The Effects of Fading and Rule-Stating on the Instructed Reacquisition of a Five-Link Behavioral Chain

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THE EFFECTS OF FADING AND RULE-STATING ON THE INSTRUCTED REACQUISITION OF A FIVE-LINK BEHAVIORAL CHAIN

by

Okechukwu S. Ozuzu

A Dissertation
Submitted to the
Faculty of The Graduate College
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Although instructions tend to generate rapid and near errorless responding during acquisition, this efficiency in performance is not necessarily maintained in reacquisition. The present study addressed this issue of performance maintenance by utilizing procedures designed to strengthen the control function of instruction stimuli.

Five 6 to 10 year-old children, two females and three males, were trained in the repeated acquisition of a behavioral chain using monetary reinforcement. The operanda for the five-component behavioral chain consisted of fifteen plastic discs displayed on an intelligence pad. For each session the subjects' task was to learn or relearn a new sequential order by picking up the "correct" disc in each of the five groups of three discs. The study consisted of six blocks of two paired sessions. Each block was comprised of an acquisition session and a reacquisition session on Day I; an instructed acquisition session and an instructed reacquisition session on Day II. This repeated acquisition and reacquisition provided a steady state from session to session against which the effects of experimental manipulations were evaluated.

Three experiments were conducted. Experiment I evaluated the effects of instructional stimuli which involved the conspicuous displacement of the correct discs during instructed acquisition
only. When instruction was provided, subjects learned without errors; but removal of instruction resulted in reacquisition errors similar to those of non-instructed acquisition sessions. Experiment II investigated the effects of a five-step stimulus-fading procedure during instructed acquisition to increase stimulus control of responding to the correct disc sequence. Performance during instructed reacquisition was at best only slightly better than the instructed reacquisition of Experiment I. Experiment III assessed the role of rule-stating during instructed acquisition. Again there were no clear improvements over the instructed reacquisition of Experiment II. Taken together these findings do not show a clear and systematic improvement from acquisition to reacquisition conditions when stimulus fading and rule-stating were superimposed on instruction.
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Okechukwu S. Ozuzu

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INTRODUCTION

Skinner observed that instruction has a dual effect: On the one hand, it reduces both the error rate and the number of trials to criterion; and on the other, it tends to reduce sensitivity to the contingencies that are critical in shaping behavior in the environment (Matthews, Shimoff, Catania, and Sagvolden, 1977). Despite this dilemma "much of education is instruction in verbal behavior" (Skinner, 1974, p.134). "And because of the practical benefits, the verbal community shapes the behavior of following instructions across a ... range of activities" (Catania, 1979, p.246).

Recently, however, the disadvantages of instruction have been investigated in greater detail to identify the important variables and procedural difficulties so as to maximize the practical benefits and reduce the problems associated with instruction. One major problem is that, though instructional stimuli may generate rapid discriminative control of behavior during training, they do not necessarily lead to efficient performance during transfer (Boren and Devine, 1968; Peterson, 1980). Performance under instructional control is particularly poor in situations that require the transfer of performance from one condition to another.

The focus of the current research is on the investigation of conditions under which instructional control of responding in a behavioral chain can be improved. The study is designed to determine what procedures might facilitate the discriminative stimulus control and transfer of a five-component behavioral chain from initial
acquisition training to reacquisition. The specific procedures studied were the superimposition of stimulus fading and rule-stating on instructional stimuli.

A conventional approach in the studies of behavior acquisition (learning) has been the use of a "two-group" design in which each group is treated with a different value of the independent variable; and treatment effects on the experimental group are compared with those of a control group, usually statistically. Certain features associated with studies of learning have made the use of the independent-group design prevalent in the past: a) Since a subject can learn a given problem only once, each subject can serve under only one experimental condition. b) Behavior during acquisition has been known to be in constant transition and consequently under such transition, a subject's initial acquisition cannot easily serve as a control for subsequent learning. c) Without some criterion level of performance, there is no steady baseline against which to evaluate the effects of experimental manipulations (Boren and Devine, 1968).

To study learning, some researchers have used the repeated acquisition of a simple discrimination or a simple response sequence (Sidman and Rosenberger, 1967; Boren and Devine, 1968). These studies utilize the single-subject design in which each subject serves under all experimental conditions; subjects are trained until the behavior of interest reaches a steady state, and the effects of an independent variable are seen as a change in that steady state. Within such a design strategy, intergroup variability is minimized, direct behavioral measures of the individual performance are possible and the direct
application of the effect to the individual case can be made (Sidman, 1960).

