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SCHEDULE CONTROL OVER FOLLOWING INSTRUCTIONS COMPRISED OF NOVEL COMBINATIONS OF VERBAL STIMULI

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To examine schedule control over following instructions comprised of novel combinations of verbal stimuli, three children, from 8 to 10 years old, received either continuous or intermittent reinforcement for a chain of buying and then following such instructions. Later, a series of training-extinction tests was conducted. During the training trials, the chain produced either continuous or intermittent reinforcement. During the extinction trials, buying produced instructions but following instructions never produced reinforcement. For one subject, a partial reinforcement extinction effect was detected for the chain. For two subjects, a stimulus correlated with extinction onset enhanced schedule control. Overall, the frequency of the chain covaried with the probability of reinforcement. The schedule effects detected and the methodology used extend the generality of an operant interpretation of instruction following to instructions comprised of novel combinations of verbal stimuli.

Why are texts believed, recommendations trusted, commands obeyed, or instructions followed? One answer assumes that believing, trusting, obeying, and following are operants (e.g., Skinner, 1957, p. 160). Schoenfeld and Cumming (1963) noted, however, that an individual's specific history with respect to such stimulation and behavior is often unknown. Recently such histories have been created in the laboratory to understand the processes by which instructions and schedules co-determine behavior (e.g., DeGrandpre & Buskist, 1991; Galizio, 1979; Newman, Buffington, & Hemmes, 1995). Most interesting, from the standpoint of the present research, are studies in which subjects are provided a history with accurate instructions but subsequently the schedule changes in ways that do not support instruction following.

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Galizio (1979) conducted the classic series of experiments in this area. Subjects worked on a multiple-schedule consisting of a no-loss component and three avoidance components. During the loss components, responses avoided loss for either 10 s, 30 s, or 60 s. In the initial "accurate instruction" condition, as the instructions changed (e.g., from "NO LOSS" to "10 SEC") the component schedules appropriately changed. In this condition, all subjects showed well-differentiated, schedule-appropriate behavior. In the next "no-contact" condition, the instructions changed but the no-loss schedule was always in effect. With three instructions inaccurate but instruction following not contacting loss, behavior remained well-differentiated. The correspondence between the instructions and the rate of responding suggests instructional control. In the next "contact" condition, the instructions changed but the 10-s schedule was always in effect. With three instructions again inaccurate but instruction following contacting loss, behavior was undifferentiated. The lack of correspondence between the instructions and the rate of responding suggests schedule control. When the "no-contact" condition was next reinstated, rate of responding remained undifferentiated.

The almost faithful instruction following in the initial "no contact condition" may be attributed to reinforcement: "loss was avoided in a situation in which loss previously had been encountered." The elimination of instruction following in the "contact" condition may be attributed to punishment: "adherence to the false instructions resulted in loss" (Baron & Galizio, 1983, p. 513). The absence of instructional control during reexposure to the "no contact" condition suggests that the punishing effect of the "contact" condition was temporally extended.

DeGrandpre and Buskist (1991) also examined relations between instructional accuracy and instruction following. Before every five-trial set, subjects were instructed to "press the A key" or to "press the B key." Within a five-trial set, only one key could produce points with points displayed only after a set was completed. Accuracy was manipulated across these five-trial sets. For example, 50% accuracy was implemented by randomly ordering an equal number of totally accurate instructional sets with an equal number of totally inaccurate instructional sets. As instructional accuracy (0, 50, 100%) increased, following instructions increased. Additionally, a history of reinforcement for following accurate instructions tended to increase the rate of following entirely inaccurate instructions. In a follow-up study, Newman et al. (1995) further differentiated instructional accuracy from the schedule of reinforcement for following instructions. They reported an interesting interaction: Instruction following positively covaried with instructional accuracy, but only when instruction following was reinforced on a continuous schedule.

Although these experiments suggest that previous or current schedules of reinforcement can control instruction following, several problems remain. Despite the absence of a generally accepted definition of verbal stimulation, "there are good reasons to think that verbal stimuli

are not just discriminative stimuli in the usual sense" (Hayes & Hayes, 1989, p. 161). In the studies above, however, behavior was differentially reinforced in the presence of relatively few instructional stimuli. Consider that Galizio utilized only four instructions and DeGrandpre and Buskist as well as Newman et al. (1995) utilized only two instructions. Because of differential reinforcement the stimuli may, in some conditions, have simply functioned as discriminative stimuli (Baron & Galizio, 1983; Cerutti, 1989).

For example, consider Newman et al.'s (1995) two instructions to their subjects: "Take a peg from the (left or right) side of the board to earn tokens." A simple discriminative account suggests that the instructions could have been replaced with cards of different colors (discriminative stimuli) and a similar result achieved. Indeed, Newman, Hemmes, Buffington, and Andrepoulos (1994) reported such a result when continuous reinforcement was utilized. If every instance of instruction following were, however, merely an instance of simple discriminative stimulus control, a special analysis of instruction following would be unnecessary.

Although some stimuli that are commonly called instructional are mere discriminative stimuli, others are not. For example, Hayes, Thompson, and Hayes (1989) created novel combinations of stimuli from previously established equivalence classes and found these combinations function as instructions. In the present research, instructions consisted of novel combinations of familiar discriminative verbal stimuli.

In addition to their novelty, the instructions were not freely available. Instead, the subject could choose between observing or not observing an instruction. Because observing produced monetary loss, it was designated a buying response. The behavior examined in the present research was, therefore, a chain consisting of buying and then following a novel instruction.

Because novel instructions have not been studied before, even though they represent an important class of stimulation that is commonly considered instructional, the present research examined the extent these chains functioned as operants. In particular, can the frequency of buying and following novel instructions be brought under schedule control? Is control by an extinction schedule enhanced if extinction is signaled? And, finally, to what extent is buying and following novel instructions subject to historical determinants (e.g., Baron, Perone, & Galizio, 1991; Freeman & Lattal, 1992), in particular, the partial reinforcement extinction effect (PREE, e.g., Nevin, 1985)?

