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Learning as a function of intelligence, training condition and sex, in a non-verbal paired-associates procedure.

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LEARNING AS A FUNCTION OF INTELLIGENCE, TRAINING CONDITION AND SEX, IN A NON-VERBAL PAIRED-ASSOCIATES PROCEDURE

by

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ABSTRACT

This study investigated the relationship between intelligence, training condition and sex on the level of learning and on response latency.

The experimental group consisted of 36 male and 36 female 12 year old school children ranging in measured IQ from 40 to 140. The subjects were divided into six IQ groups, each consisting of 6 boys and 6 girls. Two boys and two girls from each group were randomly assigned to one of three training conditions.

The conditions consisted of different temporal sequences of the training trial events, namely stimulus item, response item and response and a standard temporal order in the test trial, namely stimulus and response. The experimental task for all groups was the learning of one stimulus - response pair, namely the association of a white light and the response on the appropriate plunger. The level of learning was measured over test trials.

Analysis of variance showed significant overall changes in response latency and number of correct responses for all subjects. There were significant differences in both response measures as a function of IQ but not of training condition or sex. The differences in "reminiscence" or performance after a rest period following 100 massed trials were statistically significant for the extreme IQ groups.

Results were discussed in terms of reactive inhibition and consolidation theory.

PREFACE

This study was prompted by the author's interest in educational research and mental retardation. Specifically what is the effect of different temporal sequences of the training trial events on the learning of subjects differing in intelligence levels, and what is the effect of massed practice on the performance of these same subjects?

I would like to express my gratitude to Dr. B.P. Rourke, my director, for his continual guidance, to Dr. V.B. Cervin and Mr. A. Blackbourn, my readers, for their many helpful suggestions, and to Mr. W. Grewe, who built and programmed the apparatus.

I wish also to thank the members of the Windsor Board of Education for their kind permission to include public school children in this study, Mr. G. Gall, who supplied the information on the sample, the principals of the Windsor public schools and my young subjects.

Finally, I would like to thank Miss Margaret Field, my friend and faithful typist, and my wife Catherine, who served as assistant experimenter and assistant everything else, throughout the whole study.

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CHAPTER I

INTRODUCTION

The present study was designed to evaluate the following : (1) the relationship between intelligence and learning to perform a simple motor task; (2) the effect of three different orders of presentation of stimulus and response events during training; and, (3) the effect of sex differences on this performance. The subjects were 12 year old girls and boys whose IQ scores were between 40 and 140.

The three events in the training trial, the order of which was permuted in the three experimental conditions, were the following : the presentation of a stimulus light (a white light) ; the presentation of an informational stimulus light (an orange light) indicating the correct response ; and the pull of a plunger by the subject.

Thus there were three independent variables in this study : (1) the intelligence level of the subjects, determined by measured IQ, was varied from 40 to 140 ; (2) the three different training conditions, each characterized by a different order of training trial events ; (3) sex. The subjects were equally divided into girls and boys.

In Condition 1 , the training trial order of events was : (1) presentation of the white light; (2) presentation of the orange light beside a plunger; and, (3) the subject's response of pulling once on the plunger indicated by the orange light.

In Condition 2, the training trial order of events was : (1) presentation of the orange light beside a plunger; (2) the subject's response on that plunger; and, (3) presentation of the white light.

In Condition 3, the training trial sequence was: (1) the subject's response on a plunger; (2) the presentation of the orange light beside a plunger; and, (3) the presentation of the white light subsequent to the response. The test trial sequence, which remained constant for all conditions, was as follows: the white light followed by the subject's response (the orange light being omitted).

The dependent variable in this study was the learning under the three different training conditions. Learning was measured by the number of correct responses on the appropriate plunger. Latency of response (that is, time taken to pull one or the other of the plungers), independently of correct response, was also employed. Latency of response was measured from the onset of a stimulus to the onset of the response.

The experimental task and conditions can be described in various ways: as analogous to paired-associates learning, to the classical conditioning, or the perceptual-motor paradigms. Each of these paradigms gives a standard order of events in the training trial, viz., a stimulus, a cue, and a response. This order of events was used in the training trials of Condition 1. Since it is possible to permute this order of events, the question can be asked -- will learning occur in other orders of events? For example, when the subject is required to respond immediately after the presentation of the orange light and only thereafter presented with the white light, will he find it more difficult to learn the correct stimulus-response association, and to respond correctly in the test trial? The effect of permutations in the training trial order on subsequent performance was the subject of a previous study (Cervin, 1965).

In Condition 1, the training trial events were presented in the standard order, i.e. white light-orange light-response. In Condition 2, one permutation of the standard order was made. The training trial sequence was orange light-response-white light. In Condition 3, two permutations of the standard order were made. The training trial sequence was response-orange light-white light. The test trial sequence of events was held constant in all conditions, i.e. white light-response. Thus the subjects trained under the Conditions 2 and 3 sequences were required to symbolically restore the training trial sequence to the standard one in order to give the correct response during test trials. Since each permutation of the training trial events can be interpreted as requiring an additional symbolic operation of the subject, it was expected that learning should be successively slower in Condition 2 than in Condition 1, and in Condition 3, relative to Condition 2.

The experimental task, common to the three conditions, was the learning of one stimulus-response association, viz. the connection between one white stimulus light on a panel and the response of pulling a plunger. This study could be considered a non-verbal paired associates learning task, with similarities to the classical conditioning and perceptual-motor paradigms. Since no single paradigm adequately includes all aspects of the present study, the latter is described in terms of the experimental events which actually took place.

In summary, this study investigated the relationship between intelligence level, training condition, and sex on the learning of a single stimulus-response association. The results of studies relevant to these experimental variables will be considered in the following review of past research.

Review of the Literature

During the last 15 years there has been a marked increase in research on individual difference variables in learning. In the main, this research has focused upon comparing the performance of retarded and normal subjects on different learning tasks, with the aim of identifying the learning deficits which characterize the retarded. One of the commonly used methods of identifying these deficits is comparing the performance of retardates and normals of equal chronological age. The present study employed this method with "moderately" and "mildly" retarded, and normal 12 year olds of both sexes. Retardation is operationally defined by an IQ score below 80, derived from a standardized, individually administered IQ test. The terms "moderately" and "mildly" retarded refer to the IQ ranges between 25 and 49 and between 50 and 79, respectively.

The task presented to the subjects in this study may be described specifically as a non-verbal paired-associates task. The experimental conditions were analogous to certain classical conditioning procedures. The responses of the subjects were a kind of perceptual-motor behaviour. The conditions under which this behaviour was practiced were in two blocks of massed trials. In order to give an adequate overview of the research which has some bearing on the current study, the present review is divided into the following sections: (1) a review of paired-associates studies; (2) a review of the studies of classical conditioning; (3) a review of perceptual-motor studies; (4) a review of research on the effect of massed vs. distributed practice; (5) conclusions and hypotheses based on the results from these four areas of experimental investigation.

(1) Paired-Associates Studies

In this type of study, the usual procedure is to employ a list of pairs of syllables, words, numbers, pictured objects or some combination of the above as stimulus and response members. During the training trial the subject is presented with both members. During the test trial, the stimulus member of the pair is presented alone. Learning is measured by the number of correct responses given during the test trials.

Lott (1958) administered a list of seven pairs of common pictured objects to 69 subjects from a public junior high school. Three IQ groups, 46-77, 91-108, and 120-134 were matched for age and sex. Comparing the learning of the high and low IQ groups, Lott found that the high IQ group took significantly fewer trials to learn to a criterion of four successive correct anticipations of the response items. Though the normals learned faster than the retardates, the absence of a significant difference between these two groups suggests that mildly retarded subjects are not at a great disadvantage relative to normals when the material to be associated is highly familiar pictures.

Akutagwa and Benoit (1959) also matched their subjects for age and employed common pictured nouns as stimulus and response members. A lower IQ group, 70-89, was matched with a normal group, 90-110, at two age ranges, 8-10, and 11-13. Three eight-pair lists were administered to all subjects in the following order: a high association value list (e.g. "horse-cow"), a low association value list (e.g. "wagon-owl"), and a high interference list using the same stimulus members as List I with new response members (e.g. "horse-baby"). The older subjects showed superior learning than the younger subjects but there were no significant differences in learning as a function of IQ. This was probably due to minimum IQ differences between the groups.

In another study, Berkson and Cantor (1950) compared groups of equal chronological age and mean IQ scores of 70 and 99. Three six-item lists, consisting of various combinations of numbers, colours, and pictures of common objects were employed as stimulus and response items. The high IQ group performed increasingly better than the other group over the three lists. Significant differences were found on list II where the retardates made more errors and required more trials to reach criterion.

In a study employing the same training conditions as the present one, Cervin (1965) found significant differences in the number of training trials required to reach criterion in each condition. This result indicates that each permutation of the training trial events significantly increased task difficulty.

The results of these studies on paired-associates learning indicate that intelligence level significantly affects learning. In the current study, therefore, it was expected that IQ and learning would be positively related (Hypothesis I). Since permuting the training trial order of events was found to significantly increase task difficulty, it was predicted that the learning of subjects in the present investigation would be significantly affected by the addition of one or more permutations to the training trial sequence of events (Hypothesis II).

(2) Classical Conditioning Studies

The three events in the standard classical conditioning training trial are as follows : (1) the "to be conditioned" or neutral stimulus; (2) the "unconditioned" stimulus; and, (3) the "conditioned" response. Training consists of repeatedly pairing the two stimuli until the presentation of the neutral stimulus by itself comes to elicit the conditioned response.

Two studies comparing the conditioning of a finger-withdrawal response in normals and retardates, report conflicting results. Osipova (1926) as reported by Razran (1933) employed 58 retarded males, 67 normal boys, and 75 normal girls. He found that retarded males formed stable conditioned responses faster than normals of equal chronological age. Shock was used as the unconditioned stimulus. In another study, Marinesco and Kreindler (1933) used four subjects in the severely to moderately retarded range. With strong shock as an unconditioned stimulus and hand withdrawal as the conditioned response, they found conditioning difficult to obtain, and the conditioned responses unstable. Although conclusive evidence is lacking, these studies suggest that this type of response (which is similar to the motor response in the present study) can be conditioned to some extent in retardates.

