WELSH, James Albert, 1942-
ASSOCIATIVE LEARNING RATES OF BRIGHT, NORMAL, AND RETARDED CHILDREN USING PAIRED-ASSOCIATE LISTS OF VARYING LENGTHS.

The University of Oklahoma, Ph.D., 1967
Education, psychology

University Microfilms, Inc., Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

ASSOCIATIVE LEARNING RATES OF BRIGHT, NORMAL, AND RETARDED CHILDREN USING PAIRED-ASSOCIATE LISTS OF VARYING LENGTHS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

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Norman, Oklahoma

1967

ASSOCIATIVE LEARNING RATES OF BRIGHT, NORMAL, AND RETARDED CHILDREN USING PAIRED-ASSOCIATE LISTS OF VARYING LENGTHS

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ACKNOWLEDGMENTS

The writer would like to express his sincere appreciation to his major professor, Dr. P. T. Teska, who not only directed the research but also inspired an interest in the subject area through his teaching.

Gratitude is also extended to Dr. Omer J. Rupiper whose suggestions regarding the design and analysis of the study were invaluable; and to Dr. Lloyd P. Williams, Jr. and Dr. Mary C. Petty for contributing their time and interest. The support of each of these committee members is sincerely appreciated.

The writer would also like to thank the many school officials who cooperated in the provision of subjects for this study. Special thanks is reserved for Mrs. Nelda Ferguson of the Oklahoma City Board of Education whose help in the selection of subjects was more than could have been expected.

A singular debt of gratitude is owed Dr. Gladys W. Hiner who provided the material for this study and gave selflessly of her time in theoretical and procedural discussions with the writer.

Appreciation is extended to the three experimenters, Mrs. Susan Peters, Miss Barbara Campbell, and Mr. Thomas Thomason, who contributed considerable time and skill in the running of the subjects.

Finally, the author must thank his wife, Sally, without whose patient understanding and emotional support this research could never have been accomplished.

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CHAPTER I

INTRODUCTION AND PROBLEM

Over the years one of the most neglected areas of educational research has been in the learning process differences of bright, normal, and retarded children. It appears that educators have become so preoccupied with the intellectual classification of children that they have overlooked the specific behavioral manifestations which characterize their groupings. This unfortunate situation has led to the creation and perpetuation of theoretical assumptions concerning the learning process in persons of subnormal intelligence that have not been empirically substantiated.

Although the concept of mental deficiency has existed for centuries, special educators and psychologists have still failed to agree on a definition of mental retardation. However, there is an acceptance of the general idea that mental retardation refers to both the quantitative and qualitative impairment of the functioning organism's overall efficiency. Since the competence of an organism depends a great deal upon its learning capacity, the learning process is a vital component of mental retardation. At the present time there is a lack of conclusive evidence concerning whether learning phenomena apply to mentally retarded persons in the same way as they apply to normals.

McGeoch (1942) defines learning as the improvement in performance resulting from repetitive practice in response to stimuli held constant throughout the learning period. He points out that the process involves changes in the rate, amount, and mode of acquisition. Thus, one of the ways learning process differences among persons in various levels of intelligence can be investigated is by comparing the learning rates of retarded children with those of normal and bright children. By examining the manifestations of the learning process, it should be possible to move a step closer to isolating specific operating factors which produce learning deficits in individuals whose intelligence scores place them in the mentally retarded range of intelligence.

Review of the Experimental Literature

McPherson (1948) reviewed the experimental studies of learning in retarded individuals from the period of 1907 to 1945. She included only those studies using subjects who had been demonstrated by psychometric criteria to be subnormal. These studies fell into three general classifications: (a) formation of conditioned responses; (b) learning simple tasks; (c) problem solving. None of the studies were related to school-type learning. In summary, McPherson stated:

> The outstanding impression gained from this review of learning in the subnormal is one of lack of information. The actual experiments have been few, the number of subjects small, the tasks to be learned heterogeneous within a narrow range, and the motivational factors inadequately controlled. The results of this review serve not so much as an aid to the technician in meeting clinical problems but as a reminder to the experimentalist (McPherson, 1948, p. 252).

In a similar review one decade later, McPherson (1958) surveyed the literature from 1943 to 1957. This review covered 14 studies, four of which involved verbal learning. The tasks in these four studies consisted of learning nonsense syllables or learning lists of common words. None of the studies used paired-associate tasks, nor were they related to school-type experience. McPherson concluded:

> The review reveals a diversity of methodology and of results. Some papers highlight a slow, arduous learning process among mental defectives whereas others point to more skill in acquisition than is ordinarily assumed. There is evidence that intellectual level is not an adequate predictor of the learning of mental defectives and that their learning per se is variable (McPherson, 1958, p. 877).

Since McPherson's second review, a great increase in studies investigating learning differences between normals and retardates has taken place. However, this increase in experimental activity has failed to yield any more conclusive information regarding specific learning differences than was established previously.

The most recent studies can be divided into two general categories--those which match experimental groups on the chronological age variable and those matching groups on mental age. Since the present investigation matches groups according to chronological age and uses the paired-associate method, only the recent studies of this type are included in the following discussion.

Studies Reporting No Learning Performance Differences

Eisman (1958) used the paired-associate technique for studying differences in learning, generalization, and retention among retarded, average, and superior groups of children. Her experiment included 23 subjects in each group, with chronological ages ranging from 146 to 206 months. The IQ's ranged from 46 to 77 in the retarded group, 91 to 108 in the normal group, and 120 to 134 in the superior group. The task consisted of a series of seven pairs of pictures to be learned to a criterion of four consecutive, correct trials. The author found: "A comparison of Groups I, II, and III on number of trials to criterion...revealed no significant differences" (Eisman, 1958, p. 484).

A study (Akutagawa and Benoit, 1959) using solely institutionalized children with chronological ages of 8 to

10 and 11 to 13 supports Eisman's findings. Normals of average intelligence and subaverage children (IQ's from 70 to 89) were presented three different paired-associate lists of varying difficulty, each containing eight pairs of pictures. They found that the lists were sufficiently sensitive to differentiate the CA levels (superior learning performance by the older subjects), even though they did not differentiate according to MA.

In an unpublished doctoral dissertation, Hiner (1962) also found no performance differences among brights, normals, and retardeds. The author used 30 subjects in each group whose chronological age ranged from 114 to 126 months. The IQ's of the subjects ranged from 120 to 156 in the bright group, from 90 to 110 in the normal group, and from 52 to 75 in the retarded group. The stimulus material consisted of simple outline drawings of common objects which met certain specified criteria determined by a pilot study: (a) the words represented by the pictures were one-syllable nouns; (b) the pictures were immediately recognizable; (c) the pictures were consistently identifiable; (d) the pictures were not obviously potentially affect arousing. Hiner's data failed to reveal any significant performance differences in trials to criterion and total errors among brights, normals, and retardeds.

