5-1967

Control of Behavior Through Reinforcement Menus

Gary Lyndle Holt
Utah State University

CONTROL OF BEHAVIOR THROUGH

REINFORCEMENT MENUS

by

Gary Lyndle Holt

A thesis submitted in partial fulfullment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Psychology

Approved:

Utah State University
Logan, Utah

1967

ACKNOWLEDGEMENTS

I wish to extend appreciation to Dr. Marvin F. Daley, Chairman, who gave an exorbitant amount of his valuable time to the final writing of this thesis. Appreciation is also extended to Dr. Glendon Casto and Dr. Philip Langer for their assistance.

I am also indebted to my wife, Roberta Holt, for unselfish contri - bution of her secretarial skills in addition to frequent moral support.

Gary Lyndle Holt

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

Control of Behavior through

Reinforcement Menus

by

Gary L. Holt, Master of Science

Utah State University, 1966

Major Professor: Dr. Marvin F. Daley
Department: Psychology

Reinforcement menus were used to change response probabilities while maintaining control over two "trainable," female, mentally retarded children.

An empirically determined reinforcement menu representing high probability behaviors, five for S_1 and four for S_2, was used in a contingency management system. Instructions were given concerning the contingencies for obtaining reinforcement. Subjects were allowed the opportunity to engage in a high probability behavior only after successful completion of fixed units of reading or arithmetic tasks. After stable performance was established, four additional menus were prepared to approximate in increasing degree, low probability behavior. Measurements were taken of task time and response duration, the time spent traveling to and from the reinforcement area.

Task time and response duration reached asymptotic values and remained at baseline values throughout the menu fading procedures. At the completion of the menu fading, subjects were doing units of work involving reading and mathematics in order to have the opportunity to do some reinforcing arithmetic. (48 pages)

CHAPTER I

INTRODUCTION

Retarded children, in the schools, have traditionally been separated into two groups, trainable and educable. This distinction generally has been made on the basis of individual scholastic apptitude tests, neurological examinations, teacher evaluations and/or children's performance in academic tasks, such as reading and mathematics. Of all the criteria cited, performance on academic tasks has usually been considered to be the most significant criterion for the trainable-educable distinction. If environmental conditions were arranged to allow retarded children to successfully respond to academic tasks, there would probably be little reason for distinguishing among the retarded on the basis of academic performance.

Lindsley (1964) believes that retarded children could achieve academic success if prosthetic environments were constructed for them. He has proposed:

> Children are not retarded. Only their behavior in average environments is sometimes retarded. In fact, it is modern science's ability to design suitable environments for these children that are retarded.
>
> Free-operant methods show a special promise for laboratory analysis and both acquisition and maintenance prosthesis of retarded behavior. There is mounting evidence that the more circumscribed behavioral deficits found in retarded individuals are easier to prosthetize by appropriately designed environments than are the psychotic deficits of wider scope. In fact, some of the deficits found in retarded behavior might even prove advantageous in certain environments.
>
> A properly designed special school or class should

treat individually and use maximally the behavior of its retarded students. Special educators should arrange suitable prosthetic programs for each student. The need for a given prosthetic program for each child should be continually tested to determine when the program can be efficiently reduced or replaced with a new program to generate a higher order of behavior.

> Retardation is not the property of a child but of an inadequate child-environment relationship. It is our ability to design suitable environments for exceptional children that is retarded. Classrooms should be tailored to children--not children adjusted to classrooms. Retarded behavior is penalized and any subskills ignored in environments designed for average children. In prosthetic environments designed for average skills, exceptional children will behave adjustively, efficiently and with full human dignity. (Lindsley, pp 62,79)

Teachers often have difficulties in arranging these surroundings. Two major problems they encounter when constructing prosthetic milieus are: 1) choice of the most effective reinforcers, and 2) proper arrangement of reinforcement contingencies. Teachers often do not identify activities which are significant reinforcers; they simply have "good ideas" as to which activities will be most reinforcing. They do not quantify their "feelings" by making frequency counts of the activities emitted by the child.

This experiment demonstrated procedural controls for the arrangement of a prosthetic environment in order to effectively modify behavior.

CHAPTER II

REVIEW OF LITERATURE

Premack's Differential Probability Hypothesis

Basically, Premack's theory is that any behavior which has a low probability of occurrence, will be more likely to occur if behavior of higher probability is made contingent upon the performance of the low probability behavior (LPB).

Premack's theory has been given as five ordered propositions:

1) Anatomically different responses can be compared directly.
2) For any pair of responses, the more probable one will reinforce the less probable one.
3) An indifference principle holds such that the reinforcement value is determined by response probability independent of parameters used to produce the probability or kind of response that manifests the probability.
4) Reinforcement is a relative property. The most probable response of the set of responses will reinforce all members of the set. Intermediate members of the set both are and are not reinforcers, depending upon the relative probability of the base response.
5) The reinforcement relaton is reversible. (Premack, 1965, p. 132)

Premack also discusses the value and measurement of reinforcement, stating that "...the reinforcement value is determined solely by the duration for which the animal engages in the behavior." (Premack, 1965, p. 144) Duration as the unit of measurement is stressed for the following reasons: 1) response duration serves as a common unit so that anatomically diverse responses may be compared, 2) duration is capable of providing a reliable estimate or probability, (1965, p. 128); and 3) total reinforcement time is equal to the product of rate by duration.

Positive reinforcement is defined as the "...duration for which a subject puts itself into a particular situation relative to the duration for which it puts itself into some other state." (Premack, 1965, p. 161) Negative reinforcement is defined as the "...duration for which a subject removes itself from a given state, into which the experimenter has forced it, relative to the duration for which it removed itself from some other state."(Premack, 1965, p. 161) Thus it is possible to use the same stimulus as a positive or negative reinforcer.

Thirty-three six year old children were used as subjects. A pinball machine rewired for continuous operation and a candy dispenser were placed side by side. The candy consisted of chocolate bits, of uniform size, delivered one at a time by a conveyer belt into a dish. Each time the child ate a piece of the candy, another fell into the dish. Sixty-one per cent of the children made more pinball machine responses than they ate pieces of candy. On this basis, the children were divided into "manipulators", whose most frequent response was pinball manipulation; and "eaters", whose most frequent response was eating candy. Eating was dependent upon pinball manipulation for the eaters and vise versa for the manipulators. The result was that the higher probability response reinforced the lower probability response.

In another experiment (Premack, 1963) a Cebus monkey was placed in a chamber which had three response mechanisms attached to one wall. One or more of the mechanisms could be rendered inoperative. The subject was given time in the chamber during which response frequencies were determined with only one mechanism functioning at a time. The subject manipulated each response mechanism with different frequencies. The environment was altered so that the monkey operated the mechanism initially used most frequently. As a consequence, the response mechanism which the animal initially responded to at a low frequency was now manipulated at a much higher frequency.

Contingency Management

Homme adopted Premack's hypothesis to humans. By applying principles developed in the animal laboratory, Homme (1965) significantly increased the performance of four preschool Indian children in English and reading readiness. Individualized instructional materials and the "Contingency Management System (CMS)" were used. The CMS is a method where an individual is allowed to participate in an event which he enjoys doing at that moment. However, this opportunity is dependent upon prior successful completion of a task.

The subject's most frequently emitted responses were taken as high probability behavior (HPB). High Probability Behavior included playing baseball, painting, coloring, going to recess, eating lunch, watching movies, washing, clay modeling and putting puzzles together. These were made contingent upon the completion of low probability behavior, as an academic lesson. The classroom was divided into two sections, a task area and a reinforcement area. The task area contained desks, chairs, and instructional material programmed on a SLATE simulator (sensitive to learner automated teaching equipment). The SLATE simulator operated the task area and presented the material to each subject on his own television-like screen. An administrator was in charge of the subject's activities. His job was to control traffic to the task and reinforcement area and to control the length of time subjects spend in the reinforcement area. If subjects failed to complete the task they were not permitted to engage in the HPB. The subjects were instructed to remain in the task area until the task was completed successfully. When they finished a task session, the SLATE simulator immediately signaled them to return to the HPB area. Tasks were scheduled so that the average length of time required for subjects to complete a task was 2 minutes.

Gains in reading readiness were tabulated in terms of grade placements. Two subjects achieved an increase of one grade placement and four other subjects gained approximately one-half grade placement. A test of English literacy consisted of 52 items which required recognition responses. The mean gain was 15 recognition responses. The subjects also appeared to be more cheerful, vivacious, talkative, and independent.