A research strategy that incorporates the critical features of the single subject design to produce a steady state of relearning is the repeated acquisition procedure similar to those proposed by Harlow (1949) and Jenkins (1927) and adapted by Polidora (1963); Sidman and Rosenberger (1967); and recently Boren and Devine (1968).

Subjects are trained to acquire different but similar behavioral chains repeatedly so that the number of errors reaches a steady state, session to session. Such a steady baseline is then used to assess the effects of given variables.

The repeated acquisition procedure has been used to study a variety of phenomena, such as effects of pretraining (Behar, 1974), conditioned reinforcement (Hurch, 1977), conditional discrimination (Moerschbaecher, 1978), and the effects of various drugs (Thompson, 1970, 1971, 1975).

In a study to determine whether a type of stimulus control would facilitate the acquisition of the behavioral chain, Boren and Devine (1968) used a repeated acquisition procedure with monkeys as subjects. Two paired sessions for acquisition of each new lever sequence were arranged. The first session was initiated with the presentation of a single light above the correct lever in the required sequence. This single pilot light served as an "instruction" stimulus for the monkeys to press the lever below. In the non-instructed session, all three lights were on over the group of three levers. The focus of the study was to test "whether the subjects
would make the correct response chain as a result of repeated exposure to this stimulus control procedure or whether the monkeys would merely press the lever under the stimulus without coming under the control of the sequence itself" (p.657). As a control, a second paired session was conducted in which the first session ("learning") was non-instructed with three lights on over the corresponding three levers. The second ("relearning") session was the same as the first. This control procedure permitted comparison of the degree of transfer from one non-instructed session to the next versus the transfer from an instructed session to the next session without instruction.

Boren and Devine found that, with instructional stimuli, the subject merely pressed the lever under the light; when this specific stimulus was no longer present, the monkey could not emit the required lever sequence. It took just as long to learn the four-response chain when the light was removed as it had when no light was provided. Thus the monkey failed to profit from instruction.

Peterson (1980) replicated and confirmed the Boren and Devine study using preschool children as subjects. The subjects failed to benefit from instruction. When the instructional stimuli were removed, the children responded as if they were encountering the sequence for the first time.

Smiley (1974) evaluated the effects of instruction as a "setting event" on acquisition of a behavioral chain by young children in a guessing game situation. Five columns of pictures were displayed on a game board and subjects were required to guess and indicate with a set of ring binders which picture in a given column the experimenter
was thinking of. Correct responses were reinforced with token chips that were later exchanged for toys. All subjects received one set of instructions regarding the experimental task. In addition, one-half of the subjects were given a second set of instructions:

Listen carefully to what I say. This time I am going to tell you where to put the ring but the next time you will have to remember where to put the ring. I'll only tell you one time where to put the ring, then you'll have to do it yourself. Listen. (p.197)

Smiley found that providing this additional set of instructions concerning the pending change in the task resulted in less errors during test sessions.

In a related study designed to facilitate transfer, Peterson (1980) taught preschoolers to state rules describing the contingencies during control learning and obtained a substantial transfer in relearning. However, attempts at rule-stating during instructed learning failed to produce transfer in relearning. Even when prompts were provided, only two of the four subjects showed some transfer effects. In contrast, adults exposed to similar conditions clearly benefited from the instruction stimulus during relearning. Peterson (1980) speculated that the difference may be attributed to adults' history of dealing with sequential relations. It is possible, however, that the failure of Peterson to obtain transfer during the instructed relearning sessions for the preschoolers may be attributed to poor stimulus control of the subjects' behavior by self-rule. A procedure that could ensure an increase in stimulus control may yield a different set of results.

Terrace (1963a) was one of the first to demonstrate errorless
discrimination learning with fading. Pigeons were trained to peck in the presence of a green key (S+). Early in training the red key (S-) was gradually introduced along two dimensions - duration and intensity. In this procedure, pigeons learned transfer of stimulus control with a zero rate of responding to the new S- from the first session of transfer.

