

THE EFFECT OF CORRECTIVE AND SIGNAL FEEDBACK
ON ACADEMIC PERFORMANCE

By
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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iv
LIST OF FIGURES	vii
LIST OF CUMULATIVE RECORDS	viii
ABSTRACT	ix
CHAPTER	
I INTRODUCTION AND LITERATURE REVIEW	1
Effect of Feedback	1
Time as a Dependent Variable	6
Methodological Perspectives	9
Purpose of the Study	10
II DESIGN OF THE STUDY	12
Recording Methodology	12
Apparatus	15
Graphing	19
Subjects	20
Managers	20
Common Procedures	21
Individual Design	24
III RESULTS AND CONCLUSIONS	26
Description of Records	26
Recording Baseline	27

CHAPTER	Page
Experiment I	29
Experiment II.	40
Commentary on Results	50
Experiment III	52
IV DISCUSSION.	64
Implications for Education	64
Recommendations for Further Study.	68
APPENDIX A	72
APPENDIX B	73
APPENDIX C	74
APPENDIX D	75
REFERENCES	78
BIOGRAPHICAL SKETCH.	83

LIST OF FIGURES

Figure		Page
1	Sample cumulative record	14
2	Recording apparatus.	16
3	Back view of recording apparatus and switch box	17
4	Recording paper	18

LIST OF CUMULATIVE RECORDS

CR		Page
1	Subject 1: unit 2, sessions 1, 2	30
2	Subject 1: unit 3, sessions 1, 2, 3.	31
3.	Subject 1: unit 4, sessions 1, 2, 3.	32
4	Subject 1: unit 5, sessions 1, 2	33
5	Subject 1: unit 6, sessions 2, 3, 6.	34
6	Subject 2: unit 1, sessions 1, 2, 3.	41
7	Subject 2: unit 2, sessions 1, 2, 3.	42
8	Subject 2: unit 3, sessions 1, 2, 3.	43
9	Subject 2: unit 3, sessions 4, 5	44
10	Subject 2: unit 5, sessions 1, 2, 3.	45
11	Subject 2: unit 5, sessions 4, 5	46
12	Subject 2: unit 6, sessions 1, 2, 3.	47
13	Subject 2: unit 6, sessions 4, 5, 6.	48
14	Subject 3: unit 1, sessions 1, 2, 3.	53
15	Subject 3: unit 2, sessions 1, 2, 3.	54
16	Subject 3: unit 3, sessions 1, 2, 3.	55
17	Subject 3: unit 4, sessions 1, 3	56
18	Subject 3: unit 4, session 4.	57
19	Subject 3: unit 5, sessions 1, 2, 3.	58
20	Subject 3: unit 6, sessions 1, 2	59
21	Subject 3: unit 6, sessions 3, 4	60

CHAPTER I
INTRODUCTION AND LITERATURE REVIEW

One of the most elusive areas in the analysis of human behavior is that of academic performance. The complexities of human learning have led investigators to devise the most elaborate procedures and to design intricate analysis of experimental data.

Among the variables that have recently received renewed interest in educational research is the role of feedback on student's performance. Here, as in other areas in human learning, conflicting results are found.

Effect of Feedback

Anderson, Kulhavy & Andre (1972) have reported that the conflicting results might be caused by procedural differences. In one of the experiments cited in their study, it was possible for the subjects to copy the answers directly since the paper used enabled them to see the answers written on the next page (Krumboltz & Weisman, 1962). In two other studies cited by Anderson et al., the correct response was placed immediately after each frame, facilitating copying directly the correct answer (Lublin, 1965; Rosenstock, Moore & Smith, 1965).

In their study, Anderson, Kulhavy & Andre ,(1972) found that feedback facilitates learning when it is presented after the response is emitted. Their experiment consisted of presenting three groups with different amounts of feedback.

One group received no feedback, another received feedback after every frame and for a third group feedback was continuously in view. The programmed material consisted of 104 frames of a unit on population genetics. A copying program was also used with two other groups. This program was identical to the regular program but every frame was a copying frame. The copying program was given to two groups. One group received no feedback while the other group received feedback after their response to every frame.

The results were derived from a statistical analysis of performance on a criterion test. In their comparison between the group that received feedback after every frame and the group with feedback continuously in view, they found significant differences favoring the first group. No significant differences were found between the first group and the no-feedback group, although the first group performed better on the criterion test.

The results of this experiment by Anderson, Kulhavy & Andre ,(1972) are in agreement with the findings reported by the same investigators in a previous article (Anderson, Kulhavy & Andre, 1971).

Meyer, (1960) also found that knowledge of results

facilitates learning. In Meyer's experiment, the subjects were eighth grade students assigned to four experimental treatments. The educational content was presented via programmed textbook design to teach common prefixes. The text contained seven introductory lessons and twelve teaching lessons. A separate item was written on each page with the correct answer appearing on the next page beside the following item.

The procedures for the four experimental groups were as follows: For group A (16 S) the answers were omitted from the textbook. The experimenter corrected the answers after each class. Students in group B (15 S) scored their own answers by marking the incorrect item with an X. Group C (13 S) followed the same procedures as B but were also told to put a paper clip on the page with an incorrect response. Students in this group were given an opportunity to write another answer to the missed items after completing the lesson. The paper clip was removed if their second answer was correct. If the second answer was also incorrect they could return again to that item after they had made all the corrections. Group H (14 S) followed the same procedures of group B but their performance was not checked during their learning lesson.

The achievement measure was obtained by a prefix test administered as a posttest and as a pre-test. Achievement of group A was compared to that of group B and C. It was found that the absolute scores on posttest were

superior for groups B and C, and that the gain scores (i.e. differences between tests) was also significantly in favor of those groups. No differences were found between achievement scores of groups B and C. Posttest scores, amount learned, and number of errors made in completing the programs were equivalent for both groups.

Other investigators have reported contradictory results. Moore & Smith (1964) for example, reported that amount of feedback does not significantly affect performance. In their experiment, they randomly assigned 220 college students enrolled in two sections of an introductory psychology course into ten groups. Two groups were assigned to each of five experimental conditions. The feedback conditions were as follows: 1) no knowledge of results (only the stimulus material was presented in a teaching machine), 2) knowledge of what the correct response was (after the response was made, the correct answer appeared. The material was presented in a teaching machine), 3) knowledge of correct response (a teaching machine was used and a flashing light was presented immediately after the correct response), 4) knowledge of results plus extrinsic reward (each correct response earned one penny. The teaching machine was used), 5) immediate knowledge of what the correct response was (material presented in programmed text. Complete confirmation). One group in each treatment received multiple-choice items while the other received constructed response items.

The materials used were 1152 frames of a programmed text in introductory psychology. Three answers were provided for each frame under the multiple-choice format. (Version of Holland & Skinner, The Analysis of Behavior, McGraw-Hill, 1961.) Two tests were administered to all the experimental groups. One test consisted solely of constructed response items, while the second test had multiple-choice and constructed response items alternatively.

These investigators found no significant differences when they compared the differences in mean scores on each of the two tests as a function of the types of feedback provided. Nor was there any difference to be accounted for by response mode. An interesting finding from the experimental data in this study is that a significantly higher score on the multiple-choice test items was obtained by both the multiple-choice and the constructed-response groups.

In view of the previous presentation, it is not surprising that in a major review effort, Geis & Chapman (1971) found so much disagreement in the results reported in the literature. Indeed, the only consistent finding throughout the article is that the results of published research in the area are at best ambiguous. Among the areas reviewed by Geis & Chapman are those of: 1) feedback vs, no feedback, 2) schedule effects of confirmation, and 3) delay of confirmation. Their review of kind of feedback finds the same contradictory results. Some researchers

find that the kind of feedback used does not affect learning (Melaragno, 1960; McDonald & Allen, 1962; Bivens, 1964). On the other hand, some researchers find that kind of feedback does affect learning (Krumboltz & Bonawitz, 1962; Gilman, 1968).

In reference to their review Geis and Chapman stated that: "It could be argued that the reinforcing effect of confirmation is subtle and that the experiments cited have not been sensitive enough in terms of design or the measures of the dependent variable" (p. 45).

Time as a Dependent Variable

The lack of a satisfactory dependent variable has been repeatedly held responsible for retarding progress in a scientific field (Skinner, 1953, 1968b, c). The comment is certainly applicable to the field of education.

Recently some investigators have turned to time measures in an attempt to find a suitable dependent variable. At a global level, Carroll, (1963, 1971) has argued for a learning model based on time measures. This position was supported by Bloom, (1968) in an often quoted article on mastery learning.

Brooks, (1961) suggested the use of time measures at the molecular level. In his study with programmed materials, latency measures were obtained as part of the experimental data. He found that "longer latencies tended

to go with errors." His findings was supported in recent research (Berman & Villwock, 1971).

Time measures were used by Brooks and his colleagues in a number of subsequent experiments (Brooks, 1965, 1969; Brooks, Clark & Park, 1967; Brooks, Clark & Brown, 1969; Brooks & Clark, 1969). A variety of experimental questions were answered through an analysis of the obtained measures.

In one of Brooks experiments (1965) faster question answering resulted from the use of an automated shaping procedure. Subjects were presented with a filmed version of The Analysis of Behavior (by J. G. Holland and B. F. Skinner, 1961). Their answers were recorded by pressing a key corresponding to the first letter of their answer word or the first letter of the last word if more than one word was included in the frame. A preset time value was estimated for each question. It was possible to score, automatically, correct answers given before the present value had elapsed.

Subjects were paid one cent for each correct answer and another cent for the correct answer emitted before the present time for the question had elapsed. The procedures were statistically reliable. On the first presentation of a lesson, an increase in speed was found.

An interesting result was that on subsequent presentations of the same lesson, the trend did not continue. The subjects answered questions faster at times and slower at other times.

Outside of the programmed instruction area, a number of investigators have used time measures in a wide variety of research endeavors. The use of these measures in the area of memory and pair-associate learning are well known (Levy & Benson, 1969; Levy & Lam, 1971a, b). In concept formation, Siegel (1964) has suggested an analysis of response latencies as a further behavioral datum for an increased understanding of that area. The list is almost endless. But even the identification of a suitable dependent variable did not satisfy some investigators.

In 1964, Suppes commented on the small amount of systematic work that had been done using response times. The remark still applies. One reason that may account for the lack of systematic research after a suitable dependent variables had been identified was given by Judd and Glaser (1969). These researchers stated that a "disadvantage of latency measures is their wide variability between Ss and from trial to trial for the same subject" (p. 2).

No other statement would make a happier educational research. The experimental analysis is reduced to tracking down the sources of variability and manipulating the relevant variables in a systematic fashion to understand their effect on performance.

Now time has been identified as a satisfactory dependent variable, but a question arises as to the applicability of statistical analysis to the data generated by one individual for an extended period of time. The effects of the variables

may be hidden by such an analysis (Sidman, 1960). There are alternative approaches to data analysis that may be more germane to an understanding of the effects of independent variables at the individual level. A statistical analysis may be replaced by much simpler observational procedures (Skinner, 1966). The analysis of data in the preset experiment has been widely practiced and thoroughly described (Baer, Wolf & Risley, 1968).

For a precise analysis of the type used in this paper, the discovery of a sensitive dependent variable does not suffice. Attendant methodological procedures to data gathering and presentation are just as important.

Methodological Perspectives

The psychological area dealing with the analysis of behavior is providing educators with new ways of looking at old problems. Methodologically, the emphasis is placed on the individual organism. The research efforts in the analysis of behavior are directed towards the development of a true scientific discipline. The variables which affect the behavior of the individual organism are studied directly and continuously.

Attention is redirected to the relationship between observable environmental events and changes in performance. The analysis of behavior has steered investigators away from advancing mentalistic constructs to account for the

behavior of the organisms, and it has developed an effective methodology by which the behavior itself can be measured and analyzed directly (Skinner, 1953).

The new perspective frees educators from the masterful art of guessing the results that an instructional procedure will have on a given individual and directs them towards the more productive frontier of precisely ascertaining those results on each individual. Research at the college level (Keller, 1967, 1968; Ferster, 1968; Pennypacker, 1969; McMichael & Corey, 1969; Sheppard & Mac Dermott, 1970; Myers, 1970; Johnston & Pennypacker, 1971; Born & Herbert, 1971; Born, Gledhill & Davis, 1972; Alba & Pennypacker, 1972) has provided a fresh view on the effectiveness of applying to education the principles derived from the experimental analysis of behavior. However, even in the area of behavioral college teaching, no emphasis has been placed on a detailed analysis of the variables that influence a student's performance.

A seemingly influential variable on student's performance is that of providing immediate feedback. Some of the research reviewed was conducted to assess the effect of this variable.

Purpose of the Study

The purpose of this investigation was to determine the effects that type of feedback has on individual

performance in a systematic fashion similar to that which has proven effective in the area of the experimental analysis of behavior. The two types of feedback to be used in the present experiment are 1) immediate corrective feedback, in which the correct answer is provided to the subject immediately after he emits a response, and 2) immediate signal feedback, in which a buzzer signal is activated immediately after the subject emits an incorrect response. Feedback is defined as the response contingent stimulus that affects the future probability of the response on which the stimulus was contingent. The proposed research offers an approach in which individuals are studied in their own right and will provide a data base for truly individualized programs in education.

The significance of this type of research lies in the discovery of how selected independent variable affect a student's performance. Furthermore, the use of a recording technique which can afford a continuous and precise record of student's performance should prove valuable to an area which stresses a search for the relationships between observable environmental events and changes in individual performance. Such a recording technique is now available (Alba, 1972) and will be used in the present study.

CHAPTER II
DESIGN OF THE STUDY

Recording Methodology

The systematic study of human academic learning necessitates a recording methodology sensitive enough to detect changes in performance due to experimental manipulations. The recording procedures to be used in this research have been found to have the sensitivity and precision required to detect such changes in performance (Alba, 1972).

Briefly stated the duration of each component in a performance movement is measured in real time. One component of a performance movement is the stimulus (question). Another component is the response. The third component is the time which elapses between the termination of the stimulus and the initiation of the response. A complete performance movement consists of these three components.

Changes in the temporal variability of any one of the components become the important variables. With a research methodology that stresses the experimental study of the sources of variability, a recording procedure which detects such variability, is extremely helpful. The analysis is narrowed to an examination of the effects that experimental manipulation have on the individual student's performance.

A time measure, however, does not provide a complete assessment of performance since it ignores the accuracy of the responses. For a more complete analysis, correct and incorrect responses are also recorded.