(3) Perceptual-Motor Studies and Motor Skills

Though the tasks used in perceptual-motor studies differ widely from the task used in this study, some of the results have relevant implications. In a comparison of equal chronological age retardates and normals on a shielded maze test, Ellis, Pryer, Distefano, and Pryer (1960) found a significant increase in the number of trialsto criterion required by mildly retarded subjects

(60-70) over normals (80-99). Denny (1963), commenting on this result, pointed out that this task required the use of additional verbal mediators not required in an open maze test. He suggested that the very significant difference between the IQ groups was due to the retardates' inefficiency in the use of verbal mediating responses.

In a rotary pursuit study, Ellis, Pryer, and Barnett (1960) employed 80 mildly retarded and 80 normal subjects under a 20 second work, 20 second rest schedule for 20 trials, 5 minute rest, and an additional 20 trials with the same work and rest intervals. The normal subjects performed significantly better over the 20 prerest and 20 postrest trials. They also showed greater improvement after the rest period or greater "reminiscence".

One of the major components of motor ability is speed of response. Since latency of response was considered in the present study, experiments comparing the reaction time of normals and retardates are relevant.

These studies report in general that the lower the IQ, the poorer the performance of the retardate, as compared with the normal subject. Berkson (1960) found that, when the stimulus is held constant and the complexity of the required response is varied, a resulting significant interaction between IQ and motor tasks results.

The results of the perceptual-motor ability studies cited in this review indicate that retardates perform significantly worse than normals when verbal mediation is required; that the retardate's reminiscence is more adversely affected by massed practice; and that his latency of response is negatively related to task difficulty. It could be assumed, in the present study, that one permutation of the standard order of events in the training trials would require of the subject an additional symbolic response, over and above what is required by the standard sequence. The retardates would thus be expected to learn significantly slower in Conditions 2 and 3, than the normals. Therefore, it was predicted by Hypothesis III that there would be a significant interaction between IQ and condition.

(4) Massed vs. Distributed Practice

An important variable in a learning experiment is the condition within which the learning is acquired. This is commonly referred to as the "conditions of practice". The condition of practice that has been explored more extensively than any other is that of the distribution of practice through time. Practice is considered to be 'massed' if it is relatively continuous. 'Distributed' practice refers to practice interspersed with rest periods.

For most of the experimental tasks that have been studied, distributed practice is reported to produce better learning. The nature of the task, duration of rest periods, age, intelligence and sex of the subjects are some of the variables which complicate the determination of optimum practice conditions.

In a study of the effects of massed vs. distributed practice in a non-verbal paired-associates task, Dent and Johnson (1964) found that both 'organic' and 'familial' mental retardates made fewer errors in learning under distributed practice. Using a similar task, Madsen (1963) compared the learning of high, average and low IQ subjects, matched for age and sex, under both practice conditions. He found significant differences between the high and low IQ groups under massed practice, and significant differences between the two practice conditions for the low IQ but not for the average or high IQ subjects. On the basis of the differential effects of massed practice on retardates vs. normals, and the greater reminiscence scores of normals relative to retarded subjects, reported by Ellis, Pryer and Barnett's study (1960a), it was expected that reminiscence scores (i.e. number of correct responses in the ten post-rest trials minus the number in the ten pre-rest trials) would be positively related to IQ (Hypothesis IV).

The "Reactive Inhibition" theory of Hull (1943) is one rather popular theoretical explanation of the differences in performance as a function of the practice effects. Hull assumed that when an organism makes a response, some inhibition to that response is also generated. Such inhibition may be thought of as analogous to fatigue in that it makes the next response more difficult. Like fatigue, this reactive inhibition disappears after a period of rest; if there is not enough rest between responses, however, the inhibition accumulates from response to response. This accounts for the advantage of distributed over massed practice.

Hull made no allowance for individual differences in ability level. The more difficult the given task for the subject, the greater should be the accumulation of reactive inhibition during massed practice. Since any experimental task can be assumed to be more difficult for the retarded than the normal subject, a significant difference in reminiscence scores could be explained theoretically as a greater build up of reactive inhibition during the first block of massed trials, and a rest period too brief to allow for the dissipation of such inhibition.

(5) Conclusions and Hypotheses

The following is a brief summary of the results cited in the foregoing review of the literature, and the hypotheses for the present study which are based on them.

It was reported that high IQ subjects learned significantly faster than did low IQ subjects on paired-associates tasks. Thus Hypothesis I predicted that IQ and level of learning would be positively related in this study.

The permuting of the standard training trial order of events was found to increase the task difficulty level in a non-verbal paired-associates study. Hypothesis II therefore predicted that the permutation of the standard training trial sequence of events would significantly increase task difficulty thereby producing a significantly lower level of learning.

Studies on reaction time report that retardates take significantly longer to learn a task requiring the use of symbolic mediating responses. It could be assumed, in the present study, that one permutation of the standard training trial sequence requires of the subject an additional symbolic response over and above what is required by the standard sequence. Hypothesis III, on the basis of this assumption, predicted a significant interaction between IQ and training condition.

Retardates generally record significantly longer response latencies than normals in tests of reaction time. It was therefore predicted by Hypothesis IV that IQ and latency of response would be inversely related in the present study.

Finally, the massed practice condition was found to be more detrimental to the learning of retardates, relative to normal and high IQ subjects. Normals showed greater (non-significant) reminiscence in a post rest block of massed trials. Since this study presented a longer series of massed trials, and varied IQ more widely, it was predicted by Hypothesis V that reminiscence would be positively related to IQ.

Purpose of the Present Research

The present investigation is directed as a precise determination of the relationship between intelligence level, training trial order of events, and sex to the level of learning in a given number of trials, and to the latency of response.

This research is considered in order for two reasons: (1) no research, with the exception of Cervin (1965) has reported employing the three conditions used in this study. (2) most of the studies which vary intelligence, do so for two or at the most three levels. It is believed that by varying IQ over six mean values, more sensitive measures of the level of learning at different IQ levels will be obtained.

CHAPTER II

APPARATUS AND PROCEDURE

Subjects

The subjects were selected in the following manner. The Windsor Board of Education supplied the names and IQ scores of approximately 170 girls and boys of varying IQ levels. The six IQ groupings used by the Board in classifying all public school students were selected as the intervals of the six experimental groups. The six girls and six boys whose IQ scores most closely approximated the mean IQ of each group were chosen. In Table 1 the group classifications, intervals, the mean IQ, and standard deviation for each experimental group are given.

Table 1

IQ Group Classifications, Intervals, Mean IQ, and Standard Deviations for each Experimental Group.

Group Classification	Group Intervals	IQ Means	Standard Deviations
A	121-140	129	4.8
B	111-120	115	2.2
C	91-110	102	5.1
D	81-90	85	2.0
E	61-80	73	2.6
F	41-60	44	5.2

Apparatus

The Grason-Stadler Learning Apparatus of the Department of Psychology, University of Windsor, was used. The apparatus consisted of two identical panels, one in each of two partitioned booths. A representation of one panel is presented below in Figure 1.

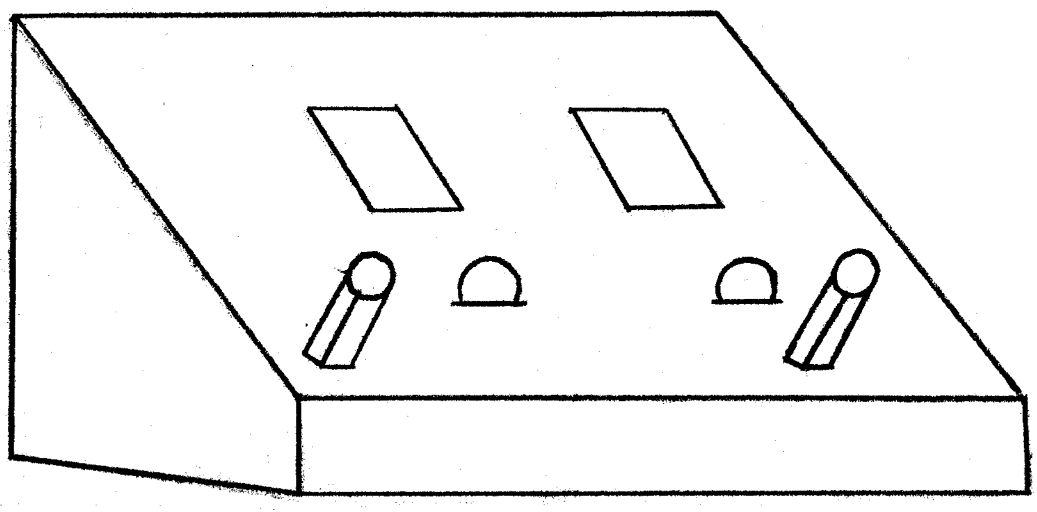

Figure 1. Individual subject panel of the Grason-Stadler Learning Apparatus.

The panel included two large white lights, two smaller orange lights and two plungers, one beside each orange light. The subject's response consisted in pulling one of the plungers out as far as it would go (two inches) and letting it return to its former position.

The following conditions remained constant for all the experimental conditions. One ring of the warning bell began every trial. The stimulus member of the pair was the left hand white light. The response member was the right hand orange light. A pull on the right hand plunger constituted a correct response. The warning bell, onset, duration and offset of the white and orange light, and the inter-trial interval were pre-programmed and operated from a master console in an adjacent control room.

An interval transistor type Model AW (style 90 MT) Esterline-Angus Event Recorder charted the following: (1) the onset and offset of each trial; (2) the onset and offset of the white and orange lights; and (3) the correct and incorrect responses of each subject. A manually operated modified Esterline-Angus Chart Inspector was used to measure the number of correct responses, and the latency of each response to the nearest hundredth of a second.

Procedure

The three experimental conditions each consisted of a pre-training phase, and 100 test and 100 alternating training trials.

Condition 1. In Condition 1, (no permutation of the training trial events) the subject was required to learn one white light-plunger association. Each time the white light was presented, the subject could pull either plunger once.

If he pulled the right hand plunger, a correct response was recorded.

The subjects were tested two at a time. After being seated, and shown the lights and plungers on the panel, they were instructed in the pre-training phase as follows:

PRE-TRAINING PHASE INSTRUCTIONS

> First you will hear a bell. Then an orange light beside one of the plungers will come on. When this happens, pull the plunger beside that orange light.