Subsequently, Moore and Goldiamond (1964) used a stimulus-fading procedure to train visual discrimination with human subjects. In this study, correct choice (S+) appeared at the final intensity from the outset of training. The S- was gradually faded in until it reached the same intensity as the S+. Sidman and Stoddard (1967) further demonstrated the effectiveness of fading by teaching both normal and retarded children to discriminate a circle from an ellipse. Results of other researchers have confirmed that fading can be effective in facilitating stimulus control (Koegel and Rincover, 1976; Bijou, 1968; McCleave, 1970; Schilmoeller and Etzel, 1977). Fading has not been universally effective, however, as some studies have yielded equivocal results. For instance, Gollin and Savory (1968); Guralnick (1975); Karpicke and Hearst (1975); and Chenry and Stein (1974) failed to obtain transfer of stimulus control following fading in training with a conditional discrimination. Sidman and Stoddard (1967) found that interdimensional transfer of stimulus control may result in errors or even complete failure, if not done in a "proper" or gradual enough fashion. And McCleave (1965) failed to teach preschoolers to discriminate a backward "C" from a proper "C" using size of the letters as the fading dimension.
More recent studies, however, (Schilmoeller, et al., 1979) have pointed to the likely explanation for failures to strengthen stimulus control through fading. These authors pointed out that it is possible that "intensity fading misdirects subjects' attention" and suggested instead stimulus shaping which focuses attention on the stimulus dimensions that are ultimately critical for correct responding on the final discrimination. Thus relative effectiveness of fading would depend on the nature of the final task.

The acquisition of behavioral chains constitutes a major part of the human repertoire. The majority of the learning that goes on in schools is produced through instruction. Yet there is evidence to show that instruction is not an effective way to teach behavioral chains. (Boren and Devine, 1968; Peterson, 1980). One difficulty derives from the fact that instruction tends to exert poor stimulus control over behavior. It may be, however, possible to increase the effectiveness of an instructional stimulus in the acquisition of a behavioral chain by combining instruction with other establishing operations such as fading and rule-stating on the acquisition and reacquisition of a five-component behavioral chain.

The present study replicated and extended the findings of two previous studies on repeated acquisition (Boren and Devine, 1968; Peterson, 1980). An instructional control baseline generated by the repeated acquisition of a behavioral chain was used to determine the effects of fading and rule-stating during instructed acquisition sessions and tested during reacquisition in terms of decreases in both error rate and number of trials to criterion.
METHOD

Subjects

Five grade school children served as subjects, two females and three males with an age range of six to ten years. Two other subjects participated in the early stages of the study but failed to learn the preliminary tasks and were removed from the study. They were four and a half and six and a half years old. Parental permission for subjects' participation was obtained by their signing of the consent forms supplied in accordance with the rules and regulations of the Human Subjects Review Committee, Western Michigan University.

Apparatus

A schematic of the yellow foam rubber pad measuring 100.5 cm. long and 1 cm. thick which was used as an intelligence pad is shown in Figure 1. Fifteen self adhesive red coding labels, 5 cm. in diameter, were used as position markers along the center of the pad, end to end. These position dots were pasted in five sets of three. A distance of approximately 7.5 cm. separated one set from another and 2.5 cm. dot to dot. Fifteen blue plastic discs were displayed in an array to correspond to the positions marked by the dots. One disc in each set was designated as "correct". A correct disc was distinguished from other discs by the 3.5 cm. star pasted on the underside center of the disc. A red plastic bar, 14.5 cm. long and 1 cm. thick was used as a discriminative stimulus.
Figure 1: A schematic drawing of the intelligence pad.

(See Method Section for detail.)
Procedure

Preacquisition

Three subjects were verbally directed while two were exposed to a shaping procedure with a backward chaining similar to that used by Boren and Devine (1986) and Peterson (1980).

Directed Procedure

The experimenter initiated this phase by reading the following statement to the subject:

Look at this array of fifteen plastic discs. Each disc is placed on a red dot. (The experimenter [E] moved one disc and replaced it on the dot.) Over here (E pointed to flip chart) is a counter on which I will keep track of the points you earn. (E indicated how points were shown on the counter.) Turning over certain plastic discs and replacing them as they were will earn points on the counter. This bar will tell you which set of discs you should work with. At the end of the session, you will earn a quarter. (E pointed to a quarter coin at side of display board.) You may save your money in this glass jar or spend it as you wish. If you pick up a wrong disc, a screen will be placed over the discs. (E demonstrated with screen.) It is up to you to choose the right plastic discs to earn points. You may only pick up one disc at a time. Do not begin until you are told to start.

