Reminiscence and Successive Retention Trials in Human Serial Rote Learning of Paired-Associate Nonsense Syllables

by

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Abstract

It is the purpose of the present study to attempt to obtain reminiscence with paired-associate nonsense syllables, and to determine a "forgetting curve" based on a continuous measure of retention. Reminiscence is defined as an improvement in retention after learning, without intervening practice, as shown by some measure of ability to recall. The experiment is designed to give an empirical demonstration of reminiscence phenomena as predicted by the rote learning theory system of C. L. Hull, and the experimental work of C. I. Hovland. Hull's prediction of an initial increase in the amount retained after learning follows from a "differential forgetting" theory in which correct responses acquire decrement in strength at a slower rate than do incorrect responses: the result is that near-correct responses at the termination of learning temporarily reach supra-threshold strength during the early stages of retention, and "reminiscence" results. The majority of rote learning studies have used lists of single nonsense syllables presented in a serial order. Reminiscence effects have been found in some of the latter studies but have not been found with paired-associate materials presented in a random order on successive trials.

In the present experiment the stimulus materials are paired-associate nonsense syllables presented in a <u>serial</u> order; the anticipation method of learning is used; the criterion of learning is 6/9 correct anticipations; two

groups of 16 Ss each are employed - an immediate recall group, and a delayed recall group; the interpolated interval between learning and the first recall measure for the delayed recall group is two minutes; and successive measures of retention are obtained on Ss in both recall groups such that the time between reaching the learning criterion and the last recall trial is six minutes.

From the results, a serial effect is demonstrated during learning and it is expected that this will enhance the possibility of reminiscence. With analyses of the data in terms of group indices, individual indices, and item indices, no difference between retention measures is found which could be called reminiscence.

Successive trial retention measures are compared between the two recall groups. The Hullian theory predicts a general decrement in retention performance on successive trials following any reminiscence effect. The results show that overlearning of some responses results in a stereotypy of retention responses which obscures reduction in strength of the less well learned responses and results in no significant decline in retention on successive trials.

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Contents

Introduction

Since Ebbinghaus's pioneer treatise in 1885 (8), psychologists have shown an appropriate and persistent interest in problems of human verbal learning; particularly, the rote learning of nonsense syllables. The rote learning of nonsense syllables is not, of course, a phenomenon of the "everyday world," but is, rather, one of those partially artificial laboratory situations designed to demonstrate a paradigm from which, it is hoped, more general laws may be induced. One empirical phenomenon which has been demonstrated in a significant number of rote learning studies is that of reminiscence. The latter demonstrations were with serially presented lists of nonsense syllables. However, no study has appeared which demonstrates reminiscence with paired-associate lists of nonsense syllables, nor has any attempt been made to account for this non-appearance of reminiscence by an empirical examination of the retention curve. It is the purpose of the present study to attempt to obtain reminiscence with paired-associate syllables, and, to determine a "forgetting curve" based on a continuous measure of retention.

Reminiscence is defined as an <u>improvement</u> in retention, without intervening practice, as shown by some measure of ability to recall. Reminiscence phenomena are somewhat atypical since it is usually stated that the ability to reproduce previously learned material decreases with the passage of time and that the most rapid forgetting occurs

immediately after learning. In other words, when efficiency of retention is plotted against successive increments of time, it is usually expected that a negatively accelerated curve will result. Nevertheless, a significant number of deviating cases have been observed in which an initial rise in the curve of retention precedes the negatively accelerated curve. It is this initial rise in the curve of retention that has been named reminiscence. The phenomenon was named in 1913 by Ballard (2).

In the typical retention experiment designed to demonstrate reminiscence four general characteristics of design are apparent.

First, serial lists of nonsense syllables are used as stimulus materials. Serially presented nonsense syllables consist of (usually 12) single nonsense syllables presented one at a time in the same sequence on successive trials. However, several experiments, notably those of Hovland (14, 15, 18), have used paired-associate syllables presented in a random order.

Secondly, the anticipation method of learning is used, i.e., after the first complete exposure of the entire list, Ss begin to try to anticipate the next-to-be-presented syllable. Or, in the case of paired-associate lists (in which pairs of nonsense syllables are presented in random order on successive trials) Ss are presented with a single syllable and attempt to anticipate its correct pair.