The experimenter then rang the warning bell and presented either the right or left orange light. An assistant observed both subjects and instructed them to pull the plunger beside whichever orange light had been presented. The warning bell, followed by orange lights in random order were presented until both subjects had responded correctly at least six consecutive times. Then they received the following instructions.

INSTRUCTIONS FOR TRAINING AND TEST TRIALS

> So every time the orange light comes on, I want you to pull the plunger beside it.
> Now one of the white lights will come on. One of the white lights <u>goes with</u> one of the plungers. You have to learn which plunger to pull after the white light comes on. Sometimes, after the white light, one of the little orange lights beside a plunger will come on. That plunger is the one to pull. Now

> you have to learn which plunger to pull when the white light comes on, and the orange light does not come on. Try to pull that plunger every time. If you do well, I will give you some money at the end.
> Any questions? (The subjects' questions were answered from the instructions).
> Please don't talk after we start.

The booth doors were closed and the experimental session began. Beginning with a test trial, the subjects were given 50 test and 50 alternating training trials. Then they were given a 5 minute rest, during which the instructions were reread. The subjects were discouraged from talking to one another during the recess. Another set of 50 test and training trials followed without pause.

Condition 2. In this training condition, the subjects were again required to learn one white light-plunger association. The training trial order was permuted once (i.e. orange light - white light - response). The pre-training phase proceeded in the same manner as Condition 1. Then the subjects were instructed as follows:

INSTRUCTIONS FOR TRAINING AND TEST TRIALS

> Every time the orange light comes on, I want you to pull the plunger beside it. Sometimes, after the orange light comes on, and you pull the plunger beside it, a white light will come on. Sometimes the white light will come on alone. Now one of the white lights goes with one of the plungers. You have to learn which plunger to pull when the white light comes on alone. Sometimes the orange light will show

> you which plunger to pull. Now you have to learn which plunger to pull when the white light comes on, and the orange light has not come on. Try to pull that plunger every time. If you do well, I will give you some money at the end. Any questions? Please don't talk after we start.

The experimental session followed. The procedure was identical to Condition 1, with the exception of the one permutation of the training trial order of events.

Condition 3. In Condition 3, the subjects were again required to learn the one white light-plunger association. The training trial order of events was permuted twice (i.e. response - orange light - white light). The subjects were instructed in the pre-training phase as follows:

INSTRUCTIONS FOR PRE-TRAINING PHASE

> First you will hear a bell. When the bell rings, pull one of the plungers. After you pull the plunger, one of the orange lights will come on. The orange light will tell you which plunger you should have pulled. If you pulled the plunger beside it, you were right. If you pulled the other plunger, you were wrong.

The experimenter then presented the bell, and after the subjects' responses, the right or left hand orange light. Again an assistant observed and corrected the subjects. Pretraining continued until both subjects responded after the bell and before the onset of the orange light. The subjects were then instructed as follows:

TRAINING AND TEST TRIAL INSTRUCTIONS

> Every time the bell rings, and no light comes on, I want you to pull one of the plungers.
> Sometimes, after the bell has rung, and you have pulled a plunger, the orange light beside one of the plungers will come on. Then one of the white lights will come on. The orange light tells you which plunger you should have pulled.
> Sometimes the bell will ring and the white light will come on alone. Now one of the white lights goes with one of the plungers. You have to learn to pull the correct plunger when the white light comes on alone. Try to pull that plunger every time.
> If you do well, I will give you some money at the end. Any questions? Please don't talk after we start.

The experimental session commenced and continued as in Conditions 1 and 2, with the exception of the training trial permutations.

The experimental events, as they occurred in the training and test trials, under the three conditions are given below in Figure 2. All the temporal relations of warning bell, white and orange lights, response intervals and inter-trial interval are given.

The following events remained constant throughout the experimental procedure. (1) The warning bell began every trial. (2) The white and orange lights always overlapped in time, and went off together. (3) The duration of the inter-trial interval was four seconds. (4) The test trial was identical in every condition.

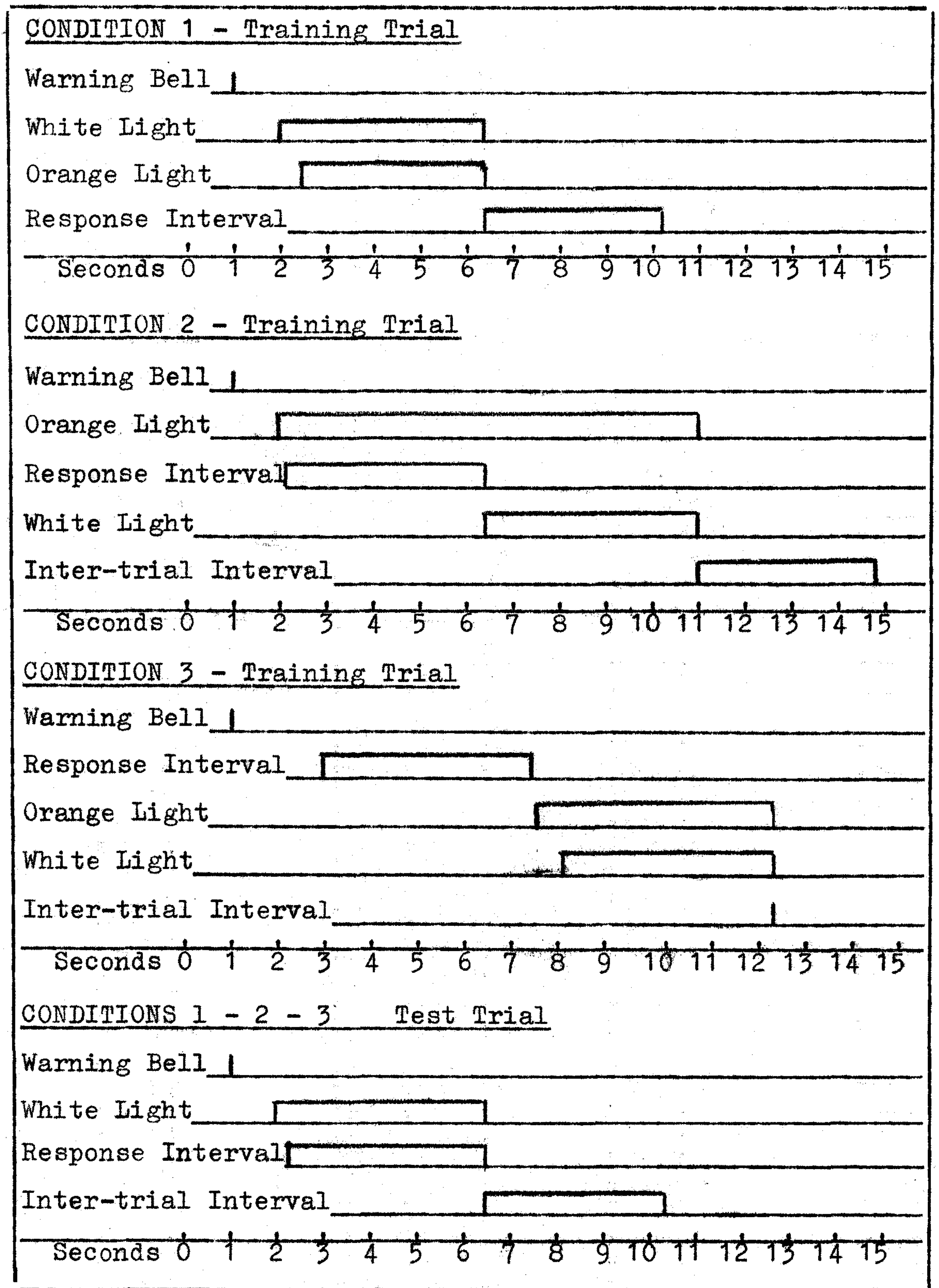

Figure 2. Temporal Relations of all Events in the Training and Test Trials of Conditions 1, 2 and 3.

The following events were varied. (1) The onset of the orange light preceded the white light by four seconds in Condition 2. (2) A four and one half second response interval preceded the onset of the orange and white lights (in that order) in Condition 3. The difference in inter-stimulus interval resulting from the permutation of the training trial sequence, was not expected to affect learning. (Ladd, 1965).

The subject was instructed initially to pull the plunger beside the orange light, or the plunger beside the orange light which he anticipated would go on. He was also instructed to pull one of the levers when the white light came on alone. Pretraining was sufficient for the normal subject to learn what to do. For a few of the mildly retarded subjects, and for most of the mental retardates, it was necessary to repeat the instructions from time to time during the session. When the experimenter noted that the subject was not responding correctly during the training or not pulling one of the plungers when the white light was presented in the test trial, he instructed the subject to do so by saying: "Pull the plunger beside the orange light while the light is on;" or "Pull one of the plungers while the white light is on". These instructions were given from the control room during the inter-trial interval, and were clearly audible to the subject. The only interruption in the testing session occurred after 50 test and training trials, at which time the subjects were given a five minute rest.

Testing time for each pair of subjects varied from 45 minutes to one hour. The subjects were brought, two at a time, to the learning laboratory, at the University, and returned to school after the experimental session. Each subject was given 25 cents at the end of the testing session, and requested at the same time not to talk about the test to other students at his school.

CHAPTER III

RESULTS

The experimental results are presented in three sections. These sections include latency of response, level of learning, and reminiscence. Latency was measured in seconds; level of learning by the number of correct responses in each test block; and reminiscence by the number of correct responses in a post-rest block of trials, relative to a pre-rest block.

Latency of Response

Response latency was the time, to the nearest hundreth of a second, between the onset of the white light and the onset of the response in the test trials. Mean latency totals for each IQ group in each block of 20 test trials were calculated. This was done by measuring the latency of each subject's first five test responses (whether correct or incorrect) in each block of 20 test trials. The mean response latency totals for each IQ group, over each test block are given in Table 2, together with the total latency of each group and for each test block.