A graphical display of the data is important in assessing the magnitude of the changes brought about by the introduction of the independent variables. The most efficient and precise graphical display is obtained through the use of a cumulative record. An individual cumulative curve is generated for each of the components in a performance movement.

There is an additional curve that can be recorded as easily as the three components curves. The interresponse duration (interval between the termination of a response and the initiation of the next stimulus) may be of interest in certain experimental designs; however, it is not considered here because it is not an intrinsic component of a performance movement.

All charts obtained in this study will have the same dimensions. Each unit on the ordinate represents a different performance movement. The distance between each movement will be the same. The horizontal displacement will represent elapsed time. Incorrect responses are recorded on the ordinate at the point corresponding to the performance movement in which the response occurred. A sample cumulative record is shown in Figure 1.

As important as the knowledge of what data will

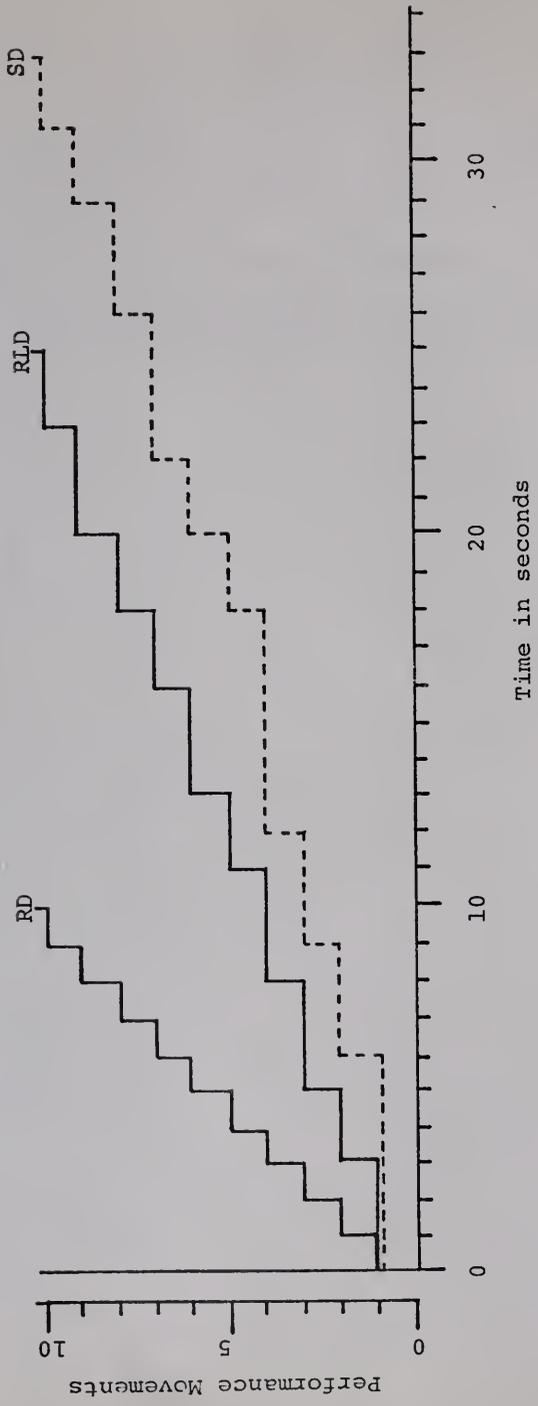


Figure 1 Sample cumulative record.

be useful in an experiment is how to obtain the data. A recording apparatus was designed to generate the necessary records.

Apparatus

The recording apparatus (See Figure 2) consisted of an Esterline Angus Graphic Recorder (Model A 620x). The Esterline has twenty recording pens and feeds paper at a constant rate which can be adjusted. The pens are fixed in sequence and leave an ink mark as the paper moves in a downward direction. The movement of the pens, when activated, is restricted to a sideway motion. The recording paper used was the Esterline Angus Record Chart #17120 C (See Figure 4). An aluminum box of approximately 5" x 3" x 2" with four relay switches controlled by outside buttons was connected to the recording equipment (See Figure 3). Each switch activated one of four pens. Other boxes could have been connected if more than one session was being run. It was also possible to use the same recording roll up to four times by merely connecting the recording box to successive sets of pens.

The pens were activated consecutively and their deflections were maintained for the duration of the component being measured. Pen 1 recorded the initiation of each complete performance movement. It was operated and immediately released at the beginning of the movement. Pen 2 was activated for the duration of the first component and was released at the



Figure 2 Recording apparatus.

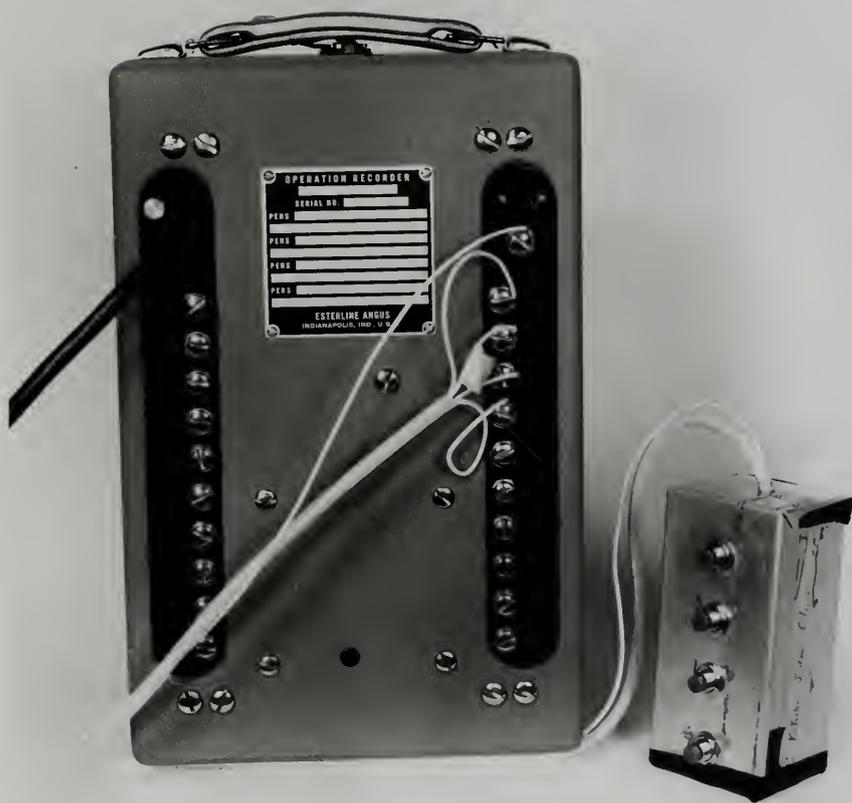


Figure 3 Back view of recording apparatus and switch box.

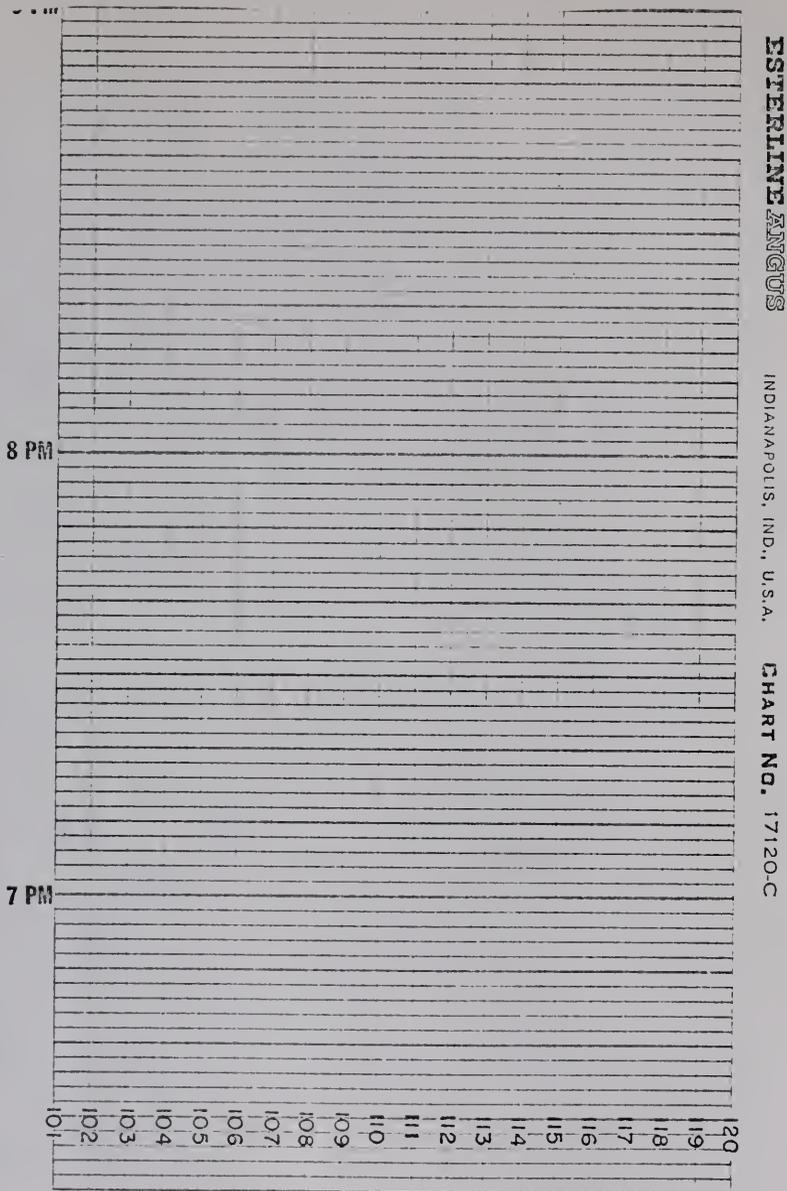


Figure 4 Recording paper. Distance between horizontal bars was transverse in one second by recording pens.

termination of that component. The record left by Pen 2 from the point it returned to its normal position (after recording the first component) to the point where Pen 3 was activated indicated the duration of the response latency component. Activation of Pen 3 measured the response duration. Pen 4 was used both to indicate incorrect response and to operate a buzzer signal.

After the performance was recorded with the equipment just described, the data was collected and transferred to cumulative graphs. The next section describes the graphing procedures.

Graphing

Each roll was removed from the recorder upon its termination. Since the speed of the recorder was constant, the distance between two horizontal bars of the charts was transversed every second. The duration of each component was transferred into numerical form and the amounts were written on a form developed for this purpose (See Appendix A).

At the beginning of each session the student manager would write down on the record chart the name of the student, the unit and the session on which he was performing. Thus, there was no confusion as to whom each record belonged.

A computer program was developed to generate the cumulative charts. The input data was keypunched on IBM

cards with the following information: 1) Subject number, 2) Unit and session number, 3) Duration in seconds for each component, 4) The number of those questions answered incorrectly. The program output consisted of the labeled cumulative charts which are used in this study. The charts were generated by a CALCOMP 563 incremental line plotter driven by an IBM 1401.

Subjects

The subjects participating in this experiment were volunteers. They were enrolled in a junior level course in human growth and development at the University of Florida.

Each one of the three subjects used in this study was assigned to an individual experimental procedure. They were told that class attendance was no longer required and were informed on the procedures to be followed.

Managers

The use of students to record subject's performance and to implement experimental procedures has been widely reported in the recent literature on learning. Some researchers have used the name proctor to designate these students (Born & Herbert, 1971; Born, Gledhill, Davis, 1972) while others have used the term managers (Jonnston & Pennypacker, 1971; Alba & Pennypacker, 1972).

Three managers were selected from a group of volunteer students not enrolled in the same class as the subjects. They received four quarter-hour credits at the end of the experiment. Each manager was assigned one experimental subject and was told to work with that subject only.

Pre-experimental training sessions were conducted. In these sessions the managers learned to record performance, fill out data forms, and transfer recorded data to numerical format.

Common Procedures

The experimental space consisted of an 8' by 10' well-lighted, soundproof room. A 5' by 3' table was set in the middle with one side against the wall. The recording box was placed on that table. An adjacent room was used to keep the event recorder, stimulus material, recording rolls, and data forms.

The subject and manager sat across the table from each other during the performance sessions. Managers were instructed in the use of the recording equipment and were given practice sessions before the actual experimental session. Their main task consisted of recording the duration of the components as the students progressed through the sessions. Their presence insured that the response would be emitted before feedback was delivered. In general, they were responsible for implementing the experimental procedures.

Before each session the manager would pick up the stimulus material and fill out the first part of the data form (See Appendix B). He would fill out the date, the unit, and session number of the performance. After the session, the manager would count the number of correct and incorrect responses and write in in the appropriate spaces in the form. He would then order the items in the same sequence and return them to the student if a repeat session was required.

The stimulus material was constructed response items (See Appendix B generated from textbook units.) The textbook used was Child Development and Personality by P. H. Mussen, J. J. Conger and J. Kagan (Third Edition, Harper and Row, New York). Textbook material was divided into seven units. Each unit was composed of two chapters except unit seven which consisted of the last three chapters in the book.

There were thirty questions (See Appendix D) per unit and they were always presented in the same sequence. The questions were typed on individual 3" by 5" index cards with the correct responses appearing on the reverse side.

The subjects were to sit at the table and hold the thirty cards in their hands in front of them. Cards were read and answered one at a time. They were placed on a different pile depending on whether they were correctly or incorrectly answered.

During the session the subject was expected to read the complete question aloud and to emit an audible response.

They were told to answer all questions in the sequence in which they appeared. The subjects knew on what material they were going to be tested and were able to study before each performance session.

A session was completed after the response to the last question was emitted. A new session was immediately started if the subject did not attain performance criterion. Criterion for successful completion of each unit was errorless performance. Sessions were repeated as many times as necessary, up to a maximum of five times, or until the criterion was achieved.

To earn a grade of A subjects had to achieve criterion level on all units. Their grade was based on their performance and there was never any mention of grades lower than A. All students achieved criterion in all units by the end of the academic quarter. The students were given five quarter-hour credits for successful completion of course requirements.

The subjects were instructed to schedule performance sessions with the same manager every week. The scheduling forms (See Appendix C) were completed a week in advance. Both subjects and managers were responsible for keeping their appointments. If criterion was not achieved in the first five sessions, the subject was told to sign for another session on a future date. Upon his return he was asked to perform on the same unit until unit criterion was attained.

Although these procedures were followed with all

subjects, there were additional procedures which were implemented according to the design of each experiment. The following sections deals with the additional procedures and the individual experimental design.