Thirdly, Ss learn a serial list of nonsense syllables to a prescribed criterion of achievement. Following this, one

of two procedures is used as a measure of the curve of retention: either (a) all Ss are given an immediate test of retention of the learned material, followed by a later test of retention, or (b) one group of Ss is tested for immediate retention, while another group, which has achieved the same degree of learning, is tested for retention after some specified interval of time. The first procedure (a) is not acceptable as a measure of reminiscence. It is actually a distributed learning situation since the immediate recall trials also constituted an additional learning trial. That is, both the immediate and delayed retention measures are made on the same group and comparison is made with the criterion learning trial: thus, both time and number of practice trials vary independently and are confounded in the interpretation of results. Procedure (b) is the generally accepted design since only <u>time</u> between criterion and the retention measure is allowed to vary.

Fourthly, only one measure of retention is compared between groups.

In the present experiment the stimulus materials are paired-associate nonsense syllables presented in a <u>serial</u> order. The anticipation method of learning is employed. The criterion of learning is 6/9 correct anticipations. Two groups of Ss are used - an immediate recall group (hereafter referred to as C (control group)), and a delayed recall group (E (experimental) group). The interpolated interval between learning and the first recall measure for

the E group is two minutes; and, successive measures of retention are obtained on Ss in both the C and E groups such that the time between reaching the learning criterion and the last recall trial is six minutes.

The purpose of the design is to provide maximally appropriate conditions for the demonstration of reminiscence with paired-associate materials, and to attempt to provide empirical data on the retention curve following learning which may give some indication of more appropriate hypotheses to account for the appearance or non-appearance of reminiscence effects.

Theoretical Background

The more recent experimental literature is reported in the next chapter. Thre present chapter is concerned with theoretical papers which have proposed systems to account for serial learning and reminiscence phenomena.

The Hullian Reminiscence Theory

A strong incentive to research on serial learning phenomena occurred in 1935 with the appearance of an explicit theoretical statement concerning rote learning. In "The conflicting psychologies of learning - a way out" (23), C. L. Hull used serial learning as a prototype of the logico-deductive method of theory construction. The subject matter of this paradigm was an extension of Lepley's (29, 30) earlier attempts to apply conditioning principles to serial learning. Hull deduced from the Lepley hypothesis that inhibitions acting at the center of rote series during learning might "die out" rather rapidly with the passage of short intervals of time, leaving the correct tendencies more free to act and perhaps giving increased success or reminiscence. A corollary of this deduction is that reminiscence, when it does occur, should be more noticeable in, if not entirely confined to, those syllables at the center of rote series.

Briefly, the deduction of reminiscence may be said to depend upon two processes: the characteristics of the learning process and the characteristics of the retention process.

The Learning Process. In the usual serial learning procedure, the successive items are exposed singly by a memory

apparatus with an interval of two or three seconds between items. The first item serves as the stimulus for the pronounciation of the second item, while the second item serves as the verification of the Ss first response and also serves as the stimulus for the third item. The serial character of the learning task is obtained by the fixed order of presentation of the items. Note that verification of the correctness of the response occurs after each response so that the situation is not analogous to the maze learning situation. It is assumed by the Hullian theory that verification of the correct response constitutes a rewarding state of affairs. The reward of correctly anticipating an association is not, however, an experimentally observable reward, but rather a secondary reinforcement or substitute or symbolic reward. The situation is more in keeping with the conditioning concept of secondary reward training, in which the conditioned response is followed by a stimulus such as a token which has acquired reward value in previous learning.

But it is often the case that, during the learning process, Ss make responses which are not appropriate at that time but which would be appropriate at a point further on in the list. These associations have been named remote forward anticipatory responses. It is assumed by the theory that each associative tendency which is shown to span an item acts as a depressant to that item. A graphic representation of Hull's 1935 (23) statement of the theory is shown in figure 1. The correct anticipations are termed "excitatory tendencies;"

while the remote forward and backward associations are called "inhibitory tendencies" since they are not only "non-rewarding" but also have a negative effect on any presently existing excitatory potential.

The learning of paired-associate nonsense syllables is not entirely parallel to that of learning serial lists. Serial lists are always presented in the same prescribed order. It has been the general practice, however, to present paired-associate lists with a different random order of presentation on each trial. The present experiment uses paired-associates presented in the same serial order on successive trials, thus enhancing the possibility of remote forward and backward associations.