Method

Subjects

Two girls and one boy, ages 8 through 10 years, were recruited from a summer, educational program sponsored by the university. Subjects worked for monetary compensation. They could withdraw at any time, in which case they could keep the money earned but forfeited a bonus, described below. Total earnings ranged from $140 to $230.

Setting and Apparatus

The study was conducted in a 2.3- by 3.6-m room. The subject sat before a computer terminal with a 20- by 26-mm monochrome monitor; only the terminal keyboard's number pad was accessible. The terminal was controlled by a microcomputer located in an adjacent room.

Procedure

The initial session was entirely devoted to consent. The experimenter slowly read an informed consent form as the child and the guardian followed along. To verify that the child could read and follow instructions, the experimenter then sat the child before the computer terminal and read the following from the consent form:

> You will be asked to enter numbers ranging from 0 to 99999 on the computer terminal. You will first be given the opportunity to buy some advice. To buy advice, you must enter the number 3. To not buy advice, enter the number 0. The cost of the advice will be indicated on the screen, but you will not be able to read the advice unless you buy the advice. After buying and reading the advice you can decide on the number you wish to enter into the terminal. Let's try the terminal now.

The child worked at the terminal for about 5 trials with a continuous schedule of reinforcement in effect for buying and following instructions. Child and guardian agreement, of course, was necessary for participation.

The first two subjects' data were collected for 12 weeks. Subsequently, the third subject's data were collected for 19 weeks. Generally, three sessions were scheduled per week. For the first two subjects, sessions were about 1.5 hours long with about 300 trials per session. For the third subject sessions were about 2.5 hours long with about 530 trials per session.

At the beginning of each session, subjects orally read the following (parenthetical instructions are for the third subject):

> How much I earn depends on two things. The first thing is buying or not buying advice and the numbers I enter. I can earn about $1.25 [75 cents] per hour. Some hours will result in much more than $1.25 [75 cents] and others much less than $1.25 [75 cents] but on the average I will earn about $1.25 [75 cents] based on my entries. The second thing is my attending all scheduled sessions. I can receive a bonus of $15 [a bonus of my earnings being *DOUBLED*] for attending all scheduled sessions.

The procedure involved several basic elements. In the presence of one of two schedule stimuli, stimuli which covaried with the schedule in effect, the subject could make a ("buy") response which produced monetary loss and a numeric instruction. The subject could subsequently follow this instruction. Only the chain of buying and then following instructions was reinforced, either on a continuous or an

intermittent schedule. If the subject did not buy, the subject was immediately prompted to enter a number; these entries were never reinforced. During extinction, in the presence of the schedule stimuli, reinforcement for buying and following instructions was discontinued.

Sessions began with a frame centered at the top of the terminal's screen. Below the frame were orientational instructions which described the cost of instructions, how to buy instructions and how to erase entries: "ADVICE COST 1 CENT(S). DO YOU WISH TO BUY ADVICE? [3 + ENTER = BUY] [0 + ENTER = PASS] [, = ERASE]." The frame and orientational instructions were always present.

Trials lasting 17 s began with a .3-s, 1-kHz tone and the schedule stimulus displayed at the frame's center. Next, below the orientational instructions, a prompt appeared for entering a single digit: "ENTER->_." Instructions were bought by depressing the "3" key and then "ENTER" key within 2 s. This removed the prompt and entry. The entry reappeared for .2 s as feedback, and then the message "Lose One Cent(s)" appeared for .3 s. Instructions were not presented when the "0" and then "ENTER" key were depressed, or when the time limit was exceeded. For these cases the feedback stimuli were "0" and "LATE," respectively.

When an instruction's cost was removed, a one-to-five digit, spelled instruction was presented, for example, ONE-THREE-FOUR-TWO-EIGHT. For two subjects, the numbers were randomly selected without replacement from the first 14,000 integers. For the remaining subject a technical error recycled about 5% of the numbers. Next, just below the numeric instruction, a prompt appeared for entering up to five digits: "ENTER-> _____." An instruction was followed by depressing corresponding keys, for example the "1," "3," "4," "2," and "8" keys, and then the "ENTER" key within 10 s. This removed the prompt and entry. The entry reappeared for .4 s as feedback. If, however, the time limit was exceeded then "LATE" appeared as a feedback stimulus.

When an entry matched the instruction and a reinforcer was scheduled, a reinforcer message appeared for .3 s, for example, "GAIN 11 CENT(S)." A reinforcer was worth 11 cents except for the first three conditions for Subject 3, where it was worth 6 cents. After the reinforcer message was removed, the numeric instruction and the schedule stimulus were removed.

If the subject neither bought an instruction nor responded in time to the single-entry, "buy" prompt, the subject was immediately prompted to enter up to five digits. In this case, because reinforcement was never available, only feedback from the entry and the schedule stimulus were subsequently removed.

At the end of each session, subjects were given a receipt for the money earned that session and for all money earned during the experiment. Subjects were paid when they completed the experiment.

Design

As noted in Table 1, Subject 1 and Subject 2 were treated similarly.

They were first exposed to a history condition which provided extensive contact with each schedule. The schedule stimuli were letter-digit-letter-digit sequences, for example, "M4L4." The schedules were either

Table 1

Sequence of Experimental Conditions

Condition	Subject 1	Subject 2	Subject 3
1 History	X	X	
2 Unsignaled	X (11)	X (11)	
3 History	X	X	
4 Unsignaled	X (5)	X (6)	
5 Signaled	X (5)	X (7)	
6 Unsignaled	X (5)		
1 History			X
2 Unsignaled/Fixed Extinction Onset			X (11)
3 History			X
4 Unsignaled/Variable Extinction Onset			X (10)
5 Intermittent Schedule Only/Variable Extinction Onset			X (4)
6 Increase Reinforcer Value/Variable Extinction Onset			X (23)
7 Signaled/Variable Extinction Onset			X (5)
8 Alternating Treatments/Variable Extinction Onset			X (10)

Note. The number of training-extinction tests is indicated in parentheses.

continuous or intermittent (13 reinforcers per 20 buying and instruction-following responses). In this condition, the subjects worked on a schedule until 25 reinforcers were earned and then they could take a 5-min break. Subsequently, the remaining schedule was put into effect. Order of presentation of each schedule was randomized for blocks of two schedules. When six blocks were completed, that is, 150 reinforcers were earned on each of the schedules, the history condition was terminated. It should be noted that although a reinforcement criterion terminated the history condition, a stability criterion terminated most other conditions.

