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Rote learning and retention performance was studied as a function of method used in original learning and as a function of intellectual level. Sixty educable mentally retarded and 60 mentally normal junior high school students were randomly selected and assigned to one of three treatment groups, each learning to a different criterion, for each intellectual category in order to learn a paired associate task. Retention was assessed by immediate recall scores, 24 hour recall scores, and relearning scores following the 24 hour interval. A 2x3 complete factorial analysis of covariance was performed for the following dependent variables: original learning; relearning; and 24 hour recall. Immediate recall was assessed utilizing a 2x3 complete analysis of the variance procedure. The results of the investigation indicated inferior learning performance and a 24 hour retention deficit for retarded subjects; and amelioration by overlearning of retention deficits in the retarded subjects. In addition, the results in the area of rote learning and retention comparing mentally retarded and normal subjects were found to be method dependent. (Author/JD)

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Ray D. Stinnett
Herbert J. Prehm

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BACKGROUND OF THE PROBLEM AND STATEMENT OF PURPOSE

Introduction

The relationship between learning and retention has been the object of interest and investigation since the time of Ebbinghaus. Experimental efforts in this area have attempted to discover generalizations that describe this relationship under varying sets of conditions and to identify the parameters that are relevant to this process. Experimental methodology has evolved from Ebbinghaus's use of a single S without control Ss to more elaborate and complex experimental designs employing larger samples and more effective controls.

Despite increased sophistication in methodology, basic questions remain in doubt. Experimental studies to date have, however, succeeded in the isolation of at least four procedural variables that may influence the results of studies in the area of verbal learning and retention with intellectually normal Ss (Belmont, 1966). These variables involve (1) the nature of the materials learned, (2) the method of original learning, (3) the length of the retention interval, and (4) the method of measuring retention.

In spite of conflicting evidence derived from various experimental procedures (sometimes investigating different aspects of the same problem) researchers have generally reached agreement on one generalization suggesting that fast learners retain more than slow learners on the basis of high positive correlations between speed of learning and amount retained (Gillette, 1936; Munn, 1951; Hilgard, 1967; Underwood, 1954.) With few exceptions (Underwood, 1954, 1964) research reports have continued to find support for this position when dealing with a population of intellectually normal children and adults.

Underwood, (1954, 1964) suggests that these findings obtain because the levels of learning reached by comparison groups at the conclusion of original learning differ. Underwood contends that association strength in paired-associate tasks varies with learning rate in such a way that fast learners have developed a higher degree of associative strength between stimulus and response items at the end of the training period than have slow learners. Hence, Underwood maintains, obtained retention differences can be attributed to different degrees of original learning and not to a theoretical retention deficit in the slow learning group. Underwood supported this position (1954) by showing that when the original learning performance of fast and slow learning groups is equated (using a probability analysis model) no difference in rate of forgetting occurs.

Contemporary researchers interested in investigating the retention performance of intellectually subnormal Ss have generally

followed experimental procedures established earlier with normal subjects. The limitations of experimental method suggested by Belmont (1966) and Underwood (1954) resulting from research with intellectually normal subjects have been noted by investigators concerned with retardate populations. Prehm (1966b) has also pointed out that matching procedures employed when comparing differential ability levels in normals and retardates are sometimes inconsistent across studies.

The variation in experimental procedures has produced data that seemingly confound the consistency the experimenter hopes to achieve with repeated experimental observations in either normal or retardate subject populations. As a result, some writers have taken the position that separate parameters are required to describe the retention performance of retardates while others suggest that retention performance is equivalent when comparing normals and retardates (Denny, 1964; Lipman, 1963; Prehm, 1966b).

While all of the procedural variables are important in gaining an understanding of retention under varying conditions, the problem of strength of original learning (which is hypothesized to be a function of method used in original learning) is selected here as the primary experimental variable for investigation. As Underwood points out, comparison groups must be equated on strength of original learning if proper inferences are to be made regarding obtained retention differences whether these differences are measured by recall or relearning methods and regardless of the materials used or the length

of the retention interval.

The purpose of this study was to make a direct comparison of three methods of stimulus presentation as they interact with defined ability levels by measuring the effect of these procedures on learning and retention. The results of this study should provide evidence bearing on the problem of basic experimental procedure in retention studies and the question of a retention deficit in mentally retarded Ss. Its more practical significance is related to the development of sound empirical instructional procedures for use with intellectually handicapped and slow learning students in public school programs. For example, if alleged retention deficits in retardates can be alleviated by overlearning or increased practice, that procedure should be followed in the instructional program.

Background

The problem of equating groups on original learning has been a persistent one in rote learning studies and probably represents the most critical variable in verbal learning investigations which use contrast groups (Runquist, in Sidowski, 1966). The development of suitable methodology for equating groups was reviewed and summarized by Gillette (1936). The first method, Equal Amount Learned, allows all Ss to learn a task to a specified criterion regardless of time or trials to completion. Gillette suggests this method favors the slow learner because of overlearning which facilitates retention (Kreuger, 1929) and consequently mitigates

possible differences in fast and slow learners. The second method, Equal Opportunity to Learn, allows all Ss an equal amount of time or trials to completion. It is hypothesized this is beneficial to fast learners because, having learned more, they retain more.

Gillette's solution to this methodological problem involves the Method of Adjusted Learning where an item is eliminated once the S has made one correct response to the stimulus. In this procedure, each S receives the same number of correct responses to each stimulus-response pair. Gillette contends that with Adjusted Learning, both the fast and slow learner are given an equal opportunity to learn without the contaminating influence of overlearning. Therefore, any difference in retention measures can be attributed to differential rates of forgetting.

This view rests on the assumption that fast and slow learners have developed an equal amount of associative strength due to having received the same number of reinforcements, i.e., correct responses. As Underwood points out (1954) the resultant generalization that fast learners retain more than slow learners becomes suspect if this vital assumption proves to be in error. Any similar generalization concerning retarded Ss would also be in error if the comparison groups are unequal in original learning.

Underwood's analysis of the variable effects of these methods is based on incremental learning theory. Incremental learning theory (Underwood, 1954; Runquist, 1957) suggests that association strength between a stimulus item and a response item in a paired-associate

list develops gradually over repeated exposures and correct anticipations of the paired items in the list. Additionally, a correct anticipation has differential strengthening effects related to speed of acquisition which favors the faster learner.

Underwood states that earlier results consistently showing the superiority of fast learners with respect to retention measures, can be attributed to the larger number of reinforcements during original learning or the differential effects of reinforcement in the studies utilizing Equal Opportunity or Equal Amount Learned methods. Under Gillette's Method of Adjusted Learning, this contention would also hold if it could be shown that a specific reinforcement has differential effects for individual Ss which leads to unequal associative strength prior to the retention interval.

Underwood does contend that with the Adjusted Learning Method, the associative strength between a stimulus and a response is greater for fast learners than for slow learners. To illustrate this difference and to control for it, Underwood developed a technique termed "Successive Probability Analysis of Learning" (1954). This procedure involves the determination of separate probabilities for fast and slow learners which are based on empirical response rates of these separate groups. It was found that fast learners have a significantly higher probability for responding correctly to a stimulus item than do slow learners with equal trials or reinforcements. By utilizing these probabilities in a post hoc analysis of data, Underwood found no difference in retention comparing fast and slow learners after a 24 hour period.

Underwood's analysis and subsequent empirical results receive considerable theoretical support from Skinner's interpretation of reinforcement (in Hill, 1963). Skinner has defined a reinforcer as anything that maintains or increases the probability of a response above operant level. When reinforcement is viewed in this manner, impressive evidence derived from a wide variety of experimental designs and subject populations lends credence to the differential effects of reinforcing events for individual subjects. Thus, the empirical definition of reinforcement favored by Underwood and Skinner results in a view that is inconsistent with that required by Gillette's Adjusted Learning rationale.

Retardate Research in Learning and Retention

Early investigators concerned with the rote learning and retention performance of the mentally retarded utilized either a specified number of trials for learning or a specified criterion for original learning as a prelude to the retention interval. These procedures have been referred to previously as Equal Opportunity to Learn and Equal Amount Learned. In addition, some researchers have used either relearning or savings scores as indicators of retention while others have used recall scores. Finally, different levels of meaningfulness or difficulty have been combined with varying levels of overlearning and the results measured over variable retention intervals. The permutations available by combining these variables make comparative analysis difficult for reviewers. It is hardly surprising, therefore, that the review articles of Denny (1964),

Goulet (1968), Lipman (1963), and Prehm (1966b, 1968) have identified a plethora of conflicting studies that both refute and support the hypothesis that the retarded exhibit deficient retention performance.