Following this statement, subjects were given two practice sessions before Experiment I was initiated.

Shaping Procedure

Step 1. The experimenter explained the point system by reading the following statement to the subject:
The work you do here will earn points on this counter (I pointed to the flip chart and demonstrated how the counter worked) and at the end of each day's work, you will receive twenty-five cents. You may save your money in this glass jar or spend it as you wish. Now you may start work.

If the subject wondered what to do, the experimenter simply said, "It is up to you to figure out what to do."

**Step 2.** Subjects were exposed to a shaping procedure in which they earned points for picking up any disc, turning it over, and replacing the disc on the position dot. This step was terminated when the subject performed this response sequence five successive times with at least five different discs.

**Step 3.** The experimenter placed the bar over a set of three discs to which the subject was to respond. Point earning was then contingent on responses to the set of discs under the bar. Picking up any disc other than those indicated by the bar resulted in a two second time-out during which the cardboard screen was placed over the entire array. The bar was randomly placed and moved from one component of the sequence to another until it reliably controlled responding. Steps 1 - 3 were completed in two sessions.

**Step 4.** The backward chaining procedure was designed to train sequential responding and began with the experimenter placing the discriminative stimulus bar over the fourth set of discs (second to the last component). On responding to any member of the set, the bar was moved to the last set of discs in the series. Responding to any disc to this terminal component resulted in a point on the counter. After five successive reinforcements, the bar was moved back one set to the third group of discs. The subject was then
required to respond to this set before the bar was moved to the fourth and subsequently to the last set. A response to the last set was followed with a point on the counter. This procedure was repeated until all sets of the series were sequentially responded to as a five-link chain.

**Step 5.** Step 5 involved a predetermined sequence. The subject was required to pick up the correct disc in each set of the five-member chain. The correct disc was identified with a star pasted on the underside. Point earning was contingent on picking up the correct disc in each set of the five-member chain. The correct disc was identified with a star pasted on the underside. Point earning was contingent on picking up the correct disc in each set. An error (picking up the wrong disc) resulted in a two-second time-out which was immediately followed by a second trial on the same set. This procedure was repeated until the correct disc was picked. The subjects were required to meet the criterion of five successive sequential trials without error for three successive sessions before the final step was introduced.

**Step 6.** Step 6 was identical to Step 5 except that the sequence of correct discs changed for each session. Reinforcement was contingent upon correctly picking up the discs in the prespecified sequence. In compiling a list of sequences, care was taken to ensure that no single sequence was repeated for two days in succession. Furthermore, simple sequential ordering was avoided (for example, middle disc in each set or last disc in one set and first disc of
next set). This final step was conducted to criterion for three consecutive sessions before Experiment I was initiated.

**General Considerations**

The following considerations applied to both groups throughout the experiment. Each subject sat directly opposite the experimenter during the session. Two five to ten minute sessions were conducted each day, morning and afternoon. Each session was concluded when the subject mastered the task to a criterion of five successive errorless trials. Initially, subjects earned points on the counter for each correct response. This was later changed so that points were given only if a sequence was completed without error. If an error occurred before the session criterion was reached, all previously earned points were lost and counting was restarted. During the preacquisition phase, subjects earned twenty-five cents for completing the two daily sessions regardless of the total number of points accumulated; however, earning during the experimental phases was five cents per session. In addition to monetary reinforcement, subjects were allowed free access to the TV and toys after sessions. Data were collected in terms of error rate and the number of learning trials per session. Stimulus presentations and recording of data were done manually.

**Experiment I - Effects of Instruction**

The basic procedure of Experiment I was derived from Boren and Devine's (1968) and Peterson's (1980) repeated acquisition studies designed to develop a stable state against which the effects of a
designated independent variable could be assessed.

Experiment I investigated the function of instructional stimuli in the acquisition of the five-component chain. As in the earlier experiments, it consisted of six blocks. Each block was comprised of four sessions conducted for two consecutive days as shown in Figure 2. On the first day (D1) two sessions were conducted: the acquisition session (AQ) in the morning, and the reacquisition session (RAQ) in the afternoon. The instructed acquisition session (IAQ) and the instructed reacquisition session (IRAQ) were run the second day (D2).

