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THE REPEATED ACQUISITION PROCEDURE AS A MEANS OF ANALYZING RULE-GOVERNED BEHAVIOR

by

Margaret E. Peterson

A Dissertation Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Doctor of Philosophy Department of Psychology

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Margaret E. Peterson
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CHAPTER I

INTRODUCTION

A most important aspect of the experimental analysis of behavior is its potential for explaining human behavior. Research may be conducted to test new methods, to satisfy curiosity, or to explore the conditions under which a phenomenon occurs (Sidman, 1960), but one of the ultimate goals is the extrapolation of principles of behavior derived from the animal laboratory to human performance. As Skinner stated in 1938, however, "Whether or not extrapolation is justified cannot at present be decided. It is possible that there are properties of human behavior which will require a different kind of treatment" (p. 441).

In a recent article, Lowe (1978) points out some properties of human behavior and of experimentation in general that have caused doubts about the applicability to humans of the principles of behavior formulated in the animal laboratory. Even the value of human operant research is being questioned. The problem is that the results with humans often differ considerably from those seen in methodologically similar infrahuman studies. The most thoroughly examined line of human operant research which exemplifies this problem has involved simple schedules of reinforcement. In terms of response patterns and relations between responding and schedule value, human performance has shown little similarity to that observed with infrahuman subjects (Harzem and Miles, 1978; Wiener, 1969;1970). In contrast,
characteristic patterns of responding seen under different schedules of reinforcement with lower animals are observed with humans in studies involving more complex response requirements - elaborate intelligence panels (binary vs. digital clocks), an observing response option, or procedures in some way varying from the typical lever press for reinforcement (Lowe, Harzem and Bagshaw, 1978; Laties and Weiss, 1963; Holland, 1958; Azrin, 1958). The discrepancies between these two lines of research have led to the investigation of the following possible explanatory variables: response effort or cost, conditioning history, experimenter instructions and self-instruction.¹

The rationale for examining effort and response cost procedures stems from the notion that animals pressing levers must exert far more energy per body weight than human subjects pressing levers. Thus, studies have been conducted where the response force requirement was increased to be more commensurate with the force requirement for infrahuman subjects (Leander, Lippman and Meyer, 1968; Azrin, 1958). Human subjects have also been "charged" points or money for each response as another way of increasing the "cost" of the lever pressing behavior (Wiener, 1969). These procedures have sometimes increased human sensitivity to the reinforcement schedule, but the results have varied considerably from study to study and also between subjects within the same study.

With respect to conditioning history, Wiener (1969) found that "high-rate FI (fixed-interval schedule of reinforcement) performance

¹ See Lowe (1978) for a detailed analysis of these variables.
were obtained consistently from subjects given an FR (fixed-ratio schedule of reinforcement) history. Low-rate FI performances were obtained from subjects given a DRL (differential reinforcement of low rate) or both DRL and FR histories. . .." (p. 369). This suggests that exposure to a particular schedule affects subsequent human performance on other schedules. However, infrahuman subjects come under the control of different schedules of reinforcement despite previous histories. Thus, Wiener's study points out the importance of conditioning histories with human subjects, but does not explain why this factor is of such importance.

The third variable, verbal instructions given to subjects by the experimenter is an important feature of human operant research, and does methodologically distinguish research with humans from research conducted with lower animals. In a recent study, Matthews, Shimoff, Catania and Sagvolden (1977) found appropriate sensitivity to schedules with humans when responding was established through shaping, rather than through verbal instruction. The experimenters conclude that although insensitivity to schedules is not an inevitable consequence of instruction, "subtle and unrecognized aspects of instructional control may be involved in human performance whenever instructions of any kind are given. .." (p. 465). Other researchers have come to similar conclusions. For example, Lowe (1978), in summarizing the research in this area, states: "...given that instructions provided to experimental subjects greatly affected schedule performance, it may appear that the only way to avoid the confounding effects of verbal factors in human operant behavior is to minimize instructions"
(p. 17).