More recent investigations in rote learning concerned with comparative studies of normal and retarded Ss are increasingly yielding data suggestive of both a learning and a retention deficit for the retarded. Vergason (1964), utilizing the Method of Adjusted Learning, reports a comparison study of 64 retarded and 64 normal Ss who received both extended and minimal learning on a paired-associate task. The results of this study indicated normals retained significantly more under minimal learning conditions for both 24 hour and 30 day intervals. No difference in retention was reported under extended learning for the 30 day interval as measured by relearning scores. In a re-examination of the data, Vergason (1966), found significant differences in retention favoring the normal Ss under both conditions of learning when recall scores were utilized as the measure of retention. Both studies were based on 24 hour and 30 day retention intervals.

Heber, Prehm, Nardi, and Simpson (1962) compared 72 normal and 72 retarded Ss on rate of learning, 24 hour retention, and 6 month retention using three levels of difficulty and two conditions of learning: 3 correct responses for minimal learning and 9 correct responses for extended learning using the Method of Adjusted Learning. In general, their findings indicate differences in rate of learning and 24 hour retention under both minimal and extended learning favoring normal Ss. However, the effects of overlearning under the extended

learning conditions were significantly beneficial to retarded Ss under both 24 hour and 6 month retention. Extended learning also facilitated 24 hour retention for all Ss on the most difficult task.

Lance (1965) employed a 2 x 2 x 2 factorial design including two levels of meaningfulness and two levels of learning with 64 retarded and 64 normal Ss in order to test for differences in learning and retention as measured by trials to criterion and the savings score method. Retarded Ss required significantly more trials than non-retarded Ss to reach criterion under both levels of meaningfulness and for both learning conditions. He observed no difference in retention following a 30 day retention interval. A ceiling effect was postulated in order to explain the lack of a retention deficit in the retarded Ss.

Madsen (1963) investigated the effects of massed versus distributed practice on the learning and retention performance of retarded and two groups of normal Ss using a list of 10 paired associates. He found that the original learning and retention performance of the retarded Ss was inferior to that of the non-retarded Ss.

Prehm (1966a,c) compared the learning and retention performance of 96 retarded and 96 normal Ss as a function of meaningfulness, task difficulty, and degree of learning. Retention was assessed at 24 hour and three month intervals by relearning scores utilizing covariance procedures. The results of this study indicated superior retention at both 24 hour and three month intervals for normal Ss. Overlearning was found to facilitate 24 hour relearning for both normal and retarded Ss.

Logan, Prehm, and Drew (1968) found that the immediate recall performance of 48 retarded Ss who learned a list of 14 meaningful paired associates was not significantly different from the recall performance of non-retarded Ss. The 24 hour recall performance of the retarded Ss was significantly inferior to that of the non-retarded Ss. More recently Prehm and Mayfield (1969) found that the learning, immediate recall, 24 hour relearning, and 24 hour recall performance of retarded Ss was inferior to that of non-retarded Ss. This was true for long term (24 hour) retention data even when rate of original learning and immediate recall performance were taken into account through the analysis of covariance. This study differed, however, from previous studies conducted by Prehm and associates in that it used a Modified Method of Adjusted Learning.

These findings are inconsistent with those reported earlier by Eisman (1958), Johnson and Blake (1960), and Cantor and Ryan (1962) who found no differences when comparing the retention performance of normal and retarded Ss following retention intervals of one week and one month. These studies differed in at least one way from the studies of Heber et al., Lance, Prehm, and Vergason. In the latter studies both the extended and minimal learning lists were learned by the Adjusted Learning Method wherein the items are removed from the list whenever criterion is reached. This procedure insures that intra list overlearning does not occur beyond the specified criterion (Stroud and Schoer, 1959) and alleges that all items are learned to the same associative strength. Since the earlier studies utilized methods that would allow intra list overlearning this factor could account for

failure to obtain retention differences in comparison groups.

Statement of the Problem

Some attempt must be made to conduct basic procedural research if we are to arrive at definitive answers to questions consistently arising in verbal learning research. As Belmont (1966, p. 252-253) points out:

> There is almost no solid evidence either to support or contradict the classic hypothesis of a retardate memory loss . . . . Two steps are here proposed to alleviate this unsatisfactory status of current knowledge. The first would be a proper and concerted effort to compare retardates and normals with simple experimental designs.

Previous researchers, beginning with Gillette and continuing through Underwood, have theorized about methods appropriate for equating original learning. The inconsistency found in the literature has been attributed to variable methodology in terms of the populations studied, matching procedures employed, and method used for original learning. To date, no study using Ss from normal and retarded populations, the statistical model available to match treatment groups, and systematic variation in learning procedures has been conducted.

The purpose of this research was therefore to compare two versions of Gillette's Adjusted Learning Method with the Method of Equal Amount Learned. These methods were used to study the rote learning and retention performance of mentally retarded and normal children so that the influence of method of learning on retention might be assessed. The results of this study should provide evidence concerning a possible retardate retention deficit, a possible difference in retention of

normals as a function of original learning method, and a possible difference in retention of retardates as a function of the method of original learning.

The independent variables in this study were method of learning (Equal Amount Learned, Modified Method of Adjusted Learning, and Method of Adjusted Learning) and S classification (retarded and non-retarded). The dependent variables were original learning scores, relearning scores, immediate recall scores, and 24 hour recall scores. With respect to the dependent variables the following comparisons were planned:

(1) Test for differences in learning and retention between intellectually normal and intellectually sub-normal populations.

(2) Test for differences in learning and retention between three groups of intellectually normal Ss as a function of experimental procedures.

(3) Test for differences in learning and retention between three groups of intellectually sub-normal Ss as a function of experimental procedures.

CHAPTER II

METHOD

Subjects

Sixty retarded Ss (IQ range 50-83[1] as determined by an individual intelligence test), who were enrolled in existing junior high and high school classes for the educable mentally retarded, and 60 normal Ss (IQ range 90-110 as determined by group intelligence tests), who were enrolled in existing junior high school classes were used as Ss in this investigation. Each sample was randomly selected from within its respective population. All Ss, both normal and retarded, were obtained from classes in the Springfield, Bethel, and Eugene District 4J school districts in Lane County, Oregon.

The classes for the retarded in these districts included students from surrounding school districts where special education facilities were not available. With the exception of the one S, Ss with IQ's which were outside the specified IQ range were excluded. Emotionally disturbed or brain damaged Ss were also excluded from the sample.

Twenty Ss within each diagnostic category were randomly assigned to one of three methods of learning the paired associate list:

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[1]The measured IQ of one S was 86. He was not dropped from the study because his inclusion would not contaminate the results.

(1) the method of Equal Amount Learned (EAL), (2) the Modified Method of Adjusted Learning (MMAL)[2]; and (3) the Method of Adjusted Learning (MAL). EAL and MAL Ss were assigned to one of two (one male, one female) Es by counterbalancing. The MMAL Ss were assigned to a second female E. Data describing the Ss in each treatment group are presented in Table 1.

The original design consisted of eight nonsense stick figure stimuli paired with 2 to 8 per cent CVC trigrams from the Archer list (1960). Of the six retarded Ss who were administered the eight pair list, four failed to reach the criterion of learning. Experimental time for some of these Ss approached two hours or 40 trials and resulted in fatigue and apparent inability to attend. In addition, the time schedules imposed by lunch breaks or bus schedules precluded completion of the task by some Ss.

As a consequence, the difficulty level of the task was adjusted by removing two stimulus/response pairs. The original six Ss were excluded from the final investigation. Following the adjustment for task difficulty, four normal Ss were lost as follows: (1) two Ss

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[2]The data on MMAL Ss were collected as part of another experiment (Prehm and Mayfield, 1969) which was conducted under the auspices of the University of Oregon Rehabilitation Research and Training Center in Mental Retardation. The MMAL experiment was designed so that there would be maximum compatability between it and the EAL-MAL investigation. The data from the two studies (which are described as one for the purposes of this report) were combined so that the effects of three methods of learning on the learning and retention performance of retarded and normal Ss could be assessed.

TABLE 1

SUBJECT CHARACTERISTICS

GROUP	SUBGROUP	N	STATISTIC	CA (IN MONTHS)	MA (IN MONTHS)	IQ*
Retarded	EAL	20	$\bar{x}$	178.65	122.05	68.40
			range	157-202	92-148	54-81
	MMAL	20	$\bar{x}$	170.35	118.45	69.60
			range	150-185	95-142	56-86
	MAL	20	$\bar{x}$	175.65	121.55	69.15
			range	143-203	85-158	50-80
Normal	EAL	20	$\bar{x}$	165.40	169.75	102.80
			range	148-188	154-187	91-110
	MMAL	20	$\bar{x}$	167.95	172.15	102.50
			range	159-180	154-191	91-110
	MAL	20	$\bar{x}$	165.50	168.75	101.90
			range	154-189	148-197	91-110

*Intelligence Test Varies

were absent for 24 hour recall, (2) one subject became involved with juvenile authorities and was excluded, and (3) one subject was lost due to experimenter error. Three retarded subjects were lost: (1) two Ss failed to reach criterion and (2) one subject was absent for 24 hour recall. Replacements were randomly selected from the available pool.