Individual Design

Feedback was administered in two ways. During corrective feedback phase the subject, after responding, was allowed to look at the back of the card for a correct answer. In case of an incorrect response, a buzzer was sounded.

For the signal feedback phase, only the buzzer was used to signal an incorrect response. The subject was not allowed to look for the correct answer regardless of whether or not he emitted a correct response.

The type of feedback used on every unit was predetermined but the subjects were not advised as to the feedback procedures under which they would perform. The individual experimental design was as follows.

Experiment 1

In experiment one the subject was given corrective feedback on units 1, 2, 3, and 5. On units 4 and 6 he received signal feedback.

Experiment 2

In experiment two the subject was given corrective

feedback on units 1, 2, and 4. He received signal feedback on units 3, 5, and 6.

Experiment 3

The requirement to read the complete question was foregone in this experiment. The subject was allowed to stop reading if he felt he had the correct answer. In order to measure the stimulus duration component, the recorder was activated as the cards were picked from the pile rather than as he started reading.

In this experiment, the subject was given corrective feedback on units 1, 3, and 5. Signal feedback was given in units 2, 4, and 6.

CHAPTER III

RESULTS AND CONCLUSIONS

Description of Records

The results of the present experiment are depicted in cumulative graph form. The graphs will be referred to as cumulative records (CR) followed by a number (e.g., See CR 1).

It will be of benefit to the reader to be acquainted with some of the conventions used in generating the records. The horizontal axis is divided into four hundred equal units with an equivalence of one second per unit. The vertical axis is divided into thirty equidistant increments each symbolizing a different performance movement. There is a one to one ratio between units on the vertical axis and units on the horizontal axis. Error marks are located inside the vertical axis at the points where the incorrect responses occurred.

Although three curves were plotted, only two different types of line were used. The stimulus duration (SD) component curve was represented by the dotted line. The response latency duration (RLD) curve and the response duration (RD) curve were both represented with solid lines.

To distinguish between the RLD and RD curves, it should be indicated that the RD curve stayed closest to

the vertical axis throughout all sessions since the duration of the responses to the constructed response items were very short. The RLD curve, on the other hand, showed the greatest amount of variability and ranged widely from session to session.

In some graphs, the RLD and RD curves were superimposed and were represented as one curve. The reason for this procedure is that a minimum of one second was arbitrarily chosen as the shortest duration for any component.

In some cases, the cumulative durations of the response latency component were longer than four hundred seconds. Those cases were represented in separate graphs containing only one curve.

Some data were lost due to apparatus malfunction. The loss of the cumulative records will be compensated somewhat by the presentation of supplementary information on the sessions missed.

It is expected that the foregoing explanation will help in the interpretation of the experimental data to be presented in this study. Before embarking in an analysis of data, however, a word should be said about behavioral baselines.

Recording Baseline

One of the major problems of research in human

learning is the selection of an appropriate baseline against which to assess changes brought about by the introduction of the independent variable. The problem is compounded as the experimental settings approximate the environment in which learning takes place routinely (as with ongoing classes) since total control of irrelevant variables is difficult to exercise.

Investigators in the field of learning have been mainly interested in studying the acquisition of new behaviors. They have assumed that the level of the acquired behavior was originally at zero. It is doubtful whether this is ever the case. Greater than zero baselines, however, can be used to study behavioral transitions just as well as zero level baselines and with the possibility of greater generalization. Behavioral transitions to reach an asymptotic level are no more a specialized case than transitions from one pattern of behavior to another.

Other workers in the field of learning have acknowledged the existence of baselines at greater than zero level but in assessing the speed of the transition (or the amount learned) have performed a simple subtraction of the baseline level from the final state. The simple calculation may be misleading since "the properties of acquisition are a function of the prior state of the behavior" (Sidman, 1960, p. 119).

Baseline in the experiments reported here was obtained in the first performance session of the subject on every unit.

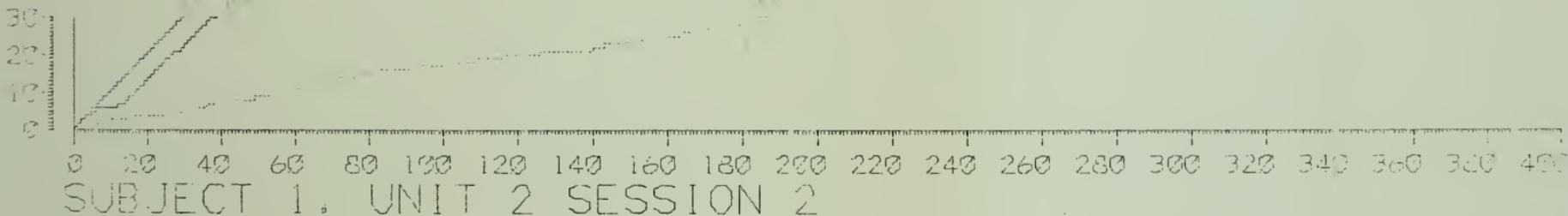
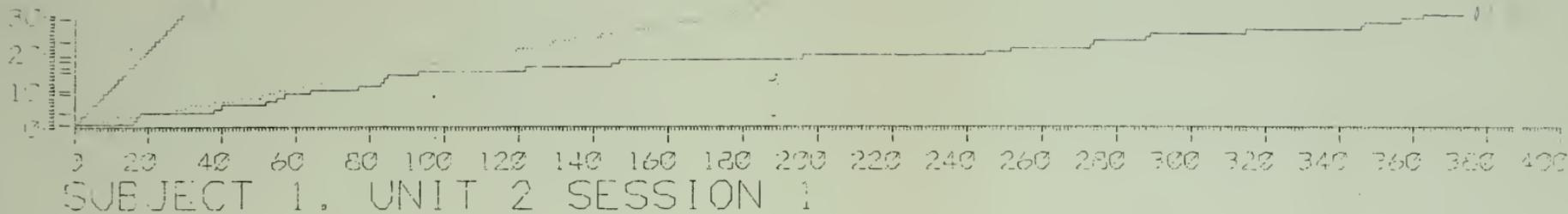
At that time, the subject had an opportunity to study the material not knowing the questions that would be presented. It was assumed that emitting his best performance on the first session could only have been to the subject's advantage since by achieving criterion he could have proceeded to the next unit. Thus, the behavioral baseline obtained reflected his knowledge at the time of the first session. Changes in the duration of the components on succeeding sessions of the same unit were considered to be due to the effects of the experimental manipulations.

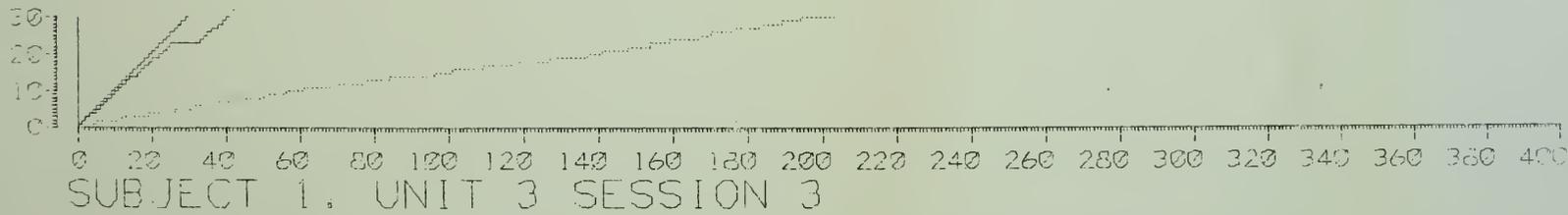
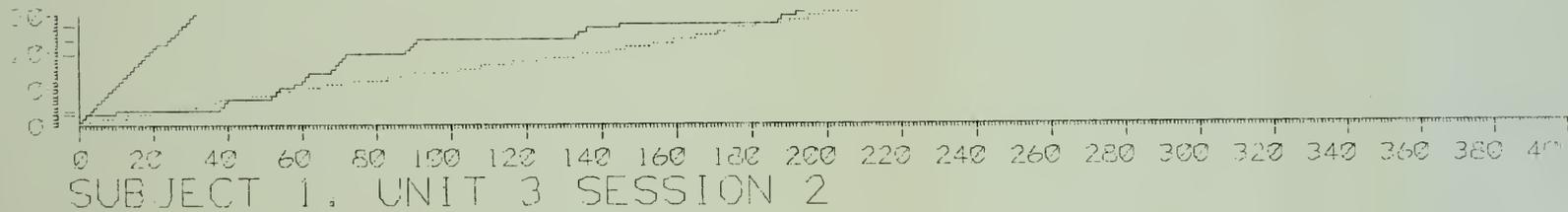
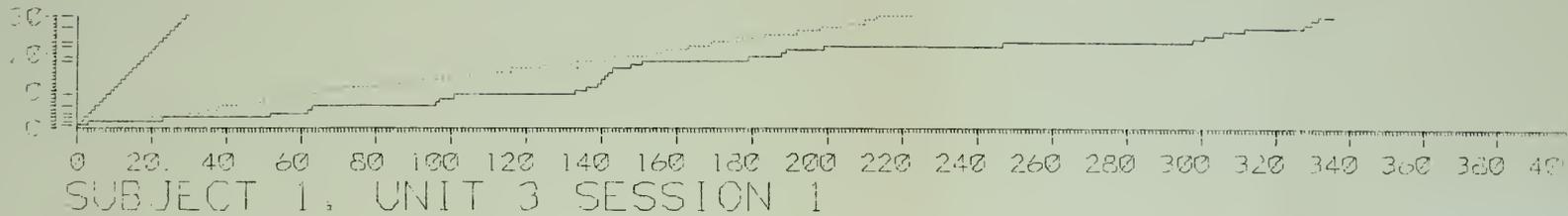
Experiment I

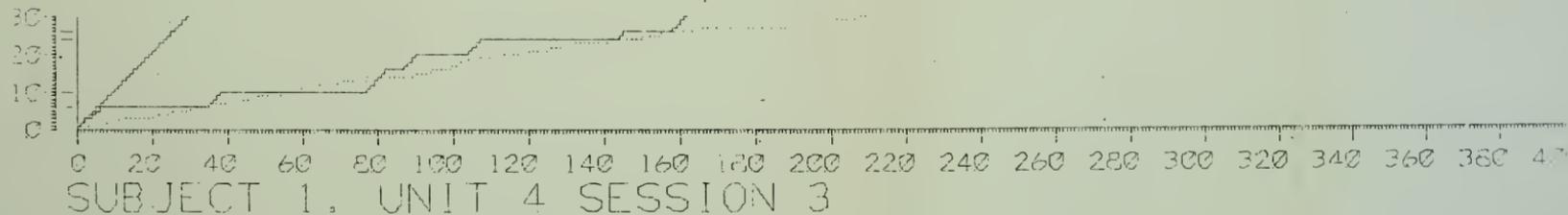
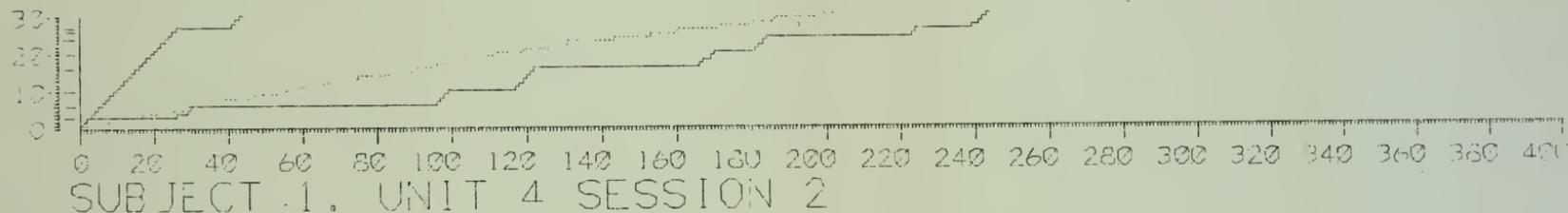
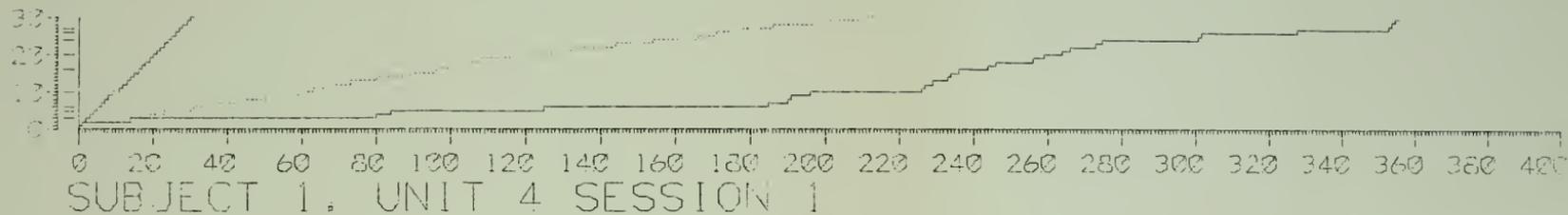
The performance of subject 1 is displayed on CR's 1 through 5. No data were obtained for this subject on unit one.

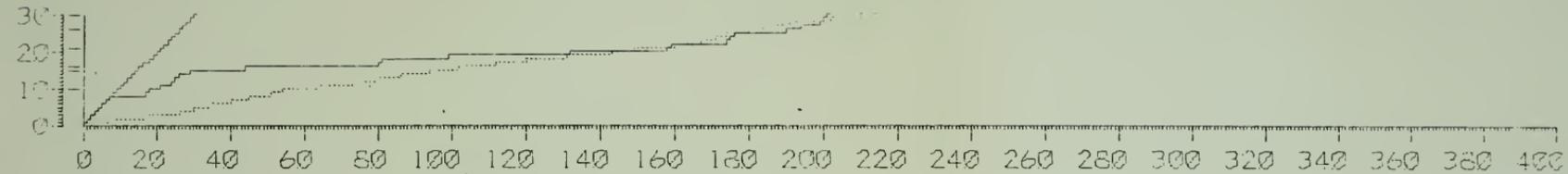
Total number of sessions for unit 2 is presented in CR 1. The subject achieved criterion in two sessions. There is a marked acceleration in the RLD component curve coupled with a substantial increase in the number of correct responses. The procedure of administering immediate corrective feedback (ICF) seems to have been very instrumental in bringing his performance to a high level of proficiency.

As it would have been expected, the SD and RD curves show remarkable stability from the first to the second session. The stability of these curves, however, may also be the result of the experimental procedures as will be presented later.