Vergason (1964) presented 13 randomly paired items, each consisting of two-by-two slides of black and white

Peabody Picture Vocabulary Test pictures, to a normal group of subjects ranging in IQ from 90 to 110 and a retarded group ranging in IQ from 60 to 75. All of the subjects were trained by the method of adjusted learning (items removed when correctly identified) to either a minimum or over-learning level of performance on the original learning trials. Other experimental manipulations followed in order to study retention effects not relevant to this review. With respect to the pertinent findings, no differences in performance were found between the normal and retarded groups.

Two other studies reported a lack of relationship between associative learning performance and intelligence as a part of more widespread results. Kingsley (1964), using the SRA Primary Mental Abilities Test as an intelligence measure and the Gates Associative Learning Test as a learning measure, found no correlation between intelligence and associative learning ability for 53 educables between the ages of 10 and 15 years, 2 months. Podolsky (1965) found that, between normal and retarded children of the same chronological age (8, 12, and 16 years), learning performance in a picture paired-associate task was not significantly different.

Studies Reporting Learning Performance Differences

Since 1958 five studies have discovered consistent differences favoring bright and/or average children in paired-associate learning tasks. Of these, only two employed pictures as the stimulus material.

Ring and Palermo (1961) presented a list of eight pairs of Stanford-Binet vocabulary pictures reproduced by a thermo-fax process to 14 mentally retarded adolescents matched according to chronological age with 14 normal adolescents. Although this study was a replication of Eisman's study, it is different in two important respects. The material was presented by a mechanical apparatus (as opposed to Eisman's personal presentation) which markedly reduced Eisman's presentation time of seven seconds. Ring and Palermo summarized their findings as follows:

> The results of the present study differ from Eisman's finding that retarded Ss were not significantly inferior in performance on this learning task, although her results were in the same direction. The findings of this study supported the hypothesis that retarded Ss would perform less well than normal individuals of the same C. A. The two groups of matched mental age did not differ significantly, and when the two normal groups were compared, the older group was superior to the younger in performance. These results would be expected if mental age is a variable affecting performance on this task (Ring & Palermo, 1961, p. 105).

In a later study, Ring (1964) administered an eight-pair list of pictures to 24 normals and 24 retardates varying the anticipation interval (two and four seconds), and discovered that retarded subjects required significantly more trials to reach the learning criterion than normals in both interval conditions.

Jensen (1963) required his subjects to learn by trial and error to associate colored geometric forms with an array of pushbuttons. His subjects averaged 14.2 years of age and the retardeds ranged in IQ from 50 to 75, the normals from 90-110, and the brights fell above the 135 IQ level. He discovered highly significant differences among the groups, with the rate of learning being related to IQ even within the retarded group. He also reported no sex or race differences within his experimental groups.

In an investigation of the effect of distribution of practice and intelligence (Madsen, 1963), the subjects were asked to associate numbers from one to ten with animal pictures. The author found that distributed practice was more beneficial than mass practice for the retardeds but no differences were found for the two types of practice in the high and average groups. The high group performed significantly better than the low group under both practice conditions.

Blue (1963), using line drawings of geometric designs from the Perceptual Reaction Test as a visual stimulus and color names as auditory response items, manipulated intelligence as one of his experimental variables. He discovered that retarded subjects required significantly more trials to learn than normals.

Studies Reporting Mixed Findings

Berkson and Cantor (1960) used the paired-associate method for comparing learning ability between normal and retarded children. They used 24 retarded public school children, aged 9 to 12, whose IQ's ranged from 55 to 85, and 30 normal children, a few months younger in age, whose IQ's ranged from 86 to 115. These two groups were subdivided into experimental and control groups for the purpose of studying the mediation phenomenon in learning, a theoretical question which is not pertinent to this discussion. The material to be learned was three six-pair lists of stimuli consisting of various arrangements of arabic numerals, pictures of common objects, and hexagons varying in color. The lists were learned to a criterion of five successive, correct repetitions. The authors reported:

> The analysis of variance revealed no significant differences in the learning of List I either for trials to criterion or number of errors.... The results of List II show a slightly different pattern than did those of List I.... While for the trials measure there were again no significant differences between any groups, the normal Ss did make significantly fewer errors in learning List II.... In List III, the experimental Ss learned significantly more quickly and with fewer errors than did the control Ss. It may also be seen that on both measures the normals were more efficient than were the retarded Ss (Berkson & Cantor, 1960, p. 85).

In another study reporting mixed findings, Baumeister (1963) used paired colored pictures as stimuli in comparing normals and retardates with respect to incidental and intentional learning. The normals were superior on both intentional and incidental immediate recall tasks. However, after 48 hours there were no differences in recall for the incidental learning groups while the retardates in the intentional learning condition were superior to the normals. Baumeister concluded that his results suggest that the learning deficit in mental retardates is task specific.

Statement of Problem

This writer feels that one cause of the contradictory findings to this date is the lack of comparability among the investigations with respect to the methodology followed and the materials used. If this is true, it would appear that the most appropriate course of action to pursue is the systematic investigation of the factors suspected to be salient to the outcome of these studies. In this regard, Prehm (1966b) criticized the previous verbal learning research in mental retardation with the following statement, among others:

> The various investigators have also assumed that the difficulty level of their experimental task was sufficient to reflect any performance differences between groups. Only Heber et al. (1962) used lists of materials which varied in the number of items to be learned in order to assure that level of task difficulty was appropriate. This procedure seems highly desirable inasmuch as it should assure the experimenter that his task would not be so simple that it would be impossible to reflect performance differences (Prehm, 1966, p. 44).

The same author undertook an experimental investigation (1966a) into the effect of list length upon the learning performance of mentally retarded and normal children. No attempt was made to match subjects on chronological age or mental age. He found that, for meaningful materials (pictures of common objects from the Peabody Picture Vocabulary Test), normals were significantly superior in both low and high difficulty conditions (defined by number of pairs in the paired-associate lists). Thus, although adding support to the contention that differences exist between normals and retardates, he failed to establish task difficulty as a discriminating factor.

Despite Prehm's failure to demonstrate that list length is a critical factor in associative learning of normals and retardates, there is sufficient evidence regarding the effect of the amount of material upon memory of paired-associate stimuli (Mayzner & Schoenberg, 1965; Wilcoxon, Wilson & Wise, 1961) to warrant further investigation into this variable.

Wilcoxon et al. presented nonsense syllables to 108 general psychology college students and discovered that increase of list length caused an increase in the mean trials to criterion.

Mayzner and Schoenberg varied list length among other variables in showing city and temperature pairs to a total of 110 subjects. Their overall results revealed significant effects on storage and retrieval capacity as a function of list length.

In view of these experimental results it is not surprising that Denny (1964) observed in his discussion of studies reporting no differences between retardates and normals, "Whether these findings would hold up with a list of about sixteen pairs of pictures within a truly retarded population would seem to be a question of considerable interest" (Denny, 1964, p. 121).

The purpose of the present study, then, is to determine the effect of list length upon the associative learning ability of bright, normal, and retarded children. In an effort to isolate list length as a factor, the method and material of a prior study (Hiner, 1962) which discovered no differences among these experimental groups is duplicated with the exception of certain procedures designed to introduce greater control: (a) the use of four experimenters, two males and two females, to allow for analysis of possible experimenter effects; (b) the use of the more difficult learning criterion of two successive, rather than one, correct repetition of the paired-associate list to ensure against chance "learning;" (c) except for a few cases in the bright group, the selection of subjects from fairly homogeneous socioeconomic neighborhoods as described by a school board official.