Homme (1965) commented on the problem of response-contingent vs. time-contingent reinforcements. Reinforcement based on passage of time rather than on the basis of performance increased the likelihood of reinforcing incompatable behaviors, including daydreaming and other non-task oriented behaviors. He also found that small and frequent reinforcements were most effective in increasing the frequency of subjects responding to low probability tasks.

Homme (1963) found that control could be exerted over three year old nursery school children, without the use of aversive methods. High probability behavior, including running and screaming, were made contingent upon the completion of low probability behaviors, such as setting quietly and paying attention to the blackboard. As Homme stated, "Even in this preliminary unsystematic application, the Premack hypothesis proved to be an exceptionally practical principle for controlling the behavior of nursery school subjects." (Homme 1963, p. 35)

Addison and Homme (1965) developed the reinforcement menu. This technique represents high probability behavior in a menu comprised of stick figures. The menu was constructed to maintain control over the children's behavior. The procedure in this study, analogous to magazine training in the animal laboratory, was to train subjects to go to the reinforcement area where toys were given. The subject was shown the menu and allowed to choose one stick figure representing a high probability behavior which he would like to engage in. The subjects then performed the task and immediately after completion the experimenter allowed the subject to engage in the high probability behavior previously requested. If the subject forgot or wished to do another high probability task indicated in the menu, the request was immediately granted.

The uniqueness of the reinforcement menu is that it avoids the problem of deciding what reinforcement to give. Without prompting, periods occur when the children do not seem to know what to do. This may have been due to the fact that children may have forgotten what reinforcements were available.

Additional behavioral control was attained through the use of "Daily Specials" such as finger painting. "Daily Specials" were events which were impractical to initiate too frequently, and thus were reserved for exceptional behavior. The combining "Daily Specials" with the reinforcement menu increased the frequency of responding in the task area.

Ferster and Simmons (1966) used contingency management and "natural reinforcers" in behavior therapy with children. They considered a reinforcement to be natural when it occurred freely in the environment. For example, one child's behavior of swinging and tumbling was interrupted by the contingency manager. The contingency manager then made swinging and tumbling contingent upon the child's behavior which successively approximated putting a piece of a puzzle into the appropriate place. The child's ratio of tasks to reinforcement was gradually increased until he was required to work an entire puzzle for one reinforcement. Puzzles of increased difficulty were then used.

Ferster and Simmons found the puzzle itself to be an example of a natural reinforcement.

> The difficulty of the puzzle specifies a schedule of intermittent reinforcement. Its physical design determines much of the behavior appropriate to completing it. In a very simple puzzle, almost any performance gets the piece in place and hence reinforcement is virtually continuous; but as the pieces become even slightly irregular, the child may need to make several attempts, only one of which will be reinforced, and graded series of puzzles is a convenient device for changing from continuous reinforcement to a difficult puzzle where some behavior may go unreinforced. Eventually the reinforcements again become continuous when the child achieves an effective repertoire. (Ferster and Simmons, 1966, p. 45)

Their statements were compatable with laboratory experiments which demonstrate that graded experience from continuous to intermittent reinforcement is the best way to develop a persistent and durable repertoire.

Addison and Homme (1966) used playing with cups as a HPB to increase frequency of puzzle activities. Puzzle manipulation was initially very simple. The child was required to put a few pieces into their appropriate places. Gradually puzzle difficulty increased. Without the successive approximation technique the reinforcing activity would probably not have been durable enough to sustain the child's behavior.

Ferster (1966) used reinforcement and contingency management to achieve substantial control over the behavior of autistic children. Within a few days these children became more outgoing and cried less.

Walder (1966) reported success with autistic children when mothers were used as contingency managers. Inappropriate behaviors, such as urination and defecation in places other than toilets, smearing feces on the furniture in the parent's bedroom, slamming doors repetatitively, moving about hyperactively and screaming rather than speaking English, were modified.

Haring and Phillips (1962) modified the behavior of emotionally disturbed children. The experimenter established low and high frequency behaviors respectively, reading a paragraph and making a model airplane. Teachers planned reading lessons immediately before the child built the model. Building the model was made contingent on engaging in reading behavior. The child had to complete five problems before he was allowed to engage in five minutes of model building. The number of problems to be completed was gradually increased. Finally, more time was spent on the low frequency behavior than on the high frequency behavior.

Walder (1966) taught parents to develop and maintain behavioral control over elementary school children. Responses that one parent wished to bring under control were: (1) eating breakfast promptly at 8:00 a.m. and (2) being properly dressed before receiving breakfast. The subject was required to appear at the breakfast table at 8:00 a.m. before receiving breakfast. Within two days the child appeared at the breakfast table promptly at 8:00 a.m. The next behavior to be controlled was being properly dressed. Eating breakfast was made contingent upon this task. After control over this behavior was achieved, the "behavioral price" for breakfast was raised again by reinforcing successive approximations of self-care. Within two weeks the mother stated that her son was "a different child." He arose on time and cared for himself cheerfully and without coercion.

Stone, Johnston, and Harris (1966) have used contingency management and a stimulus fading technique in working with young mentally retarded children. These researchers made reinforcing stimuli contingent upon verbal responses. The experimenter visually presented a picture and said, "What is this?" The experimenter then prompted the subject by saying, "Say ball." When subject responded accurately several times the verbal instructions were again initiated "What is this?" However, parts of the verbal discriminative stimuli were now faded or changed to, "Say b____" and finally to "What is this?" The picture or object then controlled the choice of the response. The verbal responses were now under stimulus control.

Contiguity and Premack's Hypothesis

Guthrie's theoritical position is most compatable with Premack's theory and the Contingency Management System. Guthrie's position is as follows: "The best information we can gain concerning how a man will behave in a given set of circumstances comes from the record of what he last did in these circumstances." (Homme, 1960, P. 234)

There are three primary implications which continguity analysis has for contingency management. (1) The HPB should temporally, geographically, and topographically, remove the organism from the LPB. Guthrie stated that the removal of the organism from the LPB during reinforcement avoids association with incompatable behaviors. The individual may be separated by the nature of the reinforcement being different from the LPB and by the reinforcement being removed in geographical location from the LPB; (2) A stimulus situation should be chosen which adequately controls the response. Guthrie's association theory suggests that external stimuli in the task area may become connected to the task. This stimuli often became incompatable with task performance and lowers frequency of responding in the task. Thus all extraneous stimuli in the task area, which may elicit incompatable responses, should be removed; and (3) A given response can be controlled by more than one stimulus. For example, mathematics behavior can be reinforced by giving subject the opportunity to participate in any of the following activities: playing with dolls, coloring, and cutting out dolls.

Summary

The literature reviewed on the use of Premack's Differential Probability Hypothesis, Contingency Management System and the Addison and Homme menu technique indicated that there was substantial evidence for the following statements: 1) "For any pair of responses the more probable one will reinforce the less probable one", (Premack, 1965, p. 135); 2) "The reinforcement value of any event is independent of the parameters producing response probability", (Premack, 1965, p. 135); 3) "Contingency management and the reinforcement menu are effective techniques in producing and maintaining control over behavior.

CHAPTER III

METHOD

Subjects

Two trainable mentally retarded girls, from the Cache Valley Day Care and Training Center in Logan, Utah were used as subjects. S_1 had a chronological age of fifteen years, mental age of six years and a recent Stanford-Binet I.Q. score of forty-one. This subject came from Denmark and was bilingual. Neurological examination including EEG results, indicated her retardation was due to brain injury. Other records suggested that her retardation was due to brain damage produced by instrumentation at birth. Behavior such as crying, walking around the room in the middle of lessons and going to the bathroom frequently was incompatable with the performance of academic lessons.

S_2 had a chronological age of twenty-three years, a mental age of six years and a Stanford-Binet I.Q. score of forty-two. The cause of her mental deficiency was unknown. She was hyperactive and did not attend to a task more than six minutes.

Apparatus

High probability behavior was represented by figures drawn on 5 in. x 8 in. white cards. Five menus were prepared for each subject and the menus were arranged in a predetermined sequence.

Figure 1 shows that S_1's first menu included five stimulus cards which represented the HPB of coloring, cutting out, playing with dolls, embroidering, and playing with a rabbit. Four stimulus cards were included in each of the four succeeding menus (figures 1 and 2), playing with a rabbit having been dropped.