After completing the history condition (Condition 1 in Table 1), the two subjects contacted a series of training-extinction tests (Condition 2). This condition is denoted as "unsignaled," in Table 1, because the beginning of the block of 100 extinction trials was unsignaled. These training-extinction tests examined the persistence of following instructions when either the continuous or intermittent schedule was replaced with extinction. Training trials were identical to those of the history condition; the schedule stimulus signaled trial onset and only the chain of buying and then following instructions produced reinforcement. When subjects earned 15 reinforcers within 100 training trials, extinction began. During the block of 100 extinction trials, the schedule stimulus signaled trial onset and subjects could buy instructions, however, reinforcement was unavailable for any sequence of numeric responses. That is, neither following instructions, ignoring instructions, nor "guessing" were reinforced. On completing a training-extinction test, the

subject could take a 5-min break. Subsequently, a training-extinction test was repeated with the remaining schedule. Schedule order was randomized for blocks of two tests. Tests continued until responding stabilized during extinction.

On completing the first unsignaled condition (Condition 2), the history condition (Condition 3) was replicated with new schedule stimuli. These schedule stimuli were used for the remainder of the experiment.

Next, Subject 1 and Subject 2 again contacted the unsignaled condition (Condition 4). Subsequently, they contacted a signaled condition (Condition 5) in which the beginning of the block of 100 extinction trials was now preceded, by a 4-s, 1-kHz tone and the terminal's cursor moving horizontally across the screen. As in the unsignaled condition, the series continued until responding stabilized during extinction. The signaled condition examined whether the initial effect of the extinction schedule on buying and following instructions could be sharpened; the unsignaled condition was the control. As noted in Table 1, only for Subject 1 did time permit returning to the unsignaled condition (Condition 6).

As indicated at the middle of Table 1, Subject 3 also began with the history condition (Condition 1). Next the unsignaled condition (see above) was modified so that training continued until the subject earned 15 reinforcers within 150 trials. The number of training trials was increased because the other subjects had often not earned a sufficient number of reinforcers, on the intermittent schedule, to commence extinction. The modified condition was denoted unsignaled/fixed extinction onset (Condition 2).

Next, as for the other subjects, Subject 3 was exposed to the history condition (Condition 3) with new schedule stimuli. Subsequently, Subject 3 contacted a series of training-extinction tests which were identical to those of the unsignaled/fixed extinction onset condition but here extinction onset was variable. The onset value randomly varied from 15 to 20 reinforcers from test to test. This unsignaled/variable extinction onset condition (Condition 4) was implemented because Subject 3's performance in the unsignaled/fixed extinction onset condition (Condition 2), suggested control by the fixed number of reinforcers (15) used there.

For Subject 3 the remainder of the conditions (5-8) focused on the intermittent schedule. On this schedule, Subject 3 had often failed to earn 15 reinforcers within 150 trials. The next two conditions addressed this problem.

In Condition 5, the continuous schedule was discontinued from the training-extinction tests. This condition is denoted, in Table 1, as intermittent schedule only/variable extinction onset. This condition determined if the low frequency of buying and following instructions on the intermittent schedule depended on the continuous schedule being in effect. In this condition, Subject 3 again failed to earn 15 reinforcers within 150 trials.

In Condition 6, reinforcement value increased to 11 cents. This

condition is denoted, in Table 1, as increase reinforcer value/variable extinction onset. Because buying and following rates increased, the new level of reinforcement was maintained for the remainder of the experiment.

In Condition 7, a signaled/variable extinction onset condition was implemented to examine if the initial control of the extinction schedule could be sharpened. The signal was identical to that used for the other subjects. Finally, because the number of sessions with this subject was limited, signaled and unsignaled extinction tests were alternated in Condition 8, the alternating treatment/ variable extinction onset condition. The stability criterion was not used to terminate this last condition.

Stability Criterion

A stability criterion generally terminated a series of training-extinction tests. The data from each 100-trial extinction were aggregated per four 25-trial blocks. These blocks were examined for each of the last four extinctions. Stability during a block was achieved when (a) the number of buy and follows did not differ by more than two from the mean for the last four extinctions of that block, and (b) no trend was visually apparent. Stability during extinction was achieved when performance for at least three of the four blocks was stable. When two schedules were studied, a condition was terminated only when stability was achieved for both schedules.

Results

With rare exception, bought instructions were followed. Consequently, the sequence of buying and following was treated as a single response and is designated below by "follow," "following," and so forth. To compare performance during training with performance per block of 25 extinction trials, training performance was expressed as a frequency per 25 trials.

Subject 1 and Subject 2

In Figure 1 and Figure 2 performance during training is noted with squares and is representative of performance during the history conditions (not shown). For Subject 1, although rates appear quite variable across training, the continuous schedule generally produced a higher frequency of following instructions than did the intermittent schedule. For Subject 2, the findings are complicated by performance on the intermittent schedule beginning with the fifth test in the second-unsignaled condition. On this test, the schedule did not support responding so that the necessary 15 reinforcers were earned for extinction onset. In the signaled condition this occurred on the first, third, and seventh tests. It is important to note that for these four tests, training frequencies were always less than 3.5 following responses per 25 trials. Thus, for Subject 2 the continuous schedule tended to produce a higher frequency of following instructions than did the intermittent schedule.