Each acquisition session, AQ and IAQ, began with a new sequence. An acquisition session (AQ) started with the experimenter placing the discriminative stimulus bar over the first component of the chain. The subject responded by picking the correct disc in that component. If the subject chose the correct disc, the experimenter advanced the bar to the next component. If the subject made an incorrect response by picking an incorrect disc, the experimenter covered the array with the time-out screen for two seconds after which the subject responded again on the same component. This was repeated until the subject picked the correct disc. The experimenter then advanced the bar to the next component and so on until the sequence was completed. Subjects earned points only for those sequences completed without an error. Each session was terminated after five successive errorless sequence trials. The second session of the day, RAQ, was conducted in an identical manner to the first session and consisted of the same correct-disc sequence.
Figure 2: Chart showing the order in which experimental sessions were conducted. Each of the six blocks was comprised of four sessions: AQ, RAQ, IAQ, and IRAQ.
The second day of block one used a new sequence. Prior to beginning each instructed acquisition session (IAQ), the experimenter placed the correct discs in each set 2 cm. forward so that the position markers were exposed on the pad. In this way each correct disc was conspicuously displaced thus providing an explicit "instruction". Subjects picked up the correct discs until they reached the criterion of five successive errorless trials. The final session, IRAQ, used the same sequence as the IAQ session in the morning. It was identical in all other ways to the AQ and RAQ sessions.

The performance of subjects during the reacquisition sessions (RAQ) was compared with the performance during the instructed reacquisition sessions (IRAQ) in terms of errors and number of trials completed prior to criterion.

Experiment II - Effects of Fading

The general design of Experiment II was identical to that used in Experiment I. Six blocks were completed and each block was conducted on two consecutive days with acquisition sessions alternating with instructed acquisition sessions. The procedure for the AQ, RAQ, and IRAQ sessions was also identical to that used in Experiment I. However, a slight change in procedure was made during the IAQ sessions. For the beginning step in the IAQ sessions in Experiment II, the discs were placed 2 cm. forward which exposed the position markers as they were in the IAQ sessions in Experiment I. But after the subject picked up each correct disc, the experimenter gradually moved it back in five steps to its original aligned position.
Experiment III - Fading plus Rule-stating

Experiment III examined the effects of rule-stating on the instructed acquisition of a behavioral chain. The procedure was identical to that in Experiment II except that during the fourth and fifth steps in the fading procedure during the IAQ sessions, subjects were required to verbalize their choices. When positioning the bar over each component, the experimenter asked: "Which disc are you going to pick up?" After the subject picked up the indicated disc, the experimenter asked, "Was it the correct one?" After the session criterion was reached, the experimenter asked, "Can you tell me, without pointing, which discs you picked up to earn a point?" If the subject was not able to verbalize the correct choice, another trial was completed with the subject again verbalizing each response. Additional trials were completed until the subject was able to state the correct sequence. Finally the experimenter covered the array and asked the subject, "Can you tell me now which discs you picked up to earn a point?" If the subject failed to state the correct sequence, the experimenter removed the screen to enable the subject to visually inspect the array and state the sequence again before the final step was repeated. Reacquisition sessions were conducted in the same way as in the other experiments. Reacquisition sessions were conducted without the verbalization requirement and were completed as in the previous reacquisition sessions.
RESUL TS

The acquisition (AQ) and instructed acquisition (IAQ) sessions were treatment sessions while the reacquisition (RAQ) and instructed reacquisition (IRAQ) sessions were transfer-test sessions in which the treatment effects of the independent variables were assessed. An important comparison is the performance of subjects during RAQ and IRAQ.

Data for all subjects in the three experiments are presented in Figure 3. Sequential dependency data on the reacquisition errors and the number of trials for all subjects are found in Appendix A. The first three subjects (S-101, S-102, S-103) were given directions before the acquisition sessions were initiated while the last two subjects (S-201, S-202) were shaped.

Experiment I

Experiment I assessed the effects of instructional stimuli on the acquisition and reacquisition of a five-member behavioral chain. Data for all subjects are summarized by the bar graphs in terms of median error rates and number of learning trials per block.