Figure 3 shows that S_2's first menu included four stimulus cards which represented the HPB of coloring, cutting out, playing with dolls and playing with a cat. Each of the succeeding menus (figures 3 and 4), were made up of three stimulus cards, playing with a cat having been dropped.

The cards in the first menu for both S_1 and S_2 had no written instruction on them. The cards in the succeeding menus changed in the following ways: (1) instructions for coloring, cutting out, playing with dolls and embroidering (S_1 only) were printed above and/or below the figures; (2) figures were modified in order to illustrate each change in instructions (3) instructions and figures were changed to approximate reading, mathematics and writing tasks.

All items in the first menu were direct representations of the empirically determined HPB. The card indicating coloring activity on the second menu, M_2, instructed subjects to color objects in a specific order. M_3, represented in figures 2 and 4, exemplified the subjects coloring one of three fish one color, and the other two fish another color. M_4 represented the subject's activities of making a judgement as to the greater of a quantity of balloons. This was accomplished by coloring the group which had the most balloons. In M_5 the subject was to do the same as was described for M_3 but, in addition, to count and give the total of all objects colored. Activities indicated in menus M_2 through M_5 made successively closer approximations in arithmetic tasks.

In M_2, on the cutting out card, subjects were directed to cut out a pattern by following numbers in sequence from 1 to 15 as indicated in figures 1 and 3. This required that the subjects practice counting. In M_3, subjects were directed to cut out a pattern by following numbers in a sequence. The numbers to be followed were products of addition problems such as 1+0=0, 1+2=3, 2+8=10. Subjects began at zero then proceeded to three then to ten. In M_4, subjects were instructed to cut out a pattern by following the numbers. However, subjects were first required to solve simple addition problems in order to determine the next appropriate number in the sequence (i.e. 1+1=?, 2+2=?). M_5 instructed subjects to cut out the correct answer to addition problems. All of these activities involved variations of arithmetic tasks.

In M_2, the item representing the doll playing activity, the subject read a booklet describing who the doll family was and what they did for work and play. M_3 required subjects dress the dolls and write the name of each article of clothing they used. M_4 directed subjects to write the dolls' names without dressing them. M_5 instructed subjects to write about where they lived, worked and played. This task was also accomplished without dressing the dolls. These activities were approximations of reading and writing tasks.

In M_2, on the items representing embroidery, S_1 was required to count each cross stitch she made as she embroidered. M_3 directed the subject to embroider by following the numbers. M_4 required the subject to name and count all the numbers of colors in the pattern. In M_5, the subject was required to add all stitches she had made. These tasks also involved arithmetic activities.

Procedures

The first experiment was an investigation with S_1 demonstrating behavioral modification using contingency management and a reinforcement menu. Task activities consisted of counting 50 pennies, making discriminations with coins, denomination terms, form and color terms, location and amount terms, and linear measurement terms. The second experiment, using S_1, was designed to demonstrate control over the task behavior of reading and/or mathematics while shifting the HPB indicated on the first menu toward the task activity. A replication of the second experiment was performed using S_2.

A frequency count of behavior emitted by both subjects during twenty-three hours of observation was compiled. Responses with the highest frequency count were used to prepare reinforcement menus. A baseline for each subject's choice of menu items was determined. Prior to the initial session subjects were observed in their classroom situation. Later, each subject received one hour of tutorial training in reading aloud and one hour of tutorial training in arithmetic within their regular classroom setting. This training did not involve contingency management.

All subjects were shown their first reinforcement menu and were familarized with its use. Verbal instructions were as follows: "See these pictures. They are pictures of yourself doing something that you do frequently or that you like to do. You will be able to do any one of these activities for five minutes but first you must do this task. As soon as you finish the task successfully, you will be able to do one of these activities. This is exactly what you do. You pick an activity from one of the figures in the menu; then complete the task successfully and you may immediately go to the play area for five minutes and do what you want." If the child forgot what he chose as a HPB after completing the LPB he was immediately allowed to choose another HPB from the menu.

On the initial day of the first experiment the subject was brought into a twenty by fifteen foot room within the Cache Valley Day Care and Training Center, where she was informed as to the experimental procedure. The subject was told that when she had met the criterion for each task she would immediately be allowed to engage in a HPB which she had previously chosen before beginning the task activity. Following an incorrect response, the subject was prompted to mimic the correct response as given by the experimenter

Five task activities examined were as follows: (1) in the "counting 50 pennies" task, the subject was required to count from 1 to 50 without error. When the subject made an error, she was prompted and asked to mimic the correct response. (2) In the "coin denomination discrimination" task, the subject was asked to verbally identify one penny as being one cent; one nickel, the same as 5 pennies; one dime, 10 pennies; a quarter, 25 pennies; 2 nickels a dime; and 5 nickels a quarter. When the correct response was not emitted the subject was allowed 15 seconds before the correct response was given by the experimenter and the subject asked to mimic it. This delay and mimicing procedures was used with all task activity. After the subject completed all coin discriminations she was immediately allowed to engage in the HPB. (3) The "form and color discrimination" tasks required the subject to discriminate both circle, square, or triangle forms and red, green, blue, yellow or orange colors. (4) The "location and amount terms" employed were "under," "bottom," "top," "middle," "in front," "in back," "left," "right," "begin," "end," "few," "fewer," "most," "least," "full," and "empty." Sample instructions were, "Which group has fewer objects?" and"Which pencil is to the right of the red square/" (5) The subjects were also required to make "linear measurement discrimination." The subject was asked to discriminate one half inch, one inch, and 12 inches as parts of a one-foot linear measurement.

In the second experiment both subjects were required to read two pages of textual material or to solve all problems on two pages of programmed arithmetic with a 90 percent level of accuracy. While one subject was reading, a second subject was working mathematics problems in an adjacent room designated expecially for this task. Upon completing their work it was quickly checked by the experimenter. If the subjects met the 90 percent criterion, they were immediately allowed to go to the reinforcement area where they had the opportunity to participate in a HPB. If the criterion was not met, the subject was returned to the task area and errors were corrected.

Time to and from the reinforcement area was determined by a stop watch. When the subject arrived at the reinforcement area, she set a timer for five minutes of reinforcement time. After five minutes, a bell rang and the subject returned to task area.

The experimenter remained at all times with the subject who was reading. If the subject performed at less than 90 percent correct criterion in each sentence, the subject was asked to repeat the sentence until 90 percent accuracy was attained.

After a stable level of responding was established to the first menu, M_2, M_3, M_4, and M_5, each successively approximating low probability tasks, were sequentially introduced. With the final menu the subjects did one low probability task for the opportunity to do another very similar low probability task.