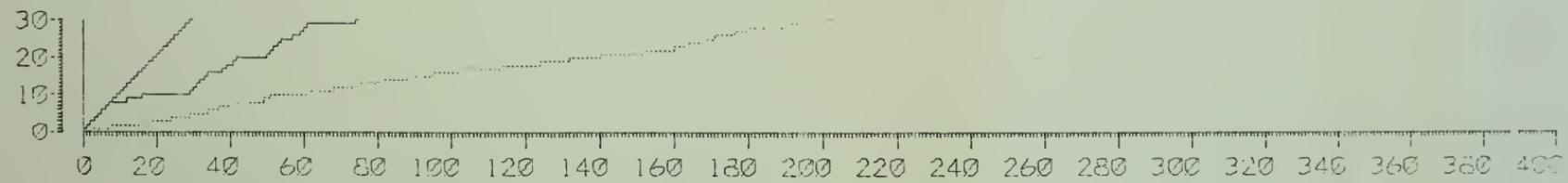




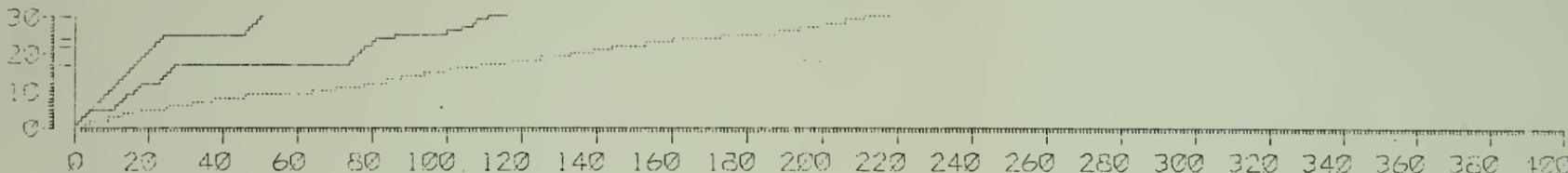




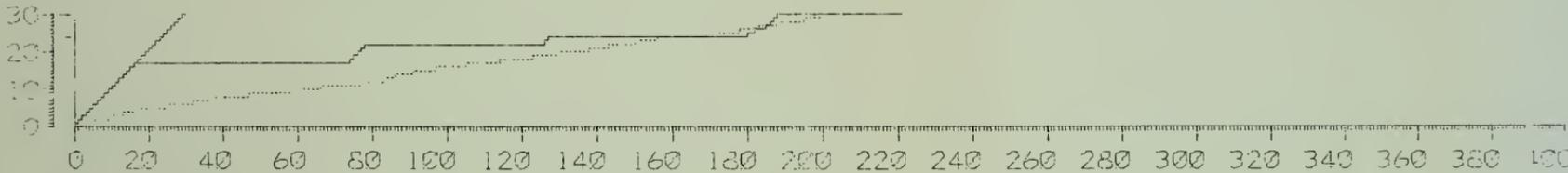
SUBJECT 1: UNIT 5 SESSION 1



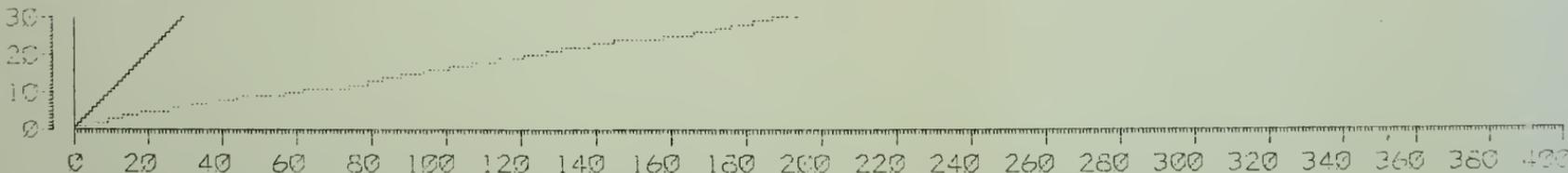
SUBJECT 1: UNIT 5 SESSION 2



SUBJECT 1, UNIT 6 SESSION 2



SUBJECT 1, UNIT 6 SESSION 3



SUBJECT 1, UNIT 6 SESSION 6

For unit 3, ICF is still operational. Here the changes in RLD are slower (See CR 2) but in the same direction as in unit 2. Three sessions are necessary to achieve errorless performance and the increase in frequency of correct response is gradual.

The SD and RD curves continue to show marked stability although minute changes can be observed. A small sustained acceleration can be seen in the SD curve from session to session. The RD presents a small deceleration from baseline on question 23 of session 2 but returns to baseline level on the following session.

Some of the data on unit 4 were not transferred to cumulative form due to an oversight of the manager. Data for this unit, however, is complete and will be included in the narrative. It took the subject six sessions to achieve the stipulated criterion. Only the first three sessions are depicted in CR 3.

Unit 4 was the first unit in which the subject was given immediate signal feedback (ISF). Changes in RLD curves were the most gradual seen so far. After session 3, the curve seemed to freeze. The duration for the RLD curve for sessions 4 and 5 were 165 and 153 seconds respectively, with an abrupt decrease in duration (38 sec.) in session 6. It should be remembered, however, that after session 5 the subject was allowed to stop performance and asked to return at a later date.

An interesting result emerging from the data in this unit is that concurrent with the gradual changes in RLD, there

is a fairly restricted increase in the number of correct responses. Furthermore, the same four questions missed by the subject on session 3 are also missed on sessions 4 and 5. In fact, from the first session those questions were incorrectly answered.

Apparently, the procedures in ISF do not provide the student sufficient information to alter his responses effectively. Since the correct alternative is not provided purposefully, the subject may emerge with the correct response in one of two ways. It may be provided to him unwillingly in the stimulus material, or he may stumble across it by trial and error. Either procedure would, of course, result in the same outcome: the emission of the correct response which could be considered to operantly alter his environment.

In the present case, the correct response to the four questions missed by the subject could not be found in the stimulus material (since he was unable to furnish the correct answer). One plausible alternative is that he emitted different responses in search of the correct answer. His behavior in this instance is not too far removed from the behavior of a lower organism placed on an extinction schedule.

Once more the SD and RD curves remain stable. Actually the stability is maintained throughout all six sessions in this unit except for an increase in duration in RD for item 27 of session 2.

Performance on unit 5 (See CR 4) is similar to that exhibited on unit 2. Two sessions were sufficient for the subject to achieve criterion. There are also certain dissimilarities between the two records that should not be overlooked. The baseline performance in unit 5 differs widely from that of unit 2. The transitions are, as would be expected, also different; but the variability is as amenable to analysis as it would be if a zero baseline level had been assumed.

Differences in RLD curves between sessions 1 and 2 are small. This could be partly due to the state of the baseline curve. There is a substantial increase in the number of correct responses while the SD and RD curves remain stable.

Cumulative records for sessions 1, 4, and 5, on unit 6 could not be obtained. CR 4 shows the records available for that unit.

The ISF procedures were implemented once more for this unit. Although the records are incomplete, it is still possible to analyze the remaining data taking into consideration that the transitory phases can only be assumed.

The only continuous transition is from session 2 to session 3. For the first time there is a reversal on the usual pattern. The RLD curve shows a deceleration while the frequency of correct responses presents a small increase. This result is difficult to explain. The best way to analyze

the findings is to track the sources accountable for the variability. The longest durations are directly related to items 17, 22, 24, and 30. Checking the previous performance (baseline in the present case), it is found that those were the exact same questions missed in session 2.

A possible explanation for the results may be similar to that given for the performance in unit 4. Here the procedure forces the subject to emit the correct response by simply informing him that the answer given previously to that question is incorrect. The effort required to emit an alternative response is measured in time and accounts for the variability in RLD.

The pattern may be typical for this subject under the same procedures. A further check revealed that on unit four the questions which the subject missed on sessions 3 through 5 also accounted for the longest RLD's.

On sessions 3 and 4 the same two questions (24 and 30) were missed. Item 30 was again answered incorrectly on the last session for that day. Upon his return to the laboratory, the subject answered all questions almost immediately. Similar performance by the subject was observed in Unit 4.

The results obtained from subject 1 indicate that there is a differential performance due to the type of feedback presented. The type of feedback provided by the experimental procedures has a direct effect on subsequent performance. Information as to the correctness of a response

does not suffice when the goal is one of teaching. It is concluded that immediate corrective feedback facilitates learning and saves time and effort.

The difference in performance is not only seen in an increase in the number of sessions to achieve criterion but more evidently in a distinct behavior pattern. Under ICF the typical performance consists of a reduction in RLD with a simultaneous increase in frequency of correct responses. Typical performance under ISF shows a radical departure.

During the beginning sessions there may be a reduction in RLD but at a certain point the reduction either freezes or reverses to longer durations for the items missed. Frequency of correct response also show a decrease but stops short before performance criterion is achieved.

It is interesting to note that the subjects seem to be working to reduce errors without regard to time. This is a direct result of the criterion imposed. The temporal differences emerge with extreme clarity under ISF because of the subject's inability to reach an asymptotic level. Changes in the criterion should produce related changes in performance.

There is a possibility that the results obtained in this experiment were not due to the type of feedback administered. An alternative conclusion is that the units on which Subject 1 performed influenced the outcomes. A second explanation may be that the results were due to a

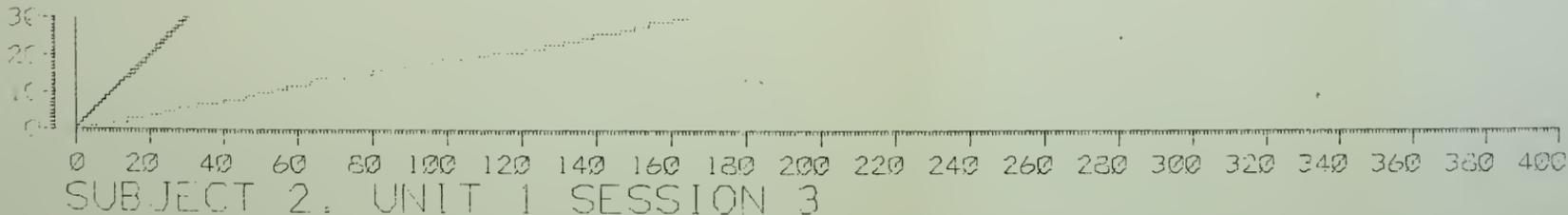
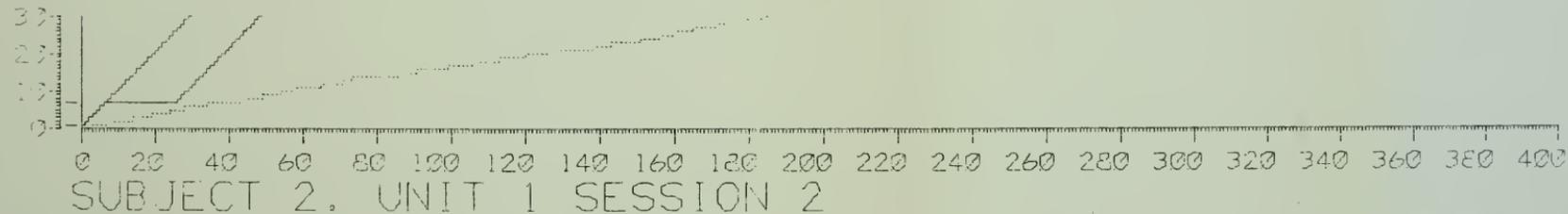
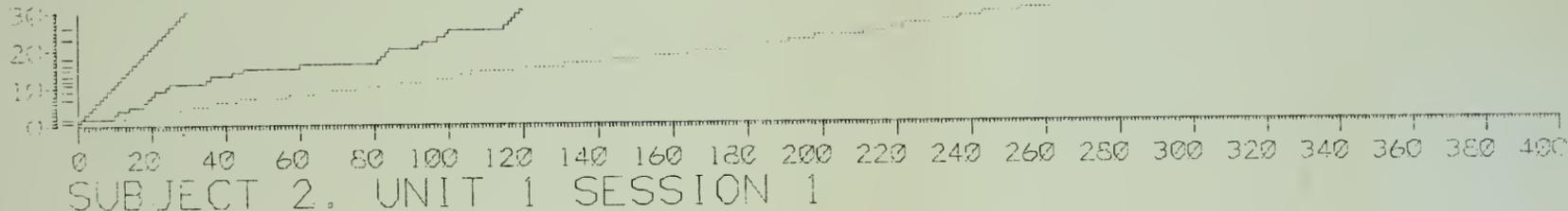
simple interaction between the subjects performance style and the experimental procedure. This conclusion would not detract from the importance of the findings, but would reduce their generalizability. To test for these alternative conclusions Experiment II was designed.