The Retention Process. In 1940, five years after the appearance of the first statement of a deductive system of rote learning, Hull (24), with the help of empirical data obtained by Hovland, and with the assistance of mathematical proofs from Ross, Hall, and Perkins, and supplemented by the logic of Fitch, published a monograph on rote learning which is the epitome of the logico-deductive method of theory construction. A special case of Hull's 1940 theory is the deduction of what happens to the associations during the time after learning when learning is interrupted before mastery. The basis of Hull's prediction of reminiscence after learning is theorem ten (55, p. 118), which states:

"In a rote learning consisting of a single massed practice, of two points equidistant (in time) from the maximum point of effective excitatory potential ($\overline{E}$) after

the termination of learning, the rate of increase of $\overline{E}$ at the point preceding the maximum is greater than the rate of decrease at the point following the maximum."

The meaning of this theorem becomes clear when theoretical values for the retention curve are calculated. These theoretical values for the effective excitatory potential are calculated by subtracting the inhibitory potential (Postulate 13 B (55, p. 67)) from the absolute excitatory potential (Postulate 12 B (55, p. 65)). From Hull's table 3 (55, p. 120) it may be noted that where t (time) following the termination of active learning equals zero then $\overline{E}$ equals four. Similarly, $2t = 4.353\ \overline{E}$ (the maximum point of $\overline{E}$, or, reminiscence), $4t = 4.158\ \overline{E}$, $6t = 3.730\ \overline{E}$, $20t = 1.072\ \overline{E}$. <u>Therefore, the retention curve shows a sharp initial rise following learning, followed by a not so rapid, but nevertheless marked, decline.</u> The empirical evidence cited to substantiate this formal deduction is the well known work of Ward (48). The prediction of reminiscence is represented in figure 2.

<u>Alternative Predictions</u>

A stereotypy of response evocation during successive recall trials might well be predicted from a Hullian "reinforcement" theory if the preceding degree of learning was high. That is, with any given pair of syllables, if the correct response has been given to the stimulus syllable on several trials it will be expected that there is, in Hullian terms, a high level of effective reaction potential. The frequent giving of the correct response - which is its own reward - will tend to build up the strength of the bond between

syllables of the particular pair. Over a short interval of time, then, there is no reason to expect that there will be anything but stereotypy of response during retention trials.

A stereotypy of response during successive recall trials might also be predicted from a Guthrian contiguity principle if it is assumed that those syllables which have been learned as discrete units. Or, if it can be assumed that there is sufficient dissimilarity among stimulus syllables and among response syllables to prevent stimulus generalization or response generalization, then there is reason to expect stereotypy. That is, in terms of the contiguity principle, paired-associations will remain intact in spite of the fact that no verification of the correctness of the response evocation is given to the subject during the retention trials.

Stereotypy of response during extinction trials (and it is submitted that, since there is repeated presentation of the stimulus without experimentally given reward following the response, the trials following learning may be legitimately called extinction trials) might also be predicted from a Pavlovian conditioning point of view. According to this view the elimination of conditioned responses depends upon some active process. This is called "inhibition" (10, p. 104) and is defined as "the reduction in strength of a response resulting from positive stimulation of some sort." That is, there must be an active interfering of some other stimulation before extinction of the old response will occur. It is quite possible that with overlearned associations there will be no

stimulus present in the experimental situation which will interfere with the association and stereotypy will result.

The discussion concerning the retention process has been concerned primarily with the retention of associations which were learned correctly during the learning process. However, it is quite possible that correct associations may appear during recall trials which were never correctly associated during learning trials. At least, the associations were never correct at an empirically demonstrable verbal level during learning. Or it may be that associations are learned correctly during learning, then do not appear during the first stages of recall, then reappear at some later recall trial. The Pavlovian concept of spontaneous recovery "...the return in strength of a conditioned response, whether partial or complete, brought about by lapse of time following its diminution by extinction" (10, p. 351), is a similar phenomenon. But in the case of correct recovery of simple paired-associates it is doubtful whether diminution of the response by extinction has actually occurred. Diminution by extinction of a discrete response unit of complex learning is generally thought to be a long term process.

