Repeated Acquisition with the Developmentally Disabled

Jeannie Madsen

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Repeated-acquisition data were obtained from four developmentally disabled adults. The task was selecting the poker chip with the sticker on its underside in a sequence of sets of chips. When a sequence was mastered (four consecutive errorless runs) the subjects were given a new sequence to learn. Money was reinforcement for correct sequence completion. Total errors before mastery was the dependent variable.

In Phase 1 the subjects completed as many sequences as possible during each 15-minute session. Errors per sequence was a reasonably stable dependent variable within subjects, and between-subject differences were what would be expected on the basis of intellectual test scores. During Phase 2 the subjects were presented with only one sequence per session. Phase 3 was a return to the conditions of Phase 1. The effects of this manipulation were unclear. During Phase 4 the number of chips per set was increased for three of the subjects. Two were able to learn the larger sequence.
ACKNOWLEDGEMENTS

I wish to thank Coral Gibbs for allowing me to "practice" with her, Kalamazoo County Human Services for their support of the work and the subjects for their participation and enthusiasm.

I am indebted to Dr. Jack Michael for his patience, assistance and continued support without which this work could not have been completed.

Jeannie Madsen
DEDICATION

To my parents, Audrey and Robert Madsen.
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CHAPTER I

INTRODUCTION

Alzheimer's Disease and Downs Syndrome

Alzheimer's disease (AD) is a neurological disorder resulting in organic deterioration of the brain. It causes a progressive decline in the intellectual and physical condition of an estimated 2 million adults over age 65 in the United States alone (Edwards, 1986). Currently there is no treatment to cure or even slow the progression of AD, and there is considerable dissatisfaction with currently available methods for evaluating the status and progress of the disease (Sim, 1965).

Recently the Special Secretary's Task Force on AD (U. S. Department of Health and Human Services, 1983) developed specific recommendations for future research which included the development of more sensitive cognitive assessment tools to measure the intellectual changes produced by AD. More sensitive measurement, especially if it could be repeatedly administered to the same person, would permit more accurate tracking of the course of the disease over time, and thus make it easier to discover effective treatments (drugs, diet, etc.) as well as to react appropriately to the patient's changing intellectual effectiveness.

Down's syndrome is a chromosomal anomaly resulting in a genetic defect that is the nation's leading cause of mental retardation in developmentally disabled adults. Down's syndrome occurs in approximately one out of 1000 live births. It results in lower than normal mental ability, increased susceptibility to infections and a higher incidence of leukemia.
Most Down's victims have three copies of chromosome 21 rather than the normal two. It has been discovered that many individuals with Down's syndrome who live beyond age 35 develop neuropathological protein deposits in brain tissue characteristic of Alzheimer's disease (AD) and show AD-like intellectual deterioration. Researchers appear to have isolated a gene on chromosome 21 which is responsible for the protein in the deposits, and genetic markers for AD have been isolated in close proximity to this gene ("Genetic Clues," 1982).

It has been difficult to detect early stages of AD, and even later stages are sometimes indistinguishable from other intellectual disorders of old age. Individuals with Down's syndrome, on the other hand, are quite easily identified, and if such individuals regularly exhibit at least some of the characteristics of AD during their later years a more intense investigation of their intellectual changes with age could throw further light on AD. It has even been suggested (Lott, 1985, as quoted in Edwards, 1986) that Down's syndrome may constitute a model disease for studying neurological disintegration due to AD.

The Repeated-Acquisition Procedure

There exists a behavioral procedure -- repeated acquisition -- that might prove useful in the study of intellectual deterioration as seen in AD. In most studies of learning it has been necessary to use different subjects for each value of the independent variable since further exposure to the same task would not constitute new learning. This means that the effects of the independent variable are inevitably confounded with individual differences, a problem that can be overcome only by assigning a number of subjects to each value of the independent variable. For some purposes -- for example, studying progressive deterioration over the course of a
slowly developing disease -- it may be practically impossible or too expensive to use groups of subjects large enough to override between-subject variability.

The repeated-acquisition technique, as first used by Boren (1963) with monkeys, involved four sets of push buttons (three buttons in each set) arranged in a straight line. The buttons in each set were close to each other and were clearly separated from adjacent sets. For each daily session one button in each set was designated as the correct button to push. The buttons could be illuminated, and at the beginning of a trial the left set of three would be illuminated as shown below. Assume that the correct sequence is center, left, right, center. When the monkey pressed the center button the second set of buttons would be illuminated and the illumination of the first set would go out. Now when the monkey pressed the left button of the illuminated set, the third set of buttons would be illuminated and that of the second set would go out. Pressing the right button of the third set would illuminate the fourth set, and pressing the center button of this last set would cause a food pellet to be delivered.