Materials

The learning materials for this experiment consisted of six pictorial stick figure stimuli paired with six nonmeaningful consonant-vowel-consonant (CVC) trigram response items. The stick-figure stimuli consisted of four 2 inch lines in random configuration paired with 2 to 8 per cent association value CVC trigrams from the Archer list (1960). The trigrams were systematically selected to avoid duplication of beginning and ending letters.

The pictures served as the stimulus member and the trigram as the response member of each pair. Stimulus and response items were drawn on 4" x 6" white bond paper and photo plates made by the University of Oregon Press. Thirty complete sets were reproduced from the photographic plates and used for periodic replacement during the experimental procedure. The complete list of paired-associate items is provided in Appendix A.

Procedure

EAL and MAL Ss were tested individually in a 15' mobile laboratory adjacent to the school in which they were enrolled. The laboratory consisted of a small room, table, and two chairs. A one-way glass separated the experimental room from an observation room where experimental procedure could be observed without the S's awareness. MMAL Ss were tested in a distraction-free room in the school in which they were enrolled.

Two Es were utilized for testing EAL and MAL Ss. The Es were students in a beginning class at Lane Community College concerned with the Psychology of Learning. Experimenters were pre-trained by the primary investigator prior to the beginning of this research. The MMAL E was a post-graduate level female research assistant employed by the Rehabilitation Research and Training Center in Mental Retardation. She was also trained by the primary investigator.

E was instructed to engage S in conversation irrelevant to the experimental task. Once inside the experimental room S was seated and asked his name and birth date. Following this, these instructions were given:

> We are going to do something with these cards. I want you to read these letters (Point to the trigram) as I show them to you and look at this design (Point) that goes along with them. Try to remember that these letters go with this design (Point) because later on I am going to show you just the design (Show S back side of the card) and ask you to tell me which letters go with this design.

Each card was manually presented at approximately 5 seconds per card and S was required to spell the trigram. No S failed to pass this pre-test. Following this initial exposure, the following instructions were given:

Now I am going to show you the design without the letter. Would you please tell me which letters go with this design?

The cards were presented with a five second exposure per card and a 30 second intertrial interval. At the end of each trial the cards were reshuffled during the 30 second intertrial interval to effect randomization of the list. When S responded incorrectly E turned the card and S verbally corrected his response. Following a correct response E responded with "good," "that's fine," or other expressions of approval and refrained from turning the card. Each S received original learning, immediate recall, twenty-four hour recall and relearning, in that order.

Definition of Terms

For the purpose of this investigation, the following procedures and measures are defined:

(1) Learning Trial. A trial is defined as one complete presentation of all the paired-associate items remaining in the list.

(2) Equal Amount Learned Method. Each S learned to a criterion of three correct responses on each paired-associate using the anticipation method. The entire list was presented on each trial, after reshuffling, until each S reached the criterion of 18 consecutive correct responses.

(3) Modified Method of Adjusted Learning. Each S learned to a criterion of three consecutively correct responses on each paired-associate using the anticipation method. After S had made three consecutively correct responses to an item it was dropped from the list. The cards remaining in the list were

shuffled at the conclusion of each trial in order to effect randomization of card position within the list.

(4) Method of Adjusted Learning. Each S learned to a criterion of three correct responses on each paired associate using the anticipation method. At the end of each learning trial the items to which S responded correctly were dropped from the list. When the number of items remaining in the list reached zero the list was reassembled. S was then administered the list a second time with items dropped after correct responses. When the number of items in the list again reached zero the list was reassembled a third time and readministered to S. Thus S made three and only three correct responses to each of the stimuli.

(5) Original Learning. The number of trials needed to reach the criterion of learning for each of the three learning methods.

(6) Relearning. The number of trials needed to relearn the list to the original criterion of learning after a period of 24 hours.

(7) Immediate Recall. The number of paired associate items correctly anticipated on a single trial which immediately followed the last trial on original learning.

(8) Twenty-four Hour Recall. The number of paired associate items correctly anticipated on the first relearning trial following the 24 hour retention interval.

CHAPTER III

RESULTS

Original Learning

A 2 x 3 complete factorial analysis of covariance was used to compare original learning scores for retarded and normal subjects. Trials to criterion served as the dependent variate and mental age as the covariate. A summary of this analysis is presented in Table 2. Significant differences were obtained for the main effects of subject classification and method of learning. The interaction effect was non-significant.

The resulting adjusted mean original learning scores for retarded subjects was 25.99 and for normal subjects 17.77. These data indicate that significantly more learning trials were required for retardates to reach criterion. The adjusted mean original learning scores for Equal Amount Learned Method was 25.10, 19.74 for the Modified Method of Adjusted Learning, and 20.82 for the Method of Adjusted Learning. Using the formula suggested by Lindquist (1953, p.327) it was determined that significantly more trials were required to reach the learning criterion under the EAL method than under either the MMAL or the MAL. The EAL-MAL 't' was 2.32 ($p<.05$). Because the EAL-MMAL difference was larger than the EAL-MAL difference, a test of significance was not performed. The MAL-MMAL difference was not statistically significant ('t' = .58, $p>.05$).

TABLE 2

SUMMARY OF ANALYSIS OF COVARIANCE OF TRIALS TO CRITERION ON ORIGINAL LEARNING

SOURCE		SS	df	ms	F	p
MR vs Normal	(A)	486.01	1	486.01	7.21	<.01
Learning Method	(B)	526.27	2	263.14	3.90	<.05
A X B		115.32	2	57.66	<1.00	
Error		7,616.53	113	67.40		
Total			118			

TABLE 3

SUMMARY OF ANALYSIS OF COVARIANCE OF TRIALS TO CRITERION ON RELEARNING

SOURCE		SS	df	ms	F	p
MR vs Normal	(A)	287.22	1	287.22	***	
Learning Method	(B)	336.42	2	168.21	***	
A X B		275.66	2	137.83	13.45	<.01
Error		1,157.83	113	10.25		
Total			118			

***Because of the significant first order interaction, separate analyses were performed for each level of each factor across each level of the remaining factor.

TABLE 4

ADJUSTED MEAN TRIALS TO CRITERION, RELEARNING

GROUP	RETARDED	NORMAL	t	p
EAL	5.92	5.14	1.88	>.05
MMAL	15.01	7.13	3.16	<.001
MAL	11.67	9.27	2.62	<.05

Relearning

The twenty-four hour relearning data were analyzed using a 2 x 3 complete factorial analysis of covariance design. Trials to criterion on original learning served as the covariate and trials to criterion, relearning, served as the dependent variate. The result of this analysis is summarized in Table 3. Inspection of the Table reveals that the interaction effect was statistically significant. The significance of the differences between adjusted cell means was determined using the formula suggested by Lindquist (1953, p.327). Inspection of Table 4 reveals that while the difference between retarded and normal EAL Ss was not significant, the differences between retarded and normal MMAL and MAL Ss were significant. For normal Ss the EAL-MMAL difference was not statistically significant ('t' = 1.93, $p>.05$); the difference between MMAL and MAL was significant ('t' = 2.09, $p<.05$). For the retarded Ss the differences between EAL and MMAL ('t' = 8.91, $p<.001$) and MMAL and MAL ('t' = 3.30, $p<.05$) were statistically significant. These data indicate that EAL groups relearned the task in significantly fewer trials than either MMAL or MAL groups. They also indicate that the retarded MMAL group required significantly more trials to relearn the task than did the retarded MAL group.

Immediate Recall

The immediate recall data were analyzed using a 2 x 3 complete factorial analysis of variance design. The result of this analysis is summarized in Table 5. The interaction effect between S classification and learning method was statistically significant. Therefore,

TABLE 5

SUMMARY OF ANALYSIS OF VARIANCE

OF IMMEDIATE RECALL DATA

SOURCE		SS	df	ms	F	p
MR vs Normal	(A)	19.20	1	19.20	***	
Learning Method	(B)	187.47	2	93.74	***	
A X B		15.20	2	7.60	4.78	<.05
Error		181.60	114	1.59		
Total		403.47	119			

***Because of the significant first order interaction, separate analyses of variance were performed for each level of each factor across each level of the remaining factor.

separate analyses of variance for each level of each factor across each level of the remaining factor were performed. The results of these analyses are summarized in Tables 6 to 10. Mean immediate recall scores are presented in Table 11.