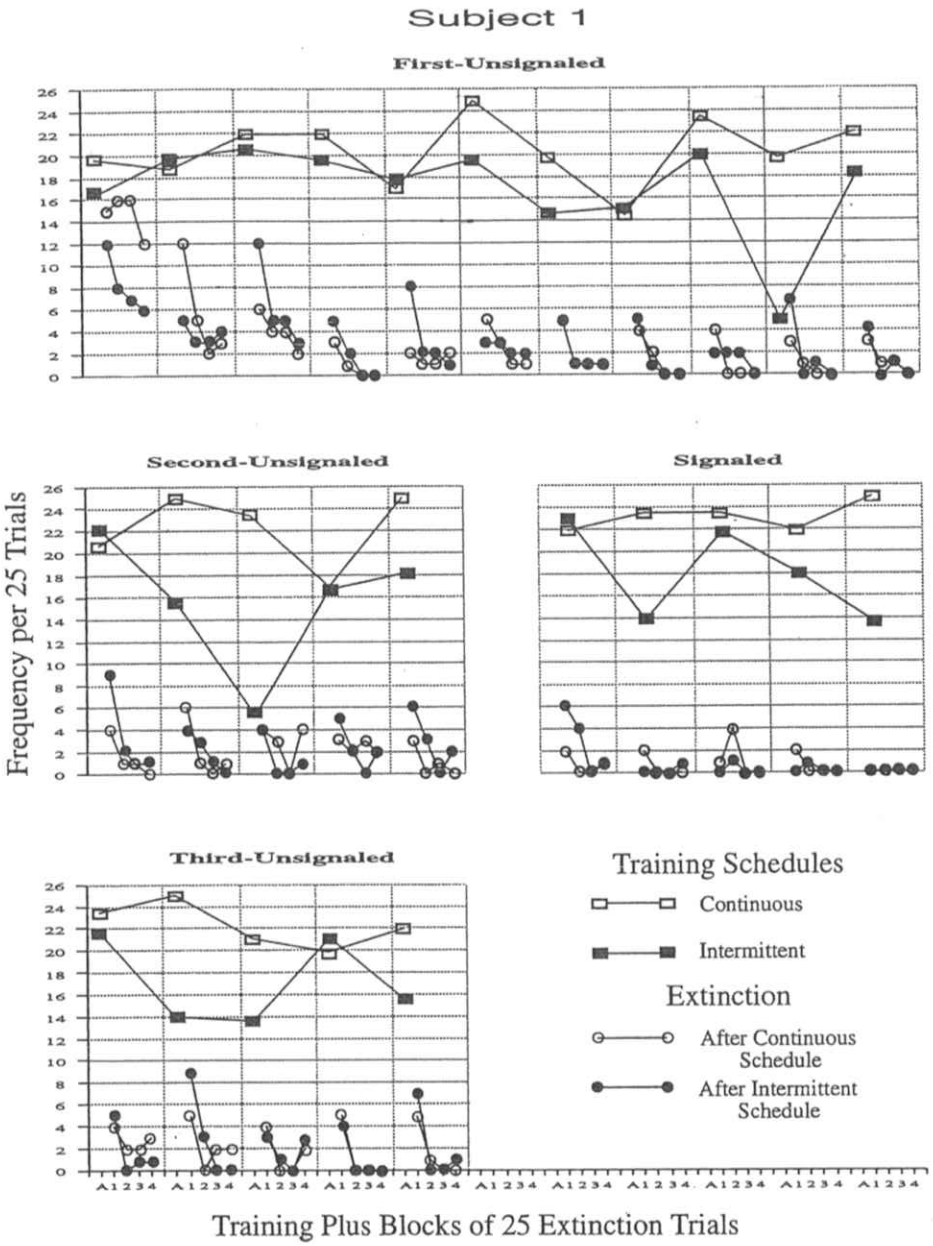

Figure 1. The frequency of buying and following instructions per 25 trials, during training and extinction, is shown for Subject 1. Separate functions are plotted for the continuous and intermittent schedules.

In Figure 1 and Figure 2 performance during extinction, noted with circles, was most frequent during the first 25-trial block and generally decreased from block to block. This pattern was most evident during the