In her investigation, Hiner used a 12-pair list of pictures of common objects. The present experiment employed a 16-pair list and a 20-pair list of common objects in addition to the same 12-pair list utilized by Hiner. The basic assumption underlying this procedure is that an increase in list length increases the difficulty of the learning task. It is further proposed that an increase in task difficulty discriminates between the learning rate performances of bright, normal, and retarded children.

The following specific hypotheses were tested:

1. Using the 12-pair list, there are no statistically significant differences in the number of trials required to meet the criterion of learning among bright, normal, and educable retarded children.

2. Using the 16-pair list, there are statistically significant differences in the number of trials required to meet the criterion of learning among bright, normal, and educable retarded children.

3. Using the 20-pair list, there are statistically significant differences in the number of trials required to meet the criterion of learning among bright, normal, and educable retarded children.

4. Using the 12-pair list, there are no statistically significant differences in the number of errors made in reaching the criterion of learning among bright, normal, and educable retarded children.

5. Using the 16-pair list, there are statistically significant differences in the number of errors made in reaching the criterion of learning among bright, normal, and educable retarded children.

6. Using the 20-pair list, there are statistically significant differences in the number of errors made in reaching the criterion of learning among bright, normal, and educable retarded children.

The level of statistical significance required to support the hypotheses was set at $p < .05$.

CHAPTER II

METHOD

The Subjects

The subjects used in this experiment were 216 boys and girls in the Oklahoma City Public School System, ranging in chronological age from 108 to 131 months. With the exception of approximately 20 students in the Bright Group who, in order to fill the prescribed sample quota, were selected from a school in an upper-middle class neighborhood, the subjects were chosen from schools located in upper-lower class neighborhoods as described by an Oklahoma City School Board Official.

There were 72 subjects in each of the three intelligence groups, 24 in each of the three list length conditions. The subjects in the Bright Group ranged from 120 to 139 in IQ, those in the Normal Group fell within the IQ range of 90 to 110, and the Retarded Group was composed of students who scored within the IQ range of 51 to 78. The California Test of Mental Maturity was used as the intelligence measure for the Bright and Normal Groups while the 1960 Revision of the Stanford-Binet Intelligence Scale was the IQ measure for the Retarded Group. Except for the equating of sex, the subjects were randomly selected within each of the experimental groups.

The Test Instrument

The test materials were the same as used by Hiner (1962). They consisted of four booklets, each containing five-inch by eight-inch cardboard cards bound together by a flexible plastic band. Two of these booklets--Booklet One and Booklet Two--contained one pair of outline pictures of common objects on each card. There were 13 cards in Booklet One, the first of which served as the sample card while the remaining 12 served as test stimuli. Booklet Two contained 8 test cards only, all of them serving as test stimuli. Booklets Three and Four contained 13 and 8 cards, respectively, on each of which appears the first picture of the corresponding original stimulus pair. The first card in Booklet Three served as the sample card corresponding to the original sample stimulus card in Booklet One while the remaining 20 cards in Booklets Three and Four served as the response-generating task stimuli. Booklets One and Three are identical to those used by Hiner, while the pictures contained within Booklets Two and Four were used by the same author in a pilot study. These pictures met the same selection criteria discussed previously as applied to the drawings in the original investigation.

In order to control serial effects and thus eliminate the necessity for a random presentation of the pairs, Hiner ran a pilot study to determine the arrangement of the pairs which would flatten the learning curve for the 12-pair list. This arrangement was followed for the 12-pair list in the present experiment. The principal reason for flattening the 12-pair list learning curve was to allow for an adequate number of differentiating test stimuli, i.e. stimuli which were not conducive to immediate correct repetition by all the subjects. If only a small number of these distinguishing stimuli existed, then the test as a whole would not allow for adequate discrimination between slow and fast learners. It was felt that the longer lengths of the 16-pair and 20-pair lists guaranteed a sufficient number of discriminative items, thereby obviating the necessity to flatten the learning curves in these lists.

Individual record sheets were used for each subject. The following information was recorded on each sheet: (a) the name, chronological age, and IQ of the subject; (b) the scoring of each response made; (c) the total number of trials required to reach the learning criterion; (d) the total number of errors made by the subject in reaching the learning criterion.

The Pilot Study

A pilot study duplicating the procedure used in the present experiment was run by the author in order to determine: (a) suitable lengths for the two additional experimental lists which were to be introduced; (b) trial ceilings to be placed upon the subjects' performance on each of the lists.

As a result of this preliminary testing the maximum list length of 20 was chosen for two reasons: (a) it was demonstrated to be significantly more difficult than the 12-pair list as measured by the total trials to criterion of learning; (b) the maximum time required to reach the success criterion (approximately 90 minutes) appeared to be the optimum allowable before the effects of fatigue, boredom, and discouragement became manifest. The 16-pair list was added so that the basic assumption that list length increases task difficulty could be tested more critically through the use of a list of expected intermediate difficulty. In addition, the intermediate list afforded an opportunity to study the data for specific trends which were relevant to the experimental hypotheses, i.e. greater differences among the intelligence groups would be expected as the list length increases.

The second function of the pilot study was to obtain an adequate ceiling on the amount of trials allowed for the successful learning of each list. In Hiner's study, it was discovered that 15 trials were sufficient to allow for success on the 12-pair list. Using this ceiling as a base, the 20-pair list was assigned an arbitrary ceiling of

30, twice the amount allowed for the 12-pair list. It was discovered that this limit provided for adequate discriminability without evidence of undue subject fatigue, boredom, or discouragement. Consistent with its status of intermediate difficulty, the 16-pair list was assigned a ceiling of 23 trials.

The Experimenters

The author and three students in special education who have experience in administering standardized tests served as experimenters. Each experimenter tested an equivalent number of subjects in each experimental group in order to afford a post-experimental analysis of experimenter effects. The experimenters were divided equally with respect to sex.

Procedure

Each subject was tested individually in a room isolated from the interference of ongoing school activity. The Subject was asked to sit to the left of, and at a right angle to, the Examiner at the end of a table. Each subject was administered only one of the three paired-associate lists.

The following instructions were given to each subject:

> Here are a number of cards (the Examiner opens Booklet One). Each card in this set has two pictures on it (the Examiner shows the subject the sample pair).

> Look at both pictures carefully and try to remember which two pictures go together. (The Examiner then closes Booklet One and shows the Subject Booklet Three.) Then I will show you another set of cards like these with only the first picture showing (The Examiner shows the sample card). I want you to tell me what picture went with this picture. (The Examiner pauses for the answer.) So, as you see the two pictures together, try to remember what two pictures went together.

If the Subject failed to answer the sample card correctly, the Examiner restated the appropriate instructions, repeating the example until he or she was satisfied the Subject understood the nature of the task.