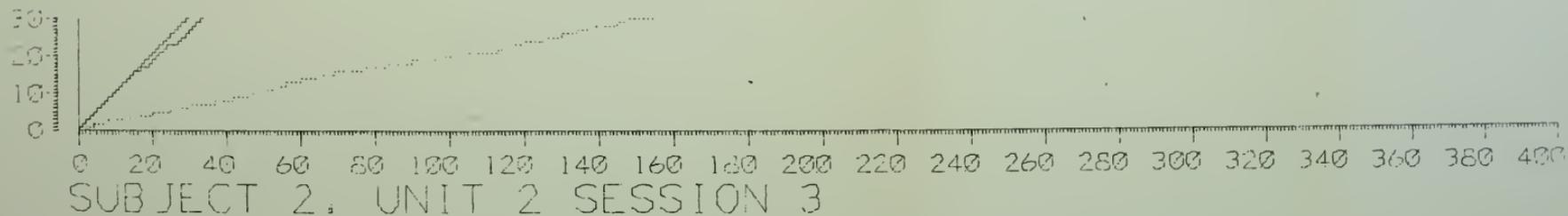
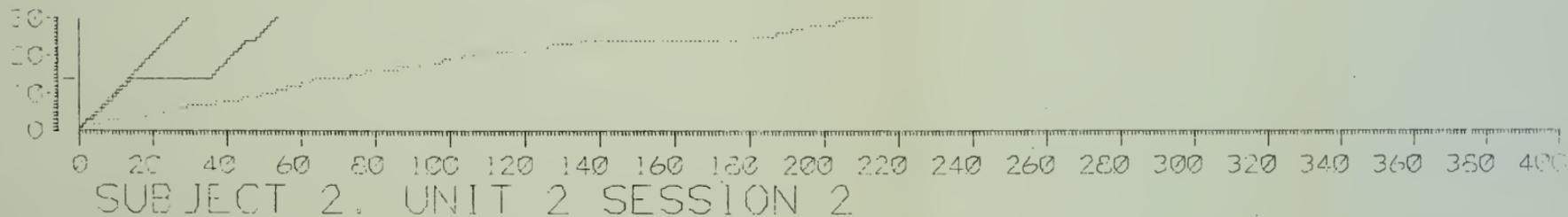
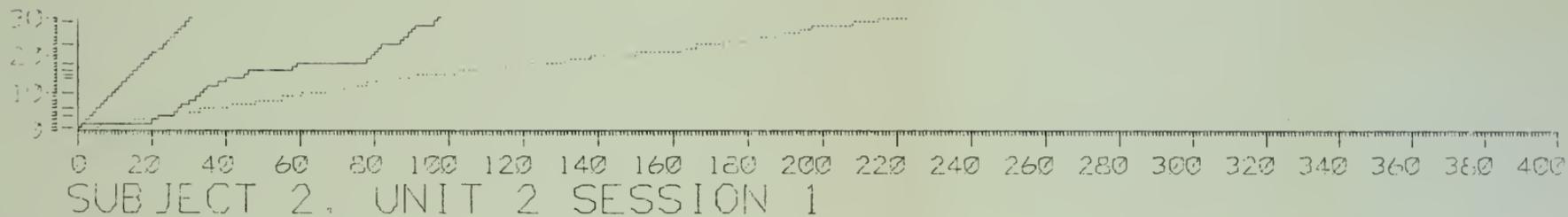
Experiment II

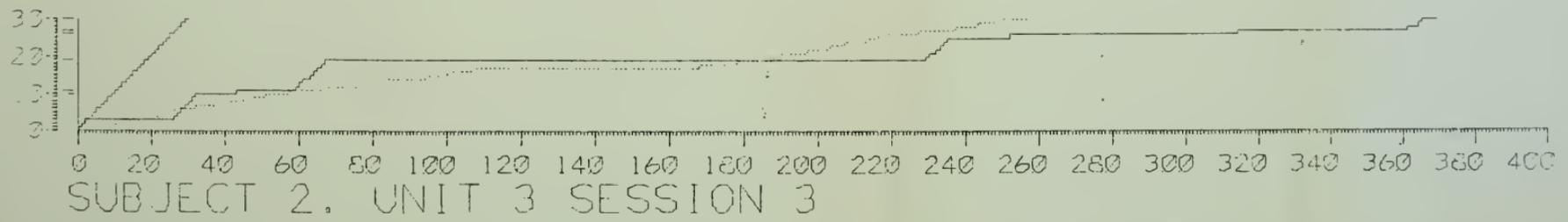
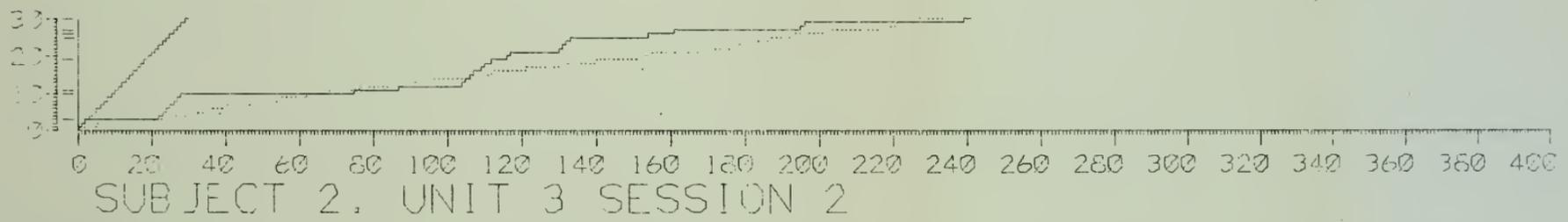
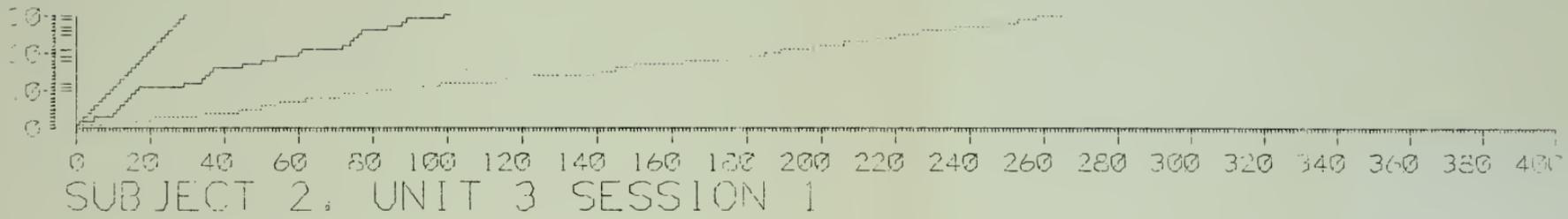
The experimental procedures were implemented on different units for subject 2. CR 6 through 13 show his performance on all units.

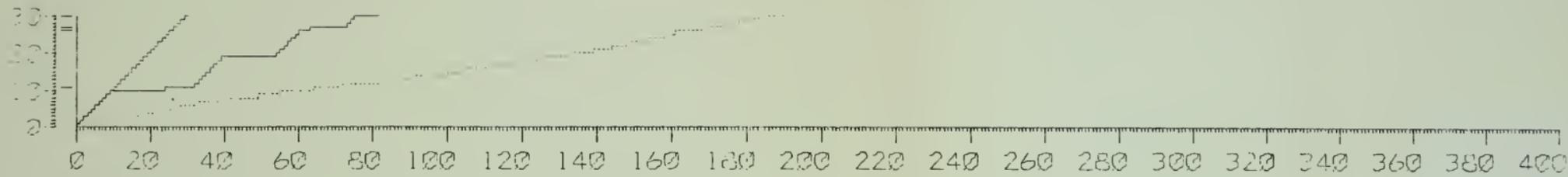
Performance on unit 1 is displayed in CR 6. Frequency of correct responses present an abrupt increase between the first two sessions. Only three sessions are necessary to achieve criterion. The RLD curve shows the pattern that was typical for subject one under the same conditions. There is a continued reduction in RLD. The SD curves shows the most marked reduction seen yet. This may be the result of an individual performance style where the subject covertly tries alternative responses as he reads the questions. After the questions achieved control of the response the reading pace quickens.

ICF is still operational during unit 2 (See CR 7). Again there is a substantial increase in the number of correct responses from session 1 to session 2. The RLD curve continues to show the reducing trend typical under the ICF procedures. For this subject the SD curve once more shows an acceleration.

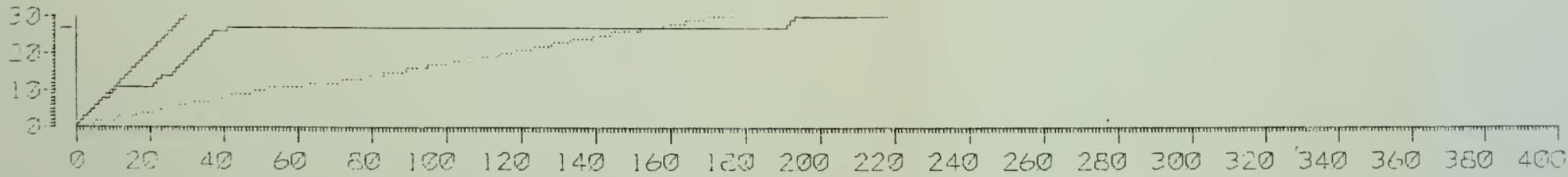




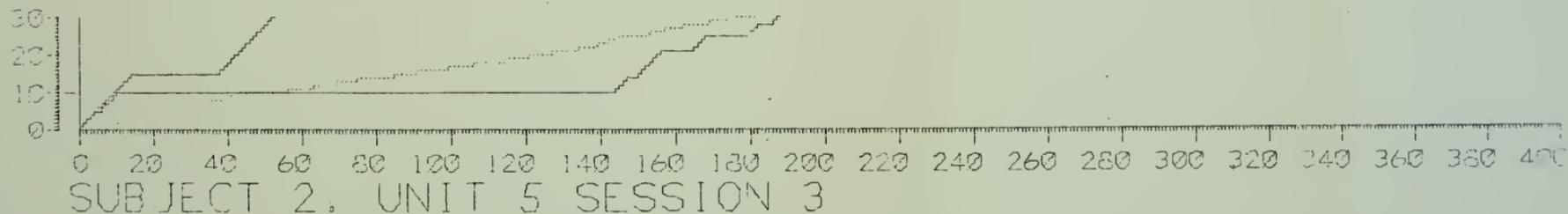
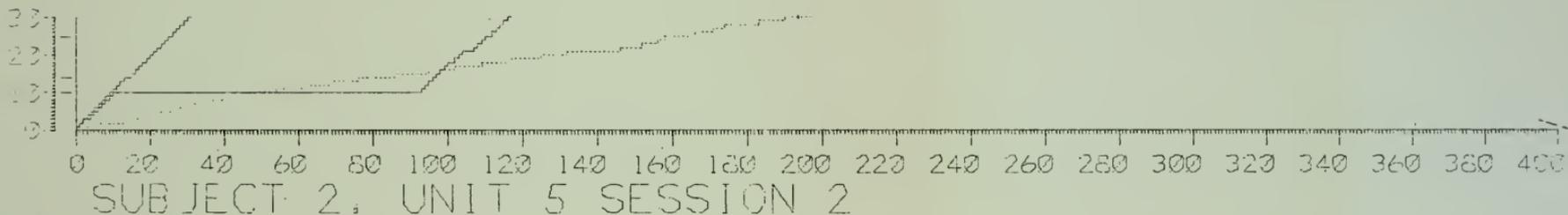
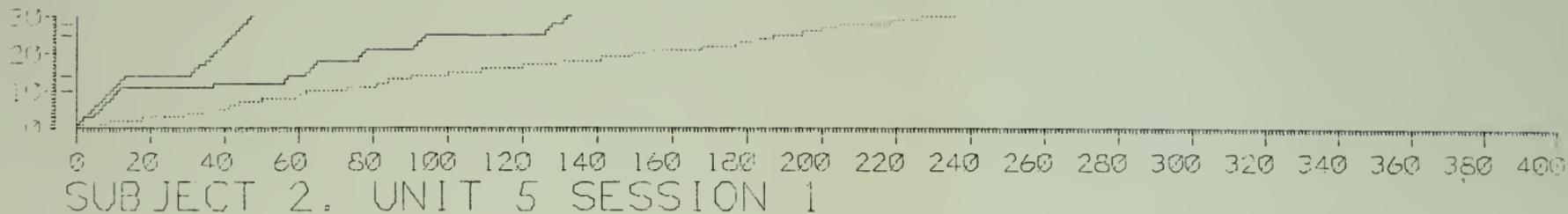


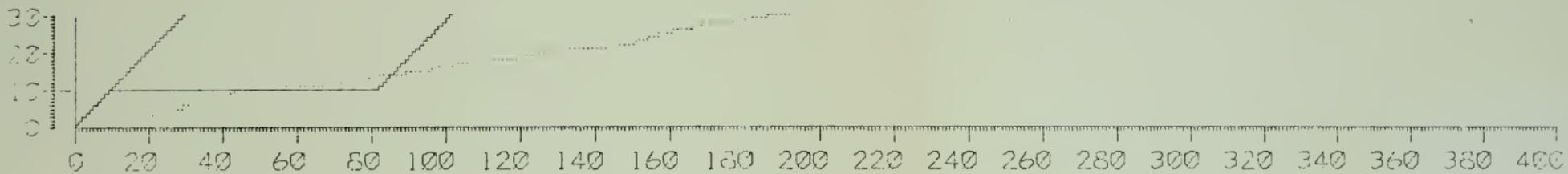


SUBJECT 2, UNIT 3 SESSION 4

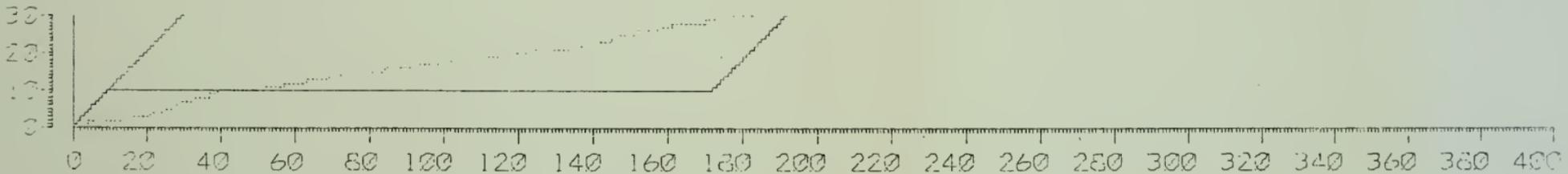


SUBJECT 2, UNIT 3 SESSION 5

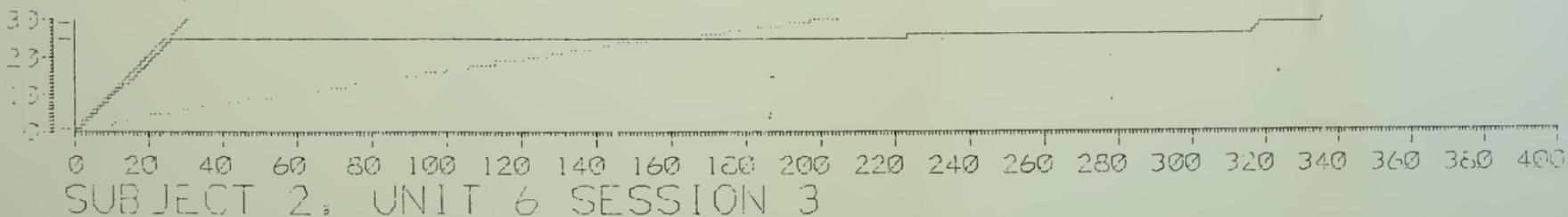
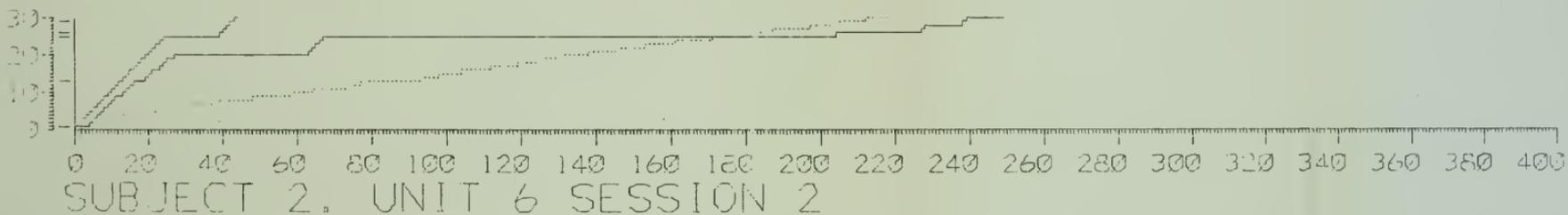
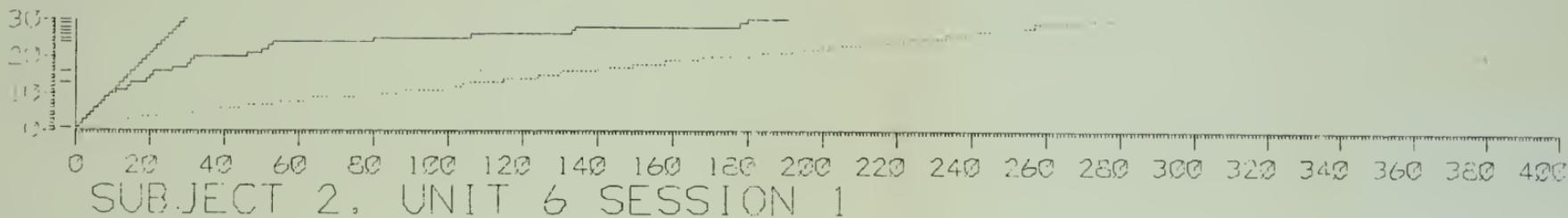