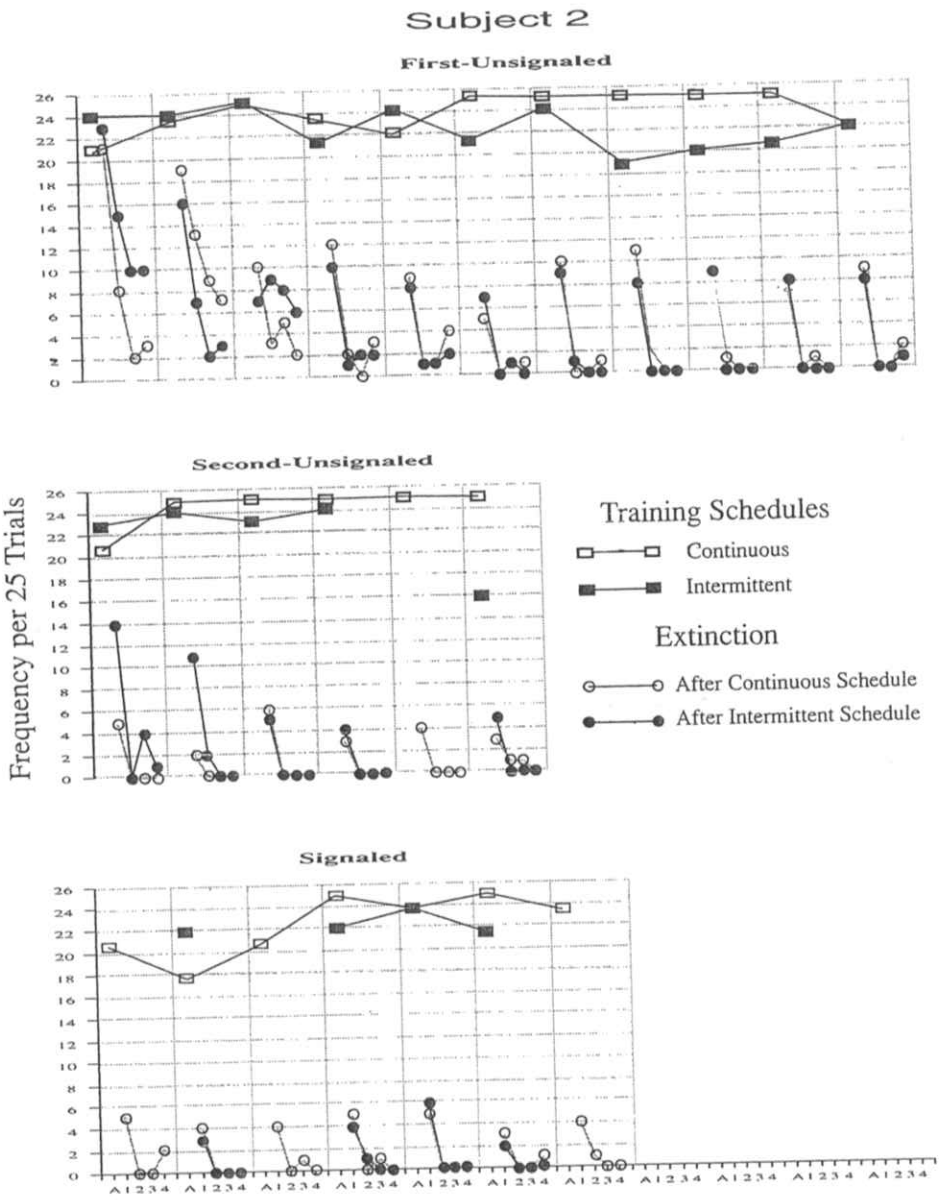

Figure 2. The frequency of buying and following instructions per 25 trials, during training and extinction, is shown for Subject 2. Separate functions are plotted for the continuous and intermittent schedules.

first-unsignaled extinction conditions. As unsignaled extinction tests were repeated, response frequency generally decreased across blocks with response frequency approaching zero for the last three blocks. For neither subject was performance during unsignaled-extinction

consistently differentiated as a function of the schedules in effect during training. More molecular analyses, in which responding was only aggregated per 12-trial and 5-trial blocks, did not detect a PREE.

For Subject 1, terminal frequencies (the last four extinctions)

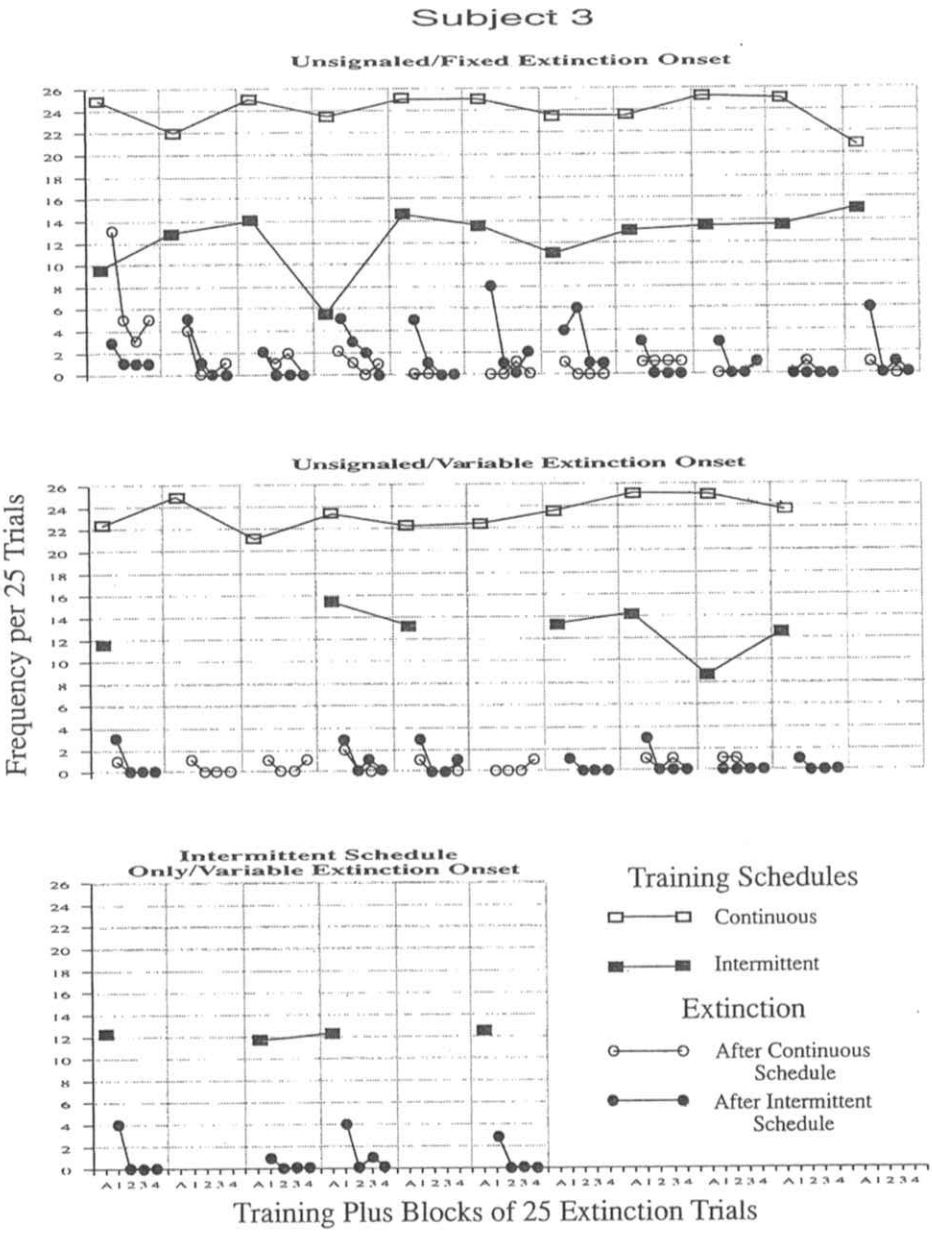

Figure 3. The frequency of buying and following instructions per 25 trials, during training and extinction, is shown for Subject 3. Separate functions are plotted for the continuous and intermittent schedules.

during the signaled condition were lower than frequencies during the unsignaled extinction conditions which preceded and followed it. For Subject 2, terminal frequency during the signaled condition did not appear to differ from that in the unsignaled extinction condition which preceded it.