After a brief pause the first set would again be illuminated and the monkey had to go through the sequence (center, left, right, center) again, and so on. The reinforcement for each correct response was the onset of the next sequence of three
lights, up to the last sequence of three where the reinforcement for a correct response was the delivery of the food pellet. The session ended after a fixed number of completed sequences.

As the session proceeded, the monkey would become more and more accurate and would eventually be performing the response sequence with very few errors. There are several possible measures of learning in this situation: percent correct responses (correct responses divided by total responses) during a session involving a fixed number of trials (successful completions of the sequence); total number of errors made in a session which has a fixed number of trials; number of errors made in reaching some specified criterion of accuracy, such as five sequences in succession with no errors, and others.

The next day the monkey would be presented with the same experimental situation, except that the correct button in each set of three would be different. For example instead of center, left, right, center as in the session described above, the correct sequence would now be left, right, left, center. As before the monkey would at first make a number of errors but eventually learn the sequence. The next day there would be still a different sequence; and so on over many sessions. The number of errors made in each session would decrease over the first several sessions but would eventually become fairly stable, for example at a value of around 30.

After the learning measure had become stable it would then be possible to introduce some other condition, such as a drug, or a procedural change, and see what effect this new condition had on the measure of learning. In other words, it was possible to see whether or not the drug at some specific dosage level interfered with the animal's ability to learn the constantly changing sequence of correct responses and thus caused an increase in the number of errors per session.
With nonhumans the repeated-acquisition technique has been used primarily to study procedural variables, or the effects of various pharmacological agents. Boren (1963) developed the repeated-acquisition technique, establishing that the rate of learning would remain stable over a large number of sessions. In 1968 Boren and Devine, using monkeys as subjects, studied the effects of two procedural variables on the acquisition of response sequences like those described above. The first experiment showed that a brief timeout following errors resulted in a much more accurate performance than when there was no timeout.

In their second experiment of the same study, Boren and Devine (1968) investigated the effect of what they called instructional stimuli on the acquisition of a behavioral chain. Since this experiment was the basis for most of the human research reported in the next section, it will be described in detail immediately before that section.

In the previous studies, although the monkeys acquired stable performances involving few errors, many of the errors resulted from the repetition of a specific chain of correct and incorrect responses. Thus, if the correct sequence were left, center, right, center, the monkey might consistently perform the sequence center, left, center, right, center, the first response being an error on the center button of the first set of three. The erroneous center response is followed by the correct left response which then causes the next set of lights to be illuminated. Such a chain involving an unnecessary response is referred to as a "superstitious chain" after Skinner's (1948) experiments on behavior which does not cause the subsequent reinforcement but is maintained by it nevertheless. Boren (1969) investigated the effects of several variables on the amount of superstitious chaining (again, monkeys were the subjects) during the acquisition of the response sequences. In his first experiment, he
examined the effect of various fixed ratio requirements on the correct levers. Results showed a general trend for errors to decrease as the fixed ratio increased. Experiment 2 added an $S^A$ (pilot lights and houselights going out) following an incorrect lever press, which considerably reduced the frequency of inappropriate responding. In a third experiment, the effect of extended training (presenting the same sequence for five consecutive sessions) was studied, and this condition also reduced the amount of superstitious chaining.

Thompson (1970) modified Boren's 1963 procedure so that repeated acquisition could be studied with pigeons in a standard three-key chamber. When the sequence started all three keys would be one color, for example, red. A correct response to the red keys, for example pecking the left key, would result in all three keys becoming a different color, for example, yellow. A correct response to the yellow keys, for example pecking the right key, would change the keys to blue; a correct response to the blue keys would change them to green; and a correct response to the green keys would be followed by food reinforcement, and the sequence would begin again. As with Boren's procedure a new sequence would be used in each session, with a session involving, for example 70 completed sequences.

Thompson ran one session with changing key colors, one with key lights white during all components of the chain followed by a session with changing key colors. There was a substantial increase in errors made in the second session as compared to the first and third. In his next study, Thompson (1971) provided data on the development of the steady state of a repeated-acquisition performance over a large number of sessions.

In 1973, Thompson began using the repeated-acquisition technique to study the effects of drugs on learning. In studying various doses of phenobarbital and chlordiazepoxide, he found that both drugs increased total errors per session, with
chlordiazepoxide having a larger detrimental effect than phenobarbital at the same doses. Thompson (1974) studied the effect of chronic administration of phenobarbital and chlordiazepoxide. He altered Boren's 1963 procedure by adding a condition in which the sequence remained the same from session to session. Results showed differing patterns of errors during learning sessions depending upon drug dose, with greater disruption under learning than under performance.

In a further study incorporating the procedural changes of his 1970 and 1974 studies (learning vs performance conditions and changing key lights vs key light colors remaining constant) Thompson (1975) again looked at the effects of varying doses of phenobarbital and chlordiazepoxide. Results showed the largest dose of both drugs impairing overall accuracy in all four conditions, with the learning condition with constant color key lights being less sensitive to drug doses than the learning condition with changing key lights, and chlordiazepoxide having a greater error increasing effect than phenobarbital during learning conditions.