A reasonable argument then can be made for the use of shaping procedures rather than instructions in human research aimed at reproducing the results obtained from infrahuman studies. But, this eliminates only one type of instructional effect. An additional type is not as easily controlled: what the human subjects say to themselves during the course of experimentation and how this comes to control subsequent nonverbal behavior. This final variable, self-instruction, has been studied little, either because of its often (but not always) private nature or because of the general difficulties that arise in studying such topographically unique behavior. It has not been completely overlooked, however. In a few studies, once data collection had been completed, subjects were asked to give their version of the programmed contingencies comprising the experiments (Lippman and Meyer, 1967; Leander, Lippman and Meyer, 1968). It was found that a high correlation existed between subjects' verbalizations and their performance (regardless of the accuracy of their report of the contingencies). For example, if a subject's verbal report emphasized number of responses necessary for reinforcement,

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2Investigating verbal behavior, and particularly self-instruction, may well be the main rationale for human schedule research. Basic research which does not deal directly with verbal behavior seems best carried out in controlled settings with nonverbal subjects having controlled histories. Many would argue that there is already ample support for the notion that principles of behavior derived from animal studies are applicable to human behavior. In experimentally studying verbal behavior, however, it seems necessary that researchers use human subjects.
the subject's response pattern was at a high rate, characteristic of an FR performance. On the other hand, if the verbal report emphasized a temporal relation, the response pattern was a low rate.

A recent study by Galizio (1979) marks the first attempt to experimentally examine the role of self-instruction on performance under certain schedules of reinforcement. Once schedule control was obtained with certain instructional stimuli which were differentially associated with specific experimental contingencies, inaccurate instructions were given to the subjects. When the inaccurate instructions did not cause any change in the consequences of the performance, that is, did not lead to any increased monetary loss, subjects continued to follow the instructions. When the inappropriate responding resulted in monetary loss, the inaccurate instructions lost their control and the performance came under the control of the actual contingencies. This suggests that subjects derived their own rules about the contingencies operating and responded accordingly, despite information to the contrary in the form of "instructions". However, it is difficult to determine whether the subjects' verbal reports of the programmed contingencies were the result of being affected by these contingencies, or whether the verbal report actually brought behavior under the control of the contingencies. The complex nature of self-instruction, exemplified by this study, and the paucity of experimentation in the area would seem to warrant a further analysis of self-instruction as well as additional research.

Self-instruction can be seen to be a special case of what Skinner
(1969) has referred to as "rule-governed behavior" (p. 146ff). People learn to be affected by a description of a contingency somewhat as they would be affected by the contingency itself. Skinner (1969) has referred to such a description as a "rule", or more technically as a "contingency specifying discriminative stimulus" (p. 149). A child is taught to react to such rules by adults in the verbal community, and is also taught to describe contingencies for the benefit of others. Self-instruction results when the person describes some contingencies and then reacts to this description as though it had been provided by someone else. In comparing rule-governed behavior and contingency-shaped behavior, Skinner (1974) identifies three features of rules that make such rule-governed behavior an especially valuable human accomplishment: (a) "rules can usually be learned more quickly than the behavior shaped by the contingencies they describe"; (b) "rules make it easier to profit from similarities between contingencies..."; and (c) "rules are particularly valuable when contingencies are complex or unclear or for any other reason not very effective" (p. 125).

To summarize, this analysis implies that what individuals say to themselves can act as effective discriminative stimuli for some further behavior, and such control can often be beneficial because it can rapidly evoke appropriate behavior.

To further study self-instruction, it would be desirable to find a situation where novel units of behavior are emitted frequently so that their acquisition can be studied. Furthermore, the novel behavior should be sufficiently complex that the effects of direct contingency
shaping can be isolated from the effects of rule stating (self-instruction). Finally, it would be methodologically desirable if such acquisition could be studied with single subjects rather than by group comparisons.

The only currently available strategy which meets these three criteria is the repeated acquisition procedure first described by Boren and Devine (1968). In essence, they refined the learning-set formation procedure, initially studied by Harlow (1949), by requiring the subject to learn a new multi-response chain each session. These response chains were similar to one another, and eventually the subject reached a steady state of relearning. For example, Boren and Devine found that "the pattern of learning and number of errors reached a steady state from session to session" (p. 652). This steady state of relearning then can serve as a baseline by which the effects of manipulating some independent variable may be evaluated. Over the past decade, the repeated acquisition procedure has been used to study a variety of phenomena, such as the effects of differential pretraining (Behar, 1974), conditioned reinforcement (Hursh, 1977), conditional discrimination (Moerschbaecher, 1978), and the effects of various drugs or toxic agents (Thompson, 1975; 1971; 1970).