These analyses indicated that while the difference between retarded and normal EAL and MAL groups was not significant, the normal MMAL Ss recalled significantly more pairs than did the retarded MMAL Ss. The data also indicated that the recall performance of the normal EAL group was superior to that of the normal MMAL group ('t' = 3.90, p.<.05) and that the recall performance of the normal MMAL group was superior to that of the normal MAL group ('t' = 3.41, p.<.05). For the retarded Ss, the recall performance of the EAL group was significantly superior to that of the MMAL group ('t' = 7.89, p.<.001); the difference between MMAL and MAL groups was not significant ('t' = .52, p.<.05).

TABLE 6

SUMMARY OF ANALYSIS OF VARIANCE OF IMMEDIATE RECALL FOR EQUAL AMOUNT LEARNED DATA

SOURCE	SS	df	ms	F	p
MR vs Normal	1.60	1	1.60	3.33	>.05
Error	18.40	38	.48		
Total	20.00	39			

TABLE 7

SUMMARY OF ANALYSIS OF VARIANCE OF IMMEDIATE RECALL FOR MODIFIED METHOD OF ADJUSTED LEARNING DATA

SOURCE	SS	df	ms	F	p
MR vs Normal	32.40	1	32.40	8.69	<.01
Error	112.00	38	2.95		
Total	144.40	39			

TABLE 8

SUMMARY OF ANALYSIS OF VARIANCE OF IMMEDIATE RECALL

FOR METHOD OF ADJUSTED LEARNING DATA

SOURCE	SS	df	ms	F
MR vs Normal	.40	1	.40	<1.00
Error	51.20	38	1.34	
Total	51.60	39		

TABLE 9

SUMMARY OF ANALYSIS OF VARIANCE OF IMMEDIATE RECALL DATA FOR NORMAL SUBJECTS

SOURCE	SS	df	ms	F	p
Method of Learning	90.14	2	45.07	26.20	<<.001
Error	98.20	57	1.72		
Total	188.34	59			

TABLE 10

SUMMARY OF ANALYSIS OF VARIANCE OF IMMEDIATE RECALL DATA FOR MENTALLY RETARDED SUBJECTS

SOURCE	SS	df	ms	F	p
Method of Learning	112.54	2	56.27	38.54	<<.001
Error	83.40	57	1.46		
Total	195.94	59			

TABLE 11

MEAN PERFORMANCE ON IMMEDIATE RECALL

GROUP	RETARDED	NORMAL
EAL	5.30	5.70
MMAL	2.30	4.10
MAL	2.50	2.70

24 Hour Recall

A 2 x 3 complete factorial analysis of covariance design was used to analyze the 24 hour retention data utilizing immediate recall scores as the covariate and 24 hour recall scores as the dependent variate. This analysis was an attempt to assess retention independent of original learning differences as measured by immediate recall. Rundquist (in Sidowski, 1962) suggests that immediate recall scores can be used as an indication of original learning for equating comparison groups. The results of this analysis are summarized in Table 12. The main effects of S classification and method of learning were statistically significant. The interaction effect was not significant.

The adjusted mean recall scores under 24 hour retention for retarded subjects was 2.28 and for the normal subjects 3.50. This difference indicates that the retention performance of the normal subjects was significantly superior to that of the retarded even when initial differences in original learning (as measured by immediate recall) were taken into account by covariance procedures. The adjusted mean recall scores for the EAL method was 3.65, for the MMAL method was 2.64, and for the MAL method was 2.40. These data indicate that the retention performance was superior under the EAL method (EAL-MMAL 't' = 2.58, p.<.02). The difference between MAL and MMAL performance was not significant ('t' = .86, p.>.05). Because the difference between EAL and MAL scores was greater than the difference of between EAL and MMAL groups, it was assumed that the retention of EAL Ss was superior to that of MAL Ss.

TABLE 12

SUMMARY OF ANALYSIS OF COVARIANCE OF

24 HOUR RECALL DATA

SOURCE		SS	df	ms	F	p
MR vs Normal	(A)	40.80	1	40.80	27.02	<<.001
Method of Learning	(B)	17.33	2	8.67	5.74	<.01
A X B		3.22	2	1.61	1.07	>.05
Error		170.34	113	1.51		
Total			118			

CHAPTER IV

DISCUSSION

The discussion of the results and implications of this study is approached in terms of the basic design. This design included a comparison of three methods of presenting learning materials to two levels of Ss: normal and retarded. Experimental effects were assessed through original learning scores, relearning scores after a 24 hour retention interval, immediate recall scores, and recall scores after the 24 hour period.

Original Learning

Initial analysis of the original learning data by analysis of variance procedures indicated significant differences in the learning performance of normal and retarded Ss. The earlier review by Prehm (1966b) suggests experimental precision can be increased by matching through analysis of covariance procedures because of the difficulty of matching on CA or MA when comparing learning abilities of normal and retarded Ss. A Pearson Product Moment correlation of -.49 between mental age and trials to learning criterion indicated that 24 per cent of the variance could be accounted for through utilizing covariance procedures. The results of the covariance analysis, indicated, as did the analysis of variance,

that the main effects of S classification and learning method were significant. This further analysis of the data furnishes further evidence of the superior learning performance of the normal Ss.

The apparent differential learning rate of normal and retarded Ss is consistent with more recent investigations concerned with this problem. Prehm (1966a), Lance (1965), and Heber et al. (1962) reported data suggestive of a retardate learning deficit. Other studies (Vergason, 1964), failing to find learning performance differences, may have used paired-associate items of insufficient difficulty to detect differences in comparison groups.

The results of this investigation indicate significantly more trials were required to reach criterion when the method of Equal Amount Learned was used. The statistical results did not change from the original analysis of variance to the subsequent analysis of covariance. This difference can probably be attributed to the relative complexity of Equal Amount Learned since in this procedure, no cards were dropped out and the subject was, in effect, required to have 18 consecutive correct responses when utilizing six stimulus-response items. It seems likely, therefore, that interference occurs from the competing responses available when following this procedure. In any event, the effects of this operation, when compared to the Method of Adjusted Learning or the Modified Method of Adjusted Learning, furnish evidence that the common criterion of three correct responses is not equivalent. Specifically, the number of trials to reach criterion may be more a function of the experimental operation than of any characteristics inherent in the S. It seems clear, therefore,

that comparisons of studies utilizing different methods for original learning are to be approached with caution.

Relearning

A 2 x 3 complete factorial analysis of covariance was conducted utilizing original learning scores as the covariate and trials to criterion, relearning, as the dependent variate. The results of this analysis revealed a significant interaction between subject classification and method of learning.

The retarded Ss required significantly more trials to reach relearning criterion than did normal subjects under the MMAL and MAL methods. the difference between normal and retarded EAL Ss on relearning scores was not statistically significant. Since the EAL groups (independent of subject classification) required significantly fewer trials to reach the relearning criterion it can be assumed that a higher degree of association strength was developed between stimulus and response items as a function of the EAL method of learning. The method allows intra-list overlearning since the criterion involves 18 consecutive correct responses. It seems likely, therefore, that failure to obtain retention differences between normal and retarded Ss under the EAL method can be attributed to the ceiling effect resulting from overlearning by both retarded and normal Ss. This inference is supported by immediate recall mean scores of 5.7 and 5.3 for normal and retarded EAL Ss respectively.

For normal subjects the difference between EAL and MMAL methods was not statistically significant, however, both EAL and MMAL Ss

performed significantly better than did MAL Ss. These data suggest that for normal subjects (who learn at a faster rate) the MMAL method allows sufficient overlearning so that asymptotic performance is approximated between stimulus and response items even though less overlearning occurs than for the EAL method. With respect to MAL procedures, however, the normal Ss do not approach this learning level because of no overlearning trials. This conceptualization is supported by the immediate recall mean scores of 5.70-EAL, 4.10-MMAL, and 2.70-MAL for normal Ss.

The relearning data for retarded Ss indicated that significantly fewer trials were required for relearning criterion as a function of the EAL method when compared with either the MMAL or MAL groups. Retarded Ss learning by the MMAL method required significantly more trials to relearn than did Ss in the MAL group.

This differential effect of learning method for retarded and non-retarded Ss illustrates the difficulty involved in obtaining equivalent original learning strength in comparative retention studies of these separate populations. There does not seem to be a straight line effect directly associated with the amount of practice for retarded Ss as seemingly obtains with normal Ss. There is the possibility that for slower learning Ss (as in the retardate population) the intermediate stage of MMAL produces intra-list interference that is resolved by overlearning in the EAL method which is not present in the MAL learning procedure. More probably, this relearning discrepancy between retarded and normal Ss is directly associated with the degree of task difficulty that varies

with MMAL and MAL methods of learning.