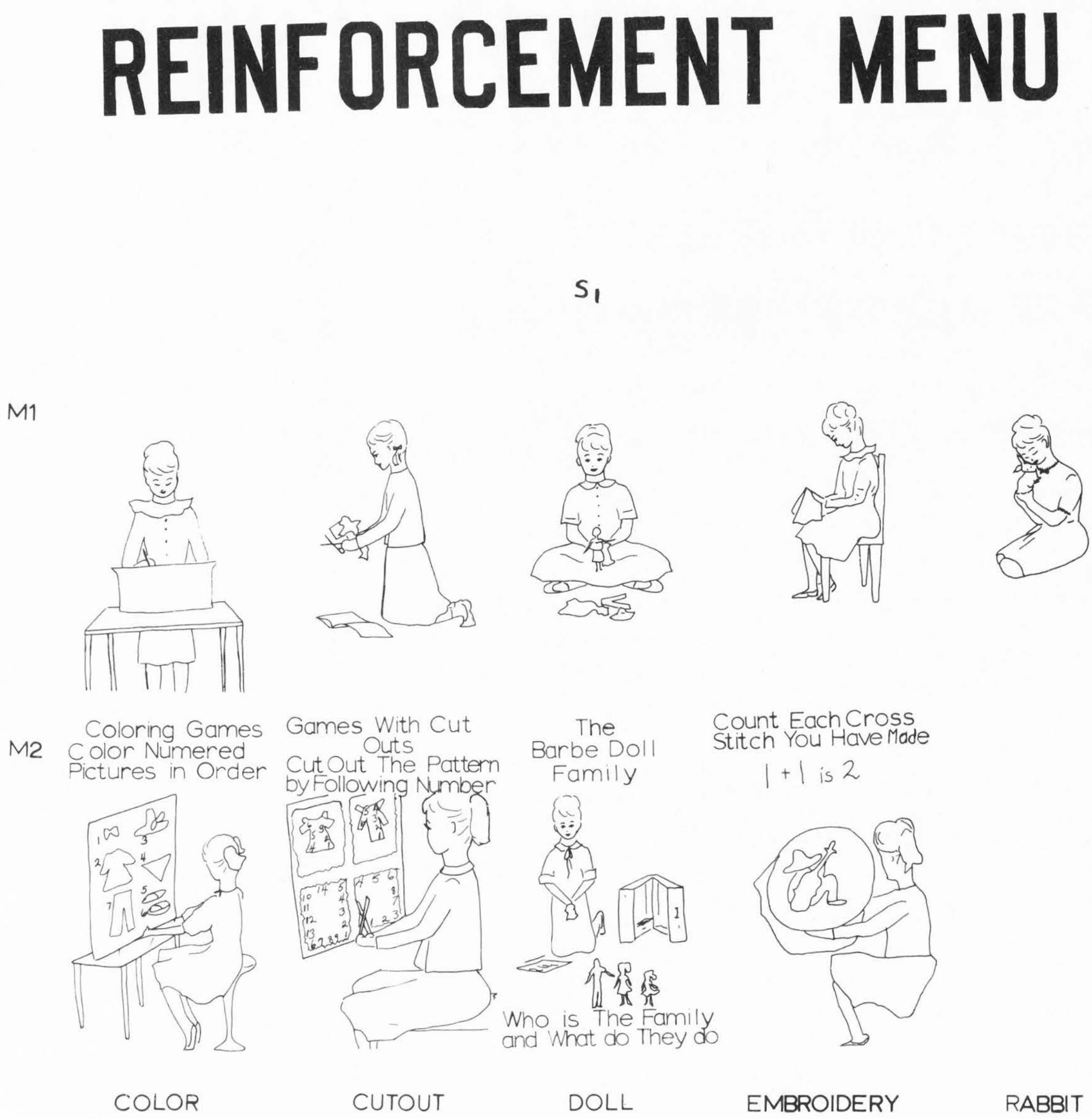

Figure 1. Reinforcement menus M_1 and M_2 for Birthe. Both menus are read from left to right and represent S_1 playing with, colors, cut-outs, dolls and embroidering. Playing with a rabbit was a component of the first menu only. The menus were employed sequentially, M_1, then M_2. Once a change in menu had occurred the old menu was not reused.

REINFORCEMENT MENU

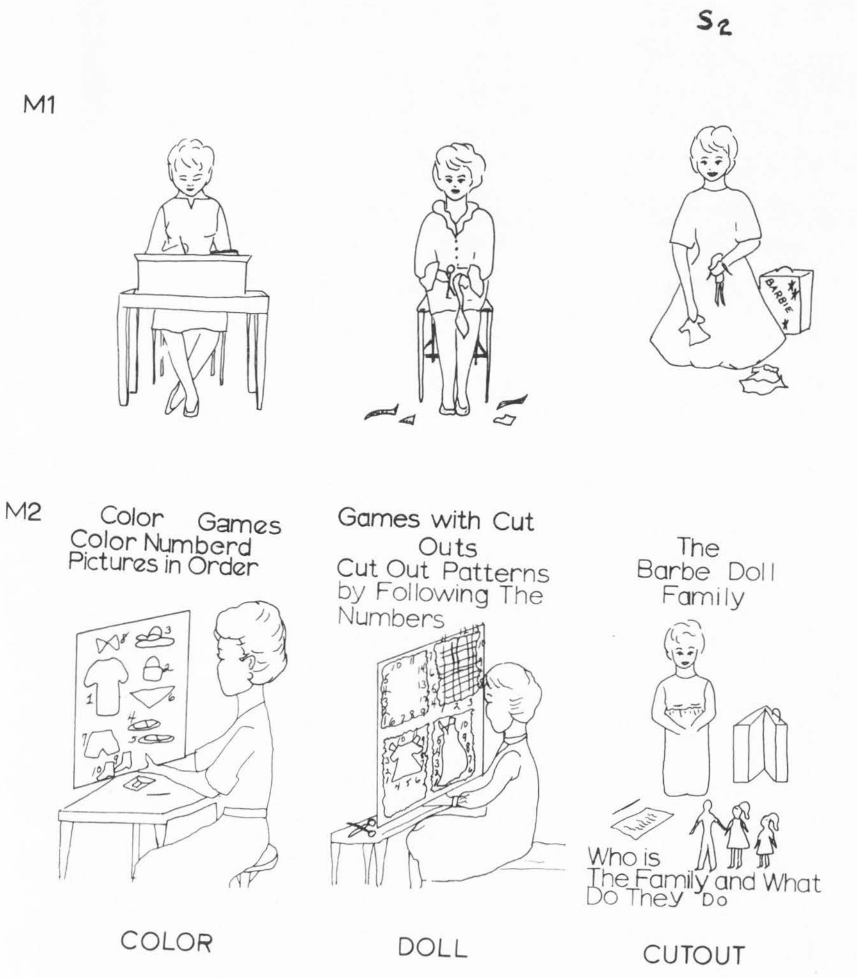

Figure 2. Reinforcement menus M_3, M_4, M_5 for S_1. These menus are used from left to right and represent S_1 playing with colors, cut-outs, dolls and embroidering. Playing with a rabbit was a component of the first menu only. The menus were employed sequentially, M_3,M_4 then M_5. Once a change in menu had occurred the old menu was not reused.

REINFORCEMENT MENU

S1

Figure 3. Reinforcement menus M_1 and M_2 for S_2. Both menus are read from left to right and represent S_2 playing with colors, cut-outs an dolls. Playing with a cat was a component of the first menu only. The menus were employed sequentially, M_1 then M_2. Once a change in menu had occurred the old menu was not reused.

REINFORCEMENT MENU

Figure 4. Reinforcement menus M3, M4, M5 for S_2. These menus are used from left to right and represent S_2 playing with colors, cut-outs and dolls. Playing with a cat was a component of the first menu only. The menus were employed sequentially, M_3, M_4, then M_5. Once a change in menu occurred the old menu was not reused.

CHAPTER IV

RESULTS

The results of the first experiment with S_1 are shown in figure 5. Substantial decreases in both mean task time and task time as a function of sessions and reinforcement number, respectively, were observed with all tasks. In the right portion of figure 5, the overall change in mean task times were:

(1) Curve A - counting 50 pennies - from 29 minutes to 2 minutes.

(2) Curve B - coin denomination discrimination - from 50 minutes to 1 minute.

(3) Curve C - form and color discrimination - from 12 minutes to 2 minutes.

(4) Curve D - location and amount discriminations from 25 minutes to 3 minutes.

(5) Curve E - linear measurement discriminations - form 28 to 2 minutes. In the left portion of figure 5, the overall changes in task time were:

(1) Curve A - counting 50 pennies - from 35 to 4 minutes.

(2) Curve B - coin denomination discriminations - from 57 minutes to 1 minute.

(3) Curve C - form and color discriminations - from 15 minutes to 2 minutes.

(4) Curve D - location and amount discriminations - from 31 minutes to 3 minutes.

(5) Curve E - linear measurement discrimination - from 45 minutes to 2 minutes.

Figure 6 shows S_1's performance with task time in minutes as a function of reinforcements on the left and mean task time as a function of session on the right. The tube at the bottom, indicates when reading and mathematics were being used as the task activity - white represents reading and black represents mathematics. Sequencial introduction of M_2, M_3, M_4 and M_5 is shown by the solid vertical arrows.

Inspection of figure 6 showed that S_1's task time in reading and programmed mathematics decreased from 28 minutes to a steady state of 8 minutes within 24 one-hour sessions. After the 25th session, subjects were allowed to talk to one another in the task area and variability was greatly decreased. Asymptotic responding was maintained at nine minutes throughout the menu fading period. Further, there was no change in performance following an additional 18 sessions using the final menu in the sequence, M_5. Overall reduction in time spent in the task activity was approximately eighty per cent.