Repeated acquisition has become a standard assay in drug research and by now a number of studies of this sort are available (Delaney & Poling, 1987; Moerschbaecher, Boren & Schrot, 1978; Moerschbaecher, Boren, Schrot, & Simoes-Fontes, 1979; Picker and Poling, 1984; Poling, Blakely, White & Picker, 1986; Thompson, 1980; Thompson & Moerschbaecher, 1979; Thompson & Moerschbaecher, 1980; Thompson & Moerschbaecher, 1981; Thompson, Moerschbaecher & Winsauer, 1983).

In 1977, Hursh investigated the enhancing effects of discriminative stimuli as opposed to the strengthening effects of differential consequences during the acquisition of a chain. He used a complex modification of Boren's (1963) technique with monkeys as subjects. Results indicated that the stimuli functioned both as conditioned reinforcers and as discriminative stimuli.
Using a very complex modification of the Thompson (1970) procedure, Moerschbaecher, Boren and Schrot (1978) investigated the effects of several variables on chains of conditional discriminations. Pigeons were used as subjects, and with the conditional discriminations, timeout was found to have no effect on either error or response rates; extended training resulted in a decrease in errors; and when chain position was not signified by color, error rate was generally increased.

Because it was the basis for the human studies reported below, the second experiment of Boren and Devine (1968) will be described here in some detail. The apparatus and general procedure (four sets of three buttons, one button correct for each set) were the same as in the first experiment (described earlier). In this experiment, however, the first two sessions involved the same sequence, and then a new sequence was used for the next two sessions. The first session was called "learning" and the second "relearning," and both were conducted as in the previous experiment, with three lights being lit, first over the left set of buttons, then the next set, and so on. As would be expected, the errors in the second session, "relearning," were fewer than in the first, since it required the same sequence of responses. That is, on the second day with a given sequence, the monkey did not completely "forget" what had been learned the day before. The third session, involving a different sequence than the one used in the first and second sessions, was called "instructed learning," because a single light appeared above the correct button of each set, and all the monkey had to do was press the buttons under the lights to complete the sequence.

The next four sessions would be just like the first four except that there would be new correct sequences, and so on with the experiment, and Devine referred to this procedure as "instruction" because it seemed to be somewhat like instructing the monkey as to the correct sequence—"telling" the monkey what the correct sequence
The fourth and last session of the four-session set was called "noninstructed relearning" because it used the same sequence as in the "instructed learning," but now all three lights over each set were on, so there was no stimulus indicating which button was the correct one to press. The researchers were interested in the extent to which the monkey could benefit from having been "instructed" when the instructional stimuli were removed, but the sequence was the same.

Of the three subjects, two were unaffected by the single light over the correct button, and reacted to it as they had to the three lights over each successive set of buttons. For these subjects the performance on the second two sessions was very much like that on the first two: a moderate number of errors on the first and third; somewhat fewer on the second and fourth. The instructional stimuli had obviously had no effect when present. The third subject was clearly controlled by the instructional stimuli, and made almost no errors in the third (instructed learning) session when these stimuli were present. However, in the fourth session with the same sequence but no instructional stimuli, the monkey's performance resembled that of session 1, the learning session. In other words, although this monkey benefited from having the instructional stimuli present, this experience did not facilitate performance of the same sequence in the next session without the instructional stimuli.

With Human Subjects

Following up on the second Boren and Devine (1968) experiment described immediately above, Vaughan (1985) was interested in seeing to what extent young

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1 The Vaughan research was part of a doctoral dissertation completed in 1980, but in the present thesis only the 1985 report of the research, cited in the bibliography, was consulted. Ozuzu and Danforth based their work on the Vaughan dissertation which was available to them by 1980.
children were affected by such "instructional" stimuli because this might be a way of investigating what has come to be called "rule-governed behavior" (Skinner, 1969, pp. 146-171). Using apparatus and procedure quite similar to that of Boren and Devine she found in her first experiment that the children behaved very much like Boren and Devine's third monkey: They were controlled by the instructional stimuli when present, but still had to learn the sequence almost as though it was a new one when the instructional stimuli were no longer available, that is, when all three stimuli were lit above each set of buttons. In Experiment 2, during the first session of the four session set (learning) she had the children state what button they were going to press, whether it was the correct button or not, and at the end of the session what the sequence had been. This verbalization resulted in a considerable drop in errors in the second (relearning) session, but the children showed no tendency to engage in the same verbal behavior during the instructed learning (third) session nor in the noninstructed relearning, and again they had to learn the sequence of the noninstructed relearning (fourth) session as though it were a new sequence.