Not only was the general procedure developed by Boren and Devine of value here, but one of their specific experiments was quite

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3See Boren and Devine (1968) for a detailed analysis of the repeated acquisition procedure and its many advantages over the traditional method of studying learning.
relevant to the topic of instruction and served as a starting point for the present research. In that experiment, using monkeys as subjects, they studied the effect of what they called an instruction stimulus (a light over the correct lever) on the error rate made in learning four-response chains. They considered the procedure "analogous to instructing a human subject, step by step, exactly what to do" (p. 657). However, two of the subjects were not controlled by the light at all, and the one who was, took just as long to learn the four-response sequence when the light was removed as it had when no light was available, in this sense not profiting from the instruction.

In considering the relevance of these results to human behavior, it is clear that human adults would be affected by such instruction.

There are many situations analogous to the experiment where such instructions do alter a person's future behavior. It is also reasonable to suppose that nonverbal humans would not do much better than monkeys (given the specific experimental arrangement used by Boren and Devine). The interesting human subject, however, is the young child, more specifically the preschool child with only the beginnings of the adult verbal repertoire. Would such children behave like monkeys, like the human adult, or would they show some intermediate performance, and if so, of what would it consist? The rationale of Experiment I, in the present study, was to answer these questions.

If the children did not profit from the instructional stimulus, could they be taught to do so by encouraging them to describe the
existing contingencies and in this sense generate self-instructional behavior? This was the question investigated in Experiment II.
CHAPTER II

METHOD

Subjects

Five children (two females and three males) served as subjects for Experiments I and II (see Figures 1, 2, 3 and 4 for specific ages of these subjects). They were selected from the population at the Child Development Center (CDC), a pre-school under the direction of the Department of Psychology, Western Michigan University (WMU), Kalamazoo, Michigan. A letter was sent to the parents of children who attended CDC five days a week, requesting permission to use their child in the study. Those children whose parents responded in the affirmative and signed a consent form were used. All subjects showed normal physical and academic development. The study was approved by the Human Subjects Review Committee at WMU and the Director of the Child Development Center prior to the investigation.

In addition to these five subjects, at the end of Experiment I, three staff members at the Center (ranging in age from 19 to 21) volunteered to participate in the study for the purpose of collecting comparative data on performance during the four phases of the procedure. These subjects were exposed to each phase only once.

Apparatus

An intelligence panel was constructed from plywood which
Figure 1. The total number of errors per session for Subject 1 (age 3 years, 4 months) are located on the ordinate and sessions along the abcissa. The upper left section of the figure represents the data for the Control Learning Phase (C/L); the upper right section of the figure represents the data for the Control Relearning Phase (C/R); the lower section of the figure represents the data for the Instruction Learning Phase (I/L); and the lower right section of the figure represents the data for the Instruction Relearning Phase (I/R). The first session in C/L and in C/R involved the same four-response sequence; likewise, the second session in C/L and C/R, etc. Similarly, the first session in I/L and in I/R involved the same four-response sequence, the second session in I/L and I/R, etc. Bars to the left of the dotted line represent the data from Experiment I, with bars to the right, Experiment II. The bars that are filled in reflect the data that were collected after numbers (either 1, 2, or 3) were placed on the intelligence panel directly under each button.
Figure 2. The total number of errors per session for Subject 2 (age 4 years, 8 months) are located on the ordinate and sessions along the abscissa. The upper left section of the figure represents the data for the Control Learning Phase (C/L); the upper right section of the figure represents the data for the Control Relearning Phase (C/R); the lower section of the figure represents the data for the Instruction Learning Phase (I/L); and the lower right section of the figure represents the data for the Instruction Relearning Phase (I/R). The first session in C/L and in C/R involved the same four-response sequence; likewise, the second session in C/L and C/R, etc. Similarly, the first session in I/L and in I/R involved the same four-response sequence, the second session in I/L and I/R, etc. Bars to the left of the dotted line represent the data from Experiment I, with bars to the right, Experiment II. The bars that are filled in reflect the data that were collected after numbers (either 1, 2, or 3) were placed on the intelligence panel directly under each button.
Figure 3. The total number of errors per session for Subject 3 (age 5 years, 5 months) are located on the ordinate and sessions along the abscissa. The upper left section of the figure represents the data for the Control Learning Phase (C/L); the upper right section of the figure represents the data for the Control Relearning Phase (C/R); the lower section of the figure represents the data for the Instruction Learning Phase (I/L); and the lower right section of the figure represents the data for the Instruction Relearning Phase (I/R). The first session in C/L and in C/R involved the same four-response sequence; likewise, the second session in C/L and C/R, etc. Similarly, the first session in I/L and in I/R involved the same four-response sequence, the second session in I/L and I/R, etc. Bars to the left of the dotted line represent the data from Experiment I, with bars to the right, Experiment II. The bars that are filled in reflect the data that were collected after numbers (either 1, 2, or 3) were placed on the intelligence panel directly under each button. In addition, arrows located on the I/L and I/R graphs indicate when the subject began to verbalize to the experimenter, during the I/L Phase, the acting contingencies.
Figure 4. The total number of errors per session for Subject 4 (age 5 years, 10 months) are located on the ordinate and sessions along the abcissa. The upper left section of the figure represents the data for the Control Learning Phase (C/L); the upper right section of the figure represents the data for the Control Relearning Phase (C/R); the lower section of the figure represents the data for the Instruction Learning Phase (I/L); and the lower right section of the figure represents the data for the Instruction Relearning Phase (I/R). The first session in C/L and C/R involved the same four-response sequence; likewise, the second session in C/L and C/R, etc. Similarly, the first session in I/L and in I/R involved the same four-response sequence, the second session in I/L and I/R, etc. Bars to the left of the dotted line represent the data from Experiment I, with bars to the right, Experiment II. The bars that are filled in reflect the data that were collected after numbers (either 1, 2, or 3) were placed on the intelligence panel directly under each button. In addition, arrows located on the I/L and I/R graphs indicate when the subject began to verbalize to the experimenter, during the I/L phase, the acting contingencies.
measured approximately 18 inches vertically and 24 inches horizontally. The panel contained twelve push-buttons and twelve lights mounted in a line across the panel (see Diagram 1). They were arranged in four groups of three lights and three push-buttons. The lights were approximately two inches above each button. When a button was pressed, a relay mounted behind the panel clicked. In addition, a tone lasting 2 seconds was used to provide feedback for correct responses. Incorrect responses activated a 2-second buzzer and led to a 2-second timeout period, during which all pilot lights were turned off. Any responding during this period reset the 2-second timer. A point counter was mounted and centered at the top of the intelligence panel. Responses on all buttons, correct and incorrect, were recorded separately on a 15-pen event recorder. Relays, timers, counters, and other electromagnetic equipment, located in an adjacent room, were used to control the experiment automatically.