Response duration data, for S_1 are displayed in figure 7 Response duration or time traveling to or from the task area, is shown as a function of sessions, on right. Shown in the graphs are a decrease from 48 seconds to 17 seconds in time traveling from the task area to the reinforcement area while there was a decrease of 45 seconds to 13 seconds for time spent in returning to the task area. There was also a difference between the two response duration measures in time which stabilization occurred. Stability was achieved by the 18th session in time spent traveling from task area to reinforcement area and by the 29th session in time spent traveling from reinforcement area to task area.

Also, menu fading had no effect on the response duration measure.

Figure 8 shows S_2's performance with task time in minutes as a function of reinforcements on the left and mean task time as a function of sessions on the right. The tube at the bottom, indicates when reading and mathematics were being used as the task activity - white represents reading and black represents mathematics. Sequential introduction of M_2, M_3, M_4, and M_5 is shown by the solid vertical arrows.

Inspection of figure 8 showed that S_2's task time in reading and programmed mathematics decreased from 27 minutes to a steady state of 9 minutes within 24, one-hour sessions. After the 25th session, subjects were not allowed to talk to one another in the task area and variability was decreased. Asymptotic responding was maintained at nine minutes throughout the menu fading period. Further, there was no change in performance following an additional 18 sessions using the final menu in the sequence, M_5. Overall reduction in time spent in the task activity was approximately 80 per cent.

Response duration data, for S_2 are displayed in figure 9. Response duration or time traveling to or from the task area, is shown as a function of reinforcements on left; mean response duration is shown as a function of sessions, on right. Shown in the graphs are a decrease from 50 seconds to 17 seconds in time traveling from the task area to the reinforcement area while there was a decrease of 49 seconds to 12 seconds for time spent in returning to the task area. There was also a difference between the two response duration measures in time at which stabilization occurred. Stabilization was achieved by the 20th session in time spent traveling from task area to reinforcement area and by the 29th session in time spent traveling from the reinforcement area to the task area. Also, menu fading had no effect on the response duration measure.

Figure 10 represents percentages of choices menu items for S_1 and S_2. Variability in baseline choices was more marked for S_2 then S_1. The range between the most and least chosen items in the baseline was 11 per cent for S_1 and 25 per cent for S_2. Most of the variability was contributed by the few choices made for playing with a rabbit, S_1, or playing with a cat, S_2.

While a steady state was being established over sessions one through 29 with task performance and response duration, the relative percentages of menu item choices were changing. Beginning with the introduction of M_2, coloring was chosen most frequently during menu fading. Cutting out was chosen one half to one third as frequently as coloring.

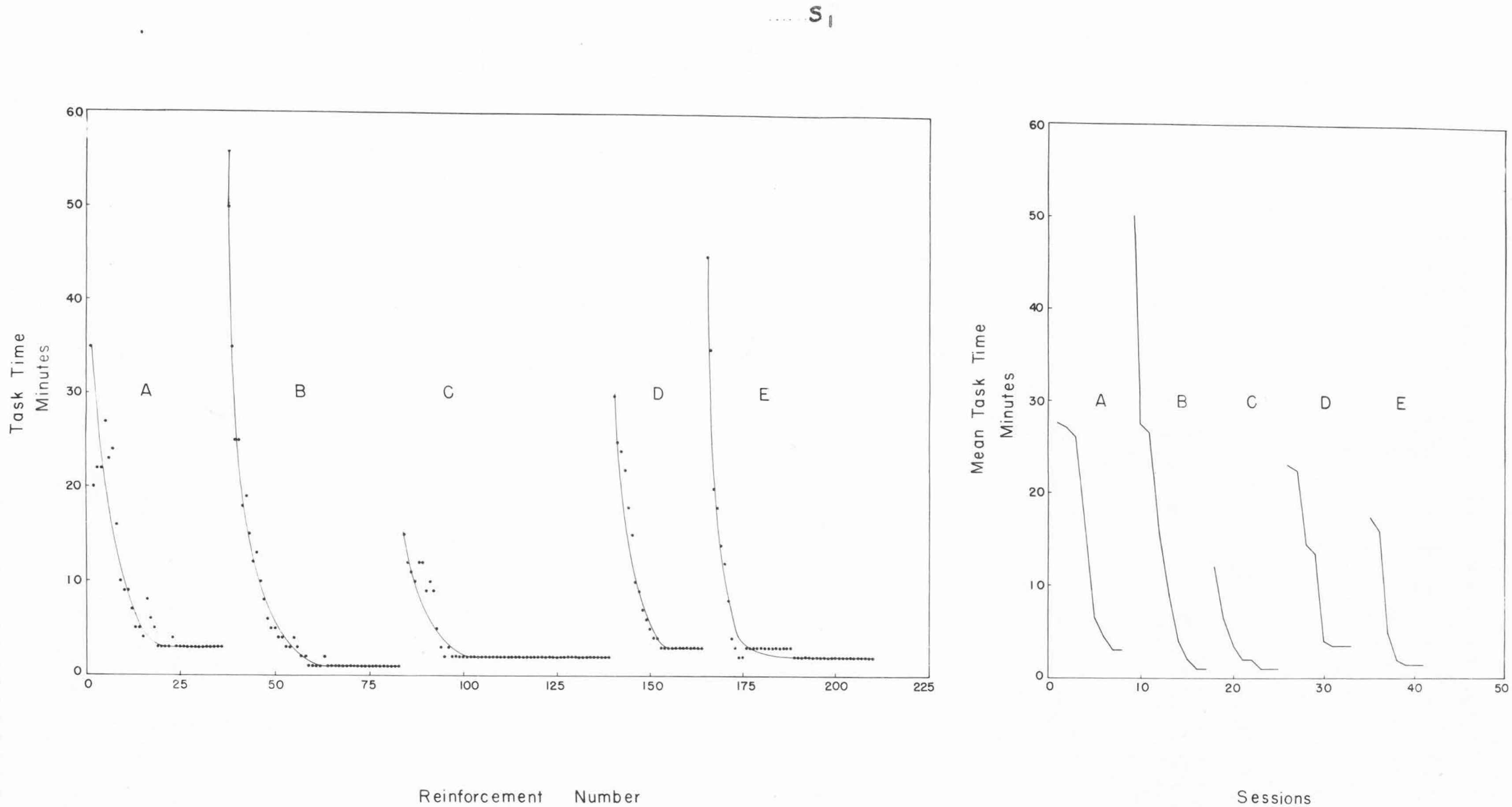

Figure 5. S_1's task time in minutes as a function of reinforcement number (left) and mean task time in minutes as a function of sessions (right). Tasks represented are: A, counting to 50, B, coin discrimination, C, formed color discriminations, D, location and amount terms, E, linear measurement discrimination.

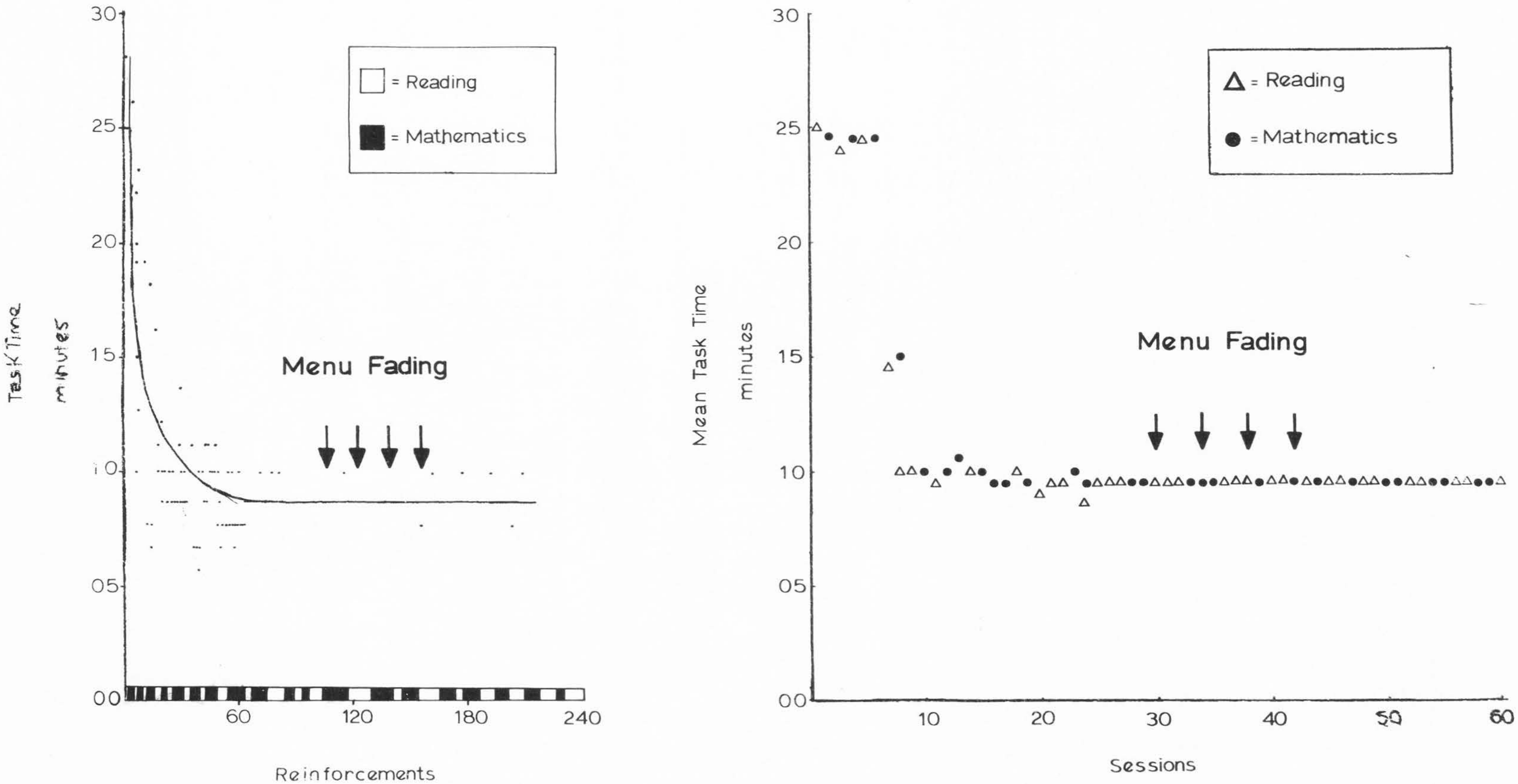

Figure 6. S_1's task time in minutes as a function of reinforcements (left) and mean task time in minutes as a function of sessions (right). The reading task is indicated as a blank space in the tube on the left and as a delta ( ) on the curve to the right. The mathematics task is indicated as a filled space in the tube on the left and as a dot ( ) on the curve to the right. Sequential introduction of menus M_2, M_3, M_4 and M_5 is indicated by solid verticle arrows.

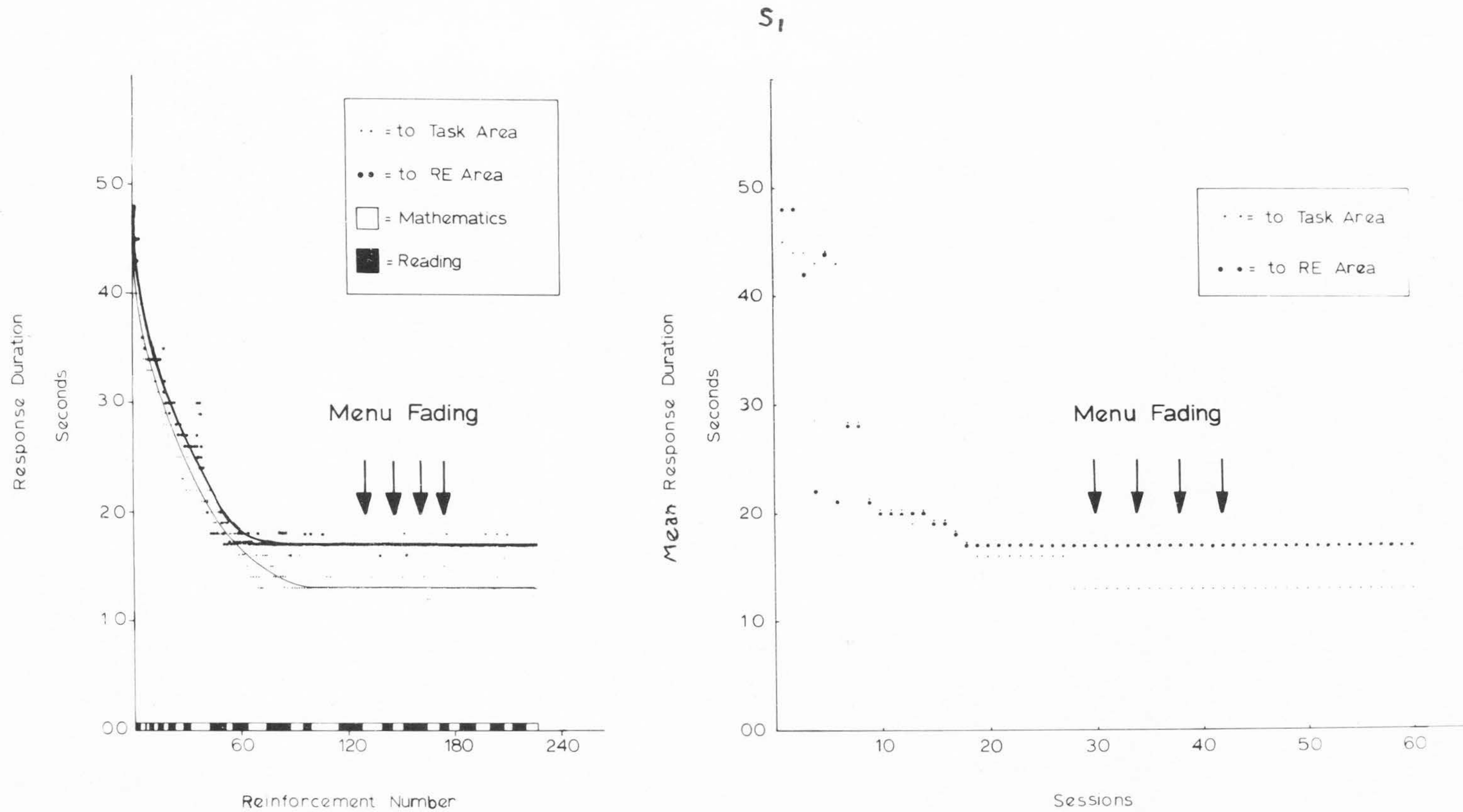

Figure 7. S1's response duration in seconds as a function of reinforcement number (left) and mean response duration in seconds as a function of sessions (right). Small dots are used to represent time spent traveling to task area while large dots are used to represent time spent traveling to reinforcement area. The tube along the reinforcement axis indicates when mathematics, in white, and reading, in black, were used as the task activities. Sequentcial introduction of menus M2, M3, M4, and M5 is indicated by solid verticle arrows.

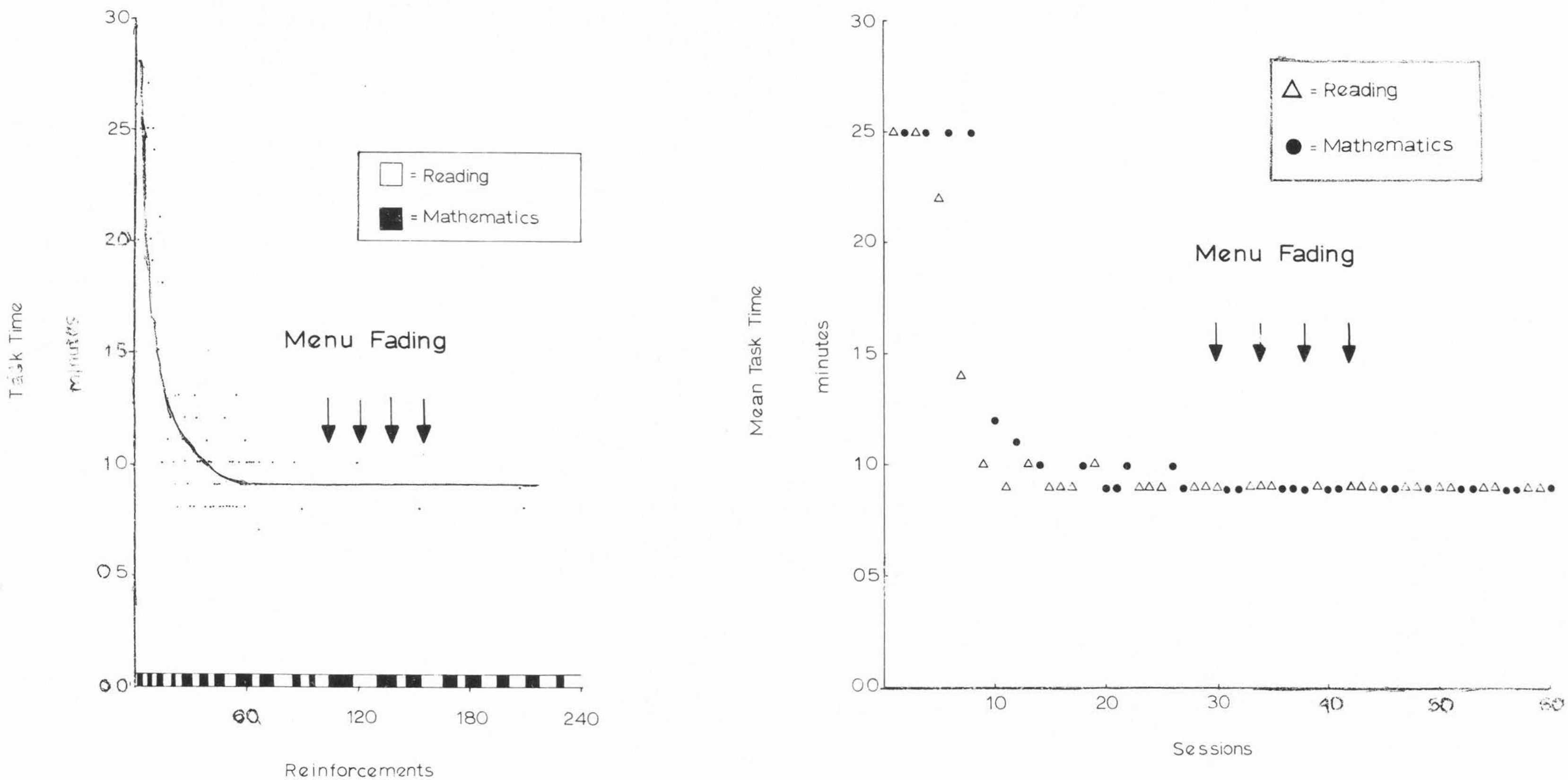

Figure 8. S_2's task time in minutes as a function of reinforcements, (left) and mean task time in minutes as a function of sessions (right). The reading task is indicated as a blank space in the tube on the left and as a delta ( ) on the curve to the right. The mathematics task is indicated as a filled space in the tube on the left and as a dot ( ) on the curve to the right. Sequential introduction of menus M_2, M_3, M_4 and M_5 is indicated by solid verticle arrows.

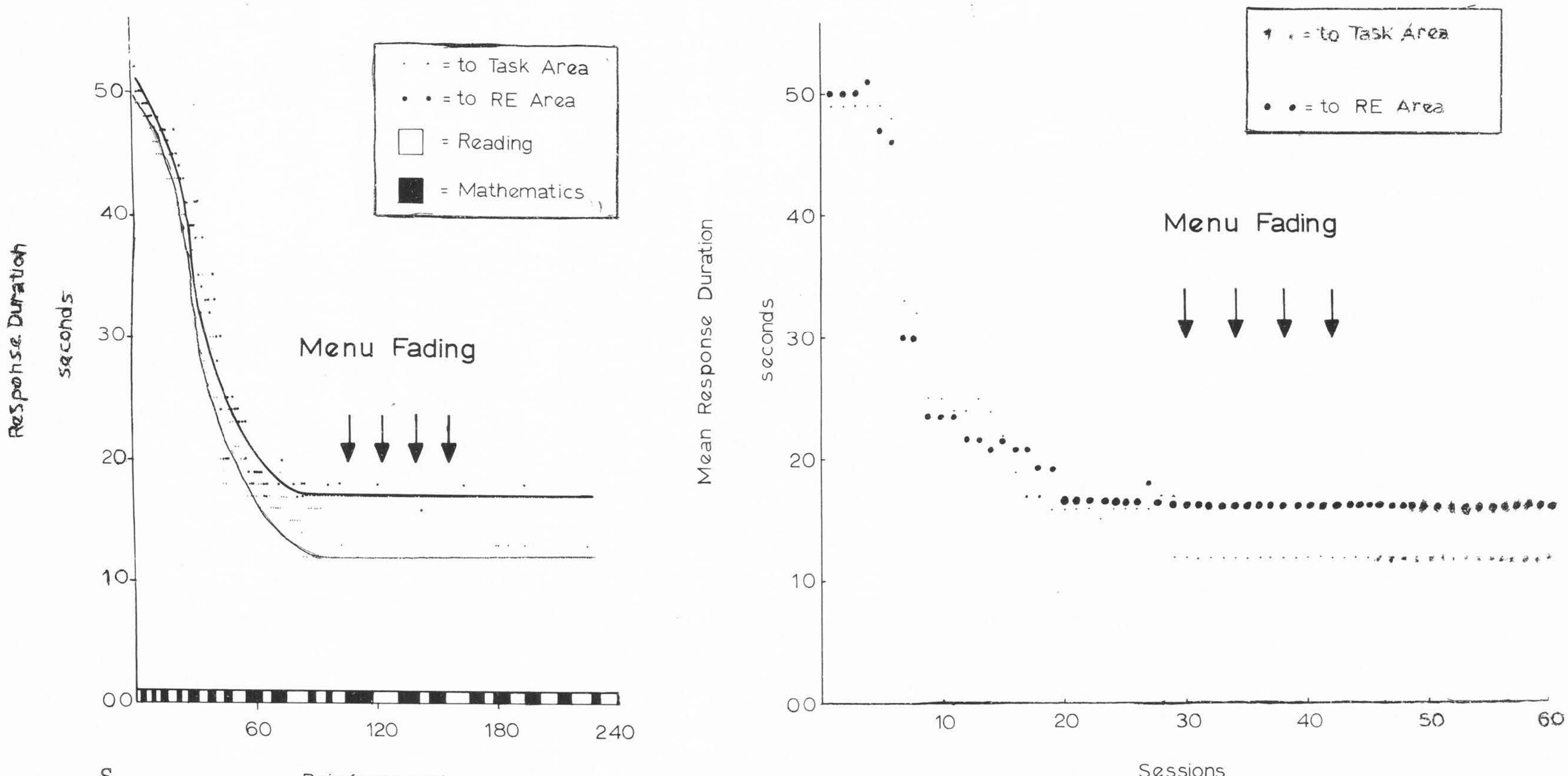

Figure 9. S_2 response duration in seconds as a function of reinforcement number (left) and mean response duration in seconds as a function of sessions (right). Small dots are used to represent time spent traveling to task area while large dots are used to represent time spent traveling to reinforcement area (RE). The tube along the reinforcement axis indicates when mathematics, in white, and reading, in black, were used as the task activities. Sequencial introduction of menus M_2, M_3, M_4, and M_5 is indicated by solid verticle arrows.

Percentage Choices of Menu Items

Sessions	No.	Menu Item: embroider	doll	color	cutout	rabbit	Choice Frequency	Menu Item: color	doll	cutout	cat	Choice Frequency
Baseline	—	22%	20	24	21	13	89	36%	21	32	11	47
1 - 10	1	16	20	48	8	8	25	58	23	13	6	31
11 - 20	1	13	26	21	40	0	38	49	20	31	0	41
21 - 29	1	12	8	30	50	0	36	34	30	36	0	50
30 - 33	2	8	0	58	33	—	12	58	0	42	—	12
34 - 37	3	0	0	67	33	—	12	75	0	25	—	12
38 - 41	4	0	0	75	25	—	12	75	0	25	—	12
42 - 60	5	0	0	67	33	—	76	70	0	30	—	76

Figure 10. Percentage choices of menu items by S_1 and S_2. Menus items include playing with dolls, colors, cutouts, a rabbit, a cat and embroidering. The menus employed, M_1, M_2, M_3, M_4, M_5 is indicated under "No." "Choice Frequency" indicates the frequency with which all reinforcement activities were chosen for each group of ten sessions for the first 29 sessions and for each group of three sessions through the 41th sessions and for the group of ten sessions between session 42 and 60.