The response latency curves for each IQ group over test blocks are presented in Figure 3. These group curves indicated that latency totals for each of the six IQ groups decreased from test block 1 through test block 4. The pattern in general was one of successive decreases over each

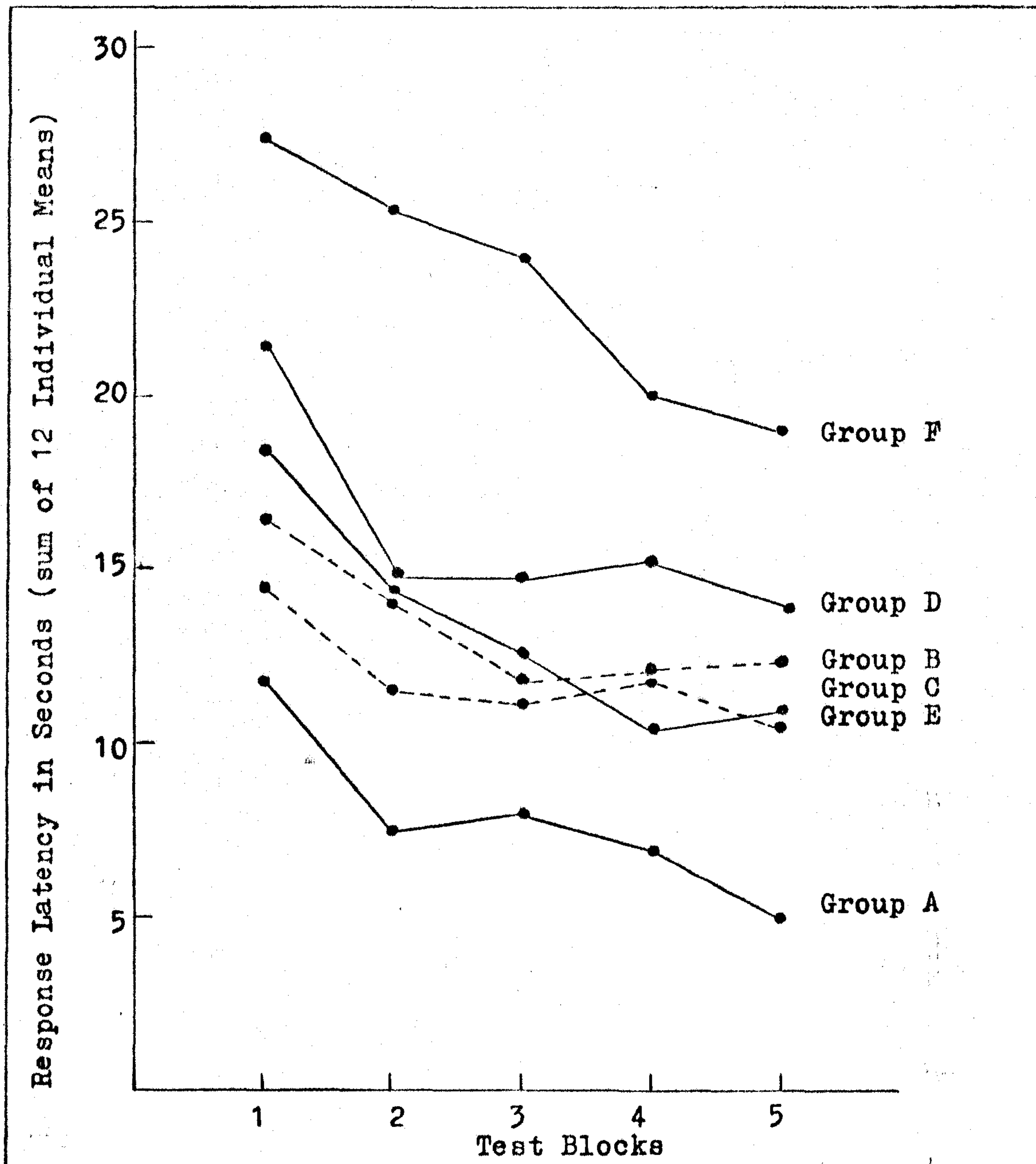

Figure 3. The response latency curves for the six IQ groups over test blocks.

test block with some minor fluctuations

Table 2

Mean Response Latencies in Seconds for all IQ Groups over Test Blocks. IQ Group and Test Block Totals

IQ Group	Test Block 1	2	3	4	5	Group Total
A	11.61	6.58	7.94	6.97	5.13	39.23
B	16.50	13.93	11.75	11.92	11.95	66.05
C	18.43	14.03	12.37	10.30	10.93	66.06
D	21.54	14.34	14.40	15.16	13.89	79.33
E	14.49	11.42	11.20	11.90	10.40	59.41
F	27.34	25.36	24.08	20.74	18.99	116.51
Total	109.91	86.66	81.74	76.99	71.29	

An analysis of variance of the mean latency totals with IQ, sex and test blocks as main effects was carried out. The summary of this analysis is given in Table 3. The F ratios of IQ and test blocks were significant at the .01 level. There were no significant interactions.

To further analyze the main effect of IQ, a Newman-Keuls test of the significance of differences between the group totals was performed. The results of this test are given in Table 4. They indicate that the latencies of Group A (high IQ)

Table 3

Analysis of Variance of Response Latency Totals, by IQ, by Sex, Over Test Blocks

Source of Variation	df	MS	F Ratio
Between Subjects	36		
A (IQ Group)	6	9.21	5.44**
B (Sex)	1	2.37	1.40
AB	5	2.35	1.39
Subj. w. Groups	60	1.69	
Within Subjects	288		
C (Test Blocks)	4	3.07	27.90**
AC	20	0.13	1.18
BC	4	0.03	0.27
ABC	20	0.09	0.81
C x subj. w. Groups	240	0.11	
Total	324		

** Significant beyond the .01 level

were significantly shorter than all other groups. The latencies of Group F (low IQ) were significantly longer than the latencies of any other group. Both q statistics were significant beyond the .05 level.

Table 4

Newman-Keuls Test of the Significant of Differences Between the Latency Totals of the IQ Groups

IQ Groups		A	E	B	C	D	F
Latency Totals		39.50	59.42	66.05	66.06	79.32	116.52
		IQ Groups					
		A	E	B	C	D	F
	A		*	*	*	*	*
	E					*	*
IQ Groups	B						*
	C						*
	D						*
	F						

* Significant beyond the .05 level

These results suggested that latency of response, on this particular experimental task, was positively related to IQ at the extremes of the IQ continuum.

In order to analyze the significant change in latency totals over test blocks, a Newman-Keuls test of the significance of differences between the latency totals for each test block was carried out. The results of this test are given in Table 5, and the total latency in each of the five test blocks is plotted in Figure 4.

Table 5

Newman-Keuls Test of the Significance of Differences between the Latency Totals of the Test Blocks

Test Blocks	5	4	3	2	1
Latency Totals	71.28	77.01	81.74	86.93	109.91

		Test Blocks				
		5	4	3	2	1
Test Blocks	5			*	*	*
	4				*	*
	3					*
	2					*
	1					

* Significant beyond the .05 level

The results of this test indicated that the latency totals decreased significantly from the first to the second block (trials 21-40) and from the second to the fourth block (trials 41-80). Both differences were significant at the .05 level.

The latency totals over test blocks are plotted in Figure 5. The curve shows an initial sharp decrease from the first to the second test block. Latencies decreased less rapidly, but still significantly, over the next two blocks.

In summary, latency of response in the present study, decreased over blocks of trials, especially during the second block. The high and low IQ groups showed significantly shorter and longer latencies respectively than the other groups. There were no significant main effects of condition or sex. These results indicated that IQ and latency of response on this task, were inversely related for the high and low IQ subjects.

Number of Correct Responses

The number of correct responses for males and females in each IQ group, and for each condition, over test blocks is given in Table 6. A four-way analysis of variance of the number of correct responses with IQ, sex, condition and test blocks as main effects, was carried out.

The results show that the *F* ratios for the main effects of IQ, condition and sex were not significant. The *F* ratio for test blocks was significant beyond the .01 level. The *F* ratio for the interaction effect of IQ and test blocks was significant beyond the .05 level. There were no other significant interactions. The data are given in Table 7.

The significant main effect of test blocks indicated

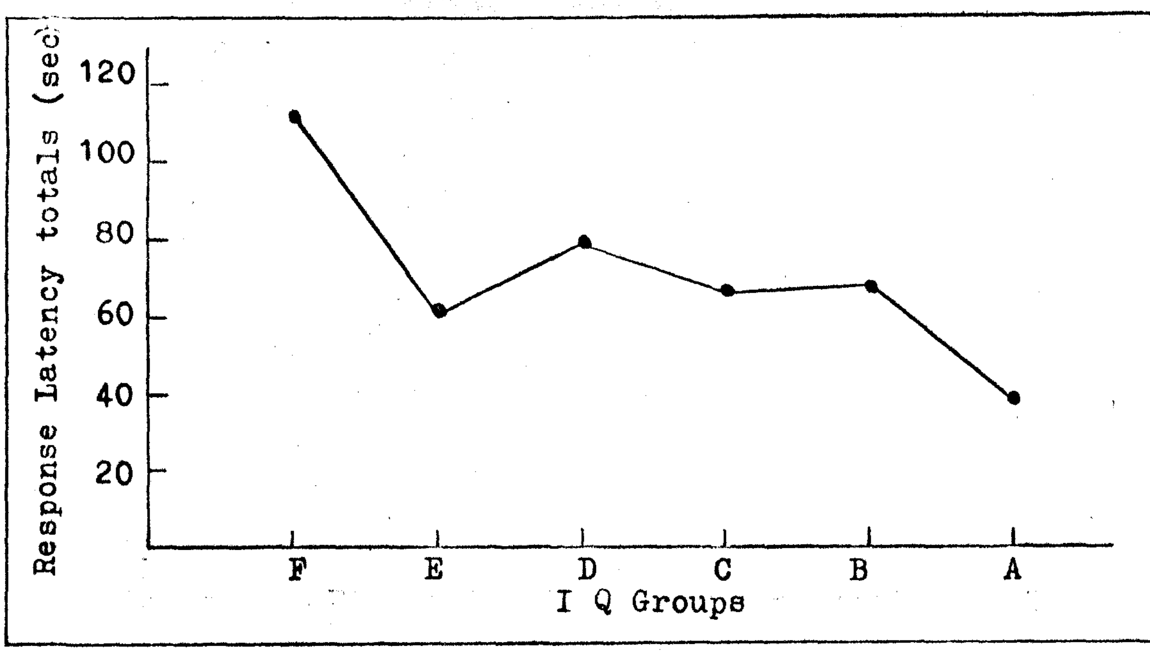

Figure 4. IQ groups latency totals (sum of five test block totals for each IQ group).