It may be argued that Hull's 1940 differential gradient hypothesis which was previously discussed would predict the same results as the alternative hypotheses discussed above. This is shown not to be the case if we reason thusly: the decrement in inhibitory potential (as shown in figure 2) is shown to be more rapid than the concurrent decrement in excit-

atory potential. However, in order that the prediction of reminiscence will be validated by the empirical findings of Ward (48), it is necessary that the decrement in excitatory potential be only slightly less rapid than the decrement in inhibitory potential. Otherwise, it would be predicted that reminiscence is a long term phenomenon. If it were the case that there were a rapid decrement in inhibitory potential following learning, but a very slow decrement in excitatory potential, it would be necessary to predict that the curve of retention after learning would rise sharply and remain somewhat consistently at this increased level of efficiency. It follows then, that the Hullian differential gradient hypothesis predicts a short term reminiscence followed by a rather steady decline in the general efficiency of retention. This latter prediction is not in agreement with the prediction of consistent level, i.e., stereotypy, of performance.

Relevant Studies

The early work on the reminiscence phenomenon was excellently reviewed in 1943 by Buxton (4). More recent general reviews of serial learning phenomena and reminiscence are by Hilgard and Marquis (10), Hovland (19), McGeoch and Irion (36), and Melton (38). Specific references to historically important (previous to 1938) studies which have given initial direction to the more recent work are those of Ebbinghaus (8), Ballard (2), Kjerstadt (28), Williams (49), Lepley (29, 30), Bunch and Magsdick (3), Hull (21, 22, 23), McGeoch (33, 34, 35), and Ward (48).

Single Syllable Serial Learning Experiments

It should be noted that no experiments have been performed in which reminiscence has been found with paired-associate material. Reminiscence has been found only in the case of serially presented lists of single nonsense syllables (5, 7, 11, 12, 14, 16, 48, 51). Reminiscence has not been found in several experiments with serial lists of single nonsense syllables (5, 6, 20, 37, 39, 40). The latter experiments had conditions very similar to those in which reminiscence was found and were, in most cases, more recently performed. The most striking example of these is that of Hovland and Kurtz's repetition (20) of an earlier experiment by Hovland (11). In the earlier experiment Hovland used 12-unit serial lists of nonsense syllables; the criterion of learning was 7/12 correct anticipations; one group of Ss had an immediate recall trial following learning, while the other group had two minutes of interpolated

color naming before recall. The results showed that the delayed recall group was able to recall more syllables and took fewer trials to reach the mastery criterion. The single trial recall comparison showed the reminiscence effect less than did the number of trials required to go from seven syllables correct to mastery. The results were interpreted as a validation of the reminiscence effect found by Ward (48). Hovland and Kurtz's (20) later work, although of primary interest for the influence of "prior work" on the subsequent learning and retention of serial lists, showed, under the control condition of no "prior work" before the experimental learning task, that forgetting rather than reminiscence is obtained during the rest pause. This, however, is not consistent with Hovland's previous findings (11) nor with the work of Ward (48), nor Buxton (5). When reminiscence was measured by the savings method, i.e., savings in terms of the number of trials to proceed to mastery following single recall trials, then a significant difference between the immediate and delayed recall groups was found. This latter measure is consistent with the findings of Noble (40).

Paired-Associate Learning Experiments

Several recent experiments have been conducted using paired-associate material. In the most recently proposed test of the differential forgetting theory, Riley (41) introduced competing responses into the paired-associate situation. His experimental design is shown in table 1. According to his interpretation of the differential forgetting theory he

predicted "...a beneficial effect of the rest in Experiment 1, no effect or a slight negative effect in Experiment 2, and a negative effect in Experiment 3 which would be larger than that in Experiment 2." Reminiscence, as measured by post-rest recall trials, was absent. But is is quite possible that this does not represent a legitimate test of the theory. The theory is based on differential rates of decrement of correct and incorrect tendencies; not on differences in strengths of tendencies at the cessation of learning. Neither would the theory assume a one-to-one correspondence between the number of trials on which correct responses are learned and the excitatory strength, or inhibitory strength, of these responses.

Underwood (46, 47) takes a somewhat different approach to the problem. He says (46, p. 134) that "...remote associations represent generalization tendencies. If this is so, and if generalization tendencies exist in paired-associate learning (as seems likely, eg., 45), the quