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ERRORLESS ESTABLISHMENT OF A RIGHT-LEFT DISCRIMINATION IN RETARDATES

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by
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THESIS

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ABSTRACT

This study was concerned with the task of determining necessary steps for establishing an errorless method of discrimination training in a right-left problem. It was designed to establish a terminal motor response of the S placing the "correct" hand on a blank stimulus board in response to an auditory stimulus of "Left" or "Right". To achieve this terminal response in a group of institutionalized retardates, stimuli of a previously learned color discrimination (pink and blue) were presented immediately following the corresponding auditory stimulus of "Left" or "Right" during each of the initial discrimination trials. To preclude or greatly diminish errors during the establishment of this discrimination, fading techniques were used to move the Ss from a discrimination controlled by visual (color) stimuli to one controlled by auditory stimuli ("Left" or "Right").

Results indicated the designed program, i.e. fading procedures, to be effective for precluding or diminishing errors to less than 10% for five of the nine Ss and for maintaining a correct response level of 70% or above for all Ss throughout procedures of fading. For three Ss who experienced difficulty, i.e. the correct response level fell below 90% at some point in fading, remedial manipulations of the visual and/or auditory stimuli were incorporated. The remedial procedures used for these Ss proved effective and the resultant data revealed possible considerations for redesigning the program.

Remedial techniques were employed if Ss did not meet the response criterion while: 1) Generalizing from one set of stimulus components (experimental) to another (testing), 2) Fading from visual to auditory stimuli, 3) Discriminating initial differences between both visual and auditory stimuli, 4) Differentiating the

motor response corresponding to the presented auditory and visual stimuli, and 5) Discriminating the reinforcing stimuli as discriminative stimuli for correct responses.

The design of the present study was one which attempted to measure behavior before learning began and after a program had been completed, in addition to demonstrating that behavior can be successful while change is being implemented. This was an analytic task set by E in attempt to establish observable functional relations between S's behavior (the dependent variable) and the program as originally designed (the independent variable). The individual analysis of behavior has as its primary concern the initiation of effective procedures. Therefore, this thesis dealt with a detailed analysis of the methodology involved in learning a right-left discrimination.

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INTRODUCTION

Purpose

Discrimination literature has produced many issues for researchers to study. One in particular, the effect of errors on an organism's discrimination acquisition, has long been debated in the fields of education and psychology. Interest in this topic has been both empirical and theoretical in nature, dividing into at least two oposing fields of thought. Supported primarily by the theory advanced by Hull, one field of thought purports the necessity of extinction trials (errors) to enable an organism to effectively form discriminations. The other, supported by Skinner's and other's views on programming techniques, considers such extinction trials unnecessary and, in fact, a detriment to the facilitation and speed of discrimination training.

Scientific investigation leading to the establishment of errorless discrimination acquisition is limited. The present study was therefore concerned with the task of determining necessary steps for establishing an errorless method of discrimination training in a left-right problem. Until such programs are evolved a comparison between errorless and trial and error methods cannot be made. Even after their establishment, comparison will be difficult, because a system for effecting a discrimination without errors eliminates the trial and error process, thus disposing of learning curves. It leaves no problem to be solved (Skinner, 1966, p. 226). For comparison of the two methods, it would therefore become necessary to design an experimental paradigm in which the same or quite similar discriminations could be acquired under the separate conditions of each.

Most experimental techniques in problem solving and discrimination have

been based on trial and error methods for reaching a desired terminal response. In such processes the correct response for each trial is the terminal response. It is either correct or incorrect with no intermediate steps introduced to facilitate the learning process. Two questions arise in evaluating such a method of learning: 1) Does trial and error experimentation actually yield information concerning how an organism learns, or does it merely indicate the effects of the one chosen experimental manipulation used in the learning process? 2) Is the trial and error method of discrimination acquisition better than other methods in terms of terminal response strength? The present study is a necessary first step to be taken before answers to these questions can be sought. With reference to the first question, this study takes its point of departure from the bias that there may be several experimental manipulations desirable for reaching a terminal discrimination with few or no errors.

The experimental method used in designing errorless discrimination programs must of necessity be based on empirical investigation. The experimenter must observe and analyze prevailing relations among the elements with which an operant discrimination is concerned: a stimulus, a response, and a reinforcing consequence. Many classical issues in human behavior have gone unresolved because one of these elements has been neglected (Skinner, 1966, p.226).

In the present study visual and auditory stimulus variables were manipulated in an attempt to design training methods which would preclude or greatly diminish incorrect responses during the establishment of a left-right discrimination in institutionalized retarded children. The primary purpose of the study was to develop behavioral (learning) control techniques through establishing programs for the Ss used, similar to each other in most aspects, but yielding to the individual learning problems of each subject.

Sidman (1960, p. 17) indicated behavioral control techniques as primary to both theory and data. The development of such techniques is, however, seldom cited as the prime goal of psychological research, though without them a science of behavior would be impossible. Barrett (1955) also pointed to the lack of laboratory investigations which systematically focus on individual patterns or steps involved in the acquisition of stimulus discrimination and response differentiation.

Review of Literature

Previous studies have pointed to two requirements for the establishment of errorless discrimination: 1) An introduction of the S^{Δ} immediately after conditioning the S^{D}, and 2) A large initial difference in the stimulus properties of the S^{D} and the S^{Δ} (Skinner, 1938, p. 203-206; Terrace, 1963a; Moore and Goldiamond, 1964). Studies of errorless transfer of discrimination have demonstrated the necessity for: 1) Introducing the terminal S^{D}s, superimposed upon the previously discriminated stimuli, during the initial phases of the discrimination transfer training, with a fading of the latter throughout the learning sequence (Terrace, 1963b; Moore and Goldiamond, 1964; Schusterman, 1965), and 2) Requiring the initial discrimination to be made between two very different stimuli with two different response topographies (Jeffery, 1958).

It has been demonstrated that the S^{Δ} (non-reinforced stimulus) must be introduced immediately after conditioning to the S^{D} (reinforced stimulus) for acquisition of errorless discrimination. Skinner (1938, p. 203-206) demonstrated that a brightness discrimination can be acquired by rats with virtually no responses to S^{Δ} if discrimination training begins immediately after conditioning of the bar-pressing response. Terrace (1963a) also found in establishing red and green light discrimi-

nation in pigeons that errors do not occur if discrimination training begins early in conditioning. In addition to this temporal aspect of errorless establishment of discrimination he further demonstrated that error rate is also dependent upon the initial difference in the stimulus properties of S^D and S^Δ. From a conditioned response to a green light, a discrimination between red and green light conditions was established by beginning with an initially large difference in the stimuli with respect to brightness, duration and wavelength, and progressively increasing the properties of the S^Δ until S^D and S^Δ were similar in all aspects other than wavelength. Moore and Goldiamond (1964) demonstrated near-errorless discrimination in preschool children utilizing Terrace's techniques with respect to brightness in a match-to-sample task. In the initial stages of discrimination formation only the correct response was lighted with the S^Δs darkened. Gradually the brightness of the S^Δs were increased until it equalled that of the S^D at which time an errorless transfer of discrimination from brightness to form had been established. Terrace (1963a) also demonstrated errorless transfer of discrimination from color to form in pigeons. Vertical and horizontal lines were superimposed upon the color stimuli, and a progressive fading of the color stimulus properties was effected while the lines remained in view. Schusterman (1965) also demonstrated errorless transfer of discrimination in a sea lion trained to respond to size cues. He reported the critical training requirements to be a combining of a previously well-established size-cue preference with a nonpreferred form-cue, and a progressive fading of the size cue.

Jeffery (1958) found difficult discriminations for preschool children can be simplified by requiring a simpler response before the terminal response was learned. The task of pointing in the same direction which a stick figure pointed was found to result in faster discrimination and less emotional behavior on a second task of

verbally labeling the figures than just the learning of the verbal label without previously establishing the simpler response differentiation. Thus results of the study indicated that the training of a prior motor response resulted in more efficient learning when a verbal label was the criterion response. Although Jeffery's study was discussed in a mediated response differentiation framework, it is equally plausable to consider his results as reflecting an effort on his part to partially "program" the learning of the essential behaviors necessary for attaining the criterion response.

The Present Study

The results of errorless discrimination and related studies have been incorporated into the present design. Differentiated motor responses, i.e. placing the "correct" color-gloved hand upon a corresponding painted hand-outline stimulus board, were required to a previously learned color discrimination (pink and blue), the latter being determined by testing prior to the experimental sessions. From the outset, the terminal auditory stimuli, "Left" or "Right", were voiced immediately preceding the presentation of the corresponding stimulus board within each of the trials. The auditory stimuli were continually voiced throughout the fading of the initially very differently colored visual stimuli until the terminal auditory discrimination had been established. The motor response was required from the first to the last, with only the S^Ds being changed throughout the fading procedure. Such fading techniques have been most successful for both infrahuman and preschool subjects and was thus the basic technique chosen for use in the present study to preclude or greatly diminish errors in the establishment of a right-left discrimination.

The design of the present study was one which attempted to measure behavior before learning began and after a program had been completed, in addition to demon-

strating that behavior can be successful while change is being implemented. This was an analytic task set by E in attempt to establish observable functional relations between S's behavior (the dependent variable) and the program as originally designed (the independent variable). The individual analysis of behavior has as its primary concern the initiation of effective procedures. Therefore, this thesis dealt with a detailed analysis of the methodology involved in learning a right-left discrimination.

Terminology

Errorless Discrimination - The acquisition of a discrimination without the occurrence of errors.

Discriminative Stimulus - A stimulus having control over a particular response. It is of note that in demonstrating the discriminative control exercised by a stimulus it is not necessary to have zero responding in the absence of that stimulus. If two distinct patterns of behavior are generated there is adequate demonstration of stimulus control (Sidman, 1960, p. 352).

S^{Δ} - Non-reinforced stimulus

S^{D} - Reinforced stimulus

Errors - Responses to S^{Δ}

Correct Responses - Responses to S^{D}

Fading - One set of conditioned stimulus properties (such as brightness) is superimposed over a set of unconditioned stimulus properties. A gradual decrease (fading) of the conditioned stimulus properties results in the presence of only the originally unconditioned stimulus properties which through the process have become conditioned. Operationally defined for this study, fading consisted of the placement of plastic sheets, two at a time, over the color-hand-outline stimulus boards. Thus a gradual "fading" of the visual stimuli took place.