Then the paired pictures (either 12, 16, or 20) were presented singly to each subject at the rate of one every three seconds. Following this, Booklet Three was opened and the first picture of each pair was presented singly at the rate of one every five seconds. The Examiner scored each oral response made by the Subject. Additional trials were then administered until the Subject reached the learning criterion of two successive, correct repetitions of the list or until the trial ceiling for the particular list being administered was reached. Intertrial intervals were ten seconds in length. Between trials the Examiner said:

> Now we will look at the pictures again. Try to remember what two pictures were together.

If the Subject questioned the Examiner about the test, he or she added:

> We will keep looking at the pairs of pictures until you learn all of them.

Subjects who failed to give one correct response on any of the first five trials were considered as having failed to understand the task and, consequently, were eliminated from the population sample. Only two subjects, both retarded, were not included for this reason.

CHAPTER III

RESULTS

Two hundred and sixteen children from the Oklahoma City Public School System were tested to compare the rate of learning of three intelligence groups using three lists of varying lengths. The Bright Group ranged in IQ from 120 to 139, the Normal Group ranged in IQ from 90 to 110, and the Retarded Group fell within the IQ range of 51 to 78. There were 24 subjects in each of the nine experimental conditions.

F_{max} tests for Homogeneity of Variance for both the trial and error dependent measures were run to determine whether the assumption of homogeneity was met. Neither the error measure (F = 98.27) nor the trial measure (F = 39.21) failed to meet the assumption of homogeneity of variance. Since this assumption was met, a four-way analysis of variance design (Winer, 1962) with list length, intelligence, sex, and experimenters as the factors was employed in the statistical analysis of the data.

Before discussing the results of the study, it is necessary to point out the procedures used in compiling the raw data. Generally, the trials and errors were directly computed from the subject's performance. With respect to the trial score, the trial in which a subject achieved the first of two successive correct repetitions was designated as his trial score, e.g. if a subject reached the learning criterion by successfully repeating the lists on trials seven and eight, he was given a trial score of seven.

However, when the ceiling limit on the amount of trials was reached before the success criterion, it was necessary to introduce arbitrary quantities to represent the total trials and errors. This circumstance prevailed in only seven cases who, from this point, are designated as non-learners. The main goal in these cases was to differentiate between the non-learners and those who completed the task directly at the ceiling level. In order to accomplish this, the following two procedures were followed: (a) the non-learners were awarded an additional trial over the ceiling which they failed to meet; (b) further errors equal to the amount of errors which they made on the ceiling trial were awarded to the non-learners. For example, a subject who missed four items on the 12-pair list at the ceiling limit of 15 trials would be awarded a trial score of 16 and an error score of 4 plus his total through the 15 trials. This latter procedure was followed in order to provide some distinction between those who missed only a few items at the ceiling level and those who were failing on a great number of the items. It was recognized that these artificial quantities probably underestimated the subjects' total trials and errors but it was evident from the distribution of scores that the imposed ceilings easily provided for discriminability among the subjects.

List Length and Task Difficulty

As stated previously, the basic theoretical assumption underlying the experimental hypotheses is that an increase in list length results in a growth in the difficulty of the associative learning task. If this assumption is not met within any of the intelligence groups, the experimental manipulation of list length loses its usefulness for the present study.

The assumed positive relationship between list difficulty and list length can be tested by comparing the total trials required by all subjects in each list. Five hundred and ten trials were required by all subjects on the 12-pair list, 649 were used on the 16-pair list, and 711 trials were needed on the 20-pair list (see Table 1). As seen in Table 2, the overall differences among the three lists in trials to criterion is significant ($F = 7.03$; $p < .01$), with the longer lists taking more trials. Since overall differences existed between lists, each of the lists were compared with each other. As noted in Table 3, a significant difference exists between the 12- and 16-pair lists ($F = 7.46$; $p < .01$), but not between the 16- and

20-pair lists ($F = 1.48$). Because of the significant difference between the less divergent 12- and 16-pair lists, a significant difference between the 12- and 20-pair lists can be inferred.

TABLE 1

TOTAL NUMBER OF TRIALS TO CRITERION
(N-24)

	12-Pair List	16-Pair List	20-Pair List	Total
Bright	141	157	179	477
Normal	179	223	185	587
Retarded	190	269	347	806
Total	510	649	711	1870

Table 4 reveals the results of an analysis of the simple main effects of list length within each level of intelligence. It can be seen from this analysis that increase in list length does not significantly increase number of trials to criterion in the Bright and Normal Groups but it does significantly increase the number of trials in the Retarded Group ($p < .01$ for both between list comparisons).

Therefore the overall differences obtained between the lists with respect to trials to criterion can be attributed to the Retarded Group's significantly poorer

TABLE 2

ANALYSIS OF VARIANCE OF TRIALS TO CRITERION

Source of Variation	df	MS	F	P<
A (Lists)	2	126.31	7.03	.01
B (Groups)	2	389.59	21.68	.001
C (Sex)	1	.66	.04	*
D (Experimenters)	3	28.92	1.61	*
AB	4	84.67	5.71	.01
AC	2	53.13	2.96	*
AD	6	37.73	2.08	*
BC	2	6.44	.36	*
BD	6	6.84	.38	*
CD	3	45.69	2.54	*
ABC	4	23.27	1.29	*
ABD	12	5.36	.30	*
ACD	6	4.40	.25	*
BCD	6	.35	.02	*
ABCD	12	15.71	.87	*
ABCD (R)	144	17.97	--	--

*Not Significant

performance as the list length increases. From this it appears that list length does significantly influence the performance of at least one intelligence group.

TABLE 3

BETWEEN LIST COMPARISONS OF TRIALS TO CRITERION

Lists	df	MS	F	P<
12 Pairs vs. 16 Pairs	1	134.17	7.46	.01
16 Pairs vs. 20 Pairs	1	26.69	1.98	*

*Not Significant

TABLE 4

SIMPLE MAIN EFFECTS OF LIST LENGTH WITHIN INTELLIGENCE LEVELS

Lists	Group	MS	F	P<
12 Pairs vs. 16 Pairs	Retarded	130.02	7.23	.01
16 Pairs vs. 20 Pairs	Retarded	126.75	7.06	.01
12 Pairs vs. 16 Pairs	Normal	40.33	2.24	*
16 Pairs vs. 20 Pairs	Normal	30.08	1.67	*
12 Pairs vs. 16 Pairs	Bright	5.33	.30	*
16 Pairs vs. 20 Pairs	Bright	10.08	.56	*

*Not Significant

This finding is consistent with the theoretical assumption underlying the current investigation and thus justifies the further analysis to test the experimental hypotheses.

Experimental Hypotheses Concerning Trials

Recall that the three hypotheses regarding trials predict no significant differences in trials to criterion among the three intelligence groups in the 12-pair list condition and significant differences among the groups in the 16- and 20-pair conditions. Table 2 reveals a significant first order interaction between list length and intelligence group. This necessitates the examination of the simple main effect of intelligence within each list which was performed in the testing of the experimental hypotheses. Table 5 summarizes the results of the simple main effect analysis of variance calculated to test Hypotheses 1, 2, and 3.