All of the directed subjects (S-101, S-102, S-103) showed a clear decrease in both error rate and in the number of learning trials from AQ to RAQ as shown by the first three subjects in Figure 3. All of the subjects showed near errorless performance during IAQ; however, when the instructional stimuli were not provided during IRAQ, there was an increase in errors yielding a performance record similar to
Figure 3. Bar graphs showing median errors and trials for each subject in each experiment. Four sessions were completed in each experiment: Acquisition (AQ) and reacquisition (RAQ) sessions as controls; the instructed acquisition (IAQ) sessions where experimental manipulations were made and instructed reacquisition (IRAQ) sessions where the effects of manipulations were assessed.
that obtained during the initial acquisition (AQ) and higher than during RAQ. There was also an increase in the number of trials during IRAQ when compared to RAQ. These results are consistent with the findings of Boren and Devine (1968) using monkeys as subjects and those of Peterson (1980) using 3-5 year old children.

The records of the subjects exposed to the shaping procedure (S-201, S-202) are shown in the last two rows. Following the withdrawal of the instructional stimuli in IRAQ, S-201's error rate was substantially more than that during RAQ; however, the number of learning trials was only slightly increased. S-202, in contrast, made the greatest number of errors and trials in all phases of Experiment I but the general trend is similar to that of S-201. Taken together, these data do not show a definite and consistent difference between the shaped and the directed groups.

In summary, performance in RAQ was better than performance in AQ in all subjects. The addition of instructional stimuli did not lead to an improvement in performance for any subjects in IRAQ. Subjects did not learn nearly as rapidly in IRAQ as in RAQ. In fact, performance was not better than the original acquisition (see Figure 3).

Experiment II

Experiment I demonstrated that instructional stimuli did not facilitate the reacquisition of a five-link behavior chain. It was speculated that a procedure which would ensure that the position of the correct disc would be closely attended to might facilitate
reacquisition. The purpose of Experiment II was to utilize a fading procedure to make it more likely that the subjects would attend to the correct elements of the sequence. In Experiment II, fading was, therefore, superimposed on instruction during IAQ and the effects assessed in IRAQ.

Figure 3, second column, provides a summary of the median rate of errors and trials data for each subject as a result of the five-step fading procedure. Immediately following the fading steps of instructed acquisition (IAQ), there was an increase in both error rate and number of learning trials in three of the five subjects (S-102, S-103, S-202); two other subjects (S-101, S-201) had only slight increases. A comparison between performances in RAQ and IRAQ show that the subjects exposed to the shaping procedure (S-201, S-202) had reduced error rates and number of learning trials in IRAQ though the degree of reduction for S-201 was less than that of S-202. In contrast, however, directed subjects showed no comparable systematic performance improvements. In fact, data for S-101 show an increase in both dependent variables, errors and trials. The sequential dependencies show the same trends as shown in Appendix B.

In summary, there was a considerable variation in errors immediately following fading in IAQ; however, there was no consistent improvement in IRAQ when compared to the performance in RAQ. Although these data do not reveal a clear improvement in performance in IRAQ with local comparisons in Experiment II, there was, however, a substantial and consistent improvement in all subjects when the
IRAQ data in Experiment I were compared to the IRAQ data in Experiment II, though these observed improvements might possibly be a function of practice.

Experiment III

Experiment III was designed to determine if a reduction in errors and number of trials can be obtained by requiring subjects to state rules controlling the sequence.

The results of Experiment III are shown in the last column of Figure 3. A comparison between RAQ and IRAQ shows only two of the five subjects (S-103, S-202) with some reduction in errors. The rest of the subjects (S-101, S-102, S-201) had increases in error rates. In terms of the number of learning trials, four out of five subjects had as many trials in IRAQ as in RAQ while S-102 had an increase in trials during IRAQ. Again there was no consistent difference between the shaped and directed subjects.

Compared to the reacquisition data in the two previous experiments, the addition of a rule-stating requirement may have been more effective in facilitating transfer than instruction alone but only slightly better than fading. However, this slight difference may be due to a longer period of practice in Experiment III. The failure to demonstrate a clear reacquisition of a previously learned behavioral chain with a rule-stating requirement is consistent with the findings of Peterson (1980) who demonstrated statement of rules during control learning to be effective in the reduction of errors in control relearning but failed to obtain the same effect during
instructed learning (I/L) and relearning (I/R). The present study showed that at best fading with rule-stating only slightly improved the reacquisition of an instructed behavioral chain compared to fading alone. Although there was some reduction in the number of trials during instructed reacquisition, there was no systematic improvement across subjects in IRAQ when compared to performance in the uninstructed acquisition. These observations are consistent with the sequential dependencies for each subject summarized in Appendix B.
GENERAL DISCUSSION