A further result indicates that when original learning scores and relearning scores are combined for the EAL and MAL methods, they are the same (1245, trials). By computing savings scores from the total OL/RL scores in each cell, the main effect of methods is 50 per cent for both normals and retardates and for the total of the Adjusted Learning procedure. By following this same analysis for Equal Amount Learned, the cells are again identical (76 per cent) with a main effect total of 76 per cent.

Obviously, the main effect of normal versus retardate would not differ and retention differences by the savings score method would be non-significant. This finding is not surprising in view of Lyon's (1916) critique of the savings score method of measuring retention. In this procedure savings scores are computed by the following formula:

$$\frac{OL - RL}{OL}$$

When retention is reflected by the percent saved a strong bias results against fast learners who learn in relatively fewer trials. The fast learner is then forced to relearn with less chance of showing relative improvement when compared with a subject who requires significantly more trials during original learning. In the study by Lance (1965), as in the present study, normals learned significantly faster than retardates; however, no differences were obtained in retention utilizing the savings score method. Lance concluded that a ceiling effect accounted for the lack of a retention deficit in retardates. An alternative explanation could be that the savings score method of

assessing retention failed to reflect retention differences that might become apparent when recall scores function as the dependent variable.

In summary the question of retention deficits (when measured by relearning) following retardate learning performance appears to be confounded by both original learning procedure and method of measuring retention. It seems apparent that some procedure such as Underwood's probability model must be developed in order to equate groups on original learning prior to any specified retention interval.

Immediate Recall

A 2 x 3 complete factorial analysis of variance was conducted to analyze immediate recall scores. The results of this analysis indicate a significant interaction between subject classification and method of learning.

The retarded Ss demonstrated significantly inferior immediate recall performance under the MMAL method of original learning. No statistically significant differences were obtained for S classification under the EAL and MAL learning procedures. Runquist (in Sidowski, 1966) has suggested that immediate recall scores of control groups can be utilized for equating original learning of comparison groups. While this study did not utilize additional control groups, this procedure seemed valid in the present study since immediate recall scores were available. Utilization of this rationale would suggest that strength of original learning for retarded and normal Ss who received MMAL was not equivalent prior to the retention

interval. Any subsequent difference in retention measures for retarded and normal groups receiving the MMAL procedure could not therefore be attributed to differential rates of forgetting.

Significant differences in immediate recall scores were obtained between normal Ss as a function of original learning procedures. Normal Ss receiving EAL original learning procedure obtained significantly higher immediate recall scores than did those normal Ss receiving MMAL. Similarly those normal Ss receiving MMAL original learning procedures performed significantly higher on immediate recall scores than did those normal subjects receiving MAL. These results correlate with the relearning data for normal subjects where amount retained appears to be a function of practice received in original learning and the concomitant effects of overlearning. The three methods do not seem to have the same effect in terms of developing associative strength between stimulus and response items.

For retarded Ss the mean recall score under the EAL method of original learning was significantly superior to the immediate recall performance of those Ss under both MMAL and MAL. No difference was obtained for Ss from the MMAL and MAL retardate comparison groups. The superior performance of those Ss under EAL learning conditions could be attributed to the larger number of correct trials received in this procedure. Incremental learning theory would predict a higher degree of associative strength because of overlearning resulting from additional practice on items already learned. The mean difference between immediate recall scores of MMAL, MAL and EAL supports the over-learning hypothesis. The failure to obtain differences between

retarded Ss in the MMAL and MAL groups is probably a function of a floor effect since the mean immediate recall scores were 2.3 for MMAL and 2.5 for MAL. Apparently Ss in these latter groups failed to learn the task because of insufficient practice.

The immediate recall data for EAL and MAL has further implications for the stimulus-trace theory of Ellis (1963) which is used to explain retention deficits in mentally retarded subjects. This theory involves two major concepts: (1) s_t or the neurological representation expressed as a trace in the neural network and (2) n_i, the central nervous system integrity which is the organismic determinant of s_t. Ellis (1963) and Butterfield (1968) report data supporting one theoretical premise which predicts a relationship between MA/IQ and n_i so that an individual of low MA would be expected to be less capable of necessary stimulus trace in learning and remembering tasks. A subject with low neural integrity could be expected to learn slower and remember less than a corresponding subject with high neural integrity. From the point of view of Ellis's theory, differences in learning and retention scores between retarded and normal subjects result from the lack of neural integrity required to adequately assimilate learned materials into short term memory for later transfer to long term memory and subsequent recall. The lack of initial differences in immediate recall (short term memory) for EAL and MAL fails to validate this theoretical prediction and cannot therefore serve as an adequate explanation of obtained differences in long term memory (24 hour recall). It is possible, however, that MA/IQ is not a valid indicator of neural integrity for borderline and mildly retarded subjects since much of the data reported by Ellis and

Butterfield reflects a hospital population of more severely retarded individuals.

Twenty-four Hour Recall

A 2 x 3 complete factorial analysis of covariance of 24 hour recall data was conducted utilizing immediate recall scores as the covariate in order to assess retention by adjusting for initial differences in original learning as measured by immediate recall scores. The results of this analysis indicate a significant main effect difference for both subject classification and method of original learning. The interaction effect was non-significant.

This analysis supports the hypothesis of a retardate retention deficit. These findings are consistent with the more recent literature and suggest that when learning materials are of sufficient difficulty the retardate does exhibit deficiencies in retentive abilities.

A further analysis of the significant main effect of method reveals a superior mean retention score for those subjects receiving training under EAL. The simple main effect of MMAL was not significantly different from the simple mean effect of MAL. The low levels of recall for these two methods suggest that researchers should utilize a learning procedure that will insure, as nearly as possible, a learning level that will allow hypothesized retention differences to appear.

Summary

The data from this study indicate both a learning and a retention deficit in mentally retarded subjects when compared to subjects of normal intellectual ability. The operations for original learning procedure and subsequent measurement of these effects were found to be quantitatively different in terms of trials to original learning criterion, relearning criterion, immediate recall and 24 hour recall. Mitigation of these observed differences seems possible through instituting overlearning procedures in training programs for educable mentally retarded children.

CHAPTER V

SUMMARY AND CONCLUSIONS

Rote learning and retention has been a major area of inquiry since 1885. The early work of Ebbinghaus has proliferated efforts to form major principles describing the memory process in normal subjects. More recently, considerable attention has been devoted by researchers to studying memory processes with intellectually subnormal subjects.

These efforts have produced major discrepancies among investigators in mental retardation. Authoritative writers have suggested that basic procedural research is imperative in order to test the hypothesis of a retardate retention deficit. The purpose of this investigation was to compare three experimental methods of stimulus presentation in original learning procedures utilizing both normal and retarded Ss. Learning and retention performance was studied as a function of method used in original training and as a function of intellectual level.

Sixty mentally retarded Ss (IQ range 50-83) and 60 mentally normal Ss (IQ range 90-110) were randomly selected from the Springfield, Eugene, and Bethel school districts. Twenty Ss in each diagnostic category were randomly assigned to one of three treatment groups for learning the paired-associate task. These methods

were (1) Method of Adjusted Learning (MAL), (2) Equal Amount Learned Method (EAL), and (3) Modified Method of Adjusted Learning (MMAL).

The experimental materials consisted of six pairs of nonsense stick figure stimuli paired with 2 to 8 per cent CVC trigrams. The stick figure stimuli were composed of four 2 inch lines in random configuration. The response members were systematically selected from the 1960 Archer list of all possible CVC trigrams.

Each S was tested individually in a 15' mobile laboratory which was situated next to the school in which the subjects were enrolled or in a distraction free room. The cards were manually presented for a period of 5 seconds with an intertrial interval of 30 seconds. Each S learned the list by either the MAL, EAL, or MMAL utilizing the anticipation procedure. Retention was assessed by immediate recall scores, relearning at 24 hours and by 24 hour recall.

Original learning data were analyzed by a 2 x 3 complete factorial analysis of covariance utilizing mental age as the covariate and trials to criterion as the dependent variate. The results of these analyses indicated that retardates required significantly more trials to reach the learning criterion than did normals. The data also revealed that significantly more trials were required to reach learning criterion as a function of the EAL method.

Immediate recall was assessed by a 2 x 3 factorial analysis of variance. This analysis indicated a significant interaction between S classification and method of learning.