Stimulus Generalization - After a particular stimulus has taken on discriminative properties through association with reinforcement, then other stimuli (even though not directly associated with the reinforcement) also take on discriminative stimulus properties, to the extent that these other stimuli are similar to the original discriminative stimulus.

Positive Reinforcement - Historically linked to Thorndike's Law of Effect, i.e. an act may be altered in its strength by its consequences, positive reinforcement refers to all those stimuli that, when presented, act to strengthen the behavior which they follow.

Extinction Trials - Non-reinforced trials; errors.

Response Topography - The physical elements or form of a response.

Response Differentiation - A response occurring in the presence of a particular stimulus may change in topography though no change in the stimulus has occurred. This change in response topography is referred to as

response differentiation. Operationally defined for this study, response differentiation referred to a change in response hands corresponding to a change in auditory stimuli, regardless of the "correctness" of the responses. An example would be observed in Ss who have complete or some response reversal in their response patterns.

Chaining - A discriminative stimulus evokes a differentiated response that in turn becomes or produces a discriminative stimulus for another differentiated response which leads, in turn, to reinforcement.

METHOD

Population

The Ss were nine girls from Parsons State Hospital and Training Center, located at Parsons, Kansas. The chronological ages of the Ss ranged from 6 to 12, with IQs ranging from 25 to 50. Requirements for including Ss in the present investigation were that they be ambulatory, show evidence of ability to respond to simple verbal commands, be without visibly gross auditory or visual impairments and be able to discriminate between pink and blue. Additional justifications for inclusion, as determined by response on the pretest, were alternation of response hands, regardless of the presented stimuli; responding with only one hand to all stimuli; response reversal; a recorded percent error between 40 and 60; or any combination of these.

Apparatus

Four white artist's canvas boards, 12" x 14", were used for the visual stimuli and were divided into two sets. Each of the stimulus boards were covered with clear heavy-duty plastic sheets to facilitate cleaning. One set of stimulus boards was blank for use in establishing a baseline, or pretest percentage, of correct responses to the auditory stimuli "Left" and "Right". The second set consisted of black (felt pen) outlines of a left hand on one board and a right hand on the other. The area within the left hand outline was painted blue and within the right, pink. Attached to the top of the reverse sides of each board were 36 plastic sheets (Baggies), arranged so they could be flipped over the top one at a time to cover the front of the board. The unattached ends of each of the plastic sheets were

lined with masking tape to facilitate handling and to provide a place on which to number the sheets for the E's use.

A pair of heavy rubber gloves was provided for the S's hands. The left glove was blue matching the paint on the left stimulus board and the right was pink, matching the right stimulus board. The paint on the stimulus boards was mixed by a paint expert to assure near perfect color matching between the gloves and the boards. Except for color, the gloves were identical to each other in all aspects.

Procedure

During all experimental sessions S was seated directly across a card table from E. Two small squares of tape were placed on the table in front of S to indicate between-trial hand placement. A two-foot square blank cardboard was in E's lap behind which was a set of stimulus boards. This cardboard was so placed to eliminate the possibility of S noting the manipulation of stimulus boards by E. On the table in front of E was a random order list for that session. These random orders were established according to listings by Gellerman (1933) and included an equal number of left and right presentations. The order was varied from session to session with each S. E randomly presented one stimulus board per trial with the left hand and small consumables for correct responses with the right. These were presented from a large container and placed into a smaller one near S which had been previously designated as belonging to S.

A pretest was run for each S to determine eligibility for the study. Prior to the pretest two demonstration trials were run. In the first, E presented one blank board and said "Left" while simultaneously placing S's left hand upon the board. The same manipulation was executed on the second demonstration trial to the audi-

tory stimulus "Right". Two blank boards were used in order to approximate as near as possible the shuffling of boards necessary in experimental trials. Instructions were given for S to replace hands on the tape squares after making a response. Following this demonstration 50 trials were run. In each trial E presented one blank board immediately following an auditory stimulus of "Left" or "Right" voiced in the random order for that session. The short delay between presentation of auditory and visual stimuli was used because it was noted in pilot studies that simultaneous presentation of the auditory and visual stimuli yielded more errors in performance than allowing a short latency between the two stimulus presentations. When the board was presented S would respond by placing a hand upon the board. If the correct hand was placed, E responded with an acknowledgment of "OK". The word "OK" was used because it was a familiar confirmation to the experimental population and the usual confirmation, "Right", was obviously inappropriate to this study. Confirmation was given in the pretest because it was necessary to use it in the posttest to avoid response extinction following experimental trials in which all correct responses were auditorally confirmed with "Good girl" and reinforced with small consumables.

In the experimental sessions auditory stimuli and stimulus boards were presented exactly as in the baseline sessions. The rubber gloves were placed upon S's hands and the boards with painted hand outlines were used. After placing the gloves on S's hands and prior to beginning the first experimental session, E presented the blue painted left hand outline and asked S, "Which hand matches this one?" The same was done for the pink right hand outline. If S correctly matched the gloved hand to the stimulus board it was assumed that S had color matching skills and could

continue the study. During the first trials of the first experimental session, E voiced "Left" or "Right" in the order determined by the random table for that session and followed this with a presentation of the corresponding stimulus board. The criterion for a recorded response was the hand S placed upon the stimulus board after presentation. For all correct responses E said "Good girl" and immediately placed a small consumable from the large container into a small one placed near S. For the first two trials S was allowed to eat the consumables immediately. Rejection of the consumables by S would have been the criterion for changing to other consumables "guessed" to be reinforcing for that S. This was, however, not necessary with the Ss used in this study. After consumption, instructions were given to save consumables in the container for later consumption. The remainder of the color matching trials, a colored gloved hand to the randomly presented colored boards, was then run.

At this point the raw data was consulted. If S had greater than 5% error in the color matching series of presentations, additional trials were run. If not, the fading procedure was begun. If S again had greater than 5% error, she was considered lacking the color matching skills necessary to begin the present program.

The fading procedure was divided into 20 trial steps. For the first 20 trials two plastic sheets attached to the reverse side of the stimulus boards were flipped to the front beginning a fading of the painted hand outlines. This two plastic sheet fading procedure will be referred to as F-2 indicating the covering of the visual stimuli with two plastic sheets. During F-2 and all succeeding fading steps the experimental conditions were identical to the matching of colored gloves to the painted hand outlines. Following the F-2 series came F-4, F-6, F-8, etc. to F-22, with

20 trials in each series. It should be noted that at F-16 to F-18 the visual stimuli were practically nonexistent. However, to completely remove the painted hand outlines it was necessary to use 36 plastic sheets. Criterion for advancing from one fading series of 20 trials to the next was less than 10% error or errorless performance by S. If S had more than 10% error within a series, remedial measures were then introduced. This consisted of returning to the preceding errorless step and advancing once again through the fading procedure. If on the second run S performed the series containing more than 10% error with the same or higher error rate, the experimental session was stopped to examine the data and to determine other possible remedial procedures.

If S successfully performed with less than 10% error or without errors on all trials to F-22, all plastic sheets were flipped forward to F-36 and a series of 20 trials was run. Errorless performance or less than 10% error throughout the entire procedure was an indication for E to switch to the original baseline stimulus boards and run 50 trials under baseline or pretest conditions.

Session length was contingent upon E's subjective determination of the presence of response fatigue or reinforcement satiation of S and results of more than 10% error repeated twice on one set of 20 trials, an indication for procedural change.

Test trials, the same as the pretest, were run at the end of many of the sessions. This procedure was incorporated for purposes of: 1) Monitoring Ss closely to determine the necessity for running the entire fading procedure from F-2 through F-22 or 24, and 2) Comparing Ss' error rate on non-programmed stimuli with their error rate on the programmed stimuli.

An observer was present in all experimental sessions and recorded the pre-

sented stimuli, the response, and the reinforcing consequences. A data sheet was used on which O checked letters indicating experimental conditions for each trial (Fig. 1).

Insert Table 1 about here (Appendix)

RESULTS

Results are presented in graphic and tabular form (Appendix). Table 1 presents the following:

1. Total trials including test trials for each S.
2. Total test trials for each S.
3. Percent correct responses on pre- and post-tests.
4. Pretest and within-session test response patterns, such as only right or left responses, high frequency of response reversals, or no particular response pattern.

Insert Table 1 about here (Appendix)

Pretest response patterns in Table 1 were categorized as: 1) Reversal, 2) Complete reversal, 3) Alternation, 4) Right only, and 5) None. The "Reversal" category indicated response patterns showing a high rate of left responses to the auditory stimulus "Right" and vice versa. One S demonstrated a pattern of "Complete reversal", in that all responses except one in the pretest were opposite to the auditory stimulus presented. "Alternation" response patterns indicated that S responded with alternating hands regardless of the stimulus presented, and "Right only" indicated responding with only the right hand to all stimuli. The "None" category indicated there was no response pattern apparent to E during the pretest. An additional category of "Right dominant" was added for the "within-session test response patterns" to indicate that, though the responding was primarily with only the right hand, there was a very low rate of responding with the left.

Results of this study showed four of the nine Ss maintained a correct response

level between 90 to 100% throughout all trials in the fading procedure. Three Ss maintained correct responses between 80 and 100%, and one between 70 and 100%. For one S (S-6; Fig. 7), who exhibited the "Complete reversal" response pattern on the pretest, the fading procedures were not used. Ignoring for a moment this study's criterion for errorless or near-errorless discrimination, correct responses for all Ss in this program were consistently above a "chance" level (chance defined as 40 to 60%) which would be expected during at least the initial part of a traditional trial and error approach.

Within-session test trials were used in this study to closely monitor the criterion behavior. The results of testing within the program indicated that even though the majority of Ss were responding at or above the set criterion (90%) on the programmed material, their responding would be at the chance level (40% - 60%) in non-programmed learning sequences (Trials labeled F-36; B(R); and (50) B(T); Figs. 2-10). Testing also allowed E to design the program to fit each S's individual learning patterns. After an S reached criterion on any step of the program it could be assumed that the learning of the intermediate steps necessary for this criterion response had been achieved. This enabled E to shorten the program for several Ss.