Hypothesis 1, predicting no differences among Brights, Normals, and Retardeds on the 12-pair list is supported. Thus, the present study successfully replicated the earlier investigation (Hiner, 1962) upon which it is based.

Hypothesis 2 predicts significant differences among the three intelligence groups on the 16-pair list. Since overall differences ($p < .001$) were found, specific intergroup comparisons were accomplished. The Brights were discovered to be significantly superior to both the Normal ($p < .05$) and Retarded ($p < .001$) Groups. However, the Normals failed to perform significantly better than the

TABLE 5

COMPARISONS OF INTELLIGENCE GROUPS WITHIN EACH LIST CONDITION ON THE TRIAL MEASURE

	df	MS	*F*	*P* <
12-Pair List				
Brights vs. Normals vs. Retardeds	2	27.54	1.53	*
Brights vs. Normals	1	30.17	1.68	*
Brights vs. Retardeds	1	50.02	2.78	*
Normals vs. Retardeds	1	17.53	.98	*
16-Pair List				
Brights vs. Normals vs. Retardeds	2	132.01	7.34	.001
Brights vs. Normals	1	90.75	5.05	.05
Brights vs. Retardeds	1	251.33	13.98	.001
Normals vs. Retardeds	1	44.08	2.45	*
20-Pair List				
Brights vs. Normals vs. Retardeds	2	378.50	22.06	.001
Brights vs. Normals	1	.75	.04	*
Brights vs. Retardeds	1	588.00	32.72	.001
Normals vs. Retardeds	1	546.75	30.42	.001

*Not Significant

Retardeds on the 16-pair list. Thus, although the hypothesis of overall differences was supported, a significant difference did not obtain between the Normals and Retardeds.

Hypothesis 3 predicts differences among the three intelligence groups on the 20-pair list. Again, overall differences were found ($p < .001$), supporting the experimental hypothesis. Inter-group comparisons in this condition revealed the Retardeds to have a significantly slower learning rate than both Brights ($p < .001$) and Normals ($p < .001$), while there were no significant differences between Brights and Normals.

It is interesting to note that, consistent with the theoretical framework underlying the hypotheses, the performance differences among the groups increase as the list lengthens.

Experimental Hypotheses Concerning Errors

The three hypotheses regarding the number of errors predict no significant differences in total errors among the three intelligence groups in the 12-pair list condition and differences among the groups in the 16- and 20-pair list conditions. A summary of the four-way analysis of variance for errors is found in Table 6. As would be expected from the hypotheses, highly significant differences exist between lists and between intelligence groups. Table 7 summarizes the raw data concerning the relationship between intelligence groups and lists. It should be noted

TABLE 6

ANALYSIS OF VARIANCE OF ERRORS MADE BEFORE REACHING CRITERION

Source of Variation	df	MS	*F*	*P*<
A (Lists)	2	33923.22	27.21	.001
B (Groups)	2	23731.20	19.03	.001
C (Sex)	1	18.96	.01	*
D (Experimenters)	3	1772.37	1.42	*
AB	4	5530.33	4.43	.01
AC	2	3601.70	2.88	*
AD	6	1712.62	1.37	*
BC	2	1175.22	.94	*
BD	6	599.94	.48	*
CD	3	1850.42	1.58	*
ABC	4	3265.34	2.61	.05
ABD	12	917.97	.73	*
ACD	6	1563.98	1.25	*
BCD	6	2388.25	1.91	*
ABCD	12	540.32	.43	*
ABCD (R)	144	1246.73	--	--

*Not Significant

that the differences are in the direction of increasing difficulty with increased list length and of increasing performance superiority as intelligence increases. Since there is a greater opportunity for increased errors as the lists lengthen, the significant difference among lists ($p < .001$) cannot be meaningfully interpreted.

TABLE 7

TOTAL NUMBER OF ERRORS BEFORE REACHING CRITERION (N-24)

Group	12-Pair List	16-Pair List	20-Pair List	Total
Bright	597	946	1316	2859
Normal	767	1428	1386	3581
Retarded	941	1740	2715	5396
Total	2305	4114	5417	11836

It should also be noted from Table 6 that first order interaction effects between lists and intelligence groups ($p < .01$) and second order interaction effects among lists, intelligence groups, and sex ($p < .05$) are significant. In view of the highly significant main effects for lists and intelligence groups, this result is not surprising. Since the interaction of lists and intelligence groups is common to both these significant higher-order interactions, it is necessary to examine the simple main effects of the groups within each list. This was completed through the statistical testing of the experimental hypotheses (see Table 8 for summary).

Hypothesis 4, stating that no significant differences in total errors exist among Bright, Normal, and Retarded Groups on the 12-pair list, was supported by the data. Therefore, the present study successfully replicated Hiner's study on both the trial and error measures.

Hypothesis 5 predicts that significant differences will obtain among Bright, Normal, and Retarded Groups on the 16-pair list. As reported in Table 8, the data support this hypothesis ($\underline{p} < .01$). Inter-group comparisons showed that Brights were significantly superior to both Normals ($\underline{p} < .05$) and Retardeds ($\underline{p} < .01$). However, no significant differences were found between the Normal and Retarded Groups. These results concur with those on the trial measure.

Hypothesis 6 postulates that significant differences exist among Brights, Normals, and Retardeds on the 20-pair list. The results confirm this hypothesis ($\underline{p} < .001$). Inter-group comparisons revealed that the Brights ($\underline{p} < .001$) and the Normals ($\underline{p} < .001$) performed significantly better than the Retardeds. No significant difference exists between the Bright and Normal Groups.

As was the case for the trial measure, the performance differences among the groups increase as the lists

TABLE 8

COMPARISONS OF INTELLIGENCE GROUPS WITHIN EACH LIST CONDITION ON THE ERROR MEASURE

	df	MS	F	P<
12-Pair List				
Brights vs. Normals vs. Retardeds	2	1232.72	1.01	*
Brights vs. Normals	1	602.08	.49	*
Brights vs. Retardeds	1	2465.33	2.01	*
Normals vs. Retardeds	1	630.75	.52	*
16-Pair List				
Brights vs. Normals vs. Retardeds	2	6667.39	5.44	.01
Brights vs. Normals	1	4840.88	3.95	.05
Brights vs. Retardeds	1	13134.18	10.73	.01
Normals vs. Retardeds	1	2028.00	1.65	*
20-Pair List				
Brights vs. Normals vs. Retardeds	2	25891.27	21.16	.001
Brights vs. Normals	1	102.08	.08	*
Brights vs. Retardeds	1	40775.02	33.32	.001
Normals vs. Retardeds	1	36796.69	30.07	.001

*Not Significant

lengthen. This finding gives added support to the theoretical basis for the present research.

Sex and Experimenter Factors

The design of the experiment provided the opportunity for an independent analysis of possible sex and experimenter effects. Tables 2 and 6 reveal that no significant differences can be attributed to these factors on either dependent measure. The only variance sources found to be significant are those resulting from the list length and/or intelligence factors.