The study was conducted in a large conference room with a partition separating the experimental area from the rest of the room. Each child sat directly in front of the intelligence panel during each session. Sessions lasted approximately 15 minutes and were run twice a day for each child – one session in the early morning, and one session immediately following lunch.

Preliminary training and general procedure

Given the results of the Matthews et al. (1977) study – which showed that responding by subjects on a FI schedule, who had not been given any instructions by the experimenter, generated patterns of
Diagram 1. Intelligence Panel. (See Method for a detailed description of the apparatus.)
behavior similar to those observed with lower animals - it was decided that preliminary training for two subjects would not include instructions but rather a shaping procedure involving backward chaining. The other three subjects were given instructions. In this way a comparison could be made to determine whether instructions substantially altered the number of errors to acquisition.

Training, then, for these two subjects consisted of the following six steps:

1) Points were given for pressing any of the 12 push-buttons.
2) Next, any response on Buttons 10, 11 or 12 (the last group of three buttons) when the pilot lights above these buttons were on, resulted in a tone and a point on the counter. Incorrect responses had no consequence. 3) Reinforcement was contingent upon a chain of two responses. When the lights were on over Buttons 7, 8 and 9, a response on any one of these results in the lights going off, a 2-second tone, and the next set of three lights over Buttons 10, 11 and 12 going on. Any response on one of these buttons resulted in these lights going off, a 2-second tone and a point on the counter. In this same way, the chain was gradually extended to include all four groups of push-buttons. 4) Whenever a child pressed a button not associated with the three lighted lights, a buzzer sounded and a 2-second timeout was instituted. Once over, the lights above the group of buttons where the error had occurred were again lighted. 5) Only responses on predetermined specified buttons from each set of four groups were reinforced, with all other responses ending in a buzzer and timeout period.
Prior to Step 5, the criterion for moving through the phases of preliminary training was met when the subjects were able to perform the specified task ten consecutive times without making any errors. The criterion was met by both subjects, for each step, within one session. Step 5 was maintained for three sessions with the sessions terminating each day when the subjects could emit the four-response sequence correctly, five trials in succession. This criterion remained in effect for the entire study for all subjects— instructed and uninstructed.