Table 2 presents the total number of errors emitted by each S during the fading procedure with an indication of the stimulus conditions under which these errors occurred. Only those errors emitted in trials of matching the correct color-gloved hand to the corresponding stimulus board (Column G-C) and in fading trials, F-2 through F-24, are included in this breakdown. All trials requiring an S to respond to the blank stimulus boards and to F-36 were considered to be probe trials

(additional to the within-session tests) which assessed the Ss' current response level in terms of the required terminal response. Errors emitted during such trials were therefore not included in the breakdown of errors emitted under stimulus conditions of the fading procedure.

Insert Table 2 about here (Appendix)

Noted in parenthesis in the G-C column (Table 2), i.e. trials of matching the correct color-gloved hand to the corresponding stimulus board, are the number of trials for each S under G-C conditions. Prior to beginning experimental sessions it was decided by E to run 50 trials G-C before beginning the fading series. However, it was noted during G-C trials for the first Ss, that this number of G-C trials was perhaps unnecessary. Thereafter, the number of G-C trials was determined according to percent correct responses, i.e. if an S maintained a high, or 100% correct response level during the first 20 trials, the fading procedure was immediately begun.

The errors listed under the various conditions shown in Table 2 reflect a total under that condition. Therefore, if an S was returned to a particular point in the fading series for remedial purposes the total number of trials under those conditions increases, i.e. if S makes 2 errors under the stimulus conditions of F-16 and thus progresses to F-18 but has to return to F-16 as a part of remedial procedures then all errors made under conditions of F-16 are totaled.

The percentage of correct responses for each S and the experimental conditions in which these responses were emitted are presented graphically in Figs. 2 through 10. S-1 corresponds with Fig. 2, etc., through S-9 and Fig. 10. The

ordinates on all graphs indicate percent correct responses. The abscissas indicate experimental conditions, i.e. the manipulation of stimulus variables, changes in Ss' motor and verbal responses, and reinforcement and/or punishment of responses emitted by the Ss. Table 3 presents a key to the symbols located on the abscissas of the graphic presentations of each S's percent correct responses.

Insert Table 3 about here (Appendix)

Each graphic point on all graphs presents results for a set of 20 experimental trials unless otherwise indicated by the number (50) on the abscissa. Those sets of trials numbering 50 were pre-, and within-session test trials. A horizontal line is drawn on the ordinates of all graphs to indicate the response criterion required for Ss to continue progressing within the program.

Insert Figs. 2-10 about here (Appendix)

A point on or above this criterion line on test sets was indication that the S emitted a correct response level necessary for achieving the post-test criterion. On this basis, experimental trials for Ss were discontinued. S-5 (Fig. 6) was an exception who was continued in experimental sessions after responding at the 92% correct response level on a post-test. On the first post-test of S-5 the response pattern indicated auditory discrimination of word differences had been achieved but response differentiation was not equal in strength to that discrimination. It was therefore decided to continue experimental sessions with this S. Response differentiation in this instance refers to switches in response hands corresponding

with changes in auditory stimuli although the responses were not necessarily correct, thus several "errors" would be made in line, indicating response reversal.

The results of S-1 (Fig. 2), the first S run in experimental sessions, are included, though not complete since S-1 left for a months vacation during experimentation. On the pretest for this S no confirmation ("OK") had been voiced by E for correct responses. After receiving small consumables and a voiced "Good girl" for correct responses on experimental trials, S-1 emitted two non-confirmed correct responses on test trials and then refused to continue responding. E experimented with the use of "OK" as confirmation resulting in the maintenance of response throughout all succeeding test trials for this S. On the basis of this information, it was decided that "OK" confirmation would be used on all test trials pre-, post-, and within session, to maintain Ss' responding during testing.

Errorless establishment of a right-left discrimination was clearly demonstrated by S-2, S-3, S-4 and S-5 (Figs. 3, 4, 5 and 6). All errors for Ss-2, 3 and 4 were emitted during test trials or in transferring from the experimental stimulus boards (after fading to F-36) to the blank boards used in testing. During the entire fading procedure, from G-C trials (matching the color-gloved hand to the corresponding stimulus board) through the final fading trials of F-36 (S's hands were gloved but the painted hand stimuli were no longer visible), responses emitted by these Ss, excepting those emitted on probe test trials, were above the 90% criterion level. S-5 demonstrated near-errorless discrimination with only one set of trials, F-24, resulting in a below 90% response level.

An unusual response pattern was demonstrated in the pretest results of S-6. (Fig. 5) This S emitted only one correct response, a near-perfect reversal of motor response, for a score of 2% correct responses. It was unnecessary to utilize the total

program of fading procedures for this S because of the existing previously learned and clearly discriminated response. Therefore a procedure was initiated which dealt directly with attaching the correct response differentiation to the presented auditory stimulus. This procedure consisted of 20 trials of G-C (matching the correct color-gloved hand to the corresponding stimulus board), 20 trials of responding to F-36 with gloves (to retain the visual stimulus properties of the colored gloves while responding to the auditory stimuli) and 20 trials of reinforced responding to the blank boards with no gloves (to aid generalization from the experimental to the testing stimulus boards). During G-C and F-36 trials, percent correct responses were at the 100% level. One error was emitted during B (R) (reinforced responding to blank boards without gloves) set of trials. At this point E ran 50 post-test trials with "OK" confirmation for S-6 which resulted in a 100% correct response level.

Correct response results of Ss 2, 3, 4 and 5 (Figs. 3, 4, 5 and 6), though above the criterion level in fading procedures through F-36, dropped below this level when experimental conditions were changed to those for testing the terminal response level. S-2 (Fig. 3) was the first S to reach this point and a fading technique of placing two plastic sheets over the blank boards, B (F-2), to more closely approximate the stimulus components of the fading stimulus boards, was tried and proved to be an effective method for moving this S from the experimental to the testing conditions. This procedure was also effective for generalization from the experimental to the testing stimulus boards with S-9 (Fig. 10).

S-3 (Fig. 4) maintained a 100% correct response level from G-C through F-36. At this time the gloves were removed from S-3 and the procedure B (F-2) was attempted for this S prior to an anticipated response breakdown but was not effective. Under the conditions of (NG) B (F-2), i.e. placing two plastic sheets over the blank boards with gloves off, S-3's correct response level dropped from

100% in F-36 to 64%. Replacement of the gloves, (G) B (F-2), increased the correct response level to 80%. At this time Session I was ended. Session II (S-3; Fig. 4) began with trials of F-16, F-20, F-36 and (NG) F-36. This moving back to earlier fading levels was done because this S had moved quickly through the fading steps in the first session and it was decided the steps were perhaps too large. Also, for purposes of generalizing from the experimental to the testing stimulus conditions the gloves were removed from S-3's hands while the experimental stimulus conditions (F-36) were still in effect. This procedure was used because of an improved correct response level when gloves were replaced at the end of Session I. An additional procedure of running 20 trials of B (R), i.e. reinforcing correct responses to blank boards with consummables and "Good girl", was tried in attempt to maintain S-3's correct response level through the 50 trial post-test. These procedures were effective for maintaining this S's correct response level at 100%.

Prior to running the 50 post-test trials, B (R) proved an effective method for moving S-5 (Fig. 6) from the experimental to the post-test conditions. This same procedure was used for Ss 6, 7, 8 and 9 (Figs. 7, 8, 9 and 10) prior to moving from experimental stimulus conditions to those of testing. The correct response level of these Ss did not drop at this point though it had done so several times during the fading procedure.

For S-4 (Fig. 5) reinforcing correct responses to the blank boards prior to the post-test did not prove an effective method for generalization from the experimental to the testing conditions. For S-4 two different pretests were given before the study started. This was done because the first set of pretest trials was carried out 21 days before it was possible to begin the study. To be certain that S-4 was still responding at the chance level, the second pretest was run just prior to the beginning of the experimental sessions. As the results indicate S-4 emitted slightly

more incorrect responses on the second set of pretest trials than she did on the first. Twenty trials of G-C (matching the correct colored gloved hand to the corresponding stimulus board) were then run. Even though S-4 had 20% error on the G-C trials, the fading procedure was begun. The usual criterion was a 5% correct response level in G-C before moving to the fading sessions. However, this S exhibited non-attending behavior, i.e. she did not orient her eyes in the direction of the stimulus boards, during the first few trials of G-C. This was noted by E and the question "Does that hand look like the one on the board?" was asked after G-C trial number 6 resulted in an incorrect response. Following this, as was shown on the cumulative correct response graphs kept by E to monitor the program, S-4's correct response level increased with only one error being thereafter emitted in the remaining 14 G-C trials. Once S-4 progressed to the fading trials a correct response level above the criterion was maintained for all trials through F-36. However, from F-8 through the first set of reinforced responses to blank boards, B (R), the remedial manipulation of using a greater auditory difference between "Right" and "Left" as voiced by E was used. This was na auditory stimulus "Left" pronounced as "LIIIleeeffftt" and "Right" pronounced as usual in all trials. The response topography of S-4 was one of starting to respond incorrectly, stopping, and changing to the correct response hand for the recorded response. This topography of response was similar to that of S-9 (Fig. 10) for whom using the greater difference in auditory stimuli had proved effective to increase the number of correct responses. During S-4's second set of B (R), i.e. reinforced responding to blank cards with consummables and "Good girl", the auditory difference was discontinued in attempt to fade into the auditory stimuli to be presented on the post-test. At this point the correct response level for S-4 dropped below the criterion and began fluctuating instead of remaining at its previously high rate.

Following 20 trials of reinforced responses to blank cards, B (R), during which E voiced a "No" following all incorrect responses, this S's correct response level on the post-test was raised to the 90% level. This punishment procedure was employed by E because this S's correct response level was below criterion even under conditions previously resulting in success. It was hoped by E that the auditory "No" would result in "knowledge of results" for this subject and thereby decrease incorrect responses and increase correct ones, as it did. Many other methods had been employed by E prior to this procedure, such as pausing (Pause) after each ten post-test trials to determine if the generalization problem from experimental to testing conditions was due to response fatigue and changing the required response topography, i.e. S was required to raise the correct hand (Raise) in response to the auditory stimuli. The procedure which finally resulted in increasing the S's correct response level to criterion was the employment of "No" following incorrect responses.

