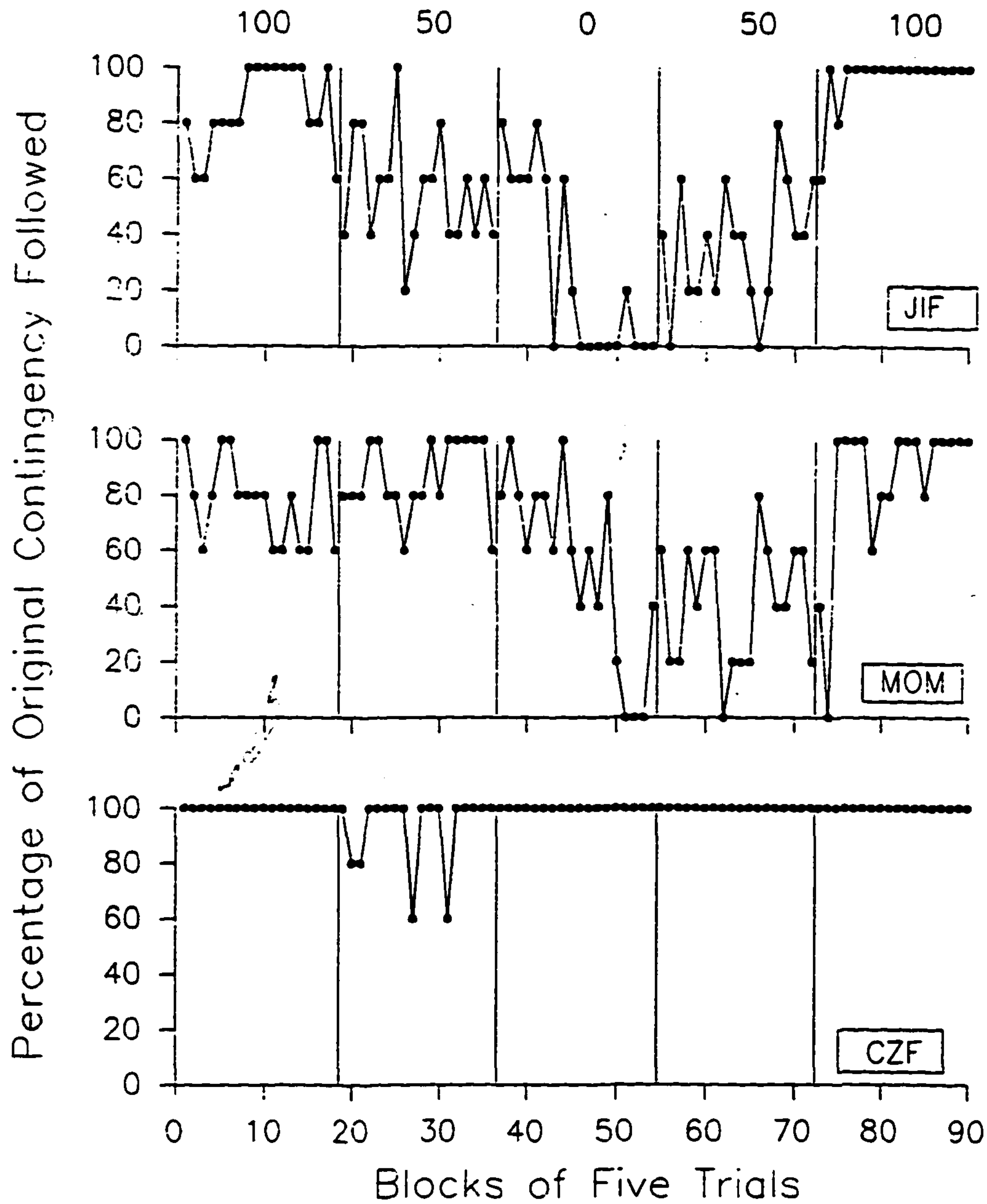

Figure 14

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