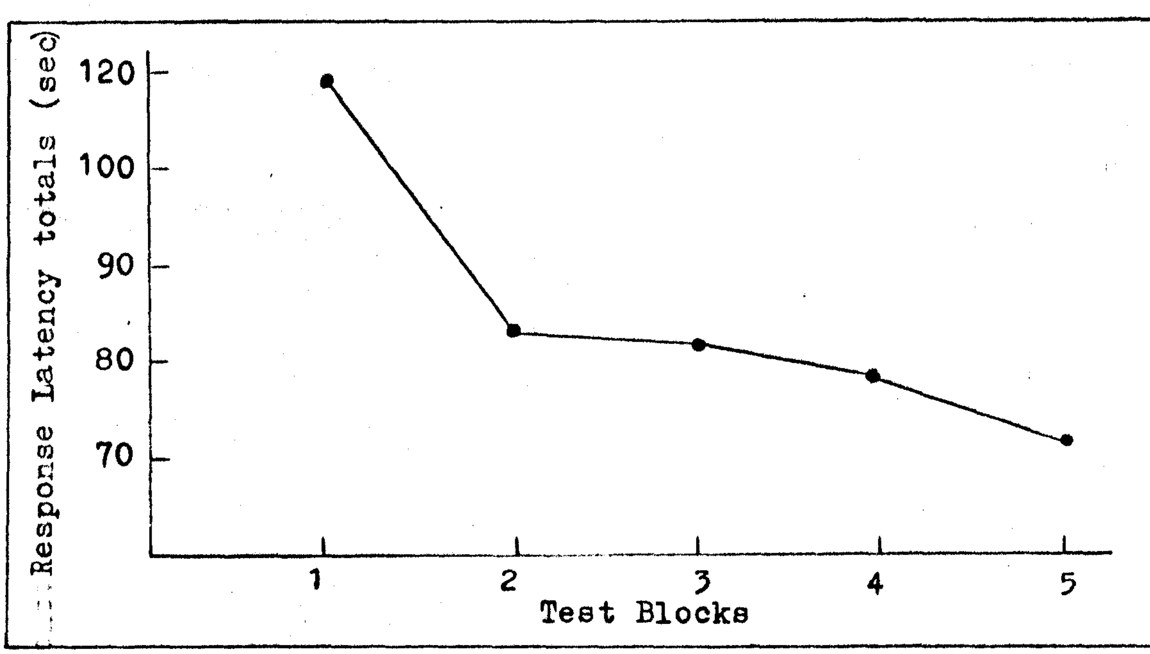

Figure 5. Response latency totals for all IQ groups over test blocks (sum of six IQ groups totals in each test block).

Table 6

Number of Correct Responses for Males and Females in each IQ Group, for each Training Condition over Test Blocks

IQ Group	Condition	Sex	Test Blocks 1	2	3	4	5
A	1	Male	1	1	18	20	20
	2		18	8	3	1	2
	3		19	22	21	8	20
	1	Female	19	20	28	40	39
	2		38	40	40	40	40
	3		40	37	36	34	36
B	1	Male	20	19	20	20	20
	2		19	19	15	20	19
	3		27	17	21	13	16
	1	Female	26	25	25	20	20
	2		18	10	12	12	15
	3		12	2	4	1	0
C	1	Male	9	0	10	10	0
	2		2	0	0	0	0
	3		21	29	32	40	40
	1	Female	16	18	15	17	17
	2		16	5	4	2	2
	3		18	21	20	14	17
D	1	Male	12	20	20	20	20
	2		28	29	26	26	21
	3		30	21	16	22	26
	1	Female	21	19	20	20	20
	2		20	20	20	20	20
	3		24	16	32	36	39

Table 6 continued

IQ Group	Condition	Sex	Test Block 1	2	3	4	5
E	1	Male	20	20	20	20	20
	2		1	0	4	16	17
	3		21	17	13	21	18
	1	Female	4	0	1	0	0
	2		18	20	20	20	20
	3		26	24	19	25	26
F	1	Male	0	0	3	0	2
	2		1	1	1	0	3
	3		17	11	23	11	0
	1	Female	30	26	16	13	7
	2		21	23	12	19	12
	3		18	15	11	27	19

that some significant change in the number of correct responses had occurred over test blocks. The significant interaction effect of IQ and test blocks suggested that IQ had been a factor in this change.

To investigate the significant main effects of test blocks, a trend analysis was performed on the number of correct responses in each block. The results of this analysis are given in Table 8. They indicate that the $\underline{F}$ ratios for the linear, quadratic, cubic and quartic trends are significant beyond the .01 level. Thus four significant changes in the

Table 7

Analysis of Variance of the Number of Correct Responses by IQ, by Condition, by Sex Over Test Blocks.

Source of Variation	df	MS	F Ratio
Between Subjects	71		
A (IQ Groups)	5	384.42	1.26
B (Condition)	2	362.80	1.19
C (Sex)	1	618.85	2.03
AB	10	142.31	0.46
AC	5	424.68	1.39
BC	2	123.02	0.40
ABC	10	148.15	0.48
Subj. w. Groups	36	304.48	
Within Subjects	288		
D (test blocks)	4	11.30	2.69*
AD	20	11.23	2.67**
BD	8	7.51	1.79
CD	4	5.22	1.24
ABD	40	3.75	0.89
ACD	20	2.95	0.70
BCD	8	8.10	1.92
ABCD	40	36.26	8.63**
D x Subj. w. Groups	144	4.20	
Total	359		

* Significant beyond the .05 level
** Significant beyond the .01 level

Table 8

Trend Analysis of the Number of Correct Responses Over Test Blocks

Source of Variation	df	MS	F Ratio
D (Linear)	1	1812.00	431.42**
D (Quadratic)	1	1407.85	335.20**
D (Cubic)	1	752.07	179.06**
D (Quartic)	1	377.17	89.80**

** Significant beyond the .01 level

number of correct responses had occurred over the five test blocks. The overall performance of all subjects was best described by a quartic function.

To determine the significance of differences between the test block totals, a Newman-Keuls test was performed. The results of this test appear below in Table 9, and the correct response totals for each of the five test blocks are plotted in Figure 6.

The test results show that there are significant differences between the number of correct respones in the first block and every other block, an significant differences between the second block, and every other block. All the differences are significant beyond the .05 level. Figure 6 indicates that the total for the first block is greater than the other block totals. The total for the second block, on the other hand, is smaller than that of any other block. Therefore performance in this experimental task was significantly higher during the first 20 trials, and significantly lower during the second 20 trials than in any subsequent trial blocks.

Table 9

Newman-Keuls Test of the Significance of Differences between the Test Block Totals.

Test Blocks	2	3	5	4	1
Total Correct Responses	575	601	613	628	651

	Test Blocks 2	3	5	4	1
2		*	*	*	*
3					*
5					*
4					
1					

* Significant beyond the .05 level

Therefore the significant changes in the number of correct responses over test blocks, indicated by the analysis of variance, were as follows: (1) a significant increase in the number of correct responses in the first 20 test trials;

(2) a significant decrease in the number of correct responses during the second block of 20 trials; (3) a significant increase in the number of correct responses over the third and fourth blocks (taken together); (4) a non significant decrease in the number of correct responses in the fifth block of trials. The overall performance curve of all the subjects (Figure 6) is best described by a quartic function.

To investigate the significant interaction of IQ and test blocks, indicated by the analysis of variance, an analysis of simple effects was carried out. The main effect of test blocks for the IQ groups was broken down into the simple main effects for each IQ group. The results of this analysis are given in Table 10.

The analysis of simple effects shows that the F ratios for Groups B and E were significant beyond the .01 level. The F ratios for Groups A and E were significant beyond the .05 level. The IQ group curves for correct responses over test blocks are plotted in Figure 7.

The results of this analysis can be interpreted from the curves in Figure 7. The performance curves of Groups A and E were characterized by a significant increase in the number of correct responses over blocks. The performance curves of Groups B and F, on the other hand, showed a significant decrease in the number of correct responses over test blocks.