Ozuzu (1982) used the same procedure with children as Vaughan (1985), but simplified the apparatus so that the task could be performed outside of a laboratory setting. The experimenter displayed five sets of poker chips (three chips in each set) on a table before the child and asked the child to find the chip with the star on its under side (the correct response). When the correct response was made, the child moved onto the next set of chips and so on until the child learned the correct sequence and reached criterion. Then (or the next day) the chips were rearranged so the child had to learn a new sequence.

Ozuzu addressed the effects of superimposing stimulus fading and rule stating on the acquisition of behavior chains. In Experiment 1, the effect of instructional stimuli (conspicuous displacement of correct chips) was evaluated. His subjects learned
without errors during the instructed learning condition, however errors during the noninstructed relearning condition were similar to those demonstrated in the relearning condition. Experiment 2 investigated the effects of a five-step stimulus-fading procedure during instructed learning to increase stimulus control of responding to the correct chip sequence. Performance during noninstructed relearning was only slightly better than during the same condition in Experiment 1. In Experiment 3, the role of rule stating during the instructed learning condition was assessed, and performance did not differ much from that of the same condition in Experiment 2. Superimposing stimulus fading and rule stating on instruction during the acquisition of behavior chains did not result in any improvement from instructed learning to noninstructed relearning conditions, essentially supporting Vaughan's findings.

Danforth (1983) with the Vaughan (1985) and Ozuzu (1982) procedure and with children as subjects further studied the effect of instructional stimuli. There were four experiments, all manipulating variables that might be expected to enhance the instructional effect of the relevant stimuli on performance of the same sequence when the instructional stimuli were removed. In general the effects of these variables were inconclusive.

In a previous study done in the Gerontology Program at Western Michigan University (Stone, 1986) the repeated-acquisition technique was used in an attempt to measure the learning ability of persons with Alzheimer's disease. It was thought that if the AD patients could and would perform the task, and if stable performances developed fairly quickly, it might be possible to use this technique to study the time course of the intellectual deterioration seen in AD. In that study, only one of the three subjects achieved a stable rate of learning new response sequences during the time available for the study. Several factors might have been responsible for this instability: choice of setting, intellectual and emotional status of the subjects,
ineffective rewards, and possibly others. The present study constitutes another attempt to obtain stable rates of repeated acquisition as a way of assessing one kind of intellectual effectiveness, this time with developmentally disabled adults.

The Purpose of the Present Research

In order to develop a better understanding of typical performances of adults with intellectual deficit, the present study obtained repeated-acquisition data from developmentally disabled individuals, including some with Down's syndrome. Many such subjects are easily rewarded and quite willing to perform the task, and although the developmentally disabled population is not perfectly analogous to the AD population, these data may be useful in themselves for developing another standardized tool for assessing learning ability. More importantly, it may be possible in future work to use the repeated-acquisition procedure to study the possible relation between Down's syndrome and Alzheimer's disease.

More specifically, the purpose of this study was to obtain repeated-acquisition data with developmentally disabled adults functioning at the mildly and moderately retarded level. The main goal was to obtain typical performances for subjects in these categories, with special concern for the stability of the performances over repeated administrations of the procedure. A secondary goal was to see to what extent performance on the repeated-acquisition task was correlated with other measures of intellectual effectiveness already available for the subjects used in this study, such as test scores and behavior ratings. Down's syndrome subjects are included in the study to obtain preliminary information that may be valuable in further studies relating Down's syndrome and Alzheimer's disease. Finally, some procedural aspects of the technique (number of sets of chips and one sequence per day versus more than one) were studied with the aim of further methodological refinement.
CHAPTER II

METHOD

Subjects

Subject characteristics are shown in Table 1 below.

Table 1
Subject Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Sex</th>
<th>Age</th>
<th>IQ</th>
<th>GAS²</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1</td>
<td>M</td>
<td>27</td>
<td>53 (WAIS-R³)</td>
<td>69</td>
<td>Moderately retarded, Down's syndrome</td>
</tr>
<tr>
<td>Subject 2</td>
<td>M</td>
<td>35</td>
<td>44 (WAIS⁴)</td>
<td>65</td>
<td>Moderately retarded, Down's syndrome</td>
</tr>
<tr>
<td>Subject 3</td>
<td>M</td>
<td>38</td>
<td>61 (WAIS)</td>
<td>75</td>
<td>Mildly retarded</td>
</tr>
<tr>
<td>Subject 4</td>
<td>F</td>
<td>47</td>
<td>49 (WAIS)</td>
<td>49</td>
<td>Moderately retarded, Down's syndrome</td>
</tr>
</tbody>
</table>

They were chosen from clients at the Life Consultation Center, Kalamazoo, Michigan, and all were served by McKercher Rehabilitation Center, Kalamazoo, Michigan. No clients of this investigator were used as subjects.