CHAPTER V

DISCUSSION

The results of these experiments are consistent with the literature and support Premack's hypothesis that "of any pair of responses the more probable one will reinforce the less probable one. (Premack, 1959, p. 132) Frequency of the LPB was increased when the HPB was made contingent upon emission of the LPB behavior. The data did not indicate any differences in response duration or task time when different reinforcing stimuli such as playing with a cat or doll, coloring or cutting out were chosen as reinforcers. This suggested that in these experiments a reinforcement was simply any response that at that moment was independently more probable than another response.

In the first experiment, the curves shown in figure 5, indicated some variability which may have been due to the "warm-up" at the beginning of each new day. Steeper slopes, faster acquisition, might have been achieved if continuous reinforcement with smaller task ratios had been used. The ratios could have been gradually raised while retaining control.

Stimulus control was maintained throughout the menu fading operation in the second experiment. As the reinforcing stimuli were changed to approximate the mathematics and reading tasks, there were no changes in the characteristics of the responding in the task area. It is suggested, therefore, that stimulus control was maintained throughout the fading procedure because the "presentation" of a menu was a conditioned reinforcer for task performance which was followed by the opportunity to participate in the menu behavior.

Beginning with the menu fading operations, the percentage of choices of specific menu items also changed. By the end of the experiment, the only reinforcing activities in which the subject chose to participate, were chosen because (1) they were, with few exceptions, consistently higher in percentage of choices in the previous sessions, and (2) they were the two activities which were best arranged to follow a gradual fading procedure. Instructions for coloring and cutting out activities were abstracted from another programmed arithmetic workbook.

Inspection of figure 5, 6, 7, 8, and 9 revealed some variability during the first twenty sessions. This may have been produced by occasional interuption of the subjects within the task areas and hallway disruptions leading to the reinforcement area. These increased task time and response duration. Another source of variability might have been due to the subjects' interaction with one another. This problem was eliminated by not allowing the subjects to talk to one another in the task area or on their way to and from the reinforcement area.

Examination of figure 6 and 8 indicated that there was very little inter-subject variability in time spent in reading or mathematics tasks. However, considerable inter-subject variability existed in response duration in seconds. This inter-subject variability on closed examination may not have been so great when one considers that both subjects were running very fast when going to and from the task area. S_1 was prognosed by a neurologist as not being capable of fast running. Until this experiment began, S_1 had not been seen to run at all during the past five years at her school.

All graphs indicated steep slopes. If changes were made in the procedures it is possible that even steeper slopes could have been attained. Most standard procedures is to begin early sessions with few task demands and with continuous reinforcement. After responding increases the reinforcement schedule is changed to fixed ratio reinforcement and gradually longer fixed ratios are required. The present experiment began with a fixed ratio reinforcement schedule which required the subject to perform extensive tasks for infrequent reinforcements. This may have partly accounted for the large number of sessions necessary to acquire asymptotic performance. It is suggested that future experiments of this nature should follow the continuous reinforcement procedure with few task requirements, then gradually increase the ratio requirement. This procedure would probably develop a more durable behavioral repertoire. In addition, producing warm-up periods at the beginning of each session would assist in maintaining better control over the subjects responding in the task area, and thus, would decrease inter-subject variability.

As an extension of these experiments it would prove valuable to determine how long behavioral control could be maintained with the final menu in the sequence. The final menu presentation could represent activities which do not approximate the HPB in any dimension. Here, all dimensions of the HPB would have been gradually faded out, leaving only the LPB.

CHAPTER VI

SUMMARY AND CONCLUSION

Summary

Two "trainable" mentally retarded girls were taught reading and arithmetic using the "Differential Probability Hypothesis," and a sequence of reinforcement menus.

Reinforcement contingencies were established as follows: The subject was presented an empirically derived menu comprised of figures representing five behaviors which she emitted most frequently, After successful completion of a fixed amount of reading or mathematics, the subject was immediately allowed to participate for five minutes in any one of the five high probability behaviors they selected. Measurements were made of time spent in task area and time spent going from task area to reinforcement area and from the reinforcement area to task area. Results were that within 15 sessions, both task time and time spent to and from reinforcement areas were decreased by two thirds from the original baseline values. Stable, baseline performances were maintained from the 20th to the 30th session.

Beginning with the 30th session, four other menus which approximated the LPB's in certain stimulus dimensions of arithmetic, reading, and writing were sequentially presented. Compared to the task behaviors at the beginning of the experiment the final menu in the sequence represented LPBs. Performance remained unchanged throughout the fading; both times in the task area or time traveling to and from the reinforcement area remained stable. The subjects were now doing one low LPB for the opportunity of doing another LPB. These subjects, who before this experiment were not able to attend to academic tasks for more than five minutes before displaying emotional behavior, such as crying or tantrums, could now attend to LPB tasks for three hours per day with only four ten minute breaks.

Factors accounting for the maintenance of stimulus control, success of the menu fading technique, variability in task time and response duration were discussed. Suggestions for further research were also proposed.

Conclusion

Lindsley's statement that, the environment is retarded and not the child, should be more evident. Before these experiments the subjects could not attend to mathematics or reading tasks for more than five minutes. However at the conclusion of this investigation the subjects were performing academic tasks at a 90 per cent criterion for one hour periods. The subjects became highly motivated.

S_1 made sufficient academic progress to be taken out of the training center and to be put into an "Educable" Junior High School group. Here she will receive much more academic training than she would have received at the training center. It is very likely that she will become semi- or completely financially independent.

It is clear that a menu fading technique is valuable in systematically maintaining stimulus control over the organism's behavior. With assimilated computerized programs, such as was reported by Homme (1965), a large group of children could be handled under a prosthetic environment. Once large numbers of retarded children are put in an environment such as has been demonstrated in this experiment, the need for training centers may possibly be eliminated. In addition, gross financial dependence of retarded persons in this community may be decreased.

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APPENDIX

S_1

First session of reading:

"What is it?" said Ricky.
"I like cookies.
But it is not cookies.
I like ice cream.
But it is not ice cream.
"What is it, Bill?"

Bill said, "look and see.
It is something you will like."

Last session of reading:

Once a little girl and her mother lived in a wee small house in an old, old town.

They had nothing to eat but porridge.

But they always had all the porridge they wanted to eat, because they owned a very wonderful porridge pot.

S_2

First session of reading:

One cold winter morning Northfield was an all-white village. A cover of snow lay over it. Snow lay on the streets, on the trees, and on all the roofs.

The snow was fine for sliding. So the village children had gone to North Hill with their sleds--all except George and Judy Bell. They were late. So they were going a shorter way. They could save time by going the back way through the woods.

Last session of reading:

"Nay! Nay!"sputtered poor John, guessing their purpose, but all his cries were to no avail, Seven feet tall though he was, and with muscles like steel, he was no match for seven of Robin's men. Laughing and shouting, they held him fast while

Figure 11. Samples of reading materials for S_1 and S_2 for the first and last sessions.

Figure 11. Continued.

Will Stutely pushed hid way through the covorting throng, holding aloft the tankard of ale.

Instantly the outlaws ceased their wild antics, least they miss a single word.

"I now christen thee Little John," cried Will, who doted on such merry pranks, and forthwith he empted the tankard of foaming ale over the tall fellow's head.

ACADENIC PROGRESS

The following is the approximate advances in reading and mathematics for both children.

S_1: Two and one-half grade levels in reading and two grade levels in mathematics.

S_2: Three grade levels in reading and two grade levels in mathematics.

VITA

Gary Lyndle Holt

Candidate for the Degree of

Masters of science

Thesis: Control of Behavior Through Reinforcement Menus.

Major Field: Child Psychology

Biographical Information:

Personal Data: Born in Livermore, California; graduated from Woodrow Wilson High School in 1959; received the Bachelor of Arts degree from San Francisco State College, with a double major in physiology and psychology, in 1965; completed requirements for the Master of Science degree in psychology at Utah State University.

Professional Experience: 1966 to present, teaching assistant, Utah State University; Summer of 1965 instructor in a graduate course in child psychology, Utah State University; 1966 research assistant, Utah State University; 1964 research assistant San Francisco State College; 1962 computer operator with Bank of America, Berkeley, California.

Publications:

1) Increased Motivation Through Behavioral Engineering, U.S.U. Special Educator 1966, 1, (2).
2) With Daley, M.F. and Vajanasoontorn, Cheryl, Reinforcement Menus in the Instruction of Mentally Retarded Children. Proceedings of Far West Laboratory for Educational Research and Development, Nov. 1966.
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