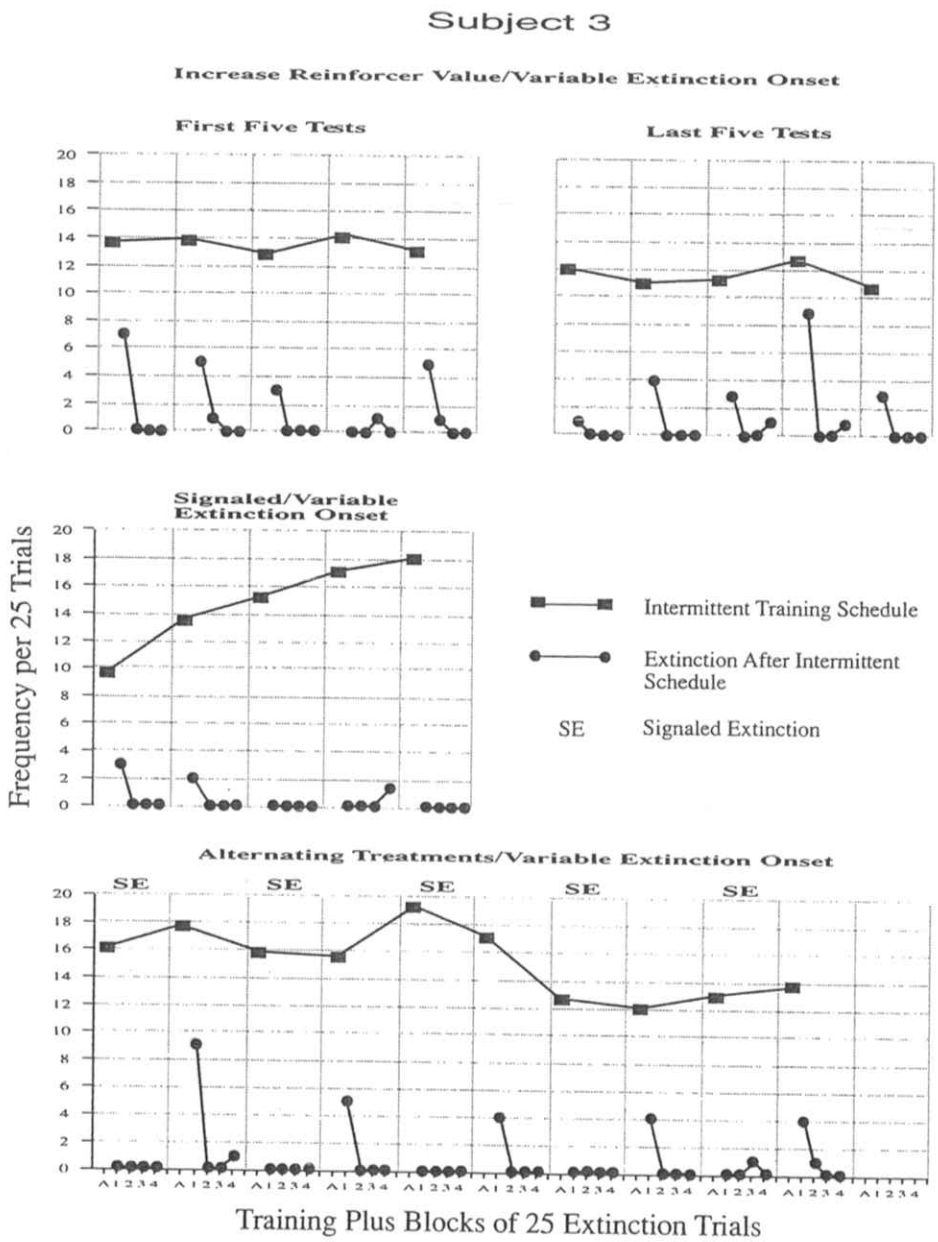

Figure 4. The frequency of buying and following instructions per 25 trials, during training and extinction, is shown for Subject 3.

Subject 3

As indicated in Figure 3, both schedules were in effect only during the unsignaled/fixed extinction onset and unsignaled/variable extinction onset conditions. Performance during these training components is representative of performance during the history conditions (not shown). During the unsignaled/variable extinction onset condition, the intermittent schedule did not always support the responding necessary for extinction onset. As for Subject 2, performance is not presented for these tests, but frequencies were always less than 3.2 responses per 25 trials. For Subject 3, therefore, the continuous schedule always produced a higher frequency of following instructions than did the intermittent schedule.

Figure 3 also depicts performance during extinction. During the unsignaled/fixed extinction onset condition frequencies generally decreased across blocks and with repeated tests. For 8 of the 11 tests a PREE was evident. During the first extinction block, following instructions was more frequent after the intermittent schedule than after the continuous schedule.

The data for the unsignaled/variable extinction onset condition are much like those just discussed except that the intermittent schedule did not always support sufficient responding to commence extinction and there was little evidence for a PREE.