² Global Assessment Scale, a rating of behavioral and functional living skills, Spitzer, Gibbon & Endicott, 1978.
³ Wechsler Adult Intelligence Scale-Revised, Wechsler, 1981.
⁴ Wechsler Adult Intelligence Scale, Wechsler, 1955.
Subjects 2 and 4 were not on any medication during the course of the study. Subject 1 was on Synthroid .15 mg once a day (restores normal thyroid function) during the entire course of the study. Subject 3 was on Motrin 600 mg as needed (an anti-inflammatory agent) throughout the entire study. Subject 3 was also on Vistaril 25 mg at bedtime as needed (used for the management of anxiety and tension), but this medication was discontinued approximately half way through the study.

There were no risks to subjects who participated in the study. Individual subjects may have benefited from the one-on-one attention they received, the productive use of their leisure time and the increase in self-esteem as a result of correct responses being reinforced verbally and with money. Informed consent (Appendix C) was obtained for each subject. The study was approved (Appendices A and B) by the Western Michigan University Human Subjects Review Board and the Director of the Kalamazoo County Human Services Department (K.C.H.S.D.).

Apparatus

Testing apparatus was very similar to that first used by Ozuzu (1982) and included a table and red, white and blue poker chips measuring 3.8 cm in diameter. A sticker measuring 2.5 cm in diameter was affixed to one chip in each set of three chips, identifying the correct chip choice. The sets of chips were placed face down horizontally on the table, each chip flush with the table. Sets of three same-color chips were placed approximately 3 inches apart with a within-set chip distance of approximately .5 inch. Chips were initially put in place manually by the investigator. A recording sheet (Appendix D) was used by the investigator to record correct and incorrect responses. A clock was used to measure the duration of each session. Verbal praise, nickels and quarters were used as reinforcement.
Procedure

The approximately 15-minute sessions occurred at McKercher Rehabilitation Center during break time for three of the subjects and for the fourth subject at his home. While the sessions were in progress each subject sat at a table opposite the experimenter. The basic procedure was derived from Boren's (1963) repeated-acquisition study. There was only one session per day, but the subjects sometimes learned more than one sequence per session. Sessions were not always on consecutive days.

To begin the session, the investigator placed the sets of colored chips face down on a table in front of the subject. The number of chips in each set was always three (except for a brief attempt in Phase 4 to increase the number of sets for Subject 4) but the number of sets varied according to the learning ability of the subject. One marked chip was placed by the investigator in each color set of chips. The location of the marked chip was randomly assigned with the restrictions that the correct chip was never placed in the same position more than two times in the same sequence, and if more than one sequence was presented in the same session each sequence was unique with respect to the placement of at least one chip. The marked chips remained in the same position until the subject completed the behavior chain.

The subject was asked by the investigator to locate the marked chip in the first set of chips to his/her left. The subject turned the chips over in the first set until the correct chip was found, then put them back in their original position and proceeded to the next set of chips to the right, and so on. When an incorrect response was made, the trial began again. That is, if an error occurred in the second set, the subject began again at the first set of chips.

In the work with nonhuman subjects and with children there was usually a brief timeout following an error, after which the subject continued the sequence at the
position where the error was made. Ozuzu (1982), for example, placed a strip of blank cardboard over the entire set of chips and made the child wait for about 10 seconds before proceeding. Without some such inconvenience to the subject as a result of errors an accurate pattern of responding develops very slowly. In this study the inconvenience consisted in having to start the sequence over again. It was reasoned that this would be more acceptable to the adult subjects, and was a more normalizing contingency than a timeout.

After being turned face up by the subject all chips were returned to a face-down position by the subject. If chips became misaligned, the investigator realigned them. A new trial was scored when the subject made an error or correctly completed the behavior chain with no errors.

A correct sequence consisted in the subject's consecutively turning over all the marked chips (of course, the subject could not see the marks until the chip has been turned over) in the appropriate order with no errors. If the correct order was left (for the red set), right (for the white set) and middle (for the blue set) and the subject turned the chips over in that order without turning over any unmarked chips this constituted one correct sequence. When the subject performed four consecutive correct sequences the response chain was considered learned. An incorrect response was turning over any unmarked chip.

Each time the subject correctly turned over all the marked chips in the appropriate order with no errors, he/she received 5 cents and verbal praise from the investigator. When the subject correctly turned over all marked chips in the appropriate order with no errors four consecutive times, he/she received 25 cents and verbal praise from the investigator.

Correct responses were scored as a plus sign on the data sheet. Incorrect responses were recorded as a minus sign along with the position of the chip actually
selected. Incorrect responses were not counted as errors, however, until after the subject had picked the correct chip for the first time. Assume that the correct chip in the first set is in the center position and the subject begins the trial by turning over the left chip. This is an incorrect response but would not be counted as an error since at that point in the trial there is no basis for correct responding. Any subsequent selection of the left or right chip in that set, however, would be counted as an error, since the subject had seen that for the first set of three chips the sticker was on the center chip. The same held true for the other sets of chips. Thus a subject could complete a sequence with no errors if, after picking the correct chip in each set he/she always picked the correct chip in each set for four consecutive runs through the sequence.