Learning Characteristics of Brights, Normals, and Retardeds

It appeared desirable to examine certain learning characteristics of each of the intelligence groups in order to contribute more explicit information concerning the experimental results. The trial measure was used to illustrate these characteristics because it afforded greater ease in statistical computation. Table 9 shows the point on the learning continuum in which the completion of the learning task occurred in each group. As mentioned previously, seven subjects failed to learn before reaching the trial ceiling: three Retarded subjects on the 12-pair list; two Retarded subjects and one Normal subject on the 16-pair list; and one Retarded subject on the 20-pair list. With the exception of the 16-pair list where both the Normals and Retardeds ranged from 4 to 24 trials, the Retarded

TABLE 9

NUMBER OF TRIALS TO COMPLETION OF THE LEARNING TASK

Trial Number	12-Pair List			16-Pair List			20-Pair List		
	B*	N*	R*	B*	N*	R*	B*	N*	R*
1			1						
2	2								
3							2		
4	5	2	3	2	3	1	4	3	
5	5	6	2	5	4		4	2	
6	6	2	5	8	3	3	1	4	1
7	3	3	4	4		4	3	3	3
8		1	2	1	1	3	1	3	1
9	1	5	2	2	3	2	4	4	
10		3		1	2	2	1		3
11	1	1			2	1	2	3	2
12			1	1	3	1	1	1	1
13							2	1	
14		1				1			1
15	1		1		1	1			1
16			3			1			6
17									
18									
19									1
20						1			
21					1	1			
22									1
23									
24					1	2			1
25									
26									
27									1
28									
29									
30									
31									1
Mean	5.9	7.5	7.9	6.5	9.7	11.2	7.5	7.7	14.5
Standard Deviation	2.8	2.4	3.9	1.9	5.1	5.9	3.1	2.6	6.5

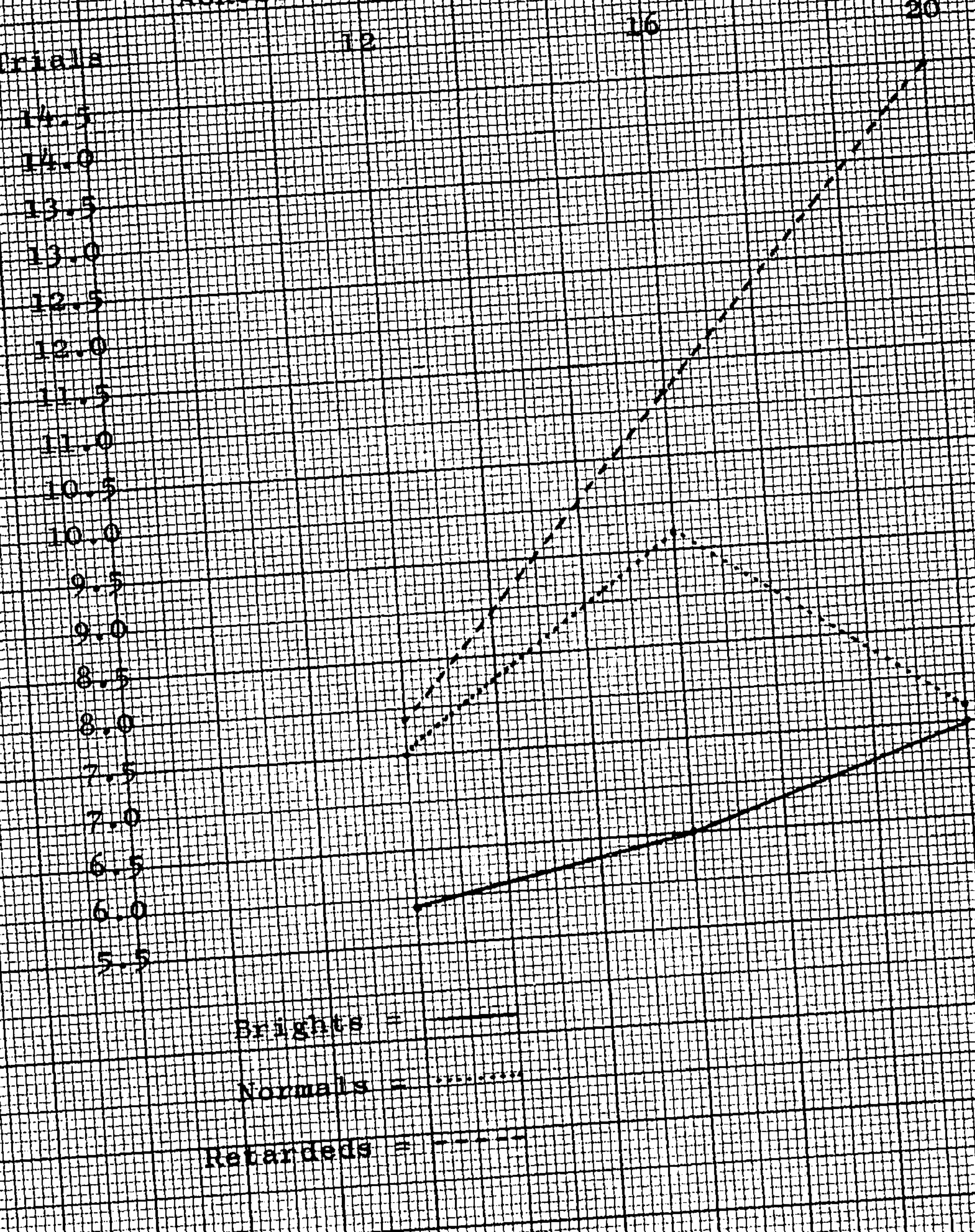
* B = Brights; N = Normals; R = Retardeds

Group demonstrated a wider range than the other groups in each of the list conditions. The considerable variability of the Retarded Group is borne out by the standard deviations shown on Table 9. Within each list the measure of variability for the Retardeds is greater than for the Normals and Brights. The Normals and Brights demonstrated similar variability on the 12- and 20-pair lists but, on the 16-pair list, the Normals displayed considerably greater variability than the Brights. It is interesting to note that the only person to reach the learning criterion on the first trial was a Retarded subject in the 12-pair list condition.

By computing the means for each experimental cell, it is possible to examine the learning trends of the three intelligence groups as they are related to list length. These trends are represented graphically in Table 10. It can be seen that the Brights showed a slight increase in trials required as the lists were lengthened. The Retarded subjects also exhibited a linear trend toward greater trials as the list length was increased, but the slope of their curve is considerably steeper than that of the Brights. The Normals displayed the most inconsistent performance over the three list length conditions. Their performance on the 16-pair list was somewhat inferior to that on the 12-pair list; but they achieved a lower mean on the 20-pair list than on the 16-pair list, suggesting a

TABLE 10

LEARNING TRENDS OF BRIGHTS, NORMALS, AND RETARDEDS ACROSS THE THREE LIST LENGTH CONDITIONS



curvilinear relationship between list length and performance for the Normal Group. However, as pointed out earlier, the between list differences for both the Normal and Bright Groups are not significant ones. Therefore any discrepant linear trend probably can be attributed to chance variation.