This notification of incorrect responses ("No") was also used for S-7 (Fig. 8) and though it increased correct responding under conditions of F-36 it did not bring the correct response level to the 90% criterion. The experimental conditions for S-7 included no auditory stimulus differences (conditions of auditory difference had resulted in decreasing S-7's correct response level to 35%), but did include the requirement that S say "Left blue" and "Right pink" following the corresponding auditory stimulus voiced by E. During the first experimental session in two sets of 20 trials, S-7 had voluntarily responded in this manner. It was therefore decided by E during the third experimental session to take the cue from S-7 and set the conditions for discrimination training in the manner originally demonstrated by this S. At the beginning of S-7's third experimental session a return to F-16 was incorporated during which S was voluntarily repeating "Left" and "Right" after E presented the correspond-

ing auditory stimulus. (This verbal response began in Session II and maintained itself). The conditions of "No" were also begun and a fading through F-36 was executed. At F-36, however, S-7's correct response level again dropped below criterion. At this point E took the cue S had given during the first experimental session and required S to say "Left blue" or "Right pink" following the corresponding auditory stimulus. However, S was emitting these mediated verbal responses after or simultaneous with E's presentation of the corresponding stimulus board and many of the verbal responses were incorrect. Therefore at the second F-36 following the G-C, E required that S give the correct verbal response before the stimulus board was presented (Correction of the verbal response was allowed). At this point responses to F-36 increased to near criterion and responses to B (R) with the required verbal response increased to 100% correct. When these conditions were changed to B (R) S-7's correct response level dropped just below criterion but a repitition of this set of trials resulted in 100% correct response level. This last decrease in correct response level could possibly have been avoided had E more gradually faded the experimental stimulus conditions. This S then demonstrated a correct response level of 92% on the post-test.

While maintaining a fairly high percentage of correct responding, S-8 (Fig. 9) did not move from the F-22 to F-24 step of the program, where visual stimuli are barely distinguishable, to F-36. This S had volunrarily emitted the verbal response of "Left" or "Right" following the corresponding auditory stimuli throughout all experimental sessions. Because S-8 exhibited difficulty in this verbal imitation (frequently S would say "Left" after E voiced "Right" and vice versa), it was determined inadvisable to use a greater auditory difference. In Session VI (S-8; Fig. 9) it was decided instead to make a greater initial difference in the visual stimuli. This was executed by cutting white strips of paper the width of the fading stimulus boards and

from 6" to 4-3/4", in 1/4" steps, in length. Beginning again with matching the correct color-gloved hand to the corresponding stimulus board, the 6" strip of paper was placed at the top of the left-hand stimulus board which left only the thumb and part of the palm visible. There were no changes made on the right-hand stimulus board. As S progressed through F-4 to F-14 the strip of paper was changed to one 1/4" shorter with each fading step. After twenty trials to F-14, S-8 requested that the gloves be removed. One more set of 20 trials was run as a probe under F-36 conditions. At this point the S's correct response level dropped. However, following this procedure, the post-test results were at the 84% correct response level and on previous within-session test trials the level was 50% or below. The session was discontinued at this point and S was returned later for Session VII to reach a correct post-test response level of 92% after four sets of fading trials, run primarily to reintroduce S to the experimental conditions.

S-9 (Fig. 10) exhibited low color matching skills in the matching trials and a response topography of touching only the index finger of the response hand to the stimulus board. Additionally, this S voluntarily repeated the presented auditory stimulus, but it was voiced in a barely audible tone. The manipulation of using a greater auditory difference was incorporated into the experimental conditions. This procedure increased S-9's correct response level but only to a curious up-down pattern on each side of the 90% criterion line. Repeating the stimulus conditions of a previous set of trials often resulted in an above criterion response and it was with such a pattern that S-9 continued through Sessions V and VI (S-9; Fig. 10) to finally achieve an above criterion correct response level of 96% on the post-test.

DISCUSSION

Results of this study indicate the use of the fading procedures alone to be sufficient for the establishment of a right-left discrimination within the 90 to 100% correct response level for four of the nine Ss. Ignoring for a moment the criterion set in this study for errorless or near-errorless discrimination, correct responses for all Ss were consistently at the "better" than chance level (chance defined as 40 to 60% correct responses). "Chance" responding would be expected during at least the initial part of a traditional trial and error approach.

Test trials were used in this study to closely monitor the criterion behavior. This monitoring allowed E to design a program to fit each S's individual learning patterns. Frequent test probes do sometimes place Ss in temporary situations of failure. However, as pointed out by many programmers, they also yield important data for the construction of a program. Such testing would not necessarily be used after a program has been "refined", but some type of monitoring system should be built in.

The issue of generalization from the experimental to the testing stimuli became obvious when some Ss who exhibited a high correct response level throughout the entire program were not able to transfer to the testing conditions. Because the conditions of the final fading trials required responding to the auditory stimuli with the visual stimuli completely faded (36 plastic sheets covered the visual stimuli at this point making them invisible), it had not been predicted by E that transferring from this experimental condition to the testing conditions of responding to blank boards would create difficulties. However, five of the nine Ss experienced breakdowns in correct response levels at this point and four of these five had progressed

through the fading procedures with percent correct responses consistently above 90% and usually at 100%. The techniques employed to effect this transfer from experimental to testing conditions were to decrease the differences between the experimental and testing stimuli and to reinforce correct responses to the blank testing boards with consumables and "Good girl" prior to running the post-test trials. Both of these procedures were generally effective and should be considered for incorporation into the general procedures of this program.

Individual analysis of behavior allows the observer to immediately monitor each S's responses and to make some definitive "diagnosis" based upon the data. One S in the present study demonstrated a complete reversal of motor responses to the auditory stimuli. A special procedure was initiated for this S which dealt directly with attaching the correct response differentiation to the presented auditory stimulus. This procedure was incorporated because this S presented a situation in which E had to deal with a previously learned and clearly discriminated response.

Another procedure employed to effect discrimination, where none had been acquired, was the use of punishment, presented in the form of a verbal "No" voiced by E and in the form of taking away reinforcers (small consumables) for incorrect responses. Results of these procedures on the two Ss for whom they were employed indicated that "No" was somewhat more effective than the removal of the positive reinforcer, i.e. take away of consumables for incorrect responses resulted in further breakdown of correct response level and "No" increased this level to above criterion for one S and to near criterion for the other. Reasons for this difference can only be speculated because the past conditioning history of each S regarding the effects of conditioned aversive stimuli or withdrawal of positive reinforcers upon them was not known.

Remedial procedures employed for those Ss who were not successful with the use of only fading procedures were: 1) Greater differences in auditory stimuli, 2) Greater initial differences in visual stimuli, and 3) Verbal mediation (chaining). It became apparent in the initial stages of experimental sessions that this specific program would not be effective for all Ss. Consequently a monitoring of the errors within the program resulted in the employment of remedial procedures. It was obvious the program might reduce to a trial and error procedure for the Ss unless these procedures were used.

Using a greater difference in auditory stimuli, as voiced by E was employed when Ss exhibited response topographies of correction, i.e. the incorrect response was begun and was then followed by a voluntary switch to the correct response. It was thought that discrimination level for these Ss was low, even though the data showed a high level of correct responses (only the response hand placed upon the presented stimulus board was recorded). This technique was employed for three Ss. Greatly improved discrimination resulted for two Ss and complete response breakdown resulted for the third.

A second remedial procedure employed was that of using a greater initial difference between the visual stimuli. The decision to use this procedure was based upon research carried out in the area of mediated discrimination (acquired distinctiveness of cues). The conditions of this procedure entailed making one visual S^D as different as possible by reducing the total stimulus complex of this stimulus. The other visual stimulus remained the same. Results showed improved discrimination by the S for whom this procedure was designed.

An intermediate verbal response of "Right" and "Left" emitted by Ss either prior to or simultaneous with the presentation of the visual stimuli and following the

corresponding auditory stimulus was also used as a remedial procedure. For one S the addition of the color name, i.e. "Right pink" and "Left blue", was used. The decision to employ these procedures for remedial purposes was based primarily upon the voluntary use of these procedures by several of the Ss. Although the procedure could be analyzed in terms of a mediation paradigm, it can also be viewed in terms of chained responses. For some Ss, who did not voluntarily emit this intermediate response and who were responding with errors, E required the intermediate verbal response. This procedure resulted in an increased and then maintained successful level of discrimination.

In retrospect it is possible that the utilization of a different and not as "well learned" (as the pink and blue discrimination) set of initial visual stimuli might have resulted in higher correct response levels for all Ss during procedures of fading from the visual to the auditory stimuli. An example of such visual stimuli might be "nonsense" designs on the gloves and within the hand outlines on the stimulus boards. The reasoning for this conjecture is the possibility that the color discrimination is well learned by these Ss from the natural (or other) environment, i.e. they may rely more heavily on color, rather than form or pattern, discriminations in their everyday lives. Thus when the fading is started they may, as a result of past color conditioning history, observe (in this case, hear) the cues of "Left" and "Right" less readily because color discriminations may have been more reinforced than auditory discriminations. It is an empirical question, whether or not the use of some very different set of visual stimuli, such as polka dots and slanting lines, could be easily matched by the Ss and then when faded would result in fewer errors when the auditory stimuli take over the discriminatives stimulus "roles". This use of black designs on white backgrounds would also avoid the problem color blind Ss

might have with color stimuli.

The response requirements of previous errorless discrimination and transfer studies have relied upon only one sense modality, vision, for acquiring and/or transferring stimulus control. This study, unlike others in this area, dealt with an initial visual discrimination which was faded into an auditory discrimination. Thus a crossing of sense modalities was effected in the fading procedure. What effects this crossing of modalities had on the success of transferring stimulus control is also an empirical question and is subject to testing.

Thus far the results presented indicate a need for more extended research on this program regarding its effectiveness for establishing a right-left discrimination. This study does not present evidence that a programmed technique is more "effective" than a trial and error approach. However, ignoring the issue of correct response level in a comparison between the traditional trial and error approach and an errorless program, another important issue may be which of these methods employs the least number of trials to reach the criterion discrimination. One reason errorless discrimination has been fostered is based on the belief that failure results in "emotional" responses or possibly a decrease in response rate as indicate by punishment studies. This may or may not be true. It may be that the effects of punishment (errors) are individual. Consequently the efficiency of learning (number of trials to criterion) could become an equally important issue.