The study consisted of four phases. Length of phase varied from subject to subject and ended when the subject's errors per sequence appeared not to be systematically increasing or decreasing. Phase 1 was an attempt to replicate the Boren (1963) and Thompson (1971) studies with developmentally disabled adults. Subjects were presented with a sequence and upon reaching criterion for that sequence were presented with another sequence and so on until the session time expired. Thus the subject learned as many behavior chains as time permitted, usually two or three, with five being the maximum achieved by any subject.

Previous research with repeated acquisition using nonhumans usually involved only one sequence per session, but the subjects in this experiment generally learned the sequences more quickly than the nonhumans; and information about the subject's learning ability would accumulate more quickly if more than one sequence could be learned per session. However, during Phase 1 the errors per sequence for three of the subjects and possibly the fourth (see Figures 1-4 in the next section) seemed to increase within the session. It was possible that learning more than one sequence per
session resulted in increased error scores for the later sequences. To examine this possibility subjects were presented with only one sequence per session in Phase 2, which was otherwise identical to Phase 1. The session ended when the subject reached criterion for the sequence or when 15 minutes elapsed.

Phase 3 was a return to Phase 1. Subjects were again presented with as many sequences as they could successfully complete during the 15 minute session. This condition was studied to be sure that any differences between Phases 1 and 2 were not simply the result of continued exposure to the testing situation and continued sequence learning.

In Phase 4 the number of sets in the sequence was increased by one for each subject (and again by one more for Subject 3), except for Subject 2 whose data did not seem stable enough for such a manipulation to be useful. Subjects again completed as many sequences as possible within 15 minutes.

Inter-observer agreement checks were conducted for one session for each subject. In each session the subject completed two sequences. The investigator sat with the subject at the table on the subject's right; the reliability observer sat away from the table on the subject's left and could not see the investigator's data record from that position. Reliability was calculated as the number of agreements divided by the total number of responses scored.
CHAPTER III

RESULTS

The main purpose of the study was to obtain typical repeated-acquisition performances with developmentally disabled adults in the mildly to moderately retarded category.

Phase 1: Multiple Sequences Per Session

In Phase 1 each subject mastered as many different response sequences (meeting the criterion of four correct sequences in a row for each sequence) as was possible during the 15-minute session. This was zero if the first sequence was not mastered during the session, and went as high as five. Each set consisted of three chips, but the number of sets of chips used with each subject depended upon the subject's ability to learn the sequences. Subjects 1 and 2 worked with three sets of chips throughout most of the study, Subject 3 with four sets of chips and Subject 4 with two sets of chips.

The data in the form of errors per sequence learned are shown in Figures 1 through 4 below. All four subjects demonstrated the ability to successfully learn the behavioral sequences. A fairly stable number of errors per sequence was demonstrated by all subjects, with Subject 1 exhibiting the most stable performance at the end of Phase 1, and Subject 3 demonstrating the most overall stable performance. The data for Subject 2 were the most variable. Subject 2 did not meet criterion in one trial and Subject 4 did not meet criterion in three trials.
Figure 1. Subject 1 Errors.

Note: Numbers above the abscissa indicate the number of sets of chips in that and subsequent sequences. Connected data points are for same-session sequences.

Figure 2. Subject 2 Errors.

Note: Numbers above the abscissa indicate the number of sets of chips in that and subsequent sequences. A mark of 0 at the top of the graph indicates that criterion was not met for that sequence. Connected data points are for same-session sequence.
Figure 3. Subject 3 Errors.

Note: Numbers above the abscissa indicate the number of sets of chips in that and subsequent sequences. Connected data points are for same-session sequences.

Figure 4. Subject 4 Errors.

Note: Numbers above the abscissa indicate the number of sets of chips in that and subsequent sequences. A mark of 0 at the top of the graph indicates that criterion was not met for that sequence. Connected data points are for same-session sequences.
Phase 2: One Sequence per Session

In the first phase the subjects learned as many sequences as they could during the 15-minute session. As can be seen in the early sessions of Phase 1 for all subjects the errors per sequence increase during the session. In Phase 2 (beginning at the first vertical line on each figure) subjects were presented with only one sequence per session.

Subjects 3 and 4 showed an overall decrease in errors per sequence and demonstrated a less variable performance than they had in Phase 1. Subjects 1 and 2 continued to perform much as they had in Phase 1. All subjects met criterion in all trials.

Phase 3: Return to Multiple Sequences

In Phase 3 (beginning at the second vertical line) subjects were again presented with as many sequences as they could successfully complete in the 15-minute session. The performances of Subjects 1 and 3 seemed somewhat more stable than they had been in Phase 2. Subject 2 showed a variable between-trial performance similar to that exhibited in Phase 1 and 2. Subject 4 made more errors per trial and exhibited a less stable performance than she had in Phase 2. Subjects 1, 3 and 4 met criterion on all trials. Subject 2 did not meet criterion on one trial.