The present series of experiments replicated and extended the findings of two previous studies, Boren and Devine (1968) and Peterson (1980) in utilizing a repeated acquisition procedure to establish a steady state of reacquisition to assess the effects of three independent variables - instructional stimuli, stimulus fading, and rule-stating. As in the earlier studies, the effects of instructional stimuli in the reacquisition of a behavioral chain was minimal, i.e. error rate and number of trials during reacquisition were similar to those obtained during the initial acquisition. The increase in errors suggested that the subjects were acquiring the behavioral chain for the first time. These results are, however, not consistent with the results of Smiley (1974) who found that by providing an additional set of instructions about changes in stimulus sequence, subjects' error rates were substantially reduced when instruction was no longer provided.

Although stimulus fading along the position dimension may have slightly improved the performance of the subjects who were exposed to the shaping procedure, there was not an equivalent improvement across all subjects. These findings are consistent with the equivocal results of some earlier studies with fading (Hearst, 1975; McCleave, 1965; Gollin and Savoy, 1968; Schusterman, 1966; Sidman and Stoddard, 1967).

There is no clear evidence that rule-stating improved reacquisition. These results are in part consistent with those of Peterson (1980). Using a different apparatus and a procedure that required
rule-stating during the control learning phase, Peterson obtained reduction in errors in two out of four subjects during control relearning but failed to produce an equivalent reduction in errors during instructed learning and relearning.

Data from the present study were analyzed in terms of the behavioral principle that the controlling stimulus dimension can be represented as a rule or concept (Skinner, 1974, p.138). Rules and directions have discriminative stimulus ($S^D$) functions. A trial on one set of three discs provides a discriminative stimulus for picking the correct disc in the subsequent set. This is consistent with Skinner's statement (1974, p.122) that "in recalling a name it is useful to go through the alphabet, not because we have stored all the names we know in alphabetical order but because pronouncing the sound of a letter is pronouncing part of the name; we prompt the response in ourselves as we prompt it in someone else whom we are helping to recall it". Furthermore, these data on the effects of instructional stimuli also support the Skinnerian analysis of the role of instruction; namely, that by providing instruction, the learner is enabled to come under instructional control speedily and with fewer errors. In addition, subjects may "avoid exposure to many of the contingencies which shape behavior". In the current study when instructional stimuli were provided, subjects learned the tasks quickly and without errors. However, removal of the instructional stimuli during reacquisition produced an increase in errors and trials.

Subjects were not told, and failed to determine, that the morning
and afternoon sequences were the same during Experiment I. This may account in part for the difference between the effects of instruction in the present study and that of Smiley (1974). Smiley gave instructions concerning the nature of the task change on the second trial thus focusing attention to the serial position of each of the correct stimuli on the first trial.

There are certain factors that may have contributed to the equivocal effects of the fading procedure used in the present study. First, fading was at best only slightly effective in improving performance in reacquisition, and for the shaped subjects only. The failure of fading with the directed subjects may have been that these subjects did not have the extended practice that the shaped subjects had during the preacquisition phase. Such a brief history for the directed group may have limited the control the fading procedure exerted over reacquisition, because the subjects only attended to the prompts, or instructional stimuli, without reference to the disc positions.

Second, it may also have been the case that the immediate reinforcement correlated with picking the correct disc in a set of three discs may not have been equally as effective in controlling behavior during instruction and fading. Because the correct discs were clearly displaced during these sessions, there was zero chance of emitting a wrong response to the stimuli. Consequently subjects responded quickly and perhaps solely on the basis of the fading cues until the last step of fading when the critical criterion-dimension, position, was the only one available. Thus behavior never shifted from
stimulus control by the displacement prompt to stimulus control by position.

Malott (Note 1, p. 57) suggested that "a major cause for lack of rule-governed behavior seems to be the failure to state the rule", and indicated that this could occur for two reasons: "a) The person might not know the rule. b) The rule statement might not be under the control of relevant cues." It is not clear why stating the rule controlling the sequence in this study should produce poor transfer. The fact that the array of discs constituted a natural set of stimuli established as cues for rule-stating and the fact that rule-stating was required in an actual problem solving situation seems to predict that statement of rules would facilitate reacquisition.