CHAPTER IV

DISCUSSION

Pedagogical practice with regard to educable retardates has been based upon assumptions concerning the learning process that have received little or no conclusive experimental substantiation. In the past, the acquisition of a low IQ has been enough to warrant broad generalizations concerning the supposed learning deficiencies of its possessor. Recently, however, the assumed direct relationship between learning skill and intelligence has been brought into question by experimental studies contradicting this long-standing postulate. Jensen's (1963) criticism of using IQ as an undeviating indicator of learning ability is a characteristic one: "Standard IQ tests are, fundamentally, achievement tests, and tell us more about what the child has learned outside the test situation than about his learning ability, *per se*" (Jensen, 1963, p. 124). Unlike IQ and achievement tests, a well-controlled learning test can measure fairly directly the person's ability to learn in the test situation without having to presume equal opportunity outside the learning situation.

Unfortunately, previous learning experiments have failed to uncover any consistent information concerning the relationship of IQ and learning ability. This writer has proposed that much of the inconsistency of past experimentation stems from the diverse methodology used and the failure to recognize uncontrolled confounding variables. The present investigation was an attempt to duplicate certain previous methodology while, at the same time, introducing and isolating list length, a possible confounding variable in previous experiments.

The theoretical framework for the present study requires the empirical demonstration that list length increases the difficulty of the paired-associate task. A test for list main effects using trials as the dependent measure in an analysis of variance demonstrated that this prerequisite was met. Since this assumption was verified, it was legitimate to determine whether there was a significant interaction of intelligence with list length as the experimental hypotheses predicted.

An analysis of the simple main effects of intelligence within each list length supported all six experimental hypotheses. Using trials and errors as dependent measures, significant differences among the three intelligence groups were found in both the 16- and 20-pair lists but none were discovered for the 12-pair list condition. When individual comparisons were made between intelligence groups the Brights were shown to be significantly superior to the Normals and Retardeds on the 16-pair list while, on the 20-pair list, both the Normals and Brights performed significantly better than the Retardeds. Therefore the longest and most difficult list occasioned a significant learning rate dichotomy between the Retardeds and the higher intelligence groups when the shortest and easiest list failed to produce a discrepancy. More evidence of the interaction between list length and intelligence was displayed by the progressively greater performance differences among the groups as the list length was increased.

The learning trends of the three intelligence groups across the three list conditions were examined to uncover the learning tendencies of the three groups which led to the significant findings. The subsequent statistical analysis of the learning curves established that the Normals and Brights did not perform significantly different across the three lists while the Retardeds performed significantly poorer as the list lengthened. Thus, the large differences found between the Retardeds and the other groups were a result of the increasingly inferior performance of the Retardeds rather than any improvement in the performance of the Brights and Normals. Apparently, the optimum Retarded performance was reached somewhere around the 12-pair level of list length while neither the Brights nor the Normals had reached their performance ceiling through the 20-pair level.

The curvilinear shape of the Normal Group's learning curve was noted. Since the between list differences were not significant, this finding was considered to be the result of chance variation.

The results of this study specifically challenge the conclusions of Hiner (1962) with respect to the learning rates of bright, normal, and retarded children. The findings also suggest limitations upon the interpretation of all the paired-associate learning studies reporting no differences between retardeds and higher intelligence groups since none of these investigations controlled for the possible confounding effect of task difficulty. Future work in this area must ensure that the task is of sufficient difficulty to reflect any latent performance differences.

Task difficulty as manipulated by list length is only one of the many possible confounding variables that need to be recognized and controlled in associative learning experiments. Other elements such as meaningfulness of material, imposed trial ceilings, and criterion of learning have been largely ignored as salient features of the experimental design. These and other factors must be recognized and controlled before knowledge of the learning characteristics of educable retardeds can be truly enhanced.

The wide variability of performance within the

Retarded Group, the achievement overlap of individuals in the three groups, and the somewhat inconsistent performance of the Normals on the 16-pair list all serve to demonstrate the need for research into factors other than intelligence that contribute to learning performance. An example of this kind of experimentation is the recent "pilot study" of Brengelmann and Hillman (1965) which investigates some of the determinants of learning in the retardate. The authors discovered a significant positive relationship between verbal ability and performance, and a significant negative relationship between performance and IQ variability on five intelligence tests. In the crucial but relatively uncharted area of motivation, they found performance and the discrepancy between the subject's self-expressed achievement concern and his actual achievement to be negatively related. Clearly, the surface is only just being scratched in the area of retardate learning. In his review of previous verbal learning research in mental retardation, Prehm (1966b) sums up the current situation with candid accuracy:

> ...With respect to our knowledge of the verbal learning abilities of retardates, we are in a woeful state of ignorance. A meaningful 'pool' of data relating to the verbal learning performance of retardates cannot be obtained unless research in this area is more programmatic than it has been. Such a pool of data becomes important if our treatment of the retarded is to become more of a science and less of an art (Prehm, 1966, p. 46).

In view of the preceding discussion, it is important for teachers to recognize that learning performance is not based solely upon the student's inherent learning skill, but upon the combination of a wide variety of factors still largely unspecified by learning research.

CHAPTER V

SUMMARY

The purpose of this investigation was to determine the effect of list length upon the associative learning rate of bright, normal, and retarded children. Two hundred and sixteen children within the age range of 108 to 131 months were administered a paired-associate test (Hiner, 1962) consisting of outline pictures of common objects. Subjects in the Bright, Normal, and Retarded Groups of intelligence were shown lists of 12, 16, and 20 pairs of pictures. There were 24 subjects in each of the nine experimental conditions with no subjects being used in more than one cell. Rate of learning was determined operationally in two ways: (a) trials to criterion of learning; (b) total errors to criterion of learning. In addition to manipulating list length and intelligence, the experimental design afforded an analysis of experimenter and sex variables.

It was hypothesized that an increase in list length would result in significant learning rate differences among the three intelligence groups. Specifically, it was proposed that significant trial and error differences would exist in the 16- and 20-pair list conditions but not in the 12-pair list condition. All of the experimental hypotheses were supported. On the 16-pair list, the Brights performed significantly superior to both Normals and Retardeds while, on the 20-pair list, the two higher intelligence groups performed significantly better than the Retarded Group. Furthermore, the performance differences among the groups increased from the 16-pair to the 20-pair list. As was hypothesized, no significant difference was found among the groups in the 12-pair list condition. An examination of the learning trends revealed that, while the Brights and Normals did not perform significantly different across the three list lengths, the Retardeds learned at a significantly slower pace in each of the two longer list length conditions. Since previous associative learning experiments had failed to recognize list length as a relevant variable, this finding places considerable doubt upon many of the conclusions resulting from the research done in this area.

An analysis of experimenter and sex effects revealed that, in this particular study, these two factors did not produce significant subject differences.

Although the mass data demonstrated highly significant differences in the direction of the experimental hypotheses, an achievement overlap among the three groups and the consistent wide variability of the Retardeds suggest the presence of unspecified factors influencing learning performance. It was proposed that teachers recognize that many variables other than inherent learning potential contribute to the retarded student's performance in any particular learning situation.