Phase 4: Increase in Sets per Sequence

In Phase 4 the number of sets of chips was increased by one for subjects 1, 3, and 4. Subject 2 did not participate in this phase due to the variability of his performance. Subject 4 was unable to successfully complete a behavior sequence
with an increased number of sets of chips, neither with three sets of chips nor with
two sets containing three chips each and the third set of only two chips (a brief
attempt to "shape" a performance with three sets). Subject 1 was able to successfully
complete sequences of four sets of chips, but with an increase in errors per sequence.
Subject 3 was able to successfully complete sequences of five sets of chips and
sequences of six sets of chips. Performance was not as stable as that demonstrated in
Phase 3, but errors per sequence appeared to be decreasing.

Overall Performance

It is not difficult to rank the four subjects in terms of the adequacy of their
repeated-acquisition performance. Subject 3 was clearly the most effective. Working
with four sets of chips he achieved an average errors-per-sequence value during
Phases 2 and 3 of around five. Furthermore he was able to learn sequences involving
five and even six sets of chips. Subject 4 was the least effective at this task, since she
was unable to learn sequences involving any more than two sets of chips. Subjects 1
and 2 were not as effective as Subject 3, but considerably more so than Subject 4.
Both worked with only three sets of chips during Phases 2 and 3, but Subject 1
averaged somewhat fewer errors per sequence (around five) than Subject 2 (around
10). Since Subject 2's performance was often quite good it may be that if the effect
of some unknown factor(s) responsible for the high degree of variability were
eliminated his performance would be quite similar to that of Subject 1.

There were no formal measurements of relationships between repeated-
acquisition performance and age, degree of retardation, or type of retardation. An
informal discussion of this issue will occur in the following section.
Interobserver Agreement

Each subject was observed for one session during which two sequences were completed. Interobserver reliability was at 100% for all subjects for all four sessions in which such checks were performed.
CHAPTER IV

DISCUSSION

This study looked at a type of repeated acquisition with four developmentally disabled adults. It also examined the procedural variables of number of sequences per session and number of sets of chips per sequence. It seems clear from the results that the present procedure, a 15-minute task requiring only sets of poker chips on an ordinary table, is a potentially valuable way to obtain an ongoing measure of a type of intellectual effectiveness. The procedure would seem especially appropriate for studying the effects of pharmacological agents and changes accompanying the aging process, where prolonged study of the single subject is either essential to the question asked, or is the only feasible strategy available.

In terms of the procedural variables investigated, although it was not clear for all of the subjects, it looks as though one sequence per session, or at most two, would generate the most stable data.

A secondary goal of the study was to see if repeated-acquisition performance was related to other measures of subject intellectual effectiveness. Table 2 below contains the same information as was in Table 1 shown earlier, but includes each subject's rank with respect to repeated-acquisition effectiveness, as discussed at the end of the previous chapter.

As can be seen from an inspection of the table, performance on the repeated-acquisition technique appears to generally correlate with Subject IQ and behavior ratings. It is interesting to note that the three Down's syndrome subjects' ranks were
Table 2
Subject Characteristics and Repeated-Acquisition Rank

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<tr>
<th>S#</th>
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<th>Age</th>
<th>IQ</th>
<th>GAS</th>
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<th>Re.-Ac. Rank</th>
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<td>44</td>
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<td>Moderately retarded, Down's Synd.</td>
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</tr>
<tr>
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<td>M</td>
<td>38</td>
<td>61</td>
<td>75</td>
<td>Mildly retarded</td>
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<tr>
<td>4</td>
<td>F</td>
<td>47</td>
<td>49</td>
<td>49</td>
<td>Moderately retarded, Down's Synd.</td>
<td>4</td>
</tr>
</tbody>
</table>

inversely related to their ages. If Down's syndrome individuals do indeed develop Alzheimer's during the later years of their life, the repeated-acquisition technique might be used for early detection, and to accurately record further changes in intellectual functioning. The study of such changes could possibly help us understand the changes seen in Alzheimer's disease. Whether non-Down's retarded people would show a similar age-performance relationship, however, cannot be seen from the present sample, since it contained only one non-Down's subject.