SUMMARY

The design of the present study is one which attempted to measure behavior before learning began, after a program had been completed, in addition to demonstrating that behavior can be successful while change is being implemented. This was an analytic task set by E in attempt to establish observable functional relations between S's behavior (the dependent variable) and the program as originally designed (the independent variable). The individual analysis of behavior has as its primary concern the initiation of effective procedures. Therefore, this thesis dealt with a detailed analysis of the methodology involved in learning a right-left discrimination.

REFERENCES

Barrett, Beatrice H. Acquisition of operant differentiation and discrimination in institutionalized retarded children. Amer. J. Orthopsychiat., 1955, 35, 862-885.

Bijou, S. W., and Baer, D. M. Some methodological contributions from a functional analysis of child development. In L. P. Lipsitt, and C. C. Spiker (Eds.), Advances in child development and behavior. Vol. 1. New York: Academic Press, 1963.

Gellermann, L. W. Chance orders of alternating stimuli in visual discrimination experiments. J. Genet. Psychol., 1933, 42, 207-208.

Jeffery, W. E. Variables in early discrimination learning: 1. Motor responses in the training of a left-right discrimination. Child Develpm., 1958, 29, 269-275.

Moore, R. and Goldiamond, I. Errorless establishment of visual discrimination using fading procedures. J. exp. Anal. Behav., 1964, 7, 269-272.

Schusterman, R. J. Errorless discrimination-reversal learning in the California Sea Lion. Proceedings of the American Psychology Association (Chicago, 1965). Washington: American Psychology Association, 1965.

Skinner, B. F. The behavior of organisms; an experimental analysis. New York: Appleton-Century-Crofts, 1938.

Skinner, B. F. An operant analysis of problem solving. In B. Kleinmuntz (Ed.), Problem solving: research, method and theory. New York: John Wiley & Sons, Inc., 1966, Pp. 225-258.

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

Terrace, H. S. Discrimination learning with and without 'errors'. J. exp. Anal. Behav., 1963, 4, 1-27. (a)

Terrace, H. S. Errorless transfer of a discrimination across two continua. J. exp. Anal. Behav., 1963, 4, 223-232. (b)

APPENDIX

Table 1

Total Experimental Trials; Total Test Trials; Pre-and Post-Test Percent Correct Responses; and Pre-and Post-Test Response Patterns for Each Subject

Subjects	Total trials including test trials	Total test trials	% correct responses pretest	% correct responses post-test	Pretest response pattern	Within-session test response pattern
S-1	870	250	48	74	Reversal	None
S-2	650	220	50	98	Right only	Right dominant
S-3	320	100	46	100	None	Right dominant
S-4	940	400	52	90	Reversals	Reversals
S-5	610	170	40	96	Reversals	Reversals
S-6	160	100	2	100	Complete reversal	None
S-7	780	100	56	92	Reversals	Reversals
S-8	1180	250	52	92	Alternation	Alternation
S-9	1400	250	52	96	Right only	None

Table 2

Total Errors Emitted by Each Subject During Fading Procedures and Division of These Errors Into Specific Categories of Experimental Conditions

Subject	Total Errors in fading	G-C (Total trials)	F-2	F-4	F-6	F-8	F-10	F-12	F-14	F-16	F-17	F-18	F-19	F-20	F-22	F-24
S-1	37	10 (100)	1				1	1		3		6		4	7	4
S-2	4	2 (50)								1				1		
S-3	1	(20)								1						
S-4	6	4 (50)			1			1								
S-5	5	(20)										1			1	3
S-6	0	(20)														
S-7	42	(20)					5			4		31		2		
S-8	48	(50)				1			4	3		14	1	5	14	6
S-9	71	10 (50)	1	3		1			1	9	2	8	6	18	12	

Note: Errors emitted on trials requiring a response to blank or F-36 visual stimuli are not included in this table. Such trials were considered as probe trials indicating the current within-sessions response level in comparison with the terminal criterion response level of the experimental program.

Table 3

Symbol Key to Experimental Conditions Noted on Abscissas of Graphs in Figs. 2-10

Categories	Symbols	Definitions	Notes
Types and No. of Trials	F	Fading out of visual stimuli trials	Plastic sheets are flipped over the painted hand outlines in the number indicated by the subsequent number; F-2; F-3; etc.
	T	Test Trials	Test trials always run with no gloves and no consumables or "Good girl" consequent to the correct response; "OK" confirmation given for correct responses.
	(Pause)	A pause between each set of ten trials	Used on the test trials for one to test response fatigue.
	(Raise)	S required to raise the correct hand	Used on one S during test trials to determine generalization.
	B (R)	Blank cards reinforced responses	Reinforcement given for correct responses to the blank cards used for testing to fade from the experimental stimulus

(Table continued on next page)

Table 3 (continued)

Categories	Symbols	Definitions	Notes
Types and No. of Trials (continued)			components to the testing stimulus components.
	G-C	Matching of the gloved hands to the corresponding visual stimulus of a painted hand outline	These trials run prior to beginning of fading.
	(50)	All sets of trials included 20 trials unless noted (50)	
Visual S^Ds	B	Blank boards only	No gloves on S's hands unless noted "G"; consumables given.
	B (F-2)	Two plastic sheets of the fading stimulus boards placed over the blank boards	No gloves on S's hands unless noted "G"
	B (F-)	Plastic sheets of the fading boards hanging behind the blank boards	No gloves on S's hands unless noted "G"
	F-2, etc., to F-36	Plastic sheets covering visual stimuli according to noted number	Gloves always on S's hands from F-2 through F-24; F-36 noted "NG" if no gloves used

(Table continued on next page)

Table 3 (continued)

Categories	Symbols	Definitions	Notes
Visual S^Ds (continued)	P6 P5-3/4, etc.	White paper cut the width of the fading boards with the length designated in inches according to the accompanying number; paper was placed at the top of the left hand fading boards to cover the fingers	This procedure was used to create an even greater difference between S^Ds than that provided by color differences; the fading technique was to use paper 1/4" shorter for each succeeding trial, until all fingers of the left hand outline were visible
Auditory S^Ds	AD	Auditory difference; "Left" pronounced "Llleeefft" and "Right" pronounced normally	This procedure used to create greater difference in auditory stimuli for S's with low percent correct responses
Response Conditions	G	Gloves on S's hands	
	NG	No gloves on S's hands	
Subject Verbal Responses	SLR	S required to say "Left" or "Right" after presentation of corresponding auditory S^D by E	Correct verbal response required

(Table continued on next page)

Table 3 (continued)

Categories	Symbols	Definitions	Notes
Subject Verbal Responses (continued)	SLRV	S voluntarily said "Left" or "Right" after presentation of corresponding auditory S^D by E	Correct verbal response required
	SLBRP	S required to say "Left" blue" or "Right pink" after presentation of corresponding auditory S^D of "Left" or "Right" by E	Correct verbal response required
	SLBRPV	S voluntarily said "Left blue" or "Right pink" after presentation of corresponding auditory S^D by E	Correct verbal response required
	SLBRP+	S required to say "Left blue" and "Right pink" after presentation of corresponding auditory S^D by E with a short latency after S's verbal response and before presentation of corresponding stimulus board by E	Correct verbal response required
Responses	L	Left	
	R	Right	
Punishment	TA	Take away of one small consumable from S's dish for incorrect response	

(Table continued on next page)

Table 3 (continued)

Categories	Symbols	Definitions	Notes
Punishment (continued)	"No"	"No" voiced by E for incorrect responses	

Note: Arrows drawn from an experimental condition symbol indicate the continuation of that condition through all sets of trials to the end of the arrow point.

Examples: (50) B (T) = 50 test trials; blank cards; no gloves; no consumables; "OK" confirmation.

(G) R (NG) L (F-36) = gloved right hand; no glove on left hand; 36 plastic sheets covering the visual color stimuli