Significant differences in immediate recall scores were obtained between normal and retarded Ss under the MMAL procedure. Normal Ss performed significantly better under EAL conditions when compared with the MMAL procedure. Normal Ss also performed significantly better under MMAL when compared with normal Ss under MAL original learning procedure. For retarded Ss the EAL method of original learning produced significantly higher immediate recall scores than either MMAL or MAL learning procedures.

A 2.3 complete factorial analysis of covariance was performed on the 24 hour relearning scores. This analysis indicated a significant interaction between method of learning and S classification.

Retarded Ss required significantly more relearning trials than did normal Ss under both MMAL and MAL. No difference was obtained as a function of S classification under EAL training procedures. For normal Ss no significant differences were obtained when comparing EAL and MMAL learning procedures although both EAL and MMAL proved superior to MAL. The EAL method was significantly superior to both MMAL and MAL for retarded Ss. Finally, retarded Ss performed significantly better on relearning trials under MMAL when compared to Ss under MAL.

Twenty-four hour recall was assessed utilizing a 2 x 3 complete factorial analysis of covariance. Immediate recall scores functioned as the covariate and 24 hour recall scores as the dependent variate. The results of this analysis indicate a 24 hour retention deficit for retarded Ss. The data also indicates superior retention scores for the method of EAL when compared to either MMAL or MAL learning procedures.

On the basis of the data reported above, the following conclusions seem warranted:

1. The retardate exhibits inferior learning performance when compared to subjects of normal intellect.
2. The experimental procedure of EAL requires more learning trials to reach a common criterion than either MMAL or MAL procedures.
3. The retardate exhibits a 24 hour retention deficit when compared to normals even when initial differences in associative strength are accounted for statistically.
4. Contemporary measures of retention fail to indicate uniformity of results when assessed from identical data.
5. Methods used in initial learning produce significantly different quantitative results.
6. Learning and retention deficits of retardates can be ameliorated by instituting overlearning procedures.
7. Rehabilitation specialists in the area of mental retardation should use extreme caution when attempting to interpret the findings of contemporary research investigating the rote learning and memory performance of the mentally retarded.
8. The results of this investigation suggest that obtained experimental results in the area of rote verbal learning with mentally retarded and normal subjects are method dependent.