As this study was the first to use the repeated acquisition with developmentally disabled subjects, there are several ways in which it could be extended. The procedural variables of number of sets of chips and number of sequences per session could be further examined for their effect on performance. The comparison of repeated-acquisition performance and prior test scores of developmentally disabled individuals could be continued. Down's syndrome individuals performance could be further compared in regards to chronological age, especially those whose IQ scores were similar at the same chronological age. Developmentally disabled individuals could be tested before and after known drug introductions or withdrawals and a within-subject comparison made.
Appendix A

HUMAN SUBJECTS REVIEW APPROVAL: W.M.U.
TO: Jeannie Madsen  
Jack Michael  
FROM: Ellen Page-Robin, Chair  
RE: Protocol #87-04-10  
DATE: May 10, 1987  

This letter will serve as confirmation that your research protocol, "Repeated Acquisition with the Developmentally Disabled" has been approved with the following provisions:  

1. To deal with the issue of potentially illiterate subjects, a witness provision is needed on the consent document, as well as the provision for the oral explanation of consent material.  
2. In addition to a witness provision, the assent of the subject is also required.  
3. The HSIRB needs to be informed of any additional changes required by the County Board of Mental Health.  

Please submit a copy of the revised consent form and additional requirements by the Mental Health Board, if any, to the HSIRB.  

If you have any questions, please contact me at 383-4917.
Appendix B

Human Subjects Review Approval: K.C.H.S.D.
TO: Barb Fisher
FROM: A. Roger Vander Schie
DATE: August 3, 1987
RE: Research Protocol: "Repeated Acquisition With The Developmentally Disabled"

I am granting approval for implementation for the research proposal entitled, "Repeated Acquisition with the Developmentally Disabled, contingent on compliance with recommendations made by the Research Review Committee.

Please forward a full report of findings as well as a summary of findings to the Recipient Rights Office upon completion of the project.

cc: Patricia Davis Baker
    Bill Miller
Appendix C

Client Consent Form
Hi! My name is Jeannie Madsen. I work at Life Consultation Center and am also a student at Western Michigan University. I am doing a research project which I hope will help me develop a test which will tell me how you learn new things. I will also look at how you score on my test and how you scored on tests like I.Q. tests. I hope to compare how you learn new things with how other people learn new things, for example people with Down's syndrome or Alzheimer's disease. This project has been approved by the Human Subjects Institutional Review Board at Western Michigan University and by the Kalamazoo County Mental Health Review Board.

You and I will work together during your free time at your day program or at my office at Life Consultation Center (230 N. Burdick, Kalamazoo) during your free time. Each time we work together, we will do so for about 15 minutes. I will place sets of poker chips in front of you, face down. Some of the poker chips will have stickers on them. I will ask you to find the poker chip in each set with the sticker on it. Every time you find all the poker chips with the stickers on them and don't make any mistakes, I will give you a nickel. When you do this four times in a row with no mistakes, I will give you a quarter. After you find all the stickers four times in a row with no mistakes, I will move the poker chips with the stickers on them and we will start again. I will keep track of when you pick the right chip with the sticker on it and when you pick the wrong chip.

We will start working together on about September 1, 1987 and will stop on about April 1, 1988. You may drop out of the study any time you wish. You may take back your consent at any time. Your decision of whether or not to work with me will in no way influence services you are currently receiving from this agency.

I think we will have fun working together. Sometimes you will pick the wrong chip but other times you will pick the right chip. You can earn some extra money and I can get some information about how you learn new things which may help others who teach you to learn new things.

All information will be private. No identifiable information about you (such as your name) will be released without your written consent. All information will be stored in a locked file cabinet in my office at Life Consultation Center. There will be other subjects in the study and everyone's test scores will be reported as part of a masters thesis to Western Michigan University and the Kalamazoo County Human Services Department. Your name or any other identifiable information will not be reported. A brief summary report of the study and your score will be placed in your record at Life Consultation Center.

I would like to look at some information in your record at Life Consultation Center. I would like to look at any WAIS, PIAT, WRAT, Peabody, Stanford-Binet, JASPP evaluations and GAS scores you may have.

Do you have any questions? Would you like to work with me? Great! I'll need you to sign this consent form which says....
Client Consent (when client is own guardian)

I ___________________________________________ consent to participate in this study.
The study has been explained to me. I have been given the chance to ask questions
and have understood the answers.

_________________________________________ Date ______________________________________ Client signature

Guardian Consent

I ___________________________________________ agree that my ward may be a subject in
this study.

_________________________________________ Date ______________________________________ Client signature

Client Assent (when client has a guardian)

I ___________________________________________ agree to participate in this study. The
study has been explained to me. I have been given the chance to ask questions and
have understood the answers.

_________________________________________ Date ______________________________________ Client signature

Witness

I ___________________________________________ have witnessed that the party consenting
has done so willingly, with full knowledge and is able to grant such consent.

_________________________________________ Date ______________________________________ Witness signature
Appendix D

Sample Data Record
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<th>Subject</th>
<th>Comments</th>
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<th>Trials</th>
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Appendix E

Errors Per Sequence for All Four Subjects
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X = incomplete trial  
(n) = number of sets  
N = end of phase

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BIBLIOGRAPHY


Thompson, D. M. & Moerschbaecher, J. M. (1979). An experimental analysis of the effects of d-amphetamine and cocaine on the acquisition and performance of