Step 6 involved changing the sequence of correct buttons each session. For example, the first day of Step 6 consisted of the following sequence: $2,1,3,1$. The next day the sequence $1,3,1,2$ was in effect. Thus, the subjects were required, each session, to learn the new four-button sequence making up the reinforced chain. Care was taken by the experimenter so that the correct button sequence in one session was not repeated in the following session. Similarly, the location of correct buttons (i.e., left, middle, right) was monitored so that, within any one programmed sequence, no simple ordering occurred (e.g., the first button in each group). Step 6 ran for four consecutive sessions. Experiment I was then initiated for these two subjects. (The data for Subject 3 are represented in Figure 3 from this point; the data for Subject 5, however, are not included here because this subject, prior to Experiment II, ceased making errors. This issue will be covered in more detail in the Results section.)

The only verbal instructions given these two subjects occurred on the first day of preliminary training. They involved an explanation...
of points on the counter and how these points could be exchanged for a small toy that they would choose at the beginning of each session. Thus, each subject, prior to sitting at the experimental table, chose a small toy from the "reinforcement box". The toy was then set along-side the experimental table so that the subjects could view it during the session. There were no further instructions provided by the investigator. In contrast, the remaining three subjects were instructed without benefit of a shaping procedure. The following instructions were read to each subject on his/her first training session:

See this? (Experimenter points to panel.) There are 12 lights across the board and there are 12 push-buttons directly under these lights. Directly ahead of you is a counter which will show the number of points you have earned. (Experimenter points to counter.) By pressing certain buttons, you will earn points on this counter. (Experimenter presses button which leads to a point on the counter.) These points can be turned in at the end of the session for the small toy you have chosen from the "reinforcement box". (The toy was placed along-side the panel so that each subject could easily view his/her toy.) Sometimes you will hear a nice sound for pressing, but, other times you will hear a loud buzzer telling you that you have pushed the wrong button. (Experimenter pushes button which Activates the buzzer.) You must figure out which buttons will lead to a point on the counter. Now, I am going to leave you here while you work with the buttons. After you have earned 5 points, I will turn off the lights on the board and come and get you. While the lights are on, you should remain in your seat. You may push only one button at a time. Do not begin pushing buttons until the panel lights come on.

After each subject was exposed to four sessions, he/she was informed that the session would end from that point on "after he/she had completed five trials successfully without any buzzers." In no other way were the instructed subjects treated differently than the shaped
subjects. The conditions for all remaining sessions for these subjects were identical to those for the subjects who were not provided such instructions. The four training sessions consisted of a new sequence of correct responses for each session – identical to Step 6 for the subjects who had been shaped. At this point, Experiment I began involving two sessions per day for all five subjects.

Experiment I

This study was designed to replicate Boren's experiment (1968) which examined the role of instruction stimuli in facilitating the acquisition of a behavioral chain. The procedure for Experiment I consisted of blocks of four phases: Control Learning (C/L) – morning session, Control Relearning (C/R) – afternoon session, and two sessions the following day, Instruction Learning (I/L) – morning session, and Instruction Relearning (I/R) – afternoon session. These phases were repeated in the same order throughout Experiments I and II.

At the start of the first session (C/L), the first three pilot lights were lighted above the first bank of 3 buttons. A correct response led to a 2-second tone, the lights in the first group going off, and the lights in the next bank of three going on; and so on until the chain was completed. Errors had the same outcome as mentioned in Step 4 of the shaping procedure. The Control Learning Phase always consisted of a new sequence of correct responses and was terminated after each subject completed 5 trials consecutively with no errors.

The afternoon session, the Control Relearning Phase, consisted
of the same sequence of correct responses. The overall procedure was identical to the Control Learning Phase.

The performance of the subjects during the control phases was contrasted with the performance during the instruction phases. The third phase, Instruction Learning (I/L), consisted of a new sequence of correct responses which included the use of instruction stimuli. During this phase, a single pilot light (an instruction stimulus) was turned on over the correct button in the first bank. When the child pressed the correct button, this light went off and the next light, located directly above the correct button in the second bank, was turned on, and so on until the entire response sequence had been emitted and a point was earned. This procedure continued throughout the session until each subject earned as many points as he/she had during C/L. (E.g., if a subject required 15 trials during C/L to meet criterion, this subject was then required to go through 15 trials during I/L.)

The final phase of the procedure, the Instruction Relearning Phase, consisted of the same programmed sequence from I/L, but without the benefit of instruction stimuli. That is, all three lights were turned on over the first group of three buttons, etc. This phase was identical to the control phases with the exception of the programmed sequence of correct responses.