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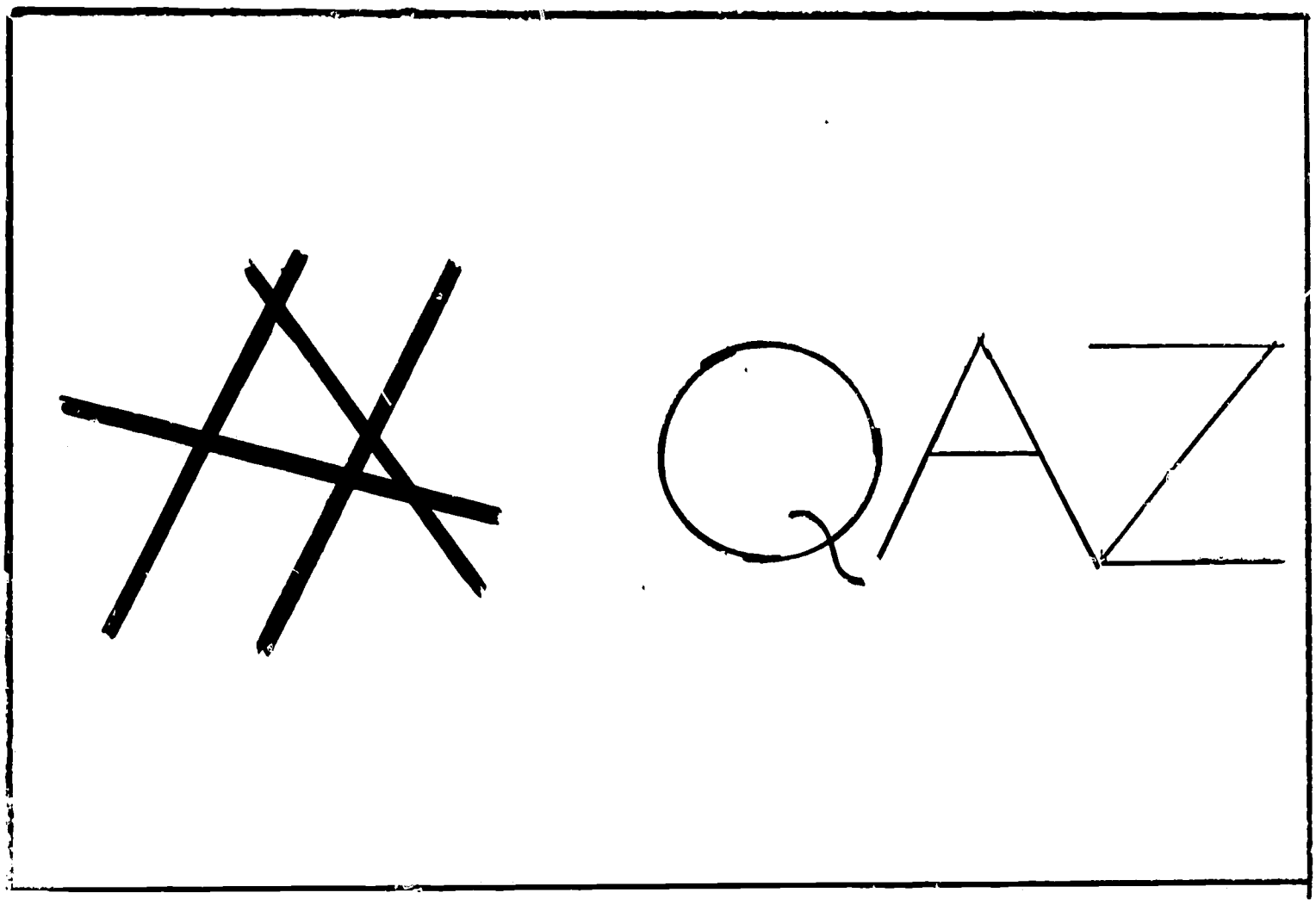
APPENDIX A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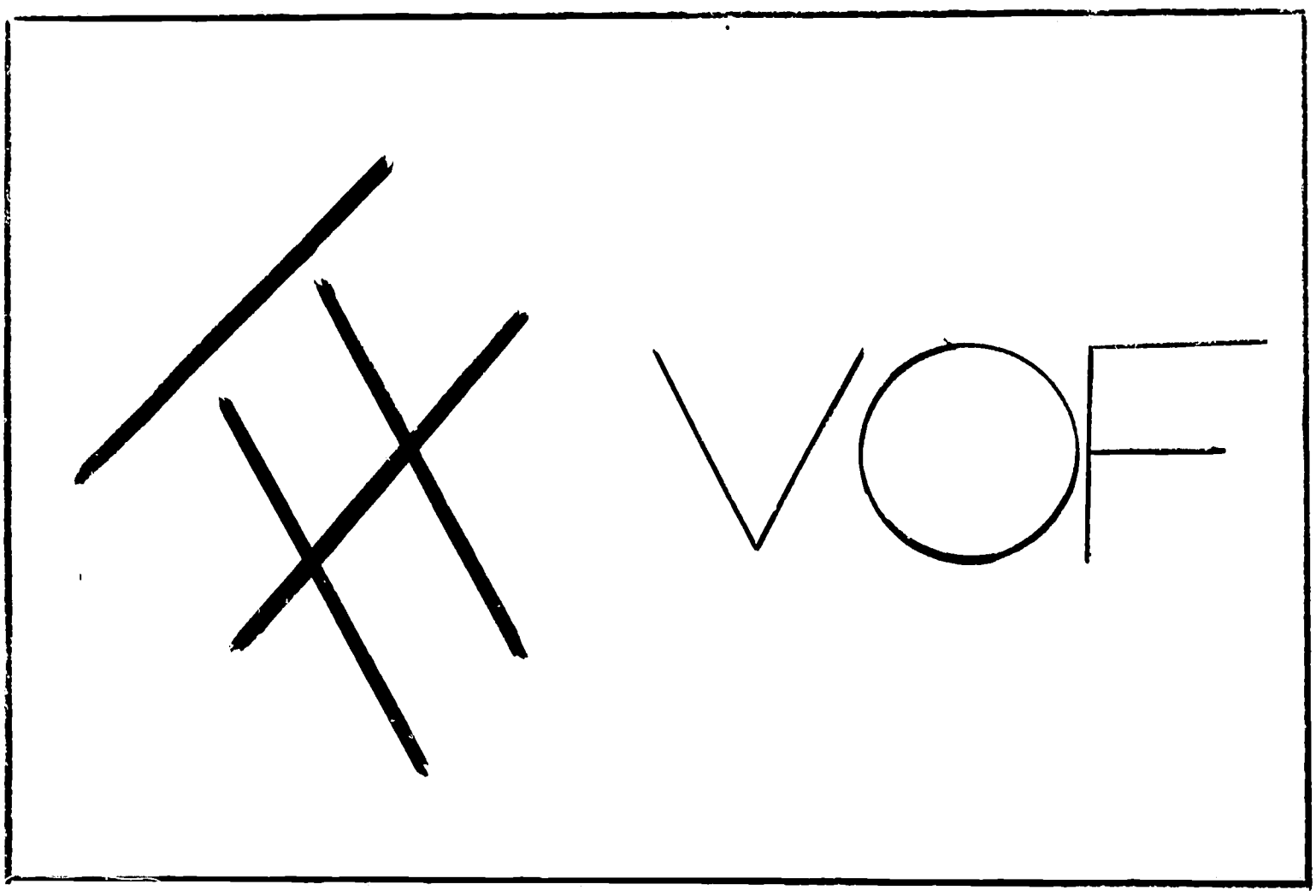
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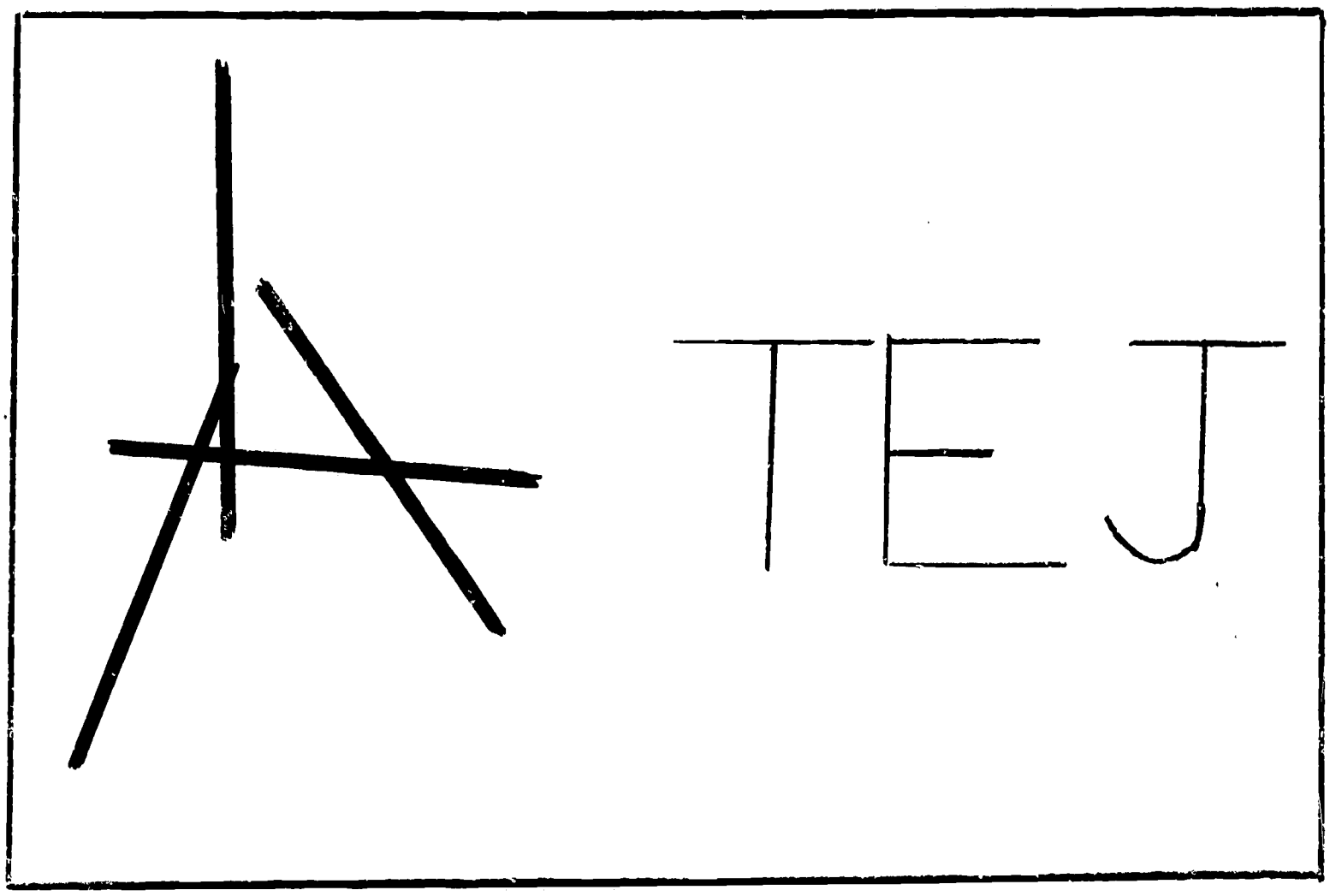
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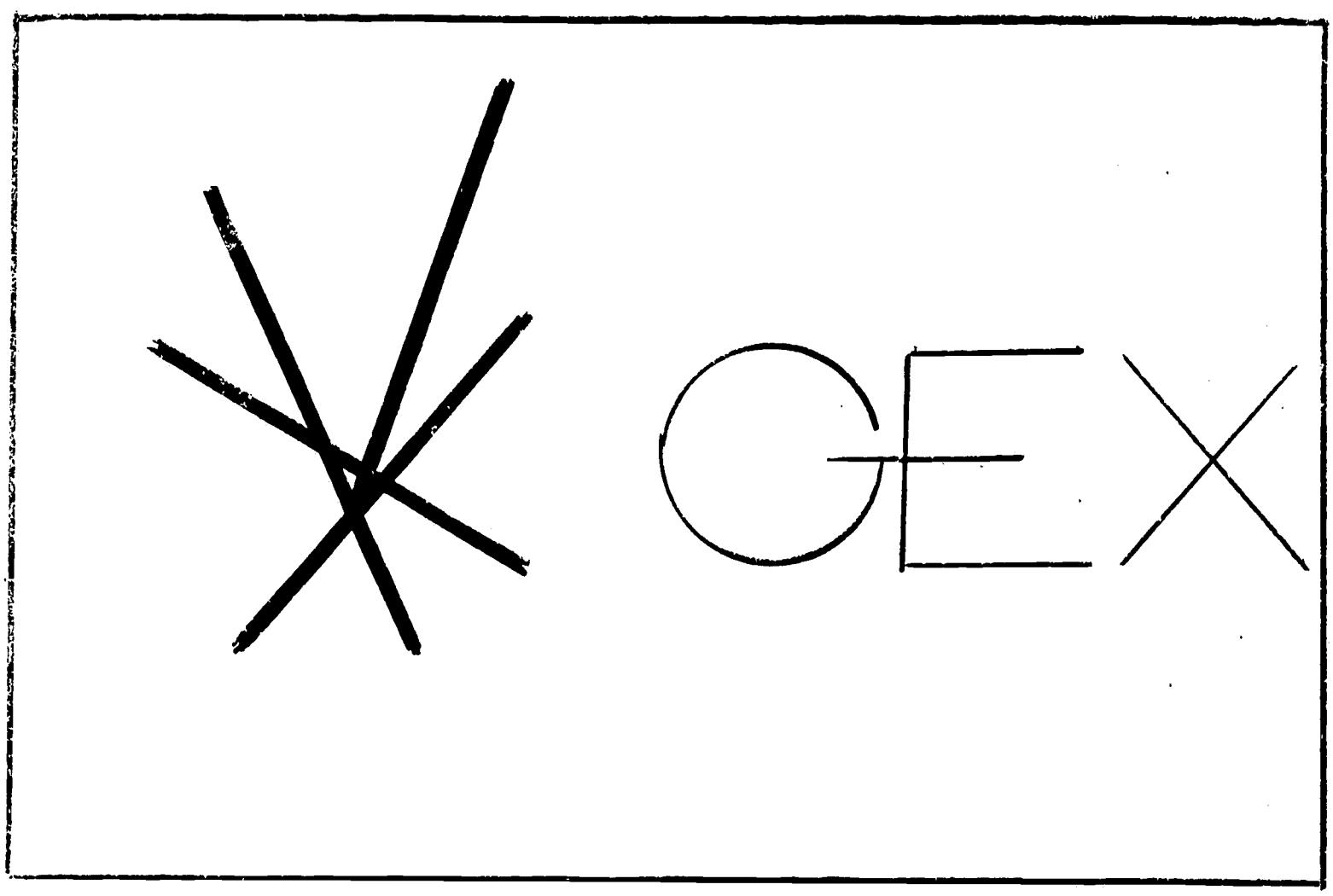
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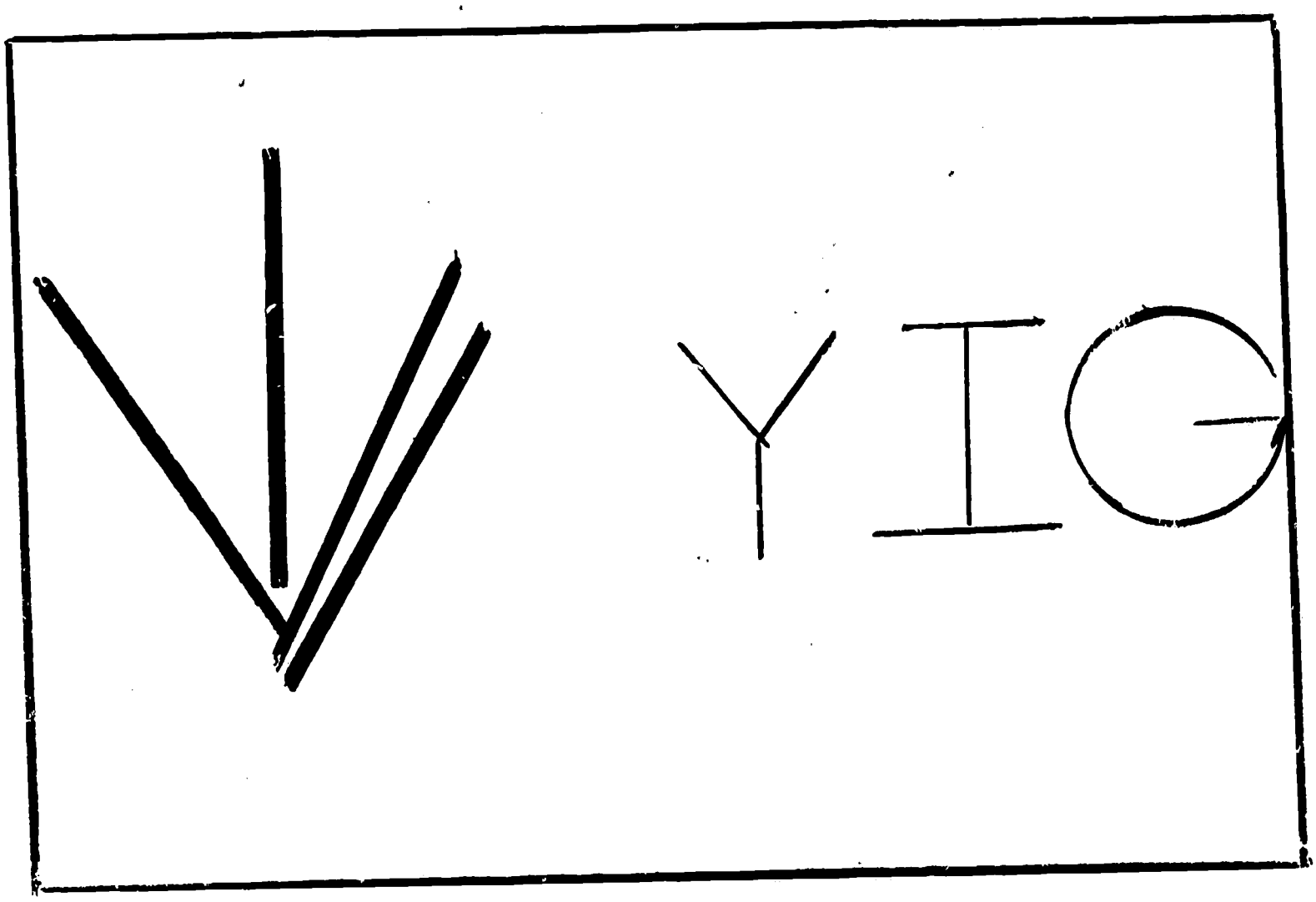