One possible reason that rule-stating had a poor transfer effect may be that subjects did not have enough practice with specific disc positions and their names before the rule-stating requirement was imposed. Consequently, rather than being a relevant cue, rule-stating was a new task superimposed on the initial discrimination task. However, this may not be a tenable argument since in Peterson's study numeric labels were attached to the button positions to ensure that subjects verbalized in numbers only: Yet they failed to benefit from the similarity between instructed learning and relearning sessions.

There are also some general problems that may have contributed to the inconsistent results obtained in these experiments. First, the duration of the study seemed too long. Although the sessions were short, most of the subjects were weary toward the end of the study as indicated by the informal observations in Appendix A.
For instance, subjects expressed boredom and engaged in inappropriate behaviors to speed up the rate at which the experiments were conducted. Some subjects incorrectly named one disc but picked the correct one. Second, the daily scheduling of run times was difficult. Flexibility was necessary so as to avoid too much disruption of the subject's home and school activities. Finally, there were inconsistencies such as unprogrammed social reinforcement and punishment differentially presented or withheld during sessions across subjects.

There are several ways by which the present study can be improved or extended. For instance, it would be interesting to replicate the study with electro-mechanical programming. It is possible that involving subjects in more verbal behavior during the initial fading steps may yield a different result. For example, subjects might verbalize the position of the discs as they are picked. There could also be modifications designed to scale the amount of monetary reinforcement on the basis of error rates. For example if (a) performance in IRAQ was errorless, subject was paid twenty-five cents; (b) if errors occurred only in the first trials, subjects received fifteen cents; and (c) if three or less errors were made after the first trial subjects got ten cents. Such a reinforcement scaling may induce subjects to attend to sequence in the morning sessions. Also the manipulations of the stimulus cues during fading can be made to be related to the final criterion discrimination. For instance the correct discs could be kept at normal positions while displacing the incorrect discs. Also of special interest to education would be the relationship between shaped responding and rule statements that
describe the contingencies operative in the educational environment. Such investigations may yield new information regarding the extent to which education should address the issue of shaped and instructed learning.
Informal Observations

During the course of these experiments some consistent individual response patterns emerged. Although these response patterns may be interesting, they had no measured effects on the results of the present study. The reason for their inclusion is, therefore, merely heuristic.

S-101 (Age 10)

This subject worked fast with a high guessing rate during the first sequence trials. Most of the subject's errors were clustered around the first and second trials. Subject was able to figure out early in Experiment II that the afternoon sequence was identical to the morning sequence. Subject expressed boredom with the "game" and attempted to speed things up by moving the bar and/or flipping the chart counter. Occasionally subject incorrectly named one disc while picking the correct one.

S-102 (Age 8)

Subject worked at a moderate rate and made many initial errors. At times subject showed resistance to doing the tasks and needed to be reminded to sit up and do what he was supposed to do. He repeatedly tried to move the bar. On two occasions subject named one disc and picked another.
S-103 (Age 6)

Subject worked methodically at a moderate rate. Although subject made many abortive responses, accuracy rate was not reduced. Subject seemed to enjoy the game and smiled often, particularly when responses were correct. Subject was verbal during sessions - muttering some numbers that did not seem to correspond with disc positions and also naming the star colors of the correctly picked discs. Subject encountered most difficulty in Experiment III with verbalization (did not seem sure what to call the disc positions) and seemed to be distracted when asked to verbalize the sequence under cover. Subject enjoyed playing alone after sessions.

S-201 (Age 7)

Subject responded at a rapid rate and made many errors as a result of fast work. Subject also knocked discs around. Subject seemed impatient during sessions, moved the bar and turned the flip chart without being asked to do so. Time-out screen seemed to irritate this subject and repeatedly he asked that the array remain uncovered. Though loss of points was aversive, there were signs that the game was interesting to the subject.

S-202 (Age 7)

This subject had lots of difficulty picking, turning, and replacing the discs and made lots of random responding. Repetitious errors occurred at a substantially high rate coupled with nervous movements and rather impulsive responding. Subject tried to respond rapidly and made lots of errors. The time-out screen was particularly
aversive to this subject. Subject had problems with position terms during verbalization and sometimes mixed up position terms, eg. second, middle; third, last one. He named one chip and picked another a number of times. He enjoyed playing with toys and other children after sessions.
### Sequential Dependencies: Error Rates and Number of Trials in Experiment I for Each Subject

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