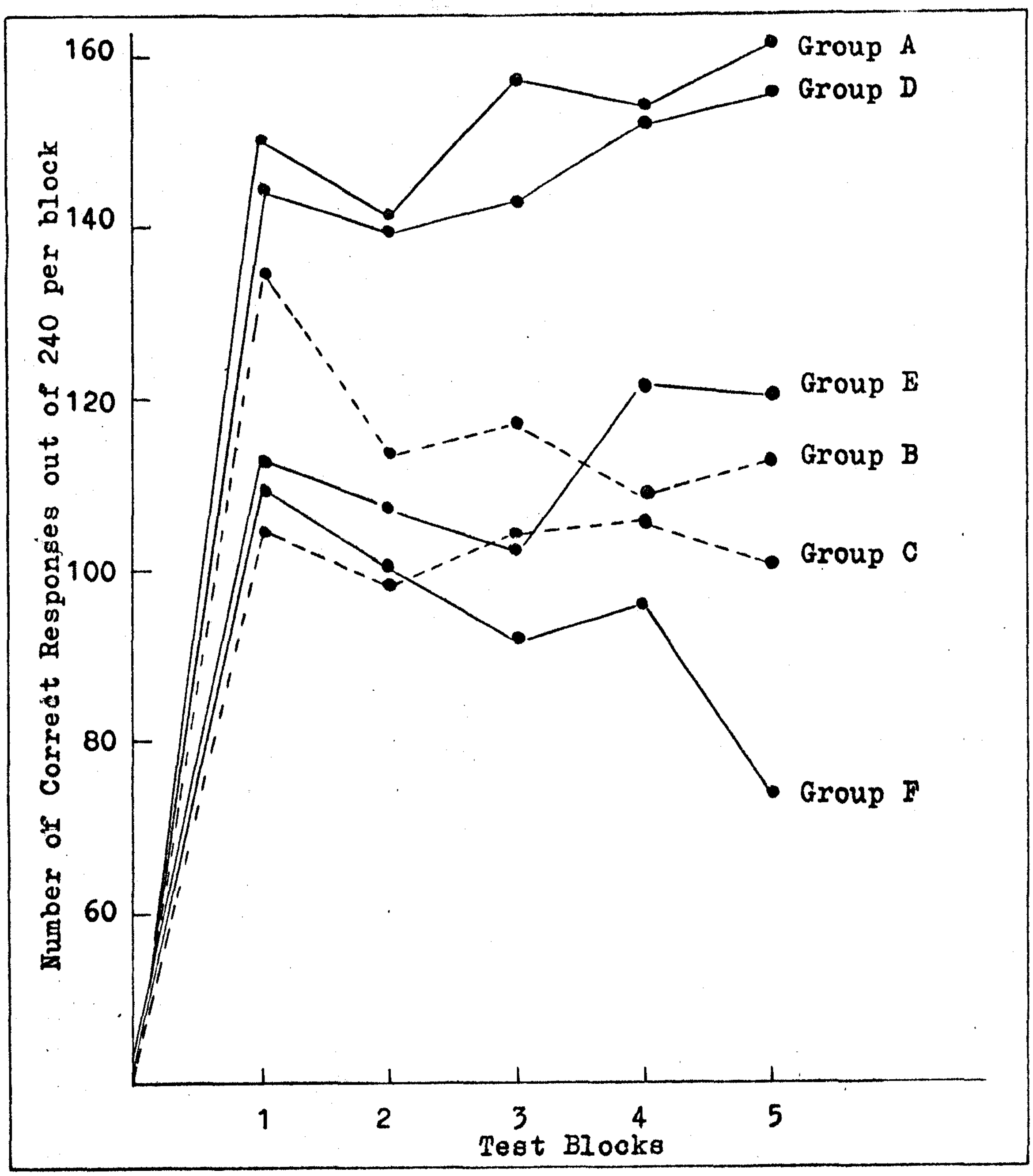

Figure 6. Number of correct responses for each IQ group over test blocks (all conditions).

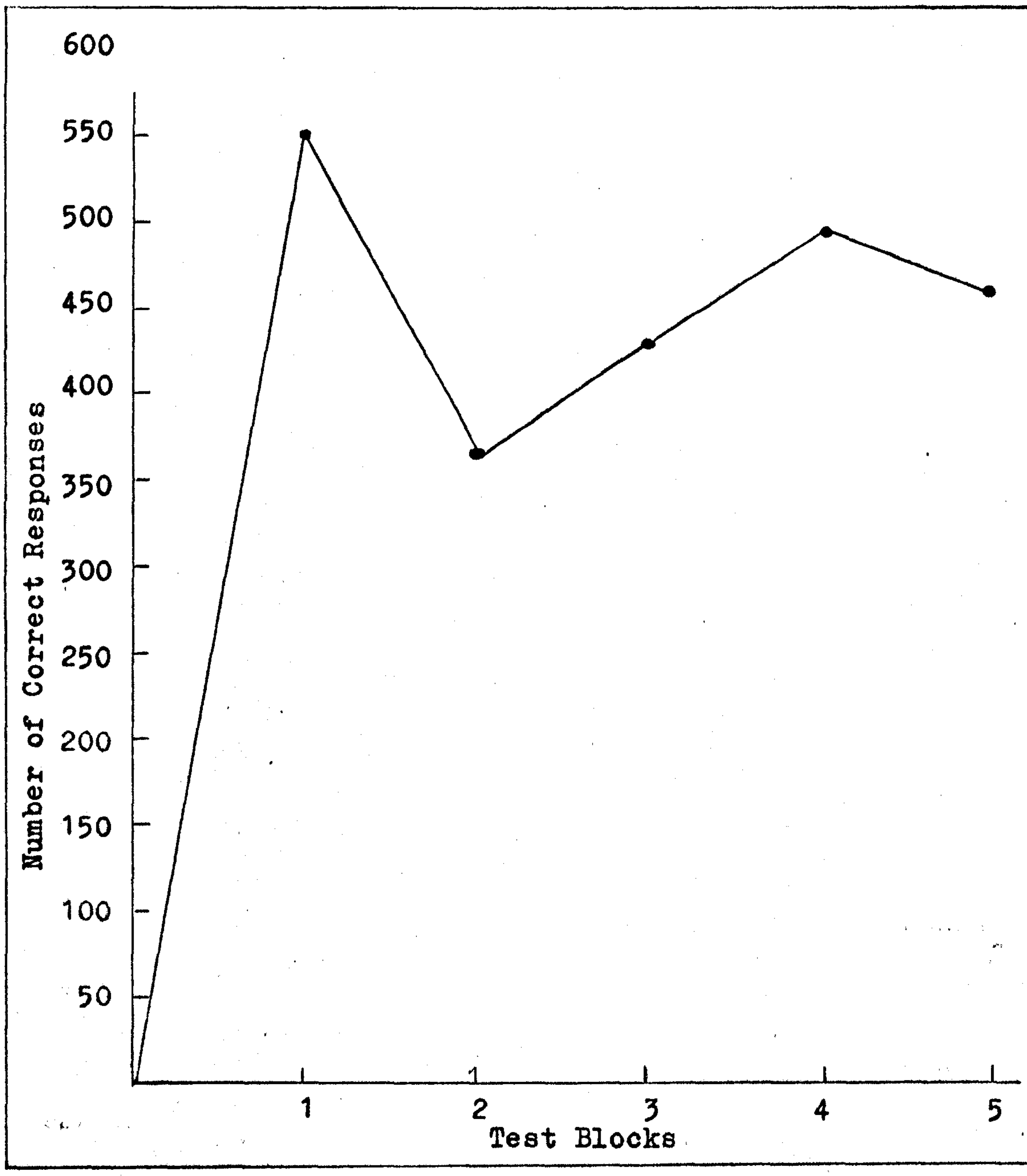

Figure 7. The number of correct responses for all IQ groups over test blocks

The significant interaction of IQ and test blocks was expressed as an overall improvement in the performance of the high IQ subjects, and an overall decrement in the performance of the low IQ subjects. Performance on this task was thus found to be positively related to IQ, at the extreme ends of the IQ continuum.

Table 10

Analysis of Variance of the Simple Effects for Each IQ Group.

IQ Group	Between Subjects' MS	df	F Ratio
Test Blocks for			
Group A	10.14	4	2.41*
Group B	11.06	4	4.06**
Group C	1.54	4	0.37
Group D	5.98	4	1.42
Group E	11.23	4	2.67*
Group F	22.02	4	5.24**
D x Subj. w. Groups	4.20		

* Significant beyond the .05 level
** Significant beyond the .01 level

To summarize the foregoing analysis of correct responses, the main effect of IQ was found to be significant as was the main effect of test blocks. The two-way interaction of IQ and test blocks was also found to be significant. This indicated that the IQ of the subjects was a significant factor in their performance; that there were significant changes in performance during the testing session; and that IQ affected performance significantly at certain stages of the session. The changes in the number of correct responses over test blocks was best described by a quartic function, since there were four significant changes in the shape of the curve over the five test blocks. Performance increased rapidly over the first test block, decreased sharply over the second block, increased gradually over the third and fourth blocks, and decreased again over the final block. The total number of correct responses was significantly higher in the first block, and significantly lower in the second block, than in subsequent blocks. The significant interaction effect of IQ and test blocks was expressed as significant increases in the performance of Groups A and E, and a significant decrement in the performances of Groups B and F. Thus IQ was found to be positively related to performance at the extreme ends of the IQ continuum, but not at the internediate levels.

Reminiscence Scores

Reminiscence is usually considered as an improvement in performance following a period of no over responding.

improvement is determined by comparing the performance scores before a rest period with the scores after the rest period.

Reminscence, in this study, was operationally defined as the change in performance in the 10 post-rest trials (51-60) relative to performance in the 10 pre-rest trials (41-50). The reminiscence score of each subject was the difference in the number of his correct responses in a pre-rest block vs. a post-rest block of 10 trials. The reminiscence scores for male and female subjects in each IQ group for each condition are given below in Table 11.

An analysis of variance of reminiscence scores with IQ, condition and sex as the main effects, was carried out. The summary of this analysis is given in Table 12.

The *F* ratio for the main effect of IQ was significant beyond the .05 level. The *F* ratios for the main effects of condition and sex were not significant. There were no significant interactions. These results indicated a significant relationship between IQ and reminiscence.

To determine the significance of differences between the reminiscence scores of the IQ groups, a Newman-Keuls test was performed on the group totals. The results of this test show that the reminiscence scores of Group A and Group F differed significantly beyond the .05 level. The reminiscence scores for each IQ group are plotted in Figure 8. This curve indicates that Groups A, B and C demonstrated reminiscence.