Fig. 1 Data Sheet for Response Recording

Name _____ Date _____

	S^D	R	S^r	S^D	R	S^r	S^D	R	S^r
1	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
2	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
3	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
4	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
5	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
6	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
7	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
8	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
9	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
10	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
11	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
12	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
13	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
14	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
15	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
16	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
17	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
18	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
19	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
20	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
21	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
22	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
23	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
24	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
25	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
26	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
27	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
28	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
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32	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
33	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
34	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
35	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
36	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
37	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
38	R L	+ -	M S	R L	+ -	M S	R L	+ -	M S
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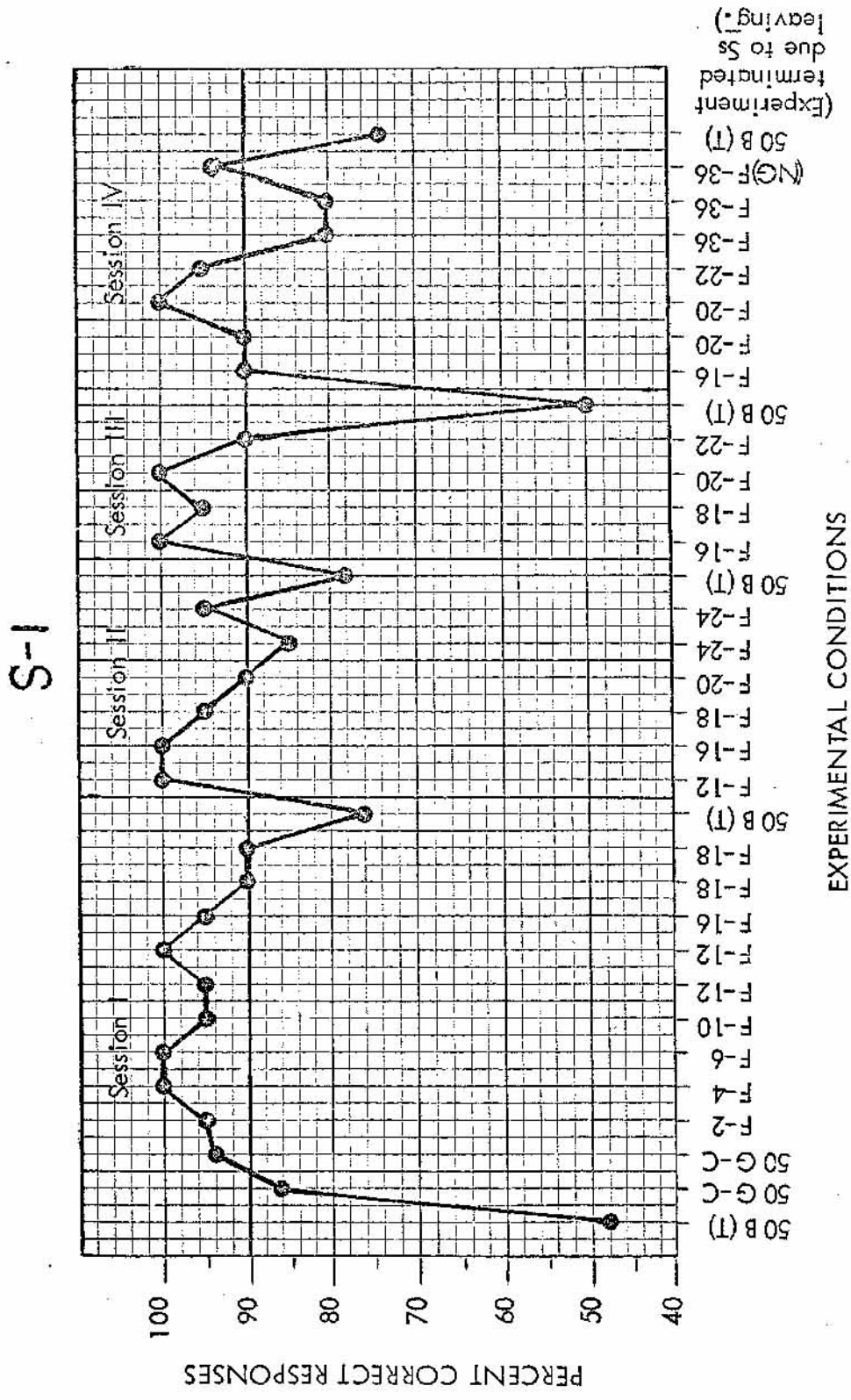

Fig. 2 Percent correct responses of S – 1 within varying experimental conditions in the fading procedure.

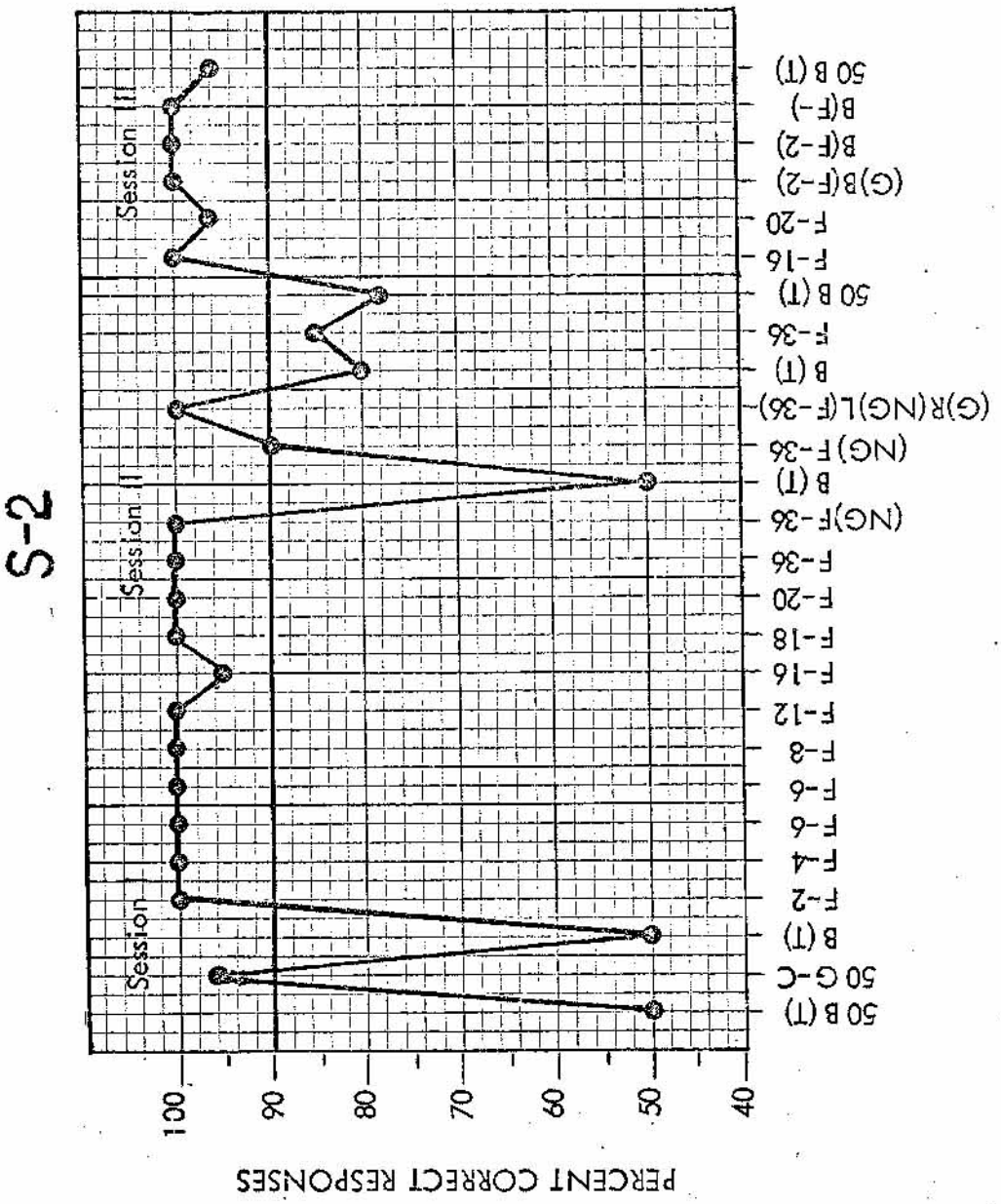

Fig. 3 Percent correct responses of S - 2 within varying experimental conditions in the fading procedure.

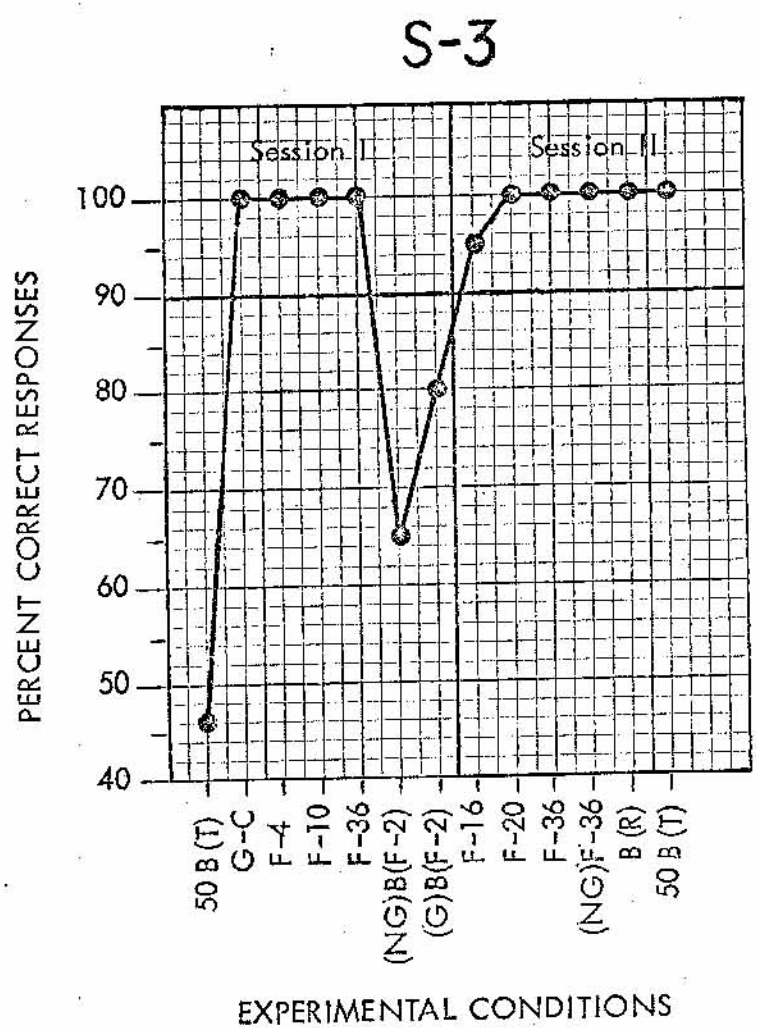

Fig. 4 Percent correct responses of S-3 within varying experimental conditions in the fading procedure.