Thus, two paired sessions were allotted for the acquisition of each new response sequence, the learning and relearning phases. Only one session, however, per block of four was instructed: the Instruction Learning session. A pair of sessions, then, one of
which used instructional stimuli, was alternated with a pair of sessions using the non-instructed control procedure.

At the end of Experiment I, each subject was asked by the experimenter: "What did you have to do today to earn a point on the counter?" In addition, they were asked, "Do the morning and afternoon sessions have anything in common - are they alike in any way?"

Prior to the start of Experiment II, three adult subjects were run through the procedure of Experiment I. These subjects were exposed to all four phases only once. The data collected from these sessions are discussed in the Results section. The rationale for the use of these additional subjects was to determine any possible variations in data due to more extensive histories in developing strategies (self-instruction) which might facilitate learning the correct sequence of responses in the study.

Experiment II

Although the subjects within each session ultimately learned the chain of responses with minimal errors, their behavior appeared not to be under the control of any self-verbal stimuli, rather they appeared to have "learned how to learn" through direct contingency shaping. That is, at the end of Experiment I, no subject could verbalize any rule which specified the experimental contingencies: they could not verbalize what behavior they had to engage in to obtained reinforcement. Thus, Experiment II was designed to examine more closely the acquisition of rule-governed behavior and how it may
facilitate this type of learning. If each subject was taught to verbalize the experimental contingencies in effect, could he/she then benefit from this "information" immediately (the Control Learning Phase) and/or at some later time (the Control Relearning Phase)? If so, the long shaping process observed in Experiment I should be by-passed with the ultimate effect being a decrease in error rate.

The procedure of Experiment I was again used with one slight modification in the Control Learning Phase. During this phase, each child was asked to 1) specify which button he/she was going to press (1, 2, or 3); 2) whether it had been the correct button; and 3) at the end of the session, which buttons were the correct ones for reinforcement. The instructions provided the subjects during the first Control Learning Phase consisted of the following:

Today, I want you to tell me which button you are going to press right before you do. Then, I want you to tell me whether you were right or wrong on your choice.

At this point, the experimenter sat along side each child during all subsequent sessions, although he/she was required to verbalize only during C/L. At the beginning of each C/L session, the experimenter asked each subject: "Which button are you going to press - button 1, 2, or 3?" After the subject pressed that button, he/she was asked, "Was that button correct?" If the button was correct, the experimenter asked: "Now, which is the correct button here?" If the button was incorrect, the experimenter asked: "Now, which button are you going to try?"

A multiple baseline, across subjects was used. That is, each subject began Experiment II on a different calendar day. The
dependent variable again was number of errors per session.

To ensure verbalizing by number (1, 2, or 3) on the part of the subjects, rather than by some other method (e.g., left, middle, or right), 2 inch by 2 inch cards were placed under each of the twelve buttons with the numbers 1, 2, or 3 on them (see Diagram 1). To avoid confounding the results of Experiment II with this additional variable, the cards were glued to the board prior to Experiment II for three of the five subjects. Each graph representing the data for the different subjects indicates this alteration by a change in the color of the bars, a switch from white to black.
CHAPTER III

RESULTS

Individual data for the first four subjects are presented in Figures 1, 2, 3 and 4, respectively. The data for Subject 5 will be discussed later. Experiment I investigated the effects of an instruction stimulus on learning and relearning a specific four-link chain. Data from Experiment 1 are represented on each graph to the left of the dotted lines. Although each subject differed with respect to the total number of errors to acquisition during the Control Learning Phase (C/L), all subjects showed a decrease in the number of errors during the Control Relearning Phase (C/R). This can be seen by comparing the first bar in the C/L quadrant with the first bar in the C/R quadrant; the second bar in the C/L quadrant with the second bar in the C/R quadrant, etc.¹

Providing an instruction stimulus during the Instruction Learning Phase (I/L) resulted in virtually errorless performances on the part of all subjects during this phase. In contrast, when the "instruction" stimulus was no longer presented, the Instruction Relearning Phase (I/R), subjects again made errors. Subject 2 made

¹The C/L data does not include the number of errors made during the first trial, since the number of errors during this trial are not a function of skill. In all other phases it would have been possible to have a perfect performance if past performance or current stimuli were in control of the behavior.
as many errors during I/L as she did during C/L; that is, it was as if she was if she was learning the sequence for the first time. Subject 3 had more errors in I/R than in C/R, but slightly less than in C/L. Subjects 1 and 4 made approximately the same number of errors in I/R as they did in C/R. The instruction stimulus did not improve the rate of acquisition for any subject during the relearning phase - the subjects did not benefit from the instructions. Thus, the results of Experiment 1 are quite similar to those reported by Borne and Devine (1968) using monkeys as subjects.