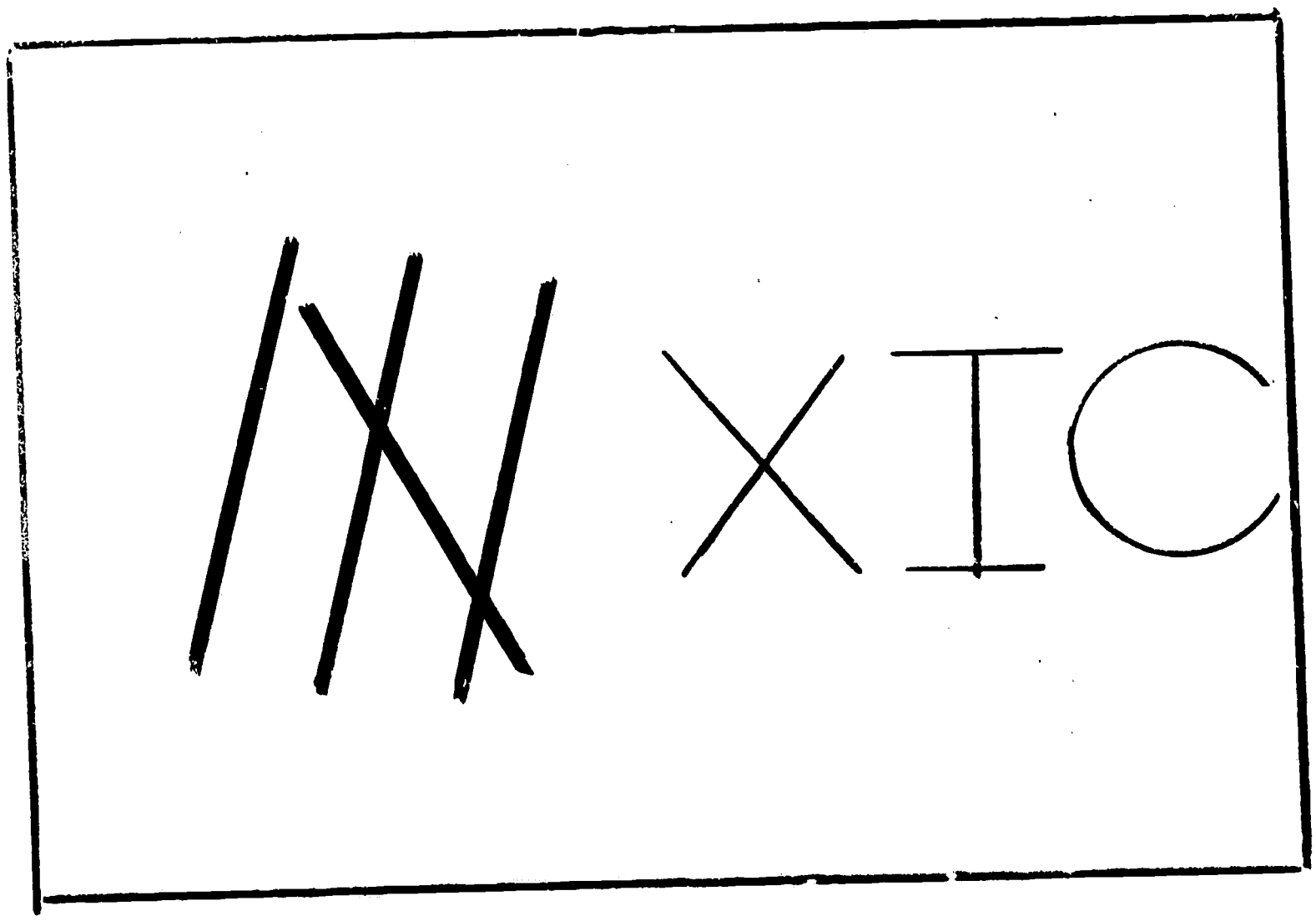

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ABSTRACT Rote learning and retention performance was studied as a function of method used in original learning and as a function of intellectual level. Sixty mentally retarded and 60 mentally normal Ss were randomly selected and assigned to one of three treatment groups for each intellectual category in order to learn a paired associate task. Retention was assessed by immediate recall scores, 24 hour recall scores, and relearning scores following the 24 hour interval. A 2 x 3 complete factorial analysis of co-variance wa performed for the following dependent variables: (1) original learning, (2) relearning, and (3) 24 hour recall. Immediate recall was assessed utilizing a 2 x 3 complete analysis of variance procedure.

The results of this investigation indicate (1) inferior learning performance for retarded Ss, (2) 24 hour retention deficit for retarded Ss, (3) retention deficits of retarded Ss can be ameliorated by overlearning of material, and (4) observed experimental results in the area of rote learning and retention comparing mentally retarded and normal Ss are method dependent.