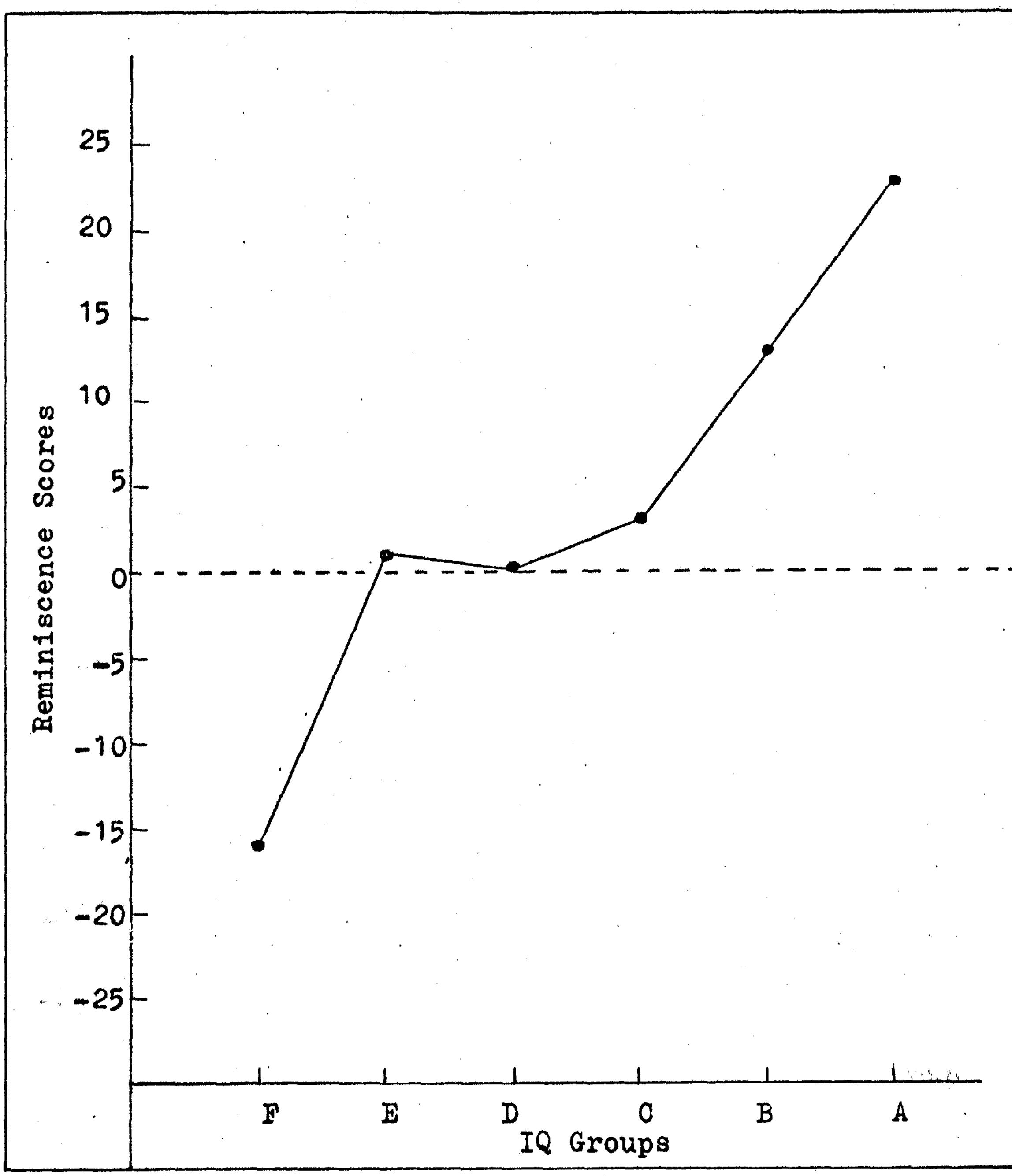

Figure 8. Reminiscence scores for each IQ group (correct responses in post-rest block of 10 trials minus correct responses in pre-rest block of 10 trials)

Table 11

Reminiscence Scores for Males and Females in Each IQ Group and for Each Condition.

IQ Group	Sex	Condition	Reminiscence Scores
A	Males	1	4
		2	-1
		3	9
	Female	1	8
		2	0
		3	3
B	Male	1	0
		2	5
		3	-1
	Female	1	3
		2	8
		3	-2
C	Male	1	8
		2	0
		3	0
	Female	1	-1
		2	-4
		3	0
D	Male	1	0
		2	6
		3	-4
	Female	1	0
		2	0
		3	-2

Table 11 continued

IQ Group	Sex	Condition	Reminiscence Scores
E	Male	1	0
		2	4
		3	-3
	Female	1	1
		2	0
		3	-1
F	Male	1	-1
		2	-1
		2	-1
	Female	1	-2
		2	-2
		3	-3

Table 12

Analysis of Variance of Reminiscence Scores by IQ, by Condition, by Sex.

Source of Variation	SS	df	MS	F Ratio
A (IQ)	72.33	5	14.46	3.19*
B (Condition)	10.58	2	5.29	1.19
C (Sex)	8.00	1	8.00	1.76
AB	67.09	10	6.71	1.62
AC	18.00	5	3.60	0.79
BC	0.75	2	0.38	0.08
ABC	44.25	10	4.42	0.97
Within Cell	163.00	36	4.52	
Total	414.00			

* Significant beyond the .05 level

Groups D and E showed little or no reminiscence, while Group F showed a decrement in performance. The results of this test are given in Table 13.

Table 13

Newman-Keuls Test of the Significance of Difference Between the Reminiscence Scores of Each IQ Group.

IQ Groups		F	D	E	C	B	A
Totals		-16	1	0	3	13	23
		IQ Groups					
		F	D	E	C	B	A
IQ Groups	F						*
	D						
	E						
	C						
	B						
	A						

* Significant beyond the .05 level

A trend analysis was performed on the reminiscence scores of each IQ Group. It revealed no significant trend. The results of the test are given in Table 14.

These results suggest that IQ and reminiscence are significantly related for the extreme IQ Subjects, and to a lesser extent, for the intermediate IQ subjects.

Table 14

Trend Analysis of the Reminiscence Scores of each IQ Group

Source of Variation	df	MS	F Ratio
A (Linear)	1	6.51	1.44
A (Quadratic)	1	0.08	0.01

To summarize, the analysis of reminiscence scores indicated that IQ and reminiscence were significantly related at the .05 level. The high IQ subject showed significantly greater reminiscence scores than the low IQ subjects. The latter showed a decrement in performance, following the rest period. Thus a differential effect of massed practice, in favour of the higher IQ subjects, was indicated.

CHAPTER IV

DISCUSSION

Latency of Response

Latency of Response was the first response measure to be considered in the analysis of the results. IQ and latency were significantly related for the extreme IQ groups. The high IQ subjects responded significantly faster and the low IQ group significantly slower than any other group condition and sex did not affect latency. Hypothesis IV, which predicted an inverse relationship between IQ and latency, was upheld in the case of the extreme groups. Thus, the general conclusion reported in the literature -- ie., that the lower the IQ, the poorer the performance of retardates as compared with normals -- is supported by the latency results of the extreme groups in this study.

The inverse relationship between IQ and latency of response was also supported by the latencies of Group E (mildly retarded). This group recorded significantly lower latencies than Group F (moderately retarded). However, the fact that Group E responded significantly faster than Group D (IQ 80-90) indicates that the relationship may not hold for the intermediate groups. There were no significant differences between the latencies of Group D and those of Group C and B. This suggests that, on a simple motor task, the mildly retarded subject is not particularly handicapped, and may perform as well as the subject of average intelligence.

Number of Correct Responses

Performance, as measured by the number of correct responses, showed four significant variations during the experimental session. Performance increased to the highest level during the first block of 20 trials, decreased to the lowest level during the second block, gradually increased again over the third and fourth block, then began to decrease gradually in the fifth block.

Hypothesis II predicted a significant effect in performance a function of training conditions. The Hypothesis was rejected, since there were no significant differences in performance as a result of training condition. The task of learning one stimulus - response association - was not made more difficult by varying the temporal sequence of events in the training trial. Therefore, the changes in overall performance were not due to the different training conditions.

The simplicity of the task, rather than its difficulty, may have been a factor in the overall pattern of performance. Task simplicity, it is believed, led to loss of interest, and boredom. Other factors, in addition to task simplicity, could have produced the performance changes, the massed practice, muscular fatigue resulting from pulling a plunger every ten seconds, and the social isolation of the experimental situation. These factors, it is believed, produced the sharp decrement in performance over the second block of trials. The improvement in performance in the third and fourth blocks suggests that the short rest, after the fiftieth trial, was sufficient to allow some of the boredom and fatigue to dissipate. The performance decrease in the fifth block suggests that the factors operating during the second block were again inhibiting performance.

It should be noted that latency of response decreased as the session went on. The most significant decrease occurred in the second block, while the number of correct responses was decreasing significantly. Performance on the motor task of pulling a plunger improved, which performance on the psychomotor task of associating a plunger and a light, was deteriorating. This suggest that for both normals and retardates, constant repetition on a simple task impedes the process of learning. Since all the subjects did not learn the correct response to criterion (six did not give one correct response) when all repeated the correct response 100 times in the training trials, mere repitition did not inevitably lead to correct performance.

These changes in performance level were found to be a function of IQ. Groups A and E showed significant overall improvement in performance, while Groups B and F showed an overall decrement in performance over test blocks. The performance of Groups A and F differed significantly. Thus the Hypothesis I prediction of a positive relationship between level of learning and IQ was supported. The results also support those paired-associates studies which report significant differences in performance as a function of IQ (e.g., Berkson and Cantor, 1950). The significant differences between the retardates and normal subjects' performance is not in agreement with the findings of Lott (1958).

The differences in the performance levels of high IQ and retarded subjects in this study agree with the findings on some classical conditioning studies of retardates and normals. Razran (1933) stated that the more intelligent the child, the more readily it forms the conditioned response. Marinesco and Kreindler (1933) found the conditioned response of hand withdrawal difficult to establish in moderately retarded subjects. Interpreting the results of this study in terms of classical conditioning paradigm, the performance deficit of the retardate relative to the normal could be explained as the inferior conditionability of the retardate.

Reminiscence Scores

The analysis of reminiscence scores revealed significant differences in the reminiscence of retardates and normals. This supported Hypothesis II. The overall increase in performance after the rest period indicated that reminiscence had occurred. The absence of a significant difference in reminiscence between normals and mildly retarded subjects (Group D and E) agree with the findings of Ellis Pryer and Barnett (1960). The significant differences between the moderately retarded and high IQ subjects, however, suggest that Ellis and his associates might have found these significant differences if they had varied the IQ variable more widely.

The curve (see Figure 8) showing the reminiscence scores of all IQ groups suggests that the positive relationship between IQ and reminiscence might hold at the intermediate levels. The three highest IQ groups showed reminiscence while little or none was shown by the lower IQ groups. The reminiscence scores were not large enough to indicate significant differences between any of the intermediate IQ groups.

The overall changes in the number of correct responses, and the analysis of the 10 pretest and 10 post-test trials can be considered in terms of Hull's theory of reactive inhibition. The massed blocks of 50 test and 50 training trials generated reactive inhibition in all subjects. The significantly higher overall level of learning achieved by the high IQ subjects and their significantly higher reminiscence relative to the low IQ group suggest that more reactive inhibition was perhaps accumulated by the retardates. This inhibited performance over the entire experimental session. The five minute rest was not sufficient to dissipate this reactive inhibition. Thus it was still present when the second block of 50 test and training trials began and resulted in the decrement in performance for the retardates.

Another possible theoretical explanation of the differences in the reminiscence of retardates and normal is the "Consolidation Theory" of learning. According to this theory, whatever processes underlie learning require a consolidation period. The results of this study indicate the higher IQ subjects required less time for the "setting process" than did the retardates. The five minute interval of no overt responding was sufficient for the high IQ subjects but not nearly enough for the retardates.