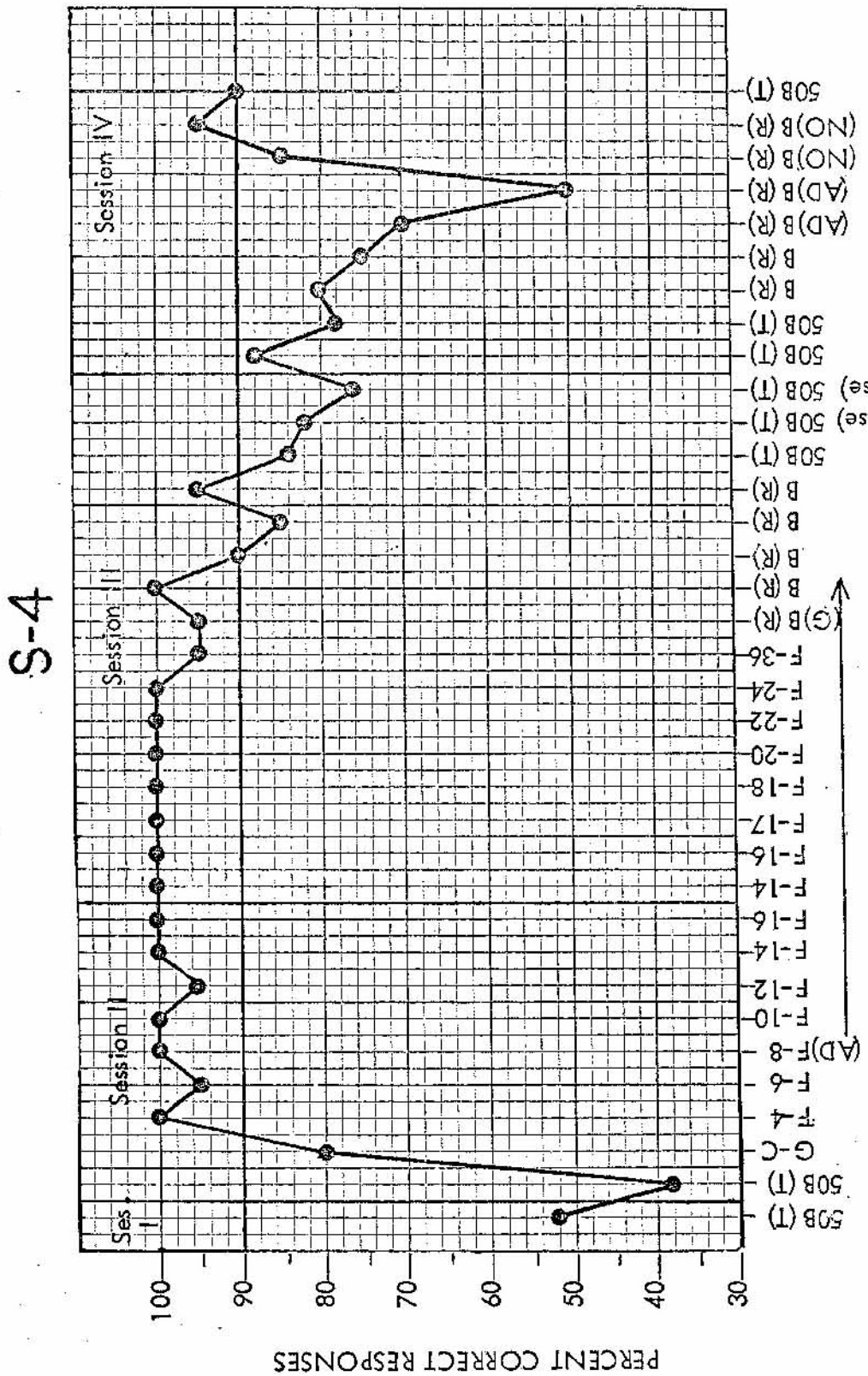

Fig. 5 Percent correct responses of S-4 within varying experimental conditions in the fading procedure.

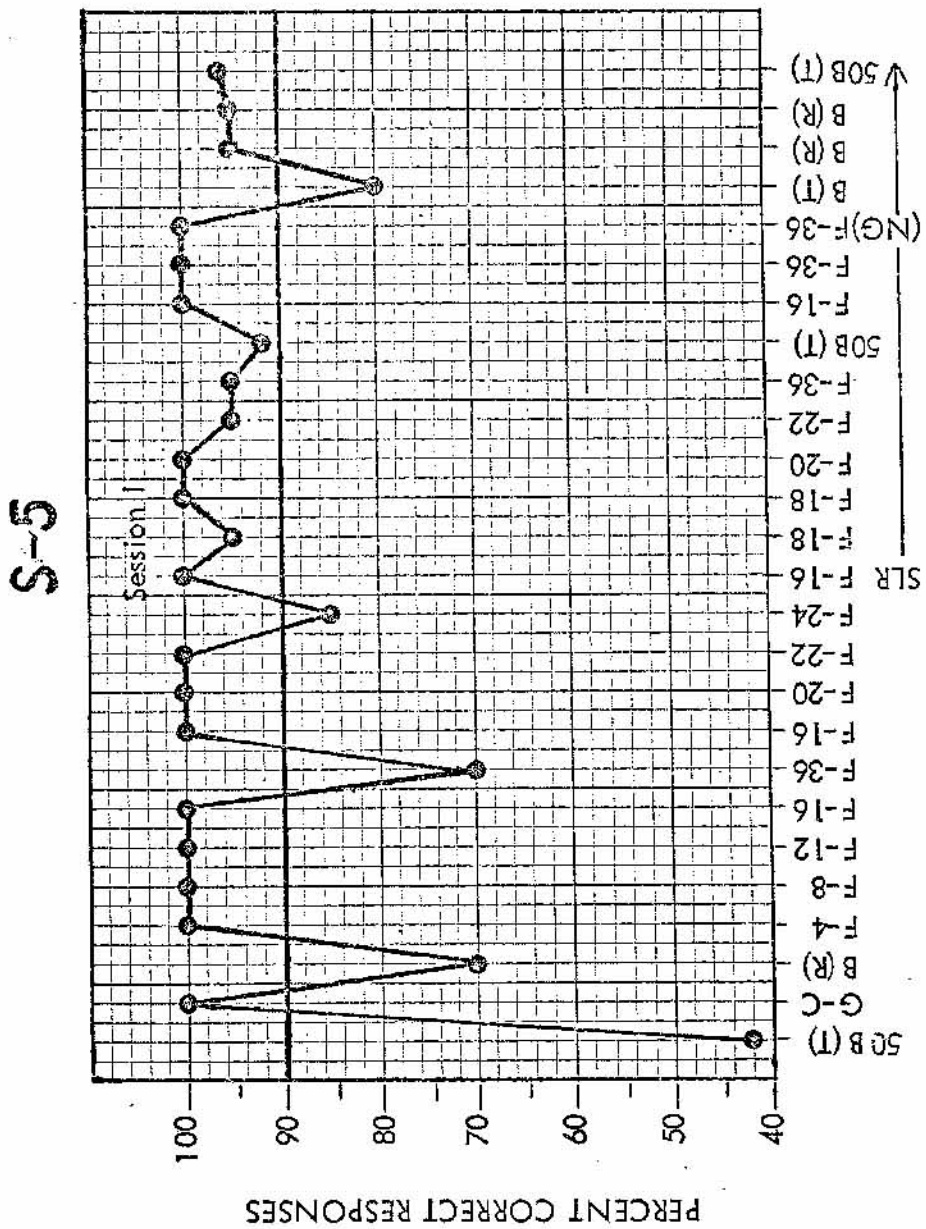

Fig. 6 Percent correct responses within varying experimental conditions in fading procedure for S-5.

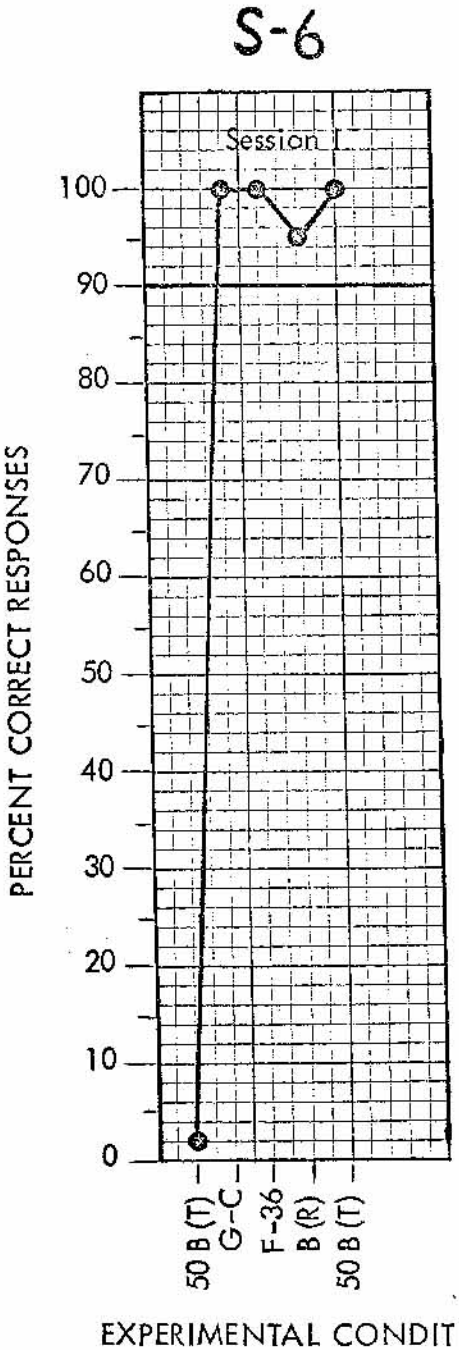

Fig. 7 Percent correct responses of S-6 within varying experimental conditions in the fading procedure.