For the remaining conditions only the intermittent schedule was studied along with variable extinction onset. During the intermittent schedule only/variable extinction onset condition the intermittent schedule twice failed to support the responding necessary for extinction onset (a stability criterion was not used to terminate this condition). As depicted in the top panel of Figure 4, once the value of a reinforcer increased, the intermittent schedule produced sufficient responding to commence extinction for 36 of the final 38 tests of the experiment. (The two tests for which responding was insufficient are among the 28 tests not displayed.)

The data, in Figure 4, for the signaled/variable extinction onset and alternating treatments/variable extinction onset conditions indicate that the signal suppressed responding during the first 25-trial block of extinction. This effect was most evident when the alternating treatments design was utilized. Signaled extinction always eliminated responding during the first 25-trial block which otherwise was at least four responses.

Discussion

In this experiment either continuous, intermittent, or extinction schedules were in effect. Two of the three subjects clearly followed instructions more frequently under the continuous schedule than under the intermittent schedule. All subjects responded least frequently on the extinction schedule. Unlike earlier research, the control these instructions exerted cannot simply be attributed to a history of reinforcement with respect to a particular instruction because an instruction was rarely if ever repeated. These results, consequently,

extend the generality of an operant interpretation of instruction following to the important class of instructions comorised of novel combinations of verbal stimuli.

When extinction onset was unsignaled, following instructions was most frequent during the first 25-trial block and typically decreased from block to block. This decrease was evident for all subjects within 28 min, the duration of the first, 100-trial, extinction test. Responding during extinction was generally highest during the initial tests and declined with repeated testing. For the later tests, responding often was absent during one or more of the last three extinction blocks. Although responding need not decrease in this way across repeated extinctions (Anger & Anger, 1976), similar patterns have been found for noninstructed operants (Gonzalez, Holmes, & Bitterman, 1967).

It is interesting to contrast the rapidity of the extinction of instruction following in the present experiment with Galizio's results. In his experiments reinforcement was monetary loss avoidance. In the "no contact" condition no losses were programmed; this rendered three of the "loss" instructions totally inaccurate. Yet, the subjects continued faithfully following these instructions. This "no contact" condition is technically an extinction procedure. The behavioral process of extinction was, however, never observed even when a subject was exposed to extinction for over 10 hours (see data for Subject MB, Galizio, 1979, p. 61).

For two subjects, responding during the first 25-trial block of signaled extinction was lower than responding during a previous or subsequent unsignaled condition. This enhancement of schedule control indicates that following novel instructions, like other operants, can come under conditional stimulus control as it did in Galizio's (1979) third experiment.

The present research also examined the process of extinction as a function of the preceding training schedules in effect. For two subjects, extinction did not differ as a function of the schedules. For Subject 3, a PREE was detected during the unsignaled/fixed extinction onset condition but not during the subsequent unsignaled/variable extinction onset condition. It is unclear whether the absence of the PREE in the second condition was caused by repetition of unsignaled extinction or extinction onset that was variable. Variable extinction onset, of course, reduces the discriminability between the offset of the continuous schedule and the onset of extinction.

The PREE detected for Subject 3 is compatible with the generalization decrement account (e.g., Nevin, 1988) which suggests that the PREE may have prevailed for all subjects had the rate of reinforcement for the intermittent schedule been less. Studying the PREE using lean reinforcement schedules, however, is complicated by response rates decreasing with reinforcement rates. Perhaps increasing the amount of reinforcement, as was done with Subject 3, will maintain following instructions so that extinction can be studied. Alternatively, reinforcer value may be increased by exchanging points at the end of each session rather than only at the end of the experiment, as was done here (Hyten, Madden, & Field, 1994).

The procedure might also be improved by reconsidering the unit of behavior: the chain of buying and following instructions. The "buying" response was introduced to control, independently of manipulating reinforcement for following instructions, the frequency of following instructions. Reducing instructional cost may, therefore, be an alternative way to increase response frequency on lean schedules. Another possibility, of course, is to eliminate the buying response.

Besides addressing response maintenance on lean schedules, future research should address response variability. Although the data were collected over multiple sessions and a stability criterion was generally utilized, responding was variable from session to session. Matthews, Shimoff, Catania, and Sagvolden (1977, p. 465) noted that "subtle and unrecognized aspects of instructional control may be involved in human performances whenever instructions of any kind are given." It may be recalled, therefore, that at the beginning of every session subjects read instructions. These instructions were included so that the child subjects would continue in the experiment even when daily earnings were low. It is possible, however, that these instructions contributed to variability, "Some hours will result in much more than $1.25 and others much less than $1.25 but on the average I will earn about $1.25 based on my entries." The phrases "much more," "much less," and "based on my entries" may have inadvertently instructed subjects to respond variably!

The present experiments indicate the feasibility of using novel instructions. These instructions are consistent with conceptions of instructional control which require a multi-member stimulus class to occasion a multi-member response class without direct training (e.g., Hayes, Thompson, & Hayes, 1989, p. 275; Reese, 1989, pp. 64-66). Moreover, novel instructions can significantly enhance the precision of studying instructional control.

For example, in Galizio's experiments instruction following could only be inferred when (1) the covariation between instructed rates and response rates was high and (2) the actual schedules in effect did not concomitantly covary with the instructions as in, for example, Galizio's initial "no contact" condition. In contrast, in the present experiments instruction following was inferred from response form and could, therefore, be ascertained on a response-by-response basis regardless of the schedule in effect (see also Hackenberg & Joker, 1994, p. 378). Other studies have used response form for inferring instructional control (e.g., DeGrandpre & Buskist, 1991; Hackenberg & Joker, 1994; Newman et al., 1994; Newman et al., 1995), but repeated use of only a few instructions raises questions about whether it is always necessary to develop an instructional interpretation when a simple discriminative stimulus interpretation is sufficient.[1]

[1]LeFrancois, Chase, and Joyce (1988) utilized variable instructions but examined issues largely independent of those addressed here.

Although the present experiment used operationally novel instructions, it is important to note that at a higher level the instructions were identical. That is, all instructions included permutations of from one-to-five spelled digits. These formal characteristics can, in part, account for the instructional control observed here.