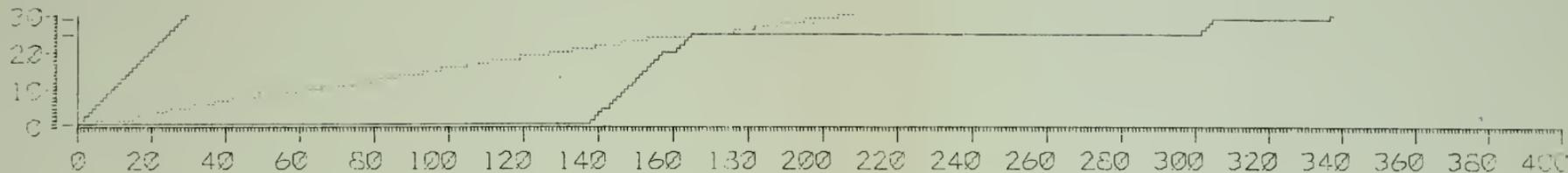


SUBJECT 2, UNIT 5 SESSION 4

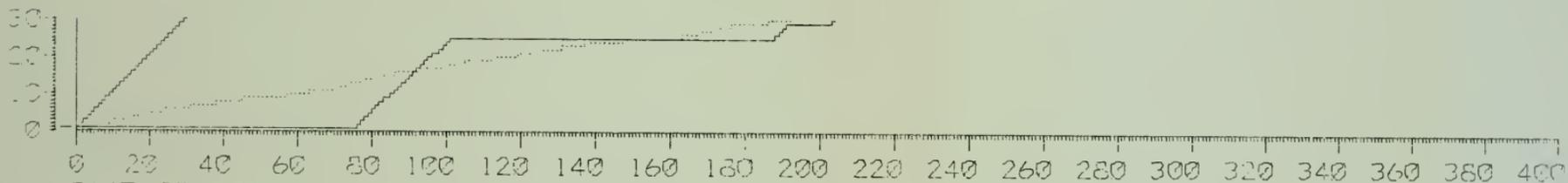


SUBJECT 2, UNIT 5 SESSION 5

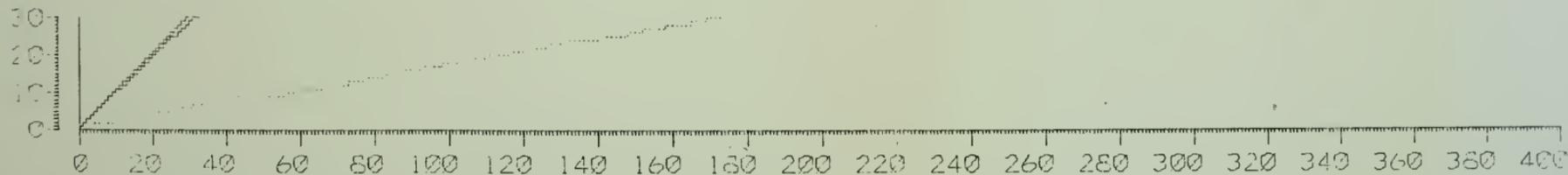




SUBJECT 2, UNIT 6 SESSION 4



SUBJECT 2, UNIT 6 SESSION 5



SUBJECT 2, UNIT 6 SESSION 6

On unit 3 the subject was under the ISF procedures. CR's 8 and 9 display his performance for that unit.

The performance for this subject on unit 3 are strikingly similar to the performance of subject 1 on units 4 and 6. The RLD curves show the same type of increase with final reduction. In this case the variability can again be traced to those items that were missed. After five sessions the subject had not yet achieved criterion. Question 27 was answered incorrectly in all sessions.

Frequency of correct responses show a very gradual increase during this unit. The SD once more presents the same reducing tendency that is becoming typical for this subject's performance. The analysis of the present results are identical to that given for the performance of subject 1 on unit 4 and need no further elaboration.

The only data available on unit 4 is that it took the subject three sessions to achieve criterion. CR's 10 and 11 present the records for unit 5.

During this unit ISF procedures were also in effect. Again, the performance of the subject reflect the typical trend under the conditions of immediate signal feedback. There is a gradual decrease in the frequency of correct response. The RLD curves show an increase in duration leading to a final reduction. There is little doubt that the different procedures affect the performance of the subject in a particular way.

The performance on unit 6 was emitted under ISF procedures. Once more the same results are observed. A typical ISF pattern emerged.

The foregoing presentation of Experiment II seems to solidly cement the conclusions given to the results of Experiment I. There is a differential performance due to the type of feedback used. The findings favor the use of immediate corrective feedback to accomplish efficient teaching where efficiency in teaching means that the student would obtain the greatest gain in knowledge through minimum behavioral effort.

Further, a negative answer should be given to the question posed at the conclusion of Experiment I. The units did not seem to influence performance outcomes since the procedures were implemented on different units in this experiment with the same results. Of course, the second question can only be partially answered here. The procedures seem to affect the performance of different subjects in the same fashion. The degree of generalizability of this finding will depend on the number of systematic replications of the procedures.

Commentary on Results

Before embarking on the presentation of Experiment III several comments are apropos to the findings and experimental design of the first two experiments.

At the beginning of the chapter an emphasis was made on baseline recording and its usefulness. A review of baseline performances by the subjects reveals the wide variability of the measures not only in comparing the subjects but also for one subject on different units. Any individual enters an experiment with a behavioral repertoire that is unique. Such uniqueness can be appreciated on their baseline performance. As it was indicated previously the behavioral transitions may be affected by prior states of the behavior. The importance of baseline assessment is therefore paramount and should be obtained whenever possible.

The recording methodology used in the present experiments afford the opportunity to assess behavioral baselines. The use of the methodology is recommended in any study of academic performance for this and for other reasons (some of those reasons will be dealt with in Chapter 4).

The research design in the analysis of behavior stresses the applicability of direct and systematic replication of experimental procedures. Direct replication can be accomplished in one of two ways. New subjects could be used varying the experimental conditions. In the last case the technique of intrasubject replication is used. Sidman (1960) argues that this is a unique and powerful method of demonstrating the reliability of a technique.

Using the method of intrasubject replication to assess the effects of a procedure it is possible to experiment with only one subject since the power of the method

resides in the number of successful replications rather than in the number of subjects studied.

Systematic replication was also accomplished in the experiments reported so far. The difference in units on which the procedures were implemented served to establish the generalizability of the findings to a different situation which is the main purpose of systematic replication.

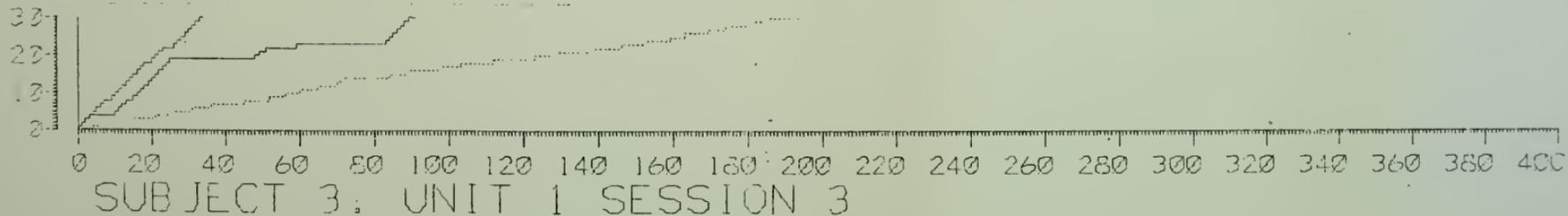
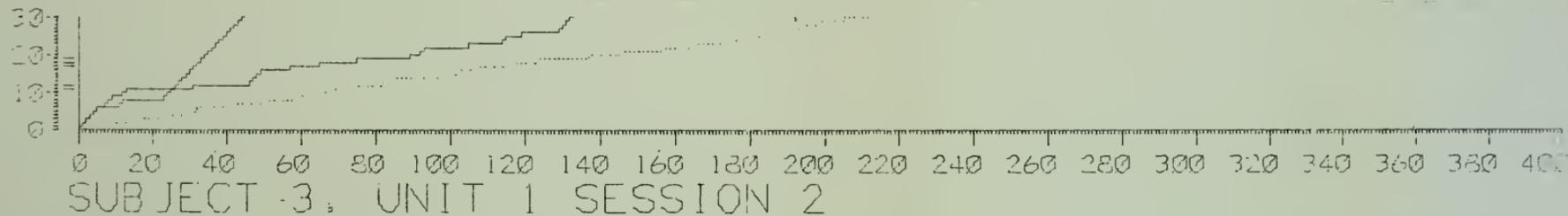
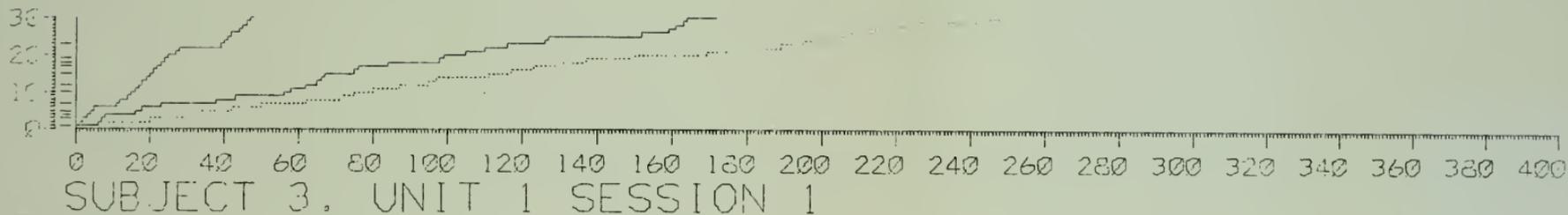
The experimental procedures were modified for Experiment III. A direct attempt at further systematic replication was made on that experiment.

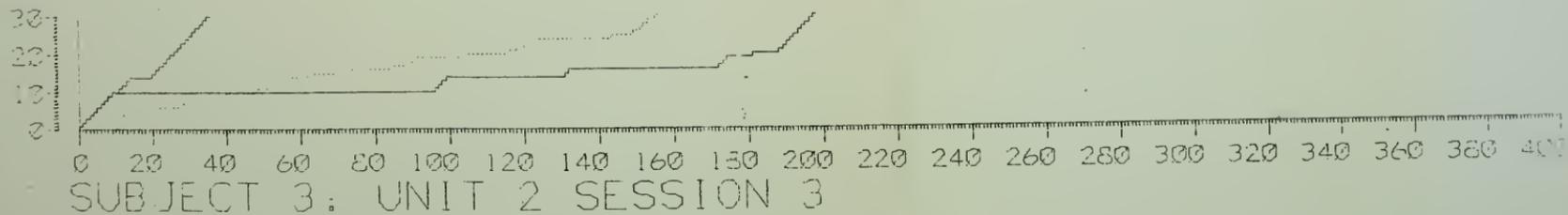
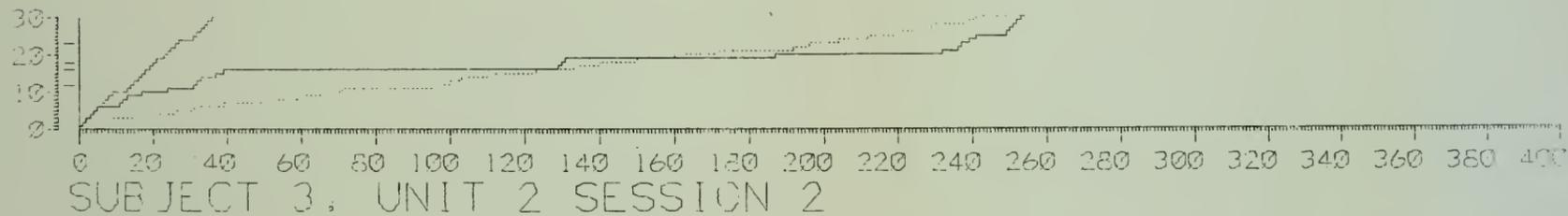
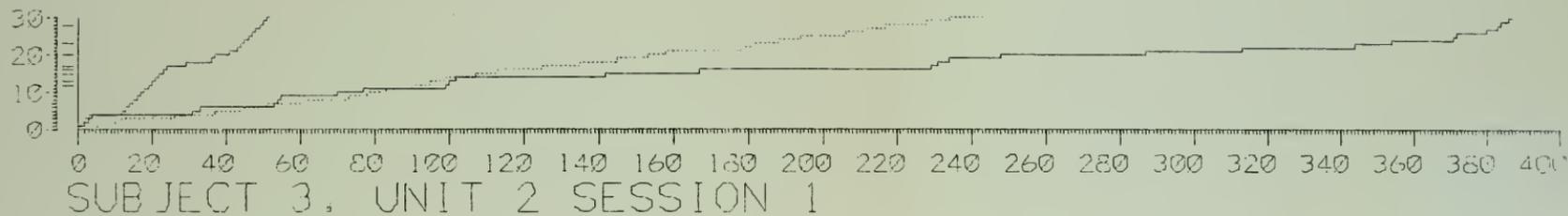
Experiment III

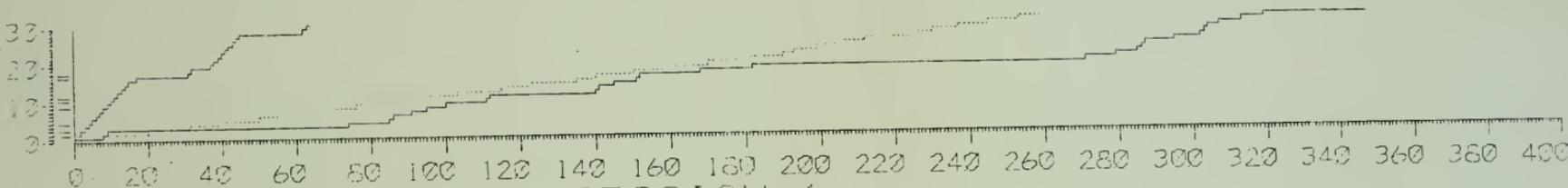
A number of changes were made in the recording procedures for this subject. He was allowed to stop reading the question if he felt he had the correct answer and the recorder was activated as the cards were picked from the pile rather than as he started reading. It was expected that the changes would produce wide variations in all component curves. CR's 14 through 21 show the performance of subject 3.