To summarize, Hypothesis I which predicted a positive relationship between IQ and level of learning, was supported by the extreme IQ groups. Hypothesis II, which predicted a significant effect due to training condition, was not supported. The assumption that one or more permutations of the standard training trial sequence would alter the task difficulty, does not appear true, when only one stimulus-response association is to be learned. Hypothesis III, which predicted a significant interaction between IQ and condition was not supported. Hypothesis IV, predicting an inverse relationship between latency of response and IQ was supported. This relationship exists in the extreme IQ groups. Hypothesis V, which predicted a significant interaction between reminiscence and IQ, was also supported by the scores of the extreme groups.

Suggestions for Further Research

The absence of significant differences as a function of condition suggest that the task should be made more difficult. An additional one of two white light-plunger combinations to the task are required in order to retest Hypothesis II and III effectively.

Another improvement in procedure would be to select subjects on the basis of individual IQ test administered by the experimenter. The lack of significant differences between Groups E and B (representing 60 points of the IQ continuum) suggests that group tests may not be very accurate in assessing the IQ of the mildly retarded and normal subjects. The results indicate that these tests do distinguish between the high and intermediate groups.

The Consolidation Theory could be investiaged by a future study which varied the number of pre-rest and post-rest massed trials and used rest periods of varying duration. The apparatus and procedure employed in this study to compare the results of massed vs. distribute practice, and to attack the difficult problems of establishing the optimum practice conditions for subjects of different intelligence levels, and on tasks , both simple and complex.

Finally, the results of the present study suggested that reminiscence and IQ might be positively related all along the IQ continuum. A follow-up study of this kind is certainly suggested by the results obtained in the present study.

CHAPTER V

SUMMARY

The present study investigated the relationship between intelligence level, training condition and sex on the learning of one stimulus-response association. Seventy-two subjects, 36 males and 36 females, were divided into six groups, on the basis of their IQ. The IQ range of the subjects varied between 40 and 140. The subjects were approximately 12 years of age.

The Grason-Stadler Learning Apparatus of the department of Psychology, University of Windsor, was used in this study. Two males and two females from each of the six IQ groups was randomly assigned to one of three training conditions. which differed only in the temporal order of stimulus itsm, response item and response in the training trials. Each subject was given 100 test and 100 alternating training trials, with a short rest at the half way point.

The results indicate that the maximum level of learning was reached in the first twenty trials, that it decreased to a significantly low point during the second block of 20 trials and to the first half of the third block. After the rest, performance increased for two blocks, then began to decrease again. The changes in performance level over trials was found to be a function of IQ. The high IQ subjects increased significantly in number of worrect responses over test blocks, while the low IQ subjects showed a significant decrement in performance over test blocks. The was no significant effect of the different training conditions, or of sex.

Latency of response show a general decrease over blocks. The latencies of the high IQ and low IQ subjects were significantly different and in the expected direction.

The reminiscence of the high IQ subject differed significantly from that of the low IQ subject , again in the expected direction. The three higher IQ groups showed reminiscence, while the three lower IQ groups showed little or none. It was concluded that: (1) there was a positive relationship between IQ and level of learning on this task, for the high and low IQ groups; (2) there was a significant relationship (positive) between IQ and latency at least for the extreme groups; (3) there was a positive relationship between IQ and reminiscence, as shown by the extreme groups and suggested by the others.

Appendix A

Correct Responses in Test Blocks for the Six IQ Groups in the Three Training Conditions and for both Sexes.

IQ Groups	Subject	Sex	Test Blocks 1	2	3	4	5
CONDITION I							
F	186	Male	0	0	3	0	2
	187		0	0	0	0	0
	10	Female	12	12	6	12	5
			18	14	10	1	2
E	226	Male	0	0	0	0	0
	228		20	20	20	20	20
	209	Female	3	0	1	0	0
	213		1	0	0	0	0
D	17	Male	2	0	0	0	0
	101		10	20	20	20	20
	54	Female	20	19	20	20	20
	50		1	0	0	0	0
C	139	Male	0	0	1	0	0
	133		9	0	9	10	0
	27	Female	15	18	15	17	17
	26		1	0	0	0	0
B	40	Male	7	0	0	0	0
	42		13	19	20	20	20
	120	Female	6	5	5	0	0
	119		20	20	20	20	20

Appendix A continued

IQ Groups	Subject	Sex	Test Blocks 1	2	3	4	5
CONDITION 1 continued							
A	99	Male	1	1	17	20	20
	98		0	0	1	0	0
	78	Female	0	0	8	20	19
	79		19	20	20	20	20
CONDITION 2							
F	15	Male	1	1	1	0	3
	180		0	0	0	0	0
	192	Female	9	11	2	3	4
	11		12	12	10	16	8
E	206	Male	1	0	3	16	17
	49		0	0	1	0	0
	248	Female	0	0	0	0	0
	48		18	20	20	20	20
D	22	Male	19	20	15	15	12
	103		9	9	11	11	9
	51	Female	3	0	0	0	0
	57		17	20	20	20	20
C	33	Male	0	0	0	0	0
	32		2	0	0	0	0
	148	Female	16	5	4	2	2
	146		0	0	0	0	0

Appendix A continued

IQ Groups	Subject	Sex	Test Blocks 1	2	3	4	5
CONDITION 2 continued							
B	44	Male	1	0	0	0	0
	41		18	19	15	20	19
	39	Female	16	10	12	12	15
	35		2	0	0	0	0
A	89	Male	15	7	2	1	1
	90		3	1	1	0	1
	81	Female	20	20	20	20	20
	76		18	20	20	20	20
CONDITION 3							
F	188	Male	5	10	14	5	0
	2		12	1	9	6	0
	1	Female	4	6	3	9	7
	4		14	9	8	18	12
E	247	Male	8	9	1	6	4
	245		13	8	12	15	14
	249	Female	19	17	15	17	15
	212		7	7	4	8	11
D	23	Male	11	7	4	4	6
	18		19	14	12	18	20
	55	Female	12	15	16	19	20
	56		12	1	16	17	19

Appendix A continued

IQ Groups	Subject	Sex	Test Blocks 1	2	3	4	5
CONDITION 3 continued							
C	130	Male	14	20	18	20	20
	415		7	9	14	20	20
	147	Female	17	20	20	14	17
	401		1	1	0	0	0
B	116	Male	14	16	20	12	16
	416		13	1	1	1	0
	118	Female	12	2	4	1	0
	405		0	0	0	0	0
A	420	Male	9	14	14	0	13
	419		10	8	7	8	7
	121	Female	20	17	17	14	16
	80		20	20	19	20	20

Appendix B

Mean Latency of Response for the Six IQ Groups in the Three Training Conditions and for Both Sexes.

IQ Groups	Subject	Sex	Test Blocks 1	2	3	4	5
CONDITION I							
F	186	Male	3.78	3.78	3.78	2.25	1.77
	187		2.02	1.86	1.53	1.85	2.01
	15	Female	1.52	2.02	1.51	1.51	2.01
	180		2.73	2.62	1.92	1.32	1.52
E	226	Male	0.37	0.18	0.03	0.34	0.18
	228		0.80	0.90	0.70	0.41	0.42
	49	Female	0.51	0.51	0.51	0.51	0.51
	206		1.04	1.04	1.50	1.11	1.60
D	17	Male	2.28	2.28	2.28	2.28	2.28
	101		1.60	1.70	1.31	1.70	0.81
	22	Female	1.502	0.90	0.91	1.42	1.21
	103		1.51	0.60	0.40	0.22	0.39
C	133	Male	1.71	1.71	1.47	0.01	0.01
	139		1.52	1.51	1.51	1.52	1.50
	33	Female	1.69	1.18	0.67	0.52	0.51
	32		1.26	1.26	1.26	1.27	1.26
B	42	Male	1.51	1.01	0.81	0.71	0.70
	40		2.21	2.21	2.21	2.21	2.21
	44	Female	1.53	1.53	1.53	1.53	1.53
	41		1.21	0.92	0.51	0.31	0.32

IQ Groups	Subject	Sex	Test Blocks 1	2	3	4	5
CONDITION 2 continued							
B	116	Male	1.71	1.11	0.91	1.12	1.41
	416		1.02	1.04	1.04	1.04	1.04
	120	Female	0.90	1.01	0.51	0.51	0.51
	119		0.32	0.20	0.52	0.02	0.21
A	419	Male	0.82	1.10	1.00	1.10	0.81
	420		0.71	1.21	0.90	0.90	0.32
	79	Female	1.01	0.21	0.30	0.22	0.22
	78		1.31	1.31	1.31	0.72	0.60
CONDITION 3							
F	11	Male	2.02	1.20	2.72	1.91	1.02
	192		2.76	1.92	0.75	1.36	1.82
	1	Female	2.52	2.02	2.03	2.60	1.10
	4		1.41	1.52	1.01	1.01	1.01
E	48	Male	1.71	1.21	1.21	1.71	1.31
	248		1.71	0.86	1.36	0.86	0.86
	249	Female	1.41	1.40	1.41	1.20	0.81
	212		1.52	1.52	1.01	1.50	0.81
D	51	Male	1.55	1.55	1.55	1.55	1.55
	57		1.21	0.81	0.81	0.70	1.01
	56	Female	1.42	0.51	0.02	0.52	0.22
	55		1.81	0.41	0.60	0.32	0.21

Appendix B continued

IQ Groups	Subject	Sex	Test Blocks 1	2	3	4	5
CONDITION 3 continued							
C	146	Male	0.85	0.52	0.20	0.20	0.36
	148		1.42	1.02	0.77	0.28	0.76
	147	Female	1.90	1.20	1.20	0.71	0.71
	401		1.04	1.04	1.04	1.04	1.04
B	39	Male	1.41	1.41	0.72	0.81	1.20
	35		1.79	1.79	1.79	1.79	1.79
	118	Female	1.21	1.02	0.52	0.52	0.52
	405		1.70	0.67	0.68	1.36	0.52
A	81	Male	1.10	0.31	0.22	0.31	0.21
	76		1.12	1.10	0.71	0.71	1.30
	80	Female	1.21	0.50	0.71	0.31	0.60
	121		2.12	1.00	0.92	1.42	0.80

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