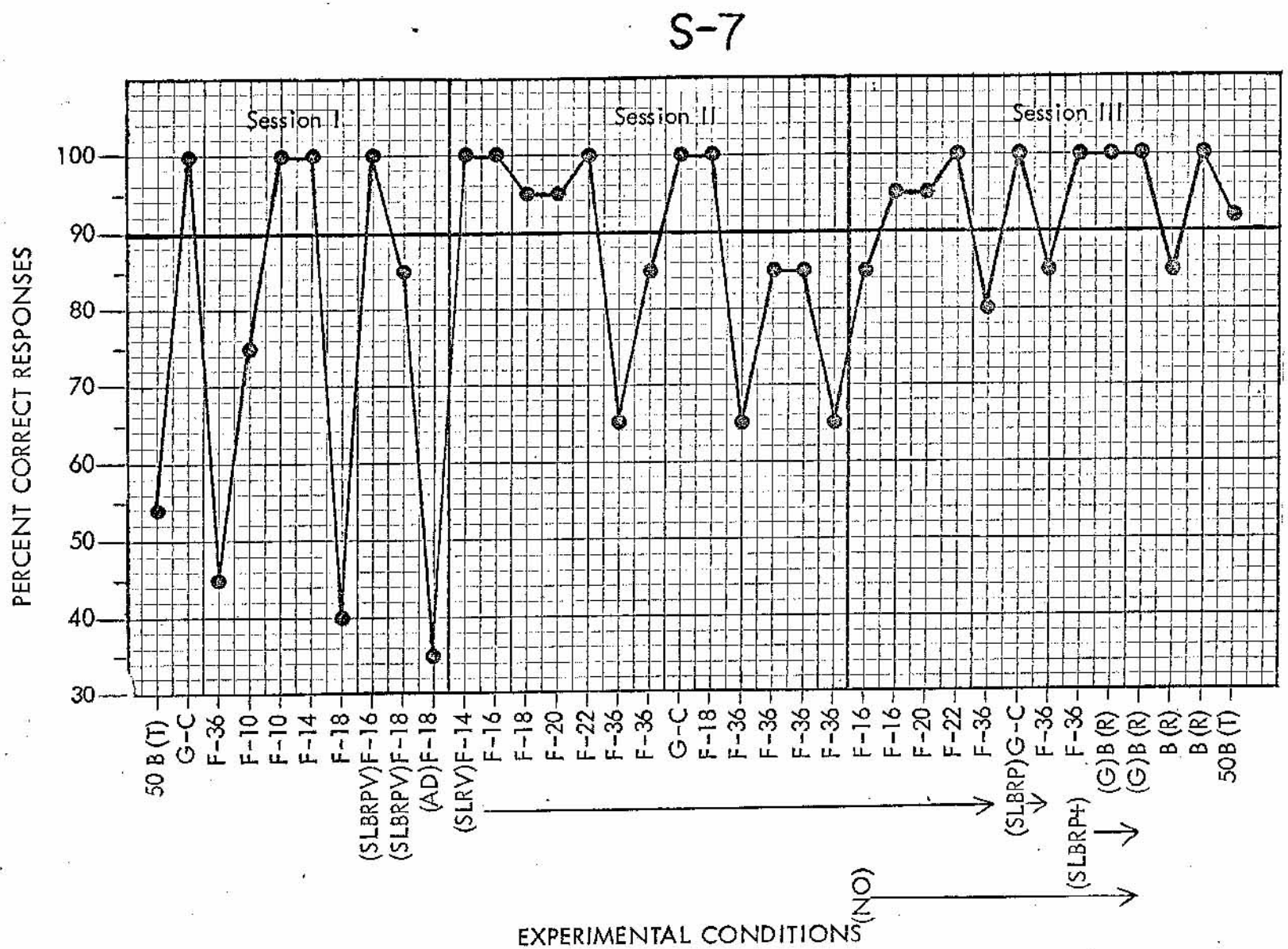

Fig. 8 Percent correct responses of S-7 within varying experimental conditions in the fading procedure.

S-8

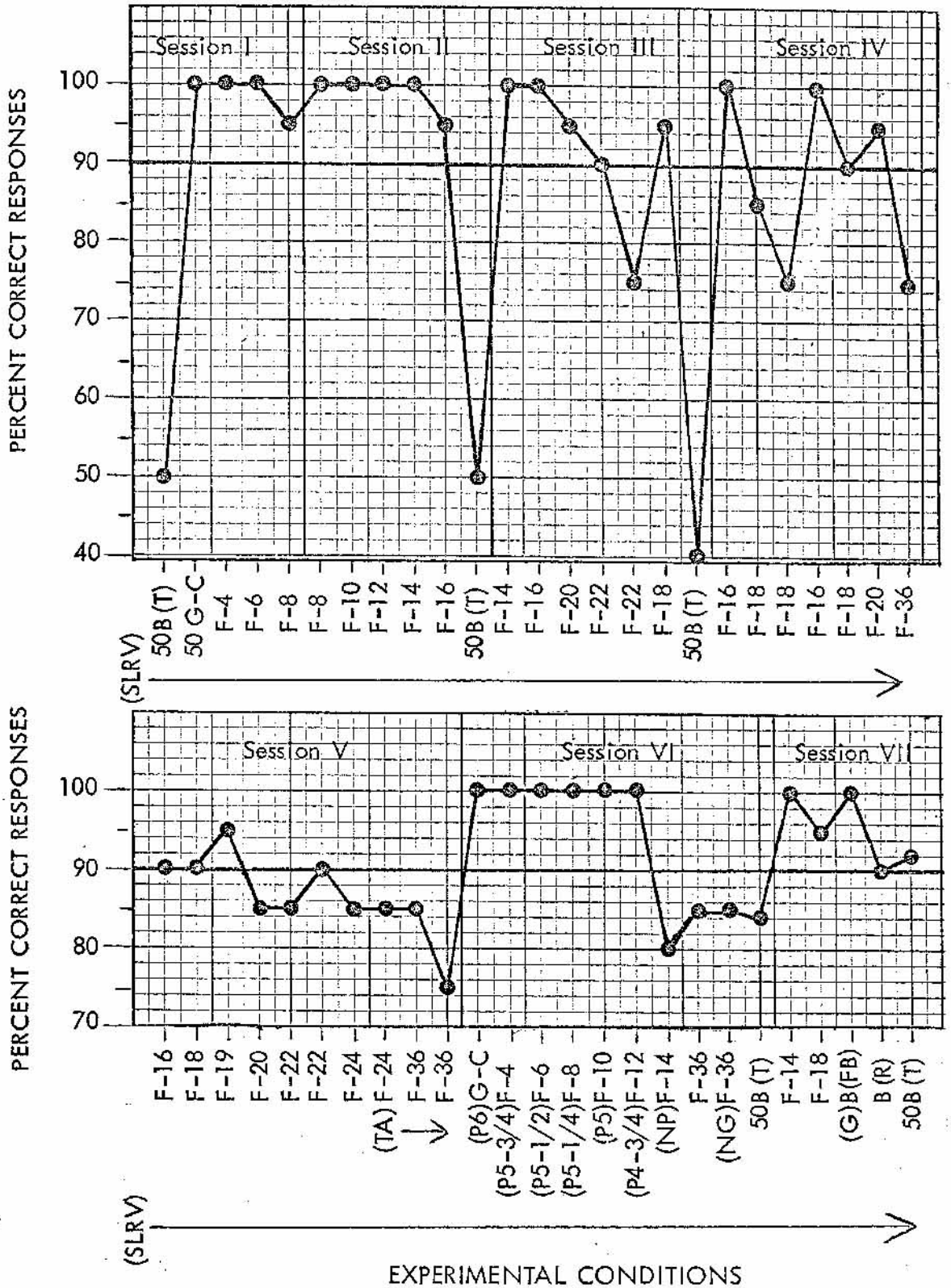

Fig. 9 Percent correct responses of S-8 within varying experimental conditions within the fading procedure.

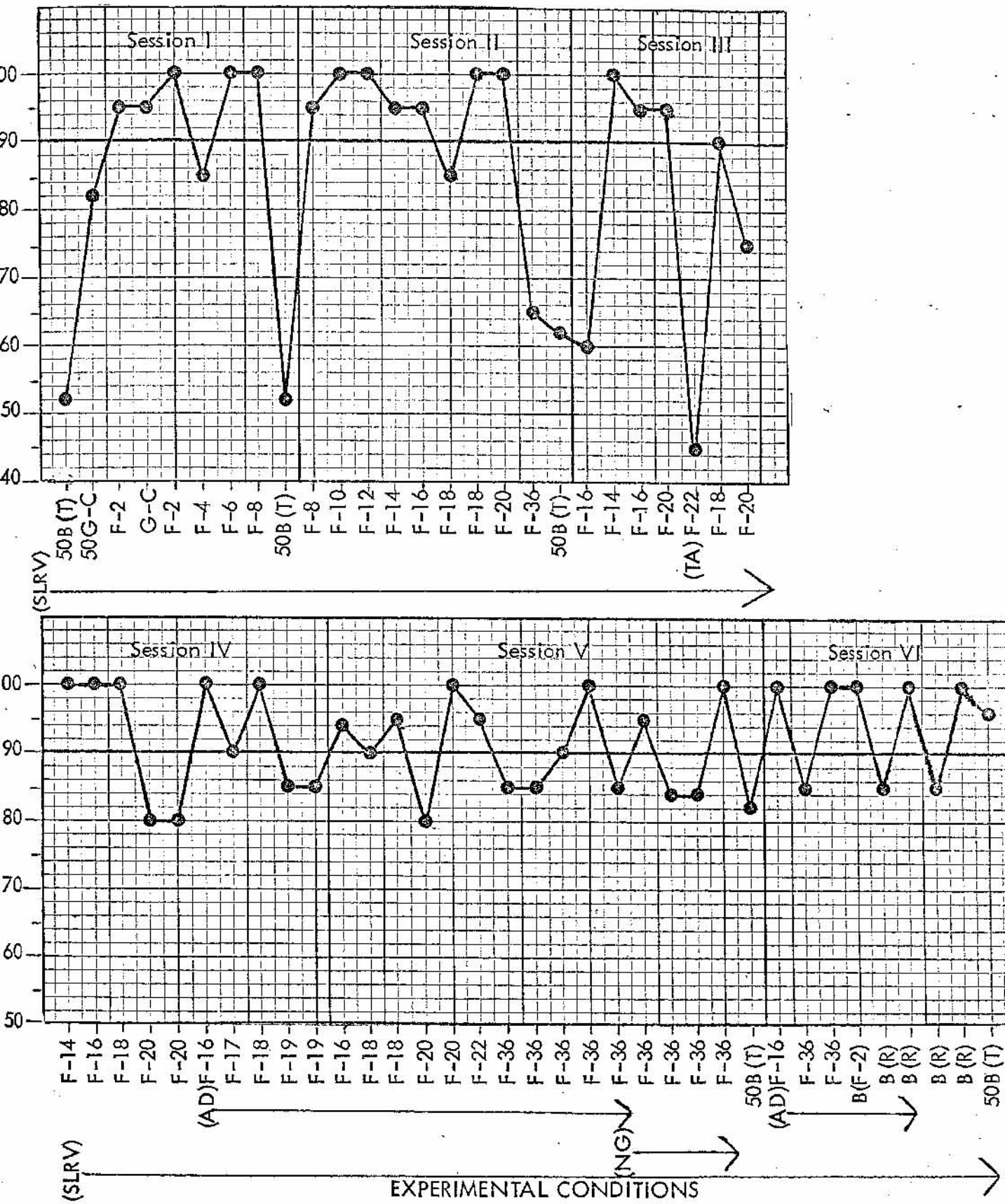

Fig. 10 Percent correct responses of S-9 within varying experimental conditions in the fading procedure.