It was also recommended that researchers in the field of verbal learning employ a more systematic and inclusive approach to the heretofore uncontrolled contingencies of the verbal learning process. In this way teachers might acquire more adequate theoretical foundations for the effective implementation of the learning process in mentally retarded children.

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APPENDIX

RAW SCORES

BRIGHT GROUP--12 Pairs

Subject	CA	IQ	Trials	Errors
1	123	125	11	40
2	114	138	2	3
3	116	134	6	23
4	126	124	5	18
5	126	122	7	33
6	120	122	2	5
7	118	126	15	95
8	110	121	4	15
9	109	129	4	12
10	108	134	6	23
11	117	125	4	15
12	126	128	6	24
13	128	120	6	33
14	116	124	4	21
15	125	125	5	24
16	125	123	5	24
17	119	126	4	11
18	115	129	5	19
19	122	122	5	22
20	122	129	6	24
21	110	122	9	29
22	124	120	7	30
23	114	134	7	31
24	112	133	6	23
Mean	118.5	126.5	5.9	24.9

RAW SCORES

BRIGHT GROUP--16 Pairs

Subject	CA	IQ	Trials	Errors
1	120	122	5	28
2	116	121	5	31
3	121	139	5	22
4	124	130	6	40
5	122	121	7	55
6	117	124	4	21
7	116	131	5	29
8	118	126	6	48
9	118	125	8	41
10	117	122	4	24
11	112	125	7	38
12	130	122	9	58
13	118	131	9	65
14	126	122	12	69
15	113	125	6	37
16	116	130	7	35
17	119	130	6	33
18	113	127	5	28
19	109	131	6	39
20	125	124	6	36
21	121	129	7	40
22	125	123	6	23
23	117	121	10	78
24	115	125	6	28
Mean	118.7	126.1	6.5	39.4

RAW SCORES

BRIGHT GROUP--20 Pairs

Subject	CA	IQ	Trials	Errors
1	109	121	7	51
2	109	121	11	65
3	125	125	3	20
4	120	122	11	100
5	117	122	10	74
6	116	122	6	24
7	116	122	4	22
8	119	122	9	74
9	119	121	9	64
10	124	130	7	65
11	110	126	3	15
12	130	129	5	53
13	129	121	13	97
14	130	128	9	75
15	116	129	4	23
16	118	129	9	42
17	116	124	12	76
18	113	135	8	56
19	109	123	7	61
20	122	123	13	120
21	128	122	5	33
22	128	126	5	40
23	112	121	4	28
24	123	122	5	38
Mean	119.1	124.4	7.5	54.8

RAW SCORES

NORMAL GROUP--12 Pairs

Subject	CA	IQ	Trials	Errors
1	113	105	6	29
2	112	90	10	53
3	112	101	5	26
4	118	95	9	39
5	124	110	4	16
6	112	102	5	30
7	122	95	11	50
8	119	109	7	19
9	116	100	7	20
10	114	92	10	55
11	116	103	7	39
12	113	102	8	38
13	125	91	5	12
14	124	94	9	43
15	115	93	6	20
16	120	106	9	35
17	114	102	10	38
18	117	95	14	51
19	119	103	5	19
20	117	99	4	16
21	119	108	5	27
22	125	98	9	29
23	110	92	5	26
24	120	103	9	37
Mean	117.3	99.5	7.5	32.0

RAW SCORES

NORMAL GROUP--16 Pairs

Subject	CA	IQ	Trials	Errors
1	129	101	6	35
2	116	93	4	19
3	117	98	6	39
4	118	91	12	65
5	122	96	5	25
6	125	101	5	32
7	127	110	5	34
8	113	98	9	46
9	117	104	10	81
10	130	99	9	65
11	125	98	11	65
12	127	92	5	23
13	120	102	24	188
14	121	106	4	19
15	118	91	15	122
16	124	94	12	90
17	119	93	12	91
18	117	110	8	52
19	118	100	9	27
20	118	90	21	163
21	124	100	6	21
22	119	98	11	51
23	127	93	4	16
24	112	90	10	59
Mean	121.0	97.8	9.7	59.5

RAW SCORES

NORMAL GROUP--20 Pairs

Subject	CA	IQ	Trials	Errors
1	121	100	6	34
2	113	95	11	109
3	110	110	13	107
4	113	99	7	45
5	117	108	9	81
6	129	94	8	60
7	110	96	9	64
8	111	92	6	41
9	116	91	5	29
10	123	110	9	64
11	125	101	6	41
12	121	90	5	29
13	127	92	11	61
14	121	104	6	42
15	113	99	4	29
16	113	94	11	90
17	128	98	5	24
18	120	98	9	73
19	111	94	12	101
20	118	96	7	48
21	128	97	7	39
22	111	108	4	37
23	122	94	8	60
24	130	98	8	58
Mean	118.8	98.3	7.7	57.8

RAW SCORES

RETARDED GROUP--12 Pairs

Subject	CA	IQ	Trials	Errors
1	124	67	9	40
2	126	76	4	22
3	131	67	6	33
4	127	66	16	89
5	129	78	6	31
6	129	75	6	31
7	131	71	8	24
8	121	75	15	56
9	131	68	5	17
10	128	62	7	25
11	110	69	7	45
12	121	77	16	80
13	128	75	5	21
14	118	71	1	0
15	115	69	4	14
16	127	68	7	23
17	116	51	12	58
18	127	62	6	33
19	118	72	16	119
20	127	65	8	48
21	112	64	8	42
22	119	75	7	39
23	124	58	4	18
24	110	70	6	33
Mean	122.9	68.8	7.9	39.2

RAW SCORES

RETARDED GROUP--16 Pairs

Subject	CA	IQ	Trials	Errors
1	128	64	8	44
2	118	58	8	56
3	121	78	7	23
4	119	74	7	47
5	122	55	9	61
6	110	74	10	82
7	119	69	20	132
8	114	78	4	20
9	111	78	8	49
10	123	74	7	38
11	121	78	11	99
12	124	71	16	101
13	118	77	6	34
14	129	62	24	208
15	116	73	24	201
16	116	70	14	80
17	111	73	9	42
18	115	61	6	31
19	126	76	10	47
20	117	74	15	91
21	119	68	21	13
22	113	55	12	50
23	114	77	7	38
24	116	73	6	35
Mean	118.3	70.4	11.2	72.5

RAW SCORES

RETARDED GROUP--20 Pairs

Subject	CA	IQ	Trials	Errors
1	126	75	16	91
2	127	78	10	62
3	130	62	6	24
4	115	46	11	94
5	127	67	27	170
6	119	75	8	67
7	126	68	16	182
8	125	73	7	31
9	124	75	10	70
10	124	63	10	75
11	122	71	15	140
12	115	68	24	264
13	121	75	7	40
14	125	65	16	144
15	117	68	14	95
16	119	65	31	241
17	130	51	16	135
18	109	72	7	72
19	127	62	12	88
20	109	73	16	88
21	123	60	19	136
22	130	65	16	136
23	110	69	11	89
24	122	61	22	181
Mean	121.8	67.8	14.5	113.1