Overall, the expected results were obtained. All curves show much variability. On the beginning sessions the SD curve does not present wide changes but on later units the differences show increasingly.

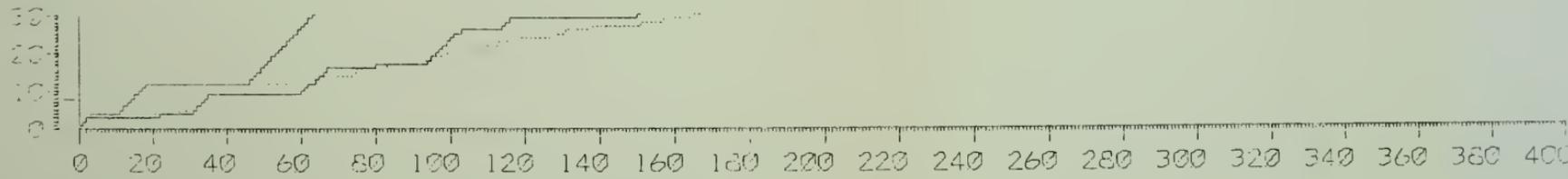
On units 1, 3, and 5, the subject received ICF (See CR's 14, 16, and 19). He achieved criterion, in three



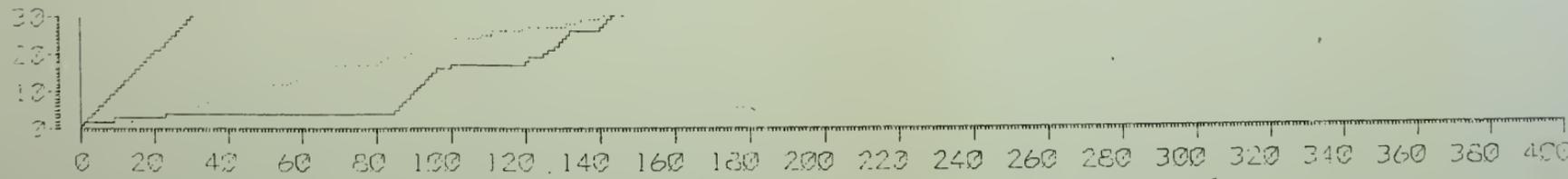




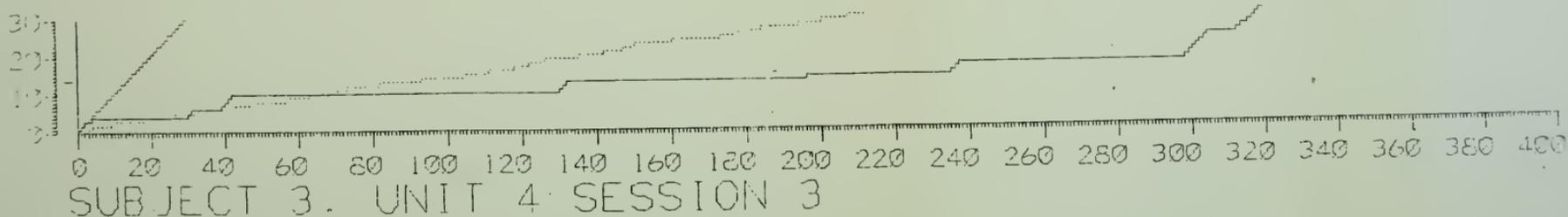
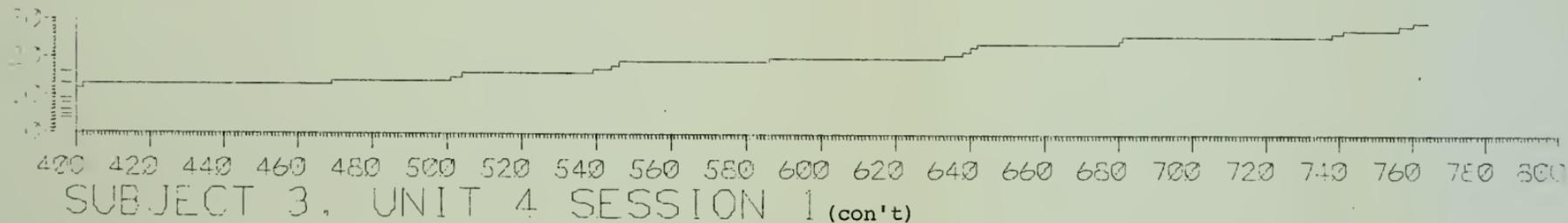
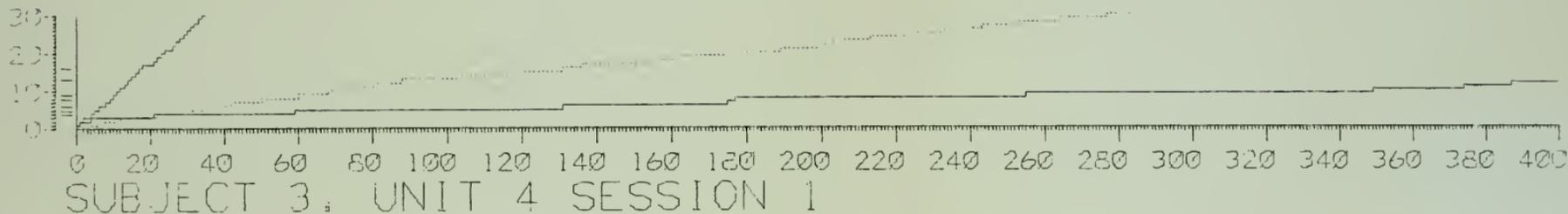
SUBJECT 3. UNIT 3 SESSION 1

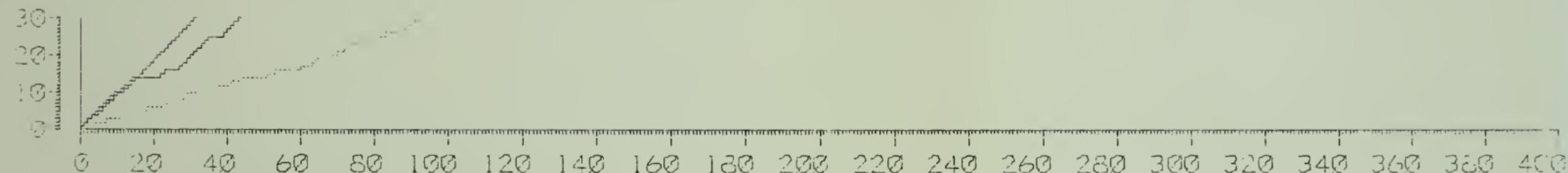


SUBJECT 3. UNIT 3 SESSION 2



SUBJECT 3. UNIT 3 SESSION 3

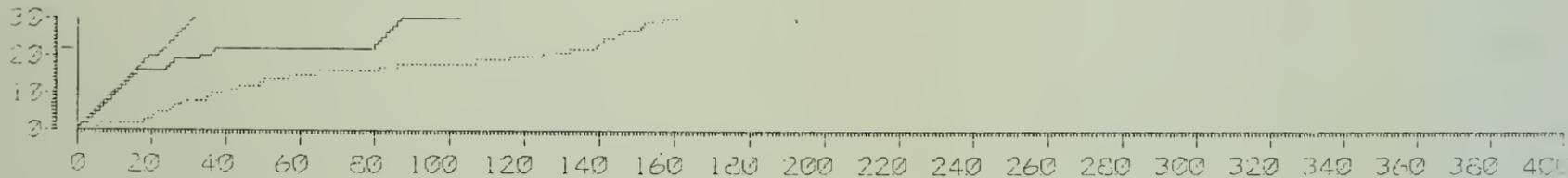




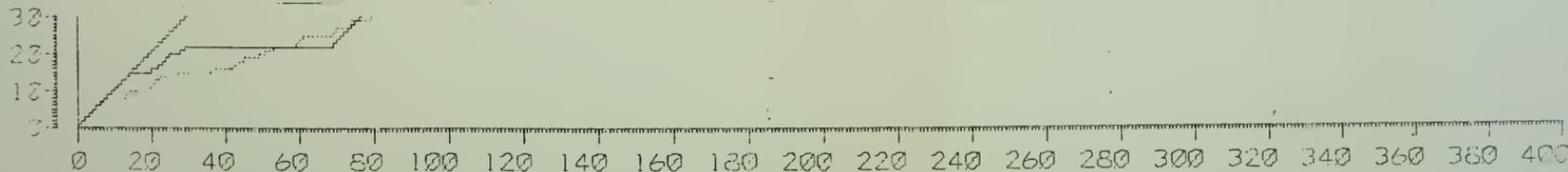
SUBJECT 3; UNIT 4 SESSION 4



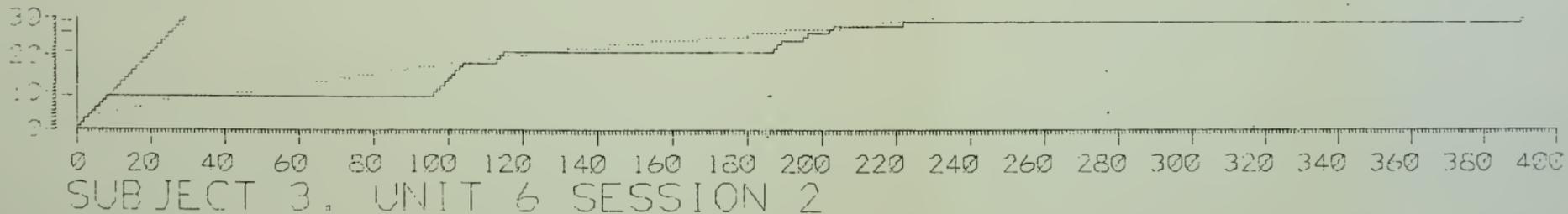
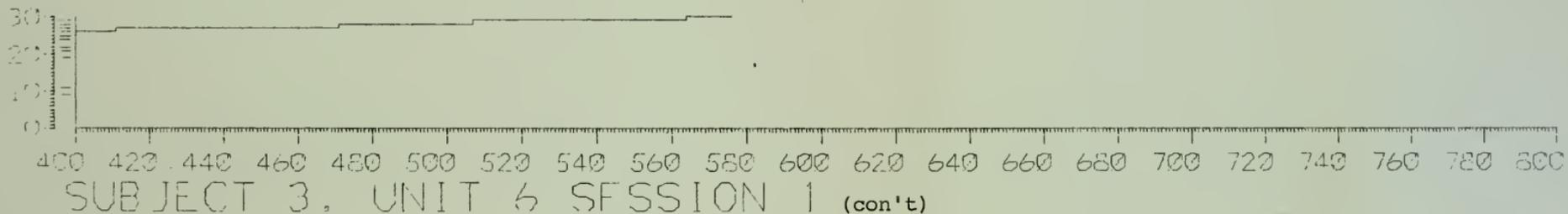
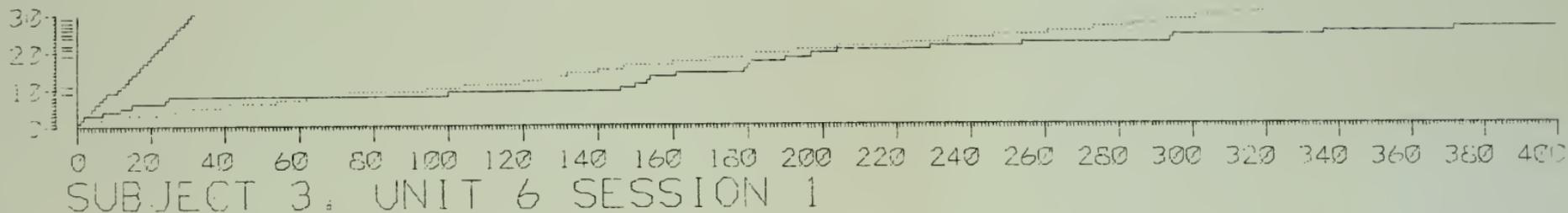
SUBJECT 3, UNIT 5 SESSION 1

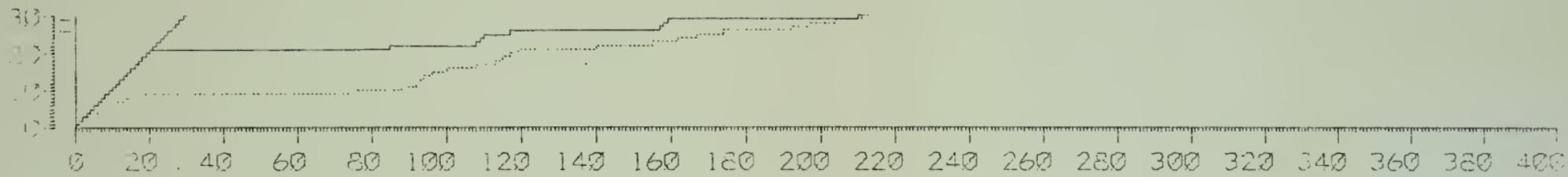


SUBJECT 3, UNIT 5 SESSION 2

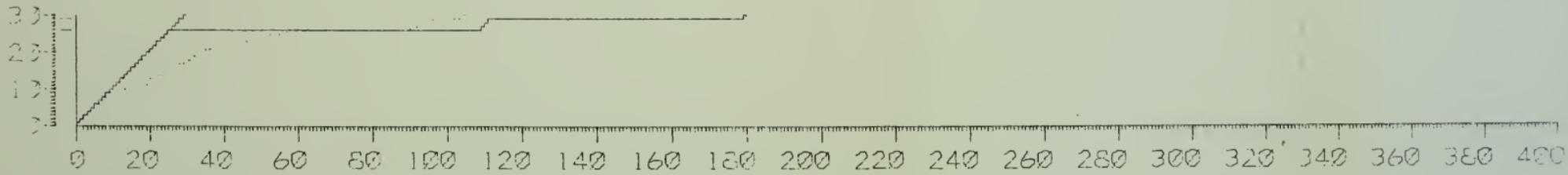


SUBJECT 3, UNIT 5 SESSION 3





SUBJECT 3, UNIT 6 SESSION 3



SUBJECT 3, UNIT 6 SESSION 4

sessions on each unit. The changes are similar to those obtained from the other subjects under the same procedures. There is an increase in the number of correct responses coupled with an accelerated RLD curve. A difference, however, is seen in the RD curve. Longer durations emerge on some items. The questions on which the increase in duration occurred are questions with more than one answer where the subject could have stopped after answering the first part.