The capability of a subject to respond to the novel instructions appears to be caused by a subject having entered the laboratory capable of responding to each single, spelled digit with a corresponding numeric response. For example, "TWO" served as a stimulus for depressing the "2" key. Such stimulus control together with a history of reinforcement for reading English from left to right appear sufficient to explain a subject's capability of following novel numeric instructions.

The sensitivity of following novel instructions to consequences appears to be caused by novel instructions being members of a higher-order stimulus class (e.g., Catania, 1992, p. 366). That is, because of contingencies outside of the laboratory or within the experiment, the instructions were conceptually identical (see Baron & Galizio's [1983] related discussion of the "instructional response"). In this way a consequence for instruction following on an early trial could contribute to instruction following on a later trial, despite each instruction's operational novelty.

In retrospect, it is somewhat surprising that novel instructions have not before been used to study instructional control. Baron and Galizio (1983) have noted the similarities between modeling and instructing. For example, in a classic study, Baer, Peterson, and Sherman (1967) used the formal correspondence between a model's behavior and a subject's behavior to infer imitation. Eventually, their subjects responded to demonstrations comprised of novel combinations of previously acquired behaviors. Perhaps, the fundamental reason novel instructions have not been used is that such research has been difficult to conduct. The present methodology, however, demonstrates procedures for reliably presenting novel combinations of verbal stimuli and measuring corresponding novel responses. Extensions of the present methodology can, therefore, enhance our understanding of how historical and current operations control instruction following.

References

ANGER, D., & ANGER, K. (1976). Behavior changes during repeated eight-day extinctions. *Journal of the Experimental Analysis of Behavior*, 26, 181-190.

BAER, D. M., PETERSON, R. F., & SHERMAN, J. A. (1967). The development of imitation by reinforcing behavioral similarity to a model. *Journal of the Experimental Analysis of Behavior*, 10, 405-416.

BARON, A., & GALIZIO, M. (1983). Instructional control of human operant behavior. *The Psychological Record*, 33, 495-520.

BARON, A., PERONE, M., & GALIZIO, M. (1991). The experimental analysis of human behavior: Indispensable, ancillary, or irrelevant? *The Behavior Analyst*, 14, 145-155.

CATANIA, A. C. (1992). *Learning* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

CERUTTI, D. T. (1989). Discrimination theory of rule-governed behavior. *Journal of the Experimental Analysis of Behavior*, 51, 259-276.

DEGRANDPRE, R. J., & BUSKIST, W. F. (1991). Effects of accuracy of instructions on human behavior: Correspondence with reinforcement contingencies matters. *The Psychological Record*, 41, 371-384.

FREEMAN, T. J., & LATTAL, K. A. (1992). Stimulus control of behavioral history. *Journal of the Experimental Analysis of Behavior*, 57, 5-15.

GALIZIO, M. (1979). Contingency-shaped and rule-governed behavior: Instructional control of human loss avoidance. *Journal of the Experimental Analysis of Behavior*, 31, 53-70.

GONZALEZ, R. C., HOLMES, N. K., & BITTERMAN, M. E. (1967). Asymptotic resistance to extinction in fish and rat as a function of interpolated retraining. *Journal of Comparative and Physiological Psychology*, 63, 342-344.

HACKENBERG, T. D., & JOKER, V. R. (1994). Instructional versus schedule control of humans' choices in situations of diminishing returns. *Journal of the Experimental Analysis of Behavior*, 62, 367-383.

HAYES, L. J., THOMPSON, S., & HAYES, S. C. (1989). Stimulus equivalence and rule following. *Journal of the Experimental Analysis of Behavior*, 52, 275-291.

HAYES, S. C., & HAYES, L. J. (1989). The verbal action of the listener as a basis for rule-governance. In S. C. Hayes (Ed.), *Rule-governed behavior: Cognition, contingencies, and instructional control* (pp. 153-190). New York: Plenum.

HYTEN, C. H., MADDEN, G. J., & FIELD, D. P. (1994). Exchange delays and impulsive choice in humans. *Journal of the Experimental Analysis of Behavior*, 62, 225-233.

LEFRANCOIS, J. R., CHASE, P. N., & JOYCE, J. H. (1988). The effects of a variety of instructions on human fixed-interval performance. *Journal of the Experimental Analysis of Behavior*, 49, 383-393.

MATTHEWS, B. A., SHIMOFF, E., CATANIA, A. C., & SAGVOLDEN, T. (1977). Uninstructed human responding: Sensitivity to ratio and interval contingencies. *Journal of the Experimental Analysis of Behavior*, 27, 453-467.

NEVIN, J. A. (1985, May). *Reinforcement, extinction, and behavioral momentum.* Invited address at the meetings of the Association for Behavior Analysis, Columbus, OH.

NEVIN, J. A. (1988). Behavioral momentum and the partial reinforcement effect. *Psychological Bulletin*, 103, 44-56.

NEWMAN, B., BUFFINGTON, D. M., & HEMMES, N. S. (1995). The effects of schedules of reinforcement on instruction following. *The Psychological Record*, 45, 463-476.

NEWMAN, B., HEMMES, N. S., BUFFINGTON, D. M., & ANDREOPOULOS, S. (1994). The effects of schedules of reinforcement on instruction-following in human subjects with verbal and nonverbal stimuli. *The Analysis of Verbal Behavior*, 12, 31-41.

REESE, H. W. (1989). Rules and rule-governance: Cognitive and behavioristic views. In S. C. Hayes(Ed.), *Rule-governed behavior: Cognition, contingencies, and instructional control* (pp. 3-84). New York: Plenum.

SCHOENFELD, W. N., & CUMMING, W. W. (1963). Behavior and perception. In S. Koch (Ed.), *Psychology: A study of a science* (pp. 213-252). New York: McGraw-Hill.

SKINNER, B. F. (1957). *Verbal behavior.* New York: Appleton-Century-Crofts.