Experiment II - depicted to the right of the dotted lines - was an attempt to investigate the effects of describing (verbalizing) the contingencies on learning and relearning a four-link chain. Each subject was asked, during the C/L phase only, what button they were going to press as they moved through the chain. In addition, after they had completed the session, they were asked: "What buttons did you press to get points on the counter?" The effects of verbalizing during C/L on error rate, in this phase, is clear: Subjects 1 and 3 showed a marked decrease in the number of errors during C/L as contrasted with data from C/L in Experiment I; Subject 2, by the fourth session made no additional errors in C/L; only Subject 4 seemed unaffected by the procedure during C/L. The most interesting result, however, was the immediate cessation of errors during the C/R for all subjects - once subjects began verbalizing in C/L, no errors occurred during C/R. Of additional interest is the fact that errors continued to occur at the same rate during I/R. That is, there was no tendency to engage in similar behavior (rule-stating and later
rule-following) during I/L or I/R, respectively.

To determine whether similar behaviors (i.e., verbalizing the contingencies) could be taught during I/L and later evoked during I/R, and thus, eliminate all errors during I/R, Subjects 3 and 4 were asked to tell the experimenter what buttons they were going to push during I/L (arrows in Figures 3 and 4 indicate when subjects began this procedure). In spite of this additional training, neither subject showed any decrease in error rate during I/R. To examine more closely what might be working against rule-stating and/or rule-following during I/R, the experimenter, prior to beginning the afternoon session (the I/R Phase), asked all four subjects (including the two without specific training during I/L) what they anticipated the sequence would be for that afternoon. When there were no stimulus lights on, none of the subjects could give the correct sequence—each subject provided a sequence which was incorrect. When all three lights were turned on above the first bank of three buttons, and the subjects were again asked what they thought the correct sequence might be, each subject made an attempt but none gave the correct sequence. Finally, when the instruction stimulus was turned on over the correct button in the first bank, subjects were again asked the same question. Under these conditions, three of the subjects (Subjects 2, 3, and 4) were able to verbalize the last three correct buttons in the sequence. Subject 1 could not emit the correct sequence even when given the prompt of the instruction stimulus for the first response in the chain. It should be noted that the stimulus conditions here were identical to those of the morning session (I/L).
Finally, three students from WMU, working at CDC agreed to participate in the experiment. These students were exposed to each phase once. Although no information was given to them about the experimental contingencies for either the control phases or the instruction phases, the subjects made no errors. At the end of the fourth session (I/R) each subject was asked what they had to do to obtain points on the counter. Each subject was able to verbalize the contingencies for the control phases and instruction phases.

As previously mentioned, the data for Subject 5 (age 4 years, 9 months) are not presented. This subject, approximately five days prior to Experiment II, showed errorless performance during all four phases. After two successive days with no errors, the subject was asked by the experimenter, "What did you do today to obtain points on the counter?" He was able to verbalize the correct sequence by reporting the location of the correct buttons (e.g., "left, then middle, then left again, and then right.") When asked if the afternoon session was like the morning session, he reported "yes" in that he "had to press the same buttons both times." The subject was run through two more sessions (C/L and C/R) and again he was able to verbalize the contingencies at the end of the session. Since he was able to accomplish the goal of Experiment II before it was implemented, he was dropped as a subject.

It is important to point out, however, that Subject 5's steady state of relearning curve was similar to that of Subject 4, in number of errors to acquisition in all four phases, as well as in the number of sessions it took to reach a steady state of relearning. This is
interesting in that Subject 4 was instructed whereas Subject 5 was not. It appears from these data, instructing subjects had no adverse effect on subsequent acquisition rate. Subject 3, however, being the other subject who went through the shaping procedure, did show a higher number of errors in the initial phases of Experiment I than did the other subjects, instructed or uninstructed. It is hard to assess at this time, however, whether these results merely pointed out individual differences, or in fact speak to the issue of shaping vs. instruction.