The subject received ISF on units 2, 4, and 6. His performance on those units is depicted on CR's 15, 17, 18, 20, and 21. Here, the performance is not typical of that obtained from the other subjects under the ISF procedures. In fact, the subject's performance more closely resembles the performance obtained under ICF. There is a gradual increase in the frequency of correct responses. The changes in direction of the RLD curve do not follow the usual pattern under the ISF procedure. Although four sessions are needed to achieve criterion on units 4 and 6, the subject answers all questions correctly before leaving the laboratory.

There are several explanations that may account for the performance of this subject. First it may be argued that the subject is not representative or that he was one of the weird subjects that makes life miserable for any researcher. The position advocated in the experimental analysis of behavior does not allow for such an interpretation. The individual behavior is being controlled by environmental

variables and his performance reflects the influence of those variables. Thus, the responsibility rests with the investigators. The question to be asked now is what differences in performance, if any, can be seen on the records.

A review of baseline performance reveals that there are marked and consistent differences in the RLD component curves. For the ISF units there are unusually long durations per item as evidenced by the fact that on two units (4 and 6) separate records had to be drawn of the first session. Apparently there is a differential performance due to the type of procedure implemented.

The results indicate an interesting conclusion. The procedures seem to affect baseline performance! Of course, this conclusion will need stronger substantiation but the idea merits experimental consideration.

A further difference in performance for this subject when compared with subjects 1 and 2 under the same feedback condition is that subject 3 always achieved criterion either before or on the fifth session. It may be concluded that he was able to distill his answers from the stimulus material. This fact alone could have accounted for the discrepancy in his performance.

On the basis of the present findings, the use of immediate corrective feedback is favored over the use of immediate signal feedback. The additional procedures in effect for Experiment III may have accounted for the failure to obtain the typical performance previously seen.

To answer whether this is in fact the case requires further experimentation. Direct replication of Experiment III should yield valuable information.

As to the generalizability of the findings it may be worthwhile to separate the results. It has been fairly well established that the type of feedback affects performance differentially and that immediate corrective feedback greatly facilitates performance with a minimum of behavioral effort. On the other hand, with respect to typical patterns of performance obtained under the two procedures studied, it is necessary to conduct additional replicative studies before statements of wide generalizability can be made.

The recording methodology and controlling techniques used in this study are recent developments. The data obtained through their use has not been seen before with such detail. As an innovation they will undergo constant revision in the heat of battle. Their value will be measured in terms of the data they will make accessible for study.

CHAPTER IV

DISCUSSION

Implications for Education

The primary purpose of this investigation was to examine the effects that type of feedback has on individual performance. The two types of feedback studied were immediate corrective feedback and immediate signal feedback. It was concluded that immediate corrective feedback is a more efficient instructional procedure than immediate signal feedback.

The findings reported here are in agreement with those of other investigators in the area (Meyer, 1960; Anderson, Kulhavy & Andre 1971, 1972). However, a number of methodological and procedural innovations are found in the present investigations that were not used in previous experiments. A secondary consideration of this study was an examination of the data afforded by the methodological and procedural innovations just mentioned.

The use of an individual research design is one of the basic features of this experiment. There is a clarity of relationships revealed by individual data that cannot be obtained with averaged data. The data used here is not fabricated, that is, they are not the result of

analytical manipulations. The data are the actual performance which is always available for observation regardless of assessment difficulties. Frequency, accuracy, and duration are real dimensions of any behavior.

If education is to deal with each individual and to develop instructional procedures that will achieve maximum returns with every student then their reliance on statistical methods of analysis is ill conceived. Only a methodology that studies individual behavior in its own right can afford education an opportunity for truly individualized programs of instruction.

Before establishing such individualized curricula it is important to study how instructional procedures affect the academic behavior of the students. In other words, to study the relationships between students' performance and the environmental variables of which it is a function.

A recording methodology that allows for a precise, direct, and continuous evaluation of students' performance is of extreme importance to the good conduct of an analysis of individual performance. Here is another point of departure from previous research. A recording technique that meets the basic requirements was used in this investigation. The use of the recording methodology afforded a final conclusion based on the findings and also a precise and continuous view of the transitory states of the subject's academic behavior.

The importance of a continuous view of performance

should not be underestimated. Precious little is known about transitional states in the acquisition of new behaviors. The use of this methodology may shed some light into the area.

In fact there are a number of areas that would benefit from direct implementation of the methodology. In the over-all educational setting some of the applications have already been seen. The selection of procedures influencing the individual student's academic performance can be easily achieved. Remedial procedures can also be implemented in those cases that demand them and only to the extent that is necessary. Such applications would provide the basis for individualized instructional programs.

A further step for individualization of instruction would be the selection of individual criterion goals based on student's performance. Ideally, it should be possible to set a criterion level and shape behavior to meet that criterion. Shaping new behaviors, however, requires reinforcement of successive approximations to the final goal. The size of the steps in the successive approximations are of extreme importance and should be designed for each individual. The subject's performance should provide an indication of the ability of the program to shape new behaviors. Constant feedback on the exact location and departing level of the student is continuously available to the teacher or investigator through analysis of the resulting charts.

Parallel to the concept of individualized criterion levels is that of learning rate. Skinner (1968a) notes that in traditional school situations the speed set is "appropriate to the average or mediocre student. Those (students) who could move faster lose interest and waste time; those who should move more slowly fall behind and lose interest for a different reason" (p. 242). One of the principal contributions of behavioral college teaching has been the emphasis on allowing the individual to proceed at his own rate. In this area the methodology may provide an accurate estimate of students' learning rates based on this performance rates.

Other areas that should derive handsome benefits from the use of the methodology are those of programmed instruction development and computer managed instruction. Some suggestions have already been made by other investigators (Brooks 1961; Suppes 1964). The development of individualized programmed texts and computer managed instructional programs based on students' performance should receive a standing ovation from the educational community. So far, these areas have produced programs that are still directed to the average student.

The problems to which the methodology can be applied seem endless. Additional areas on which the methodology should have an impact will be discussed in the following section.

Recommendations for Further Study

Some suggestions for further study can be distilled from the previous presentation. The aim of this section is to relate more specifically further studies to the actual experimental manipulations implemented in the present investigation.

A number of research investigations should stem directly from this study. To establish the generalizability of the findings more direct and systematic replications are necessary.

Various modifications of the procedures can be undertaken. There could have been several sessions after criterion was achieved. In the case of ICF where criterion was achieved fairly rapidly it would be interesting to observe what happens, when after several trials the student is still unable to provide the correct response. Will there be a sharp drop in duration due to extinction?

A finer analysis of the data is easily accessible. Local fluctuations in item duration variability can be observed in the records. This should provide for an analysis of item difficulty and possible sequential variables.

Studies of schedule effects may prove to be a bountiful area for further research. The research reviewed (Driskill, 1964; Blank & Pysh, 1967; Krumboltz & Keisler 1965; Krumboltz & Weisman, 1962; Moss & Neidt, 1969) lacked an individual performance design. This fact may account for

the contradictory results in the area. It has been suggested in the results section that in certain cases the subject may act as if under a certain schedule. The implication is that consequent knowledge of results may serve as a reinforcer. This, of course, would only be true if the environmental conditions are set to increase the reinforcing effects of feedback. Criterion level and correlated requirements may influence the strength of the reinforcing stimulus.

It is possible that the interresponse duration curve is affected by schedule effects on the performance. The IRD curve can be obtained and presented in the same fashion as any one of the other component curves.

The number of studies that can be undertaken are only limited by the imaginations of the researchers in the area. Studies of response topography, control of stimulus material, prompting and cuing, changes on the most stable component curves (SD and RD), concept formation, etc. are at the tip of the fingers.

Of course, any research that uncovers relationships between students' performance and instructional procedures shall be welcomed. The role of education should be to provide efficient teaching procedures at the individual level. This can only be accomplished by an increased understanding of environmental effects on behavior.

Academic performance is no more a specialized case

of human behavior than any other response. The experimental analysis of academic behavior will reveal those relationships which will afford a more precise arrangement of educational contingencies.

APPENDICES

APPENDIX C
WEEKLY SCHEDULE

TIME

MONDAY		
TUESDAY		
WEDNESDAY		
THURSDAY		
FRIDAY		

T.A. _____ Room _____ Subject _____

APPENDIX D

SAMPLE QUESTIONS

No one in the 19th century influenced the history of child psychology more than Charles Darwin.

The forces which influence development begin at conception.

An individual's physical features depend heavily upon his heredity.

Stages of development are of central importance in Piaget's influential theory of cognitive development.

Clinical data demonstrates that children who are severely punished and rejected react toward their parents with hostility.

Abnormalities in the structure of the chromosomes may be a basis for mental defects. The best example of this is mongolism, which is called Down's syndrome.

Learning is the process by which behavior, or the potentiality for behavior, is modified as a result of experience.

The most serious threat to the newborn during the birth process is lack of adequate oxygen.

Beginning in the preschool period, the child is more likely to be motivated by his desire to be like someone he respects, loves and admires--this process is called identification.

By the age of 28 weeks the fetus is structured enough to stand a chance of surviving in the extrauterine environment.

It is believed that the first eight weeks of the embryo constitutes a sensitive period with respect to the integrity of the nervous system.

The term congenital refers to characteristics that are present at birth and which, in some cases, may be hereditary.

Hunger and thirst are the most important of the infant's basic drives.

In toilet training, voluntary control must be substituted for reflex actions.

One of the important and interesting responses shown by the newborn is called the moro reflex, which looks as if he were embracing someone.

The only sense modality which may not be functioning immediately at birth is taste.

The quality of a child's early linguistic environment is the most important external factor affecting the rate of language development.

We (can, cannot) state conclusively that language is a necessary condition for thought and problem-solving.

Perception refers to the individual's selection, organization, and initial interpretation or categorization of sensory impressions.

The term cognition is a broad one referring to the processes by which knowledge is acquired and utilized.

The child's progress in physical, motor, cognitive and language development are critical determinants of the ease and speed of socialization.

Peer influences on personality development and behavior are probably second in importance only to those of the parents.

Along with teachers, a child's peers are also new agents of socialization in nursery school.

Democratic home environments tend to produce preschool children who are active, competitive curious, and non-conforming.

Learned responses used to avoid or reduce feelings of anxiety are called defense mechanisms.

The dependency motive is the wish to be nurtured, comforted, and protected by others.

$$IQ = \frac{MA}{CA} \times 100 .$$

According to Piaget, accommodation is the tendency to adjust to a new object, to change one's schemata of action to fit the new object.

A Frenchman, Alfred Binet, invented the IQ test.

Piaget's use of the term intelligence has a specific meaning; it is "the coordination of operations."

Piaget is the most influential theorist of intellectual development of this century.

It is fashionable these days to speak of youth who in one way or another do not "fit in," as being "alienated."

In too many instances, the teacher's preoccupation with middle-class status leads her to look upon a disadvantaged child not as different, but as inferior.

The culturally disadvantaged student usually will be poorly prepared to enter and to progress in the traditional school setting.

One of the most pressing needs of school children is to gain acceptance by their peers.

The school plays an important part in helping the child to reduce his dependent ties to his home.

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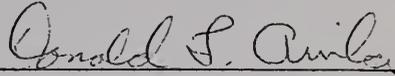
BIOGRAPHICAL SKETCH

Enrique Alba was born in Havana, Cuba, on July 15, 1946. He attended Baldor School until 1961, at which time he left Cuba and enrolled in The Salesianos School in Madrid, Spain. He finished high school at Miami Jackson in Miami, Florida, and took his degree of Associate of Arts at Miami-Dade Junior College in 1968. The bachelor's degree (1970) and the master's degree in education (1971) are both from the University of Florida.

His professional experience has included participation in curriculum development for professional (dentistry) education. He has taught and advised courses in human growth and development and principles of behavior. He has published and presented several papers.

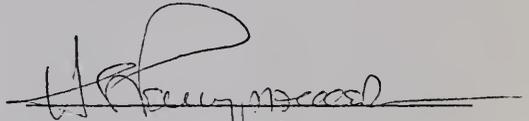
Mr. Alba is married to the former Carmen Regueira of Havana, Cuba, and has one daughter.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



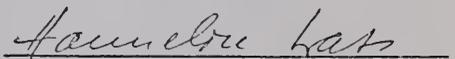
Donald L. Avila, Chairman
Professor, Foundations of Education

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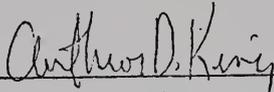
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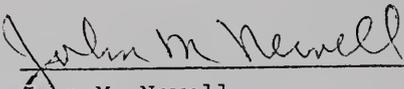
Hannelore Lina Wass
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Assistant Professor of Dentistry

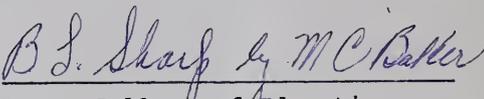
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John M. Newell
Professor, Foundations of Education

This dissertation was submitted to the Dean of the College of Education and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December, 1972



Dean, College of Education

Dean, Graduate School

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See notes 13

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