A cursory analysis of errors within session, for each of the individual subjects, showed two consistent findings. First, as with most serial learning tasks, subjects mastered the first and last components of the chain before mastering the middle components. Second, and perhaps most important, the errors made during I/R, in the early part of Experiment I, often consisted of responses that were correct for the preceding control phase. However, as the experiment progressed, these types of errors decreased considerably.
CHAPTER IV

DISCUSSION

Experiments I and II demonstrated the use of the repeated acquisition procedure for examining the possible effects of self-instruction superimposed on behavior undergoing contingency shaping, while maintaining the single-subject format. In studying the acquisition of behavioral chains with this procedure, a steady state of relearning was obtained so that the effects of self-instruction on behavior could be isolated from the effects of direct contingency shaping.

Specifically, Experiment I was conducted to see how preschool children would perform in the instruction stimulus procedure of Boren and Devine (1968). As the present study reported, adults clearly benefited from the I/L instruction stimulus but four of the five children did not. It is interesting to speculate about the causes of this difference. The critical difference may have been the tendency of the adults to consider the I/R response sequence to be the same as the preceding I/L sequence, on the basis of this relation having prevailed in the C/L - C/R sequence the day before. The abstraction, based on similar sequential relations, for the adults, overshadowed any tendency to react to the I/L and I/R tasks as different because of the obvious stimulus differences (one light vs. three). The children, on the other hand, were more strongly affected by these stimulus differences. It is reasonable to suppose that adults often have an extensive history regarding the importance of sequence as a
discriminative stimulus, but the preschool children are just beginning to make contact with this type of abstract relation. It is quite possible that had the children been told of the similarity between the morning and afternoon sessions, their performance would have improved greatly. In retrospect, it would have been interesting to test this notion at the end of Experiment II, but unfortunately it did not occur to the experimenter until after the study had been completed.

The results obtained from Experiment I may also be relevant to a distinction that Skinner (1974) made between directions and instructions.

Directions do not impart knowledge or convey information: they describe behavior to be executed and state or imply consequences. Instructions are designed to make further direction unnecessary. A person learning to drive a car responds to the verbal behavior of the person sitting beside him; he starts, stops, shifts, signals, and so on when told to do so. These verbal stimuli may at first be directions, but they become instruction if verbal help is given only as needed (pp. 120-121).

The instruction stimuli provided in Experiment I can best be described as directions, in that subjects did not show lasting effects as a function of contact with them.

Since the subjects in Experiment I were unable to profit from the instruction stimuli, Experiment II was designed to teach these same children to describe the existing contingencies and thus generate self-instructions which might improve acquisition rate. The results support the notion that self-instruction can be taught and can generate effective discriminative stimuli for subsequent nonverbal
behavior. In addition, these results, for the C/L – C/R comparison, clearly show that rules can be learned more quickly than the contingencies they describe and have the effect of evoking appropriate behavior more rapidly than the acting contingencies from which the rules were derived.

Of particular interest here, however, was the fact that subjects did not seem to profit from similarities between contingencies in the I/L – I/R comparison. That is, subjects failed to generalize the strategy (extracting rules) learned in the control phases to the instructed phase. Upon closer examination, it was found that when the stimulus conditions were identical to those conditions where the rule was initially learned, successful rule-following occurred. Only through the use of prompting could subjects emit the rule under somewhat different conditions. Adults, on the other hand, had no difficulty profiting from similarities between contingencies, in spite of these somewhat different conditions, most probably because of the sequence abstraction discussed above.

Self-instruction or rule-governed behavior is an importance dimension of all human operant research. The conditions under which humans emit rules and show control over the topography of subsequent behavior is just now being studied and analyzed. Malott (Note 1) and Michael (Note 2) have begun to classify the various types of rules and how they relate to and interact with contingencies varying in effectiveness. A complete theoretical analysis of such behavior will require much thought, observation and probably even introspection. But basic research in the area should not be delayed until such
an analysis is provided, as the practical significance of such research warrants immediate attention.

The research presented here, while only a beginning in unraveling the complexities of rule-governed behavior, suggests a number of avenues for future research. In addition to investigating all the various parameters of the present experiments, it would be useful to collect data from a larger number of subjects which encompasses a wider range of ages. Moreover, examining the conditions that lead adults to profit from similarities between contingencies needs closer scrutiny. Specifically, it would be especially fruitful to study the possible dependency of one set of self-instructions on other, more abstract self-instructions, which appeared to be the case with the adults in Experiment 1.
REFERENCE NOTES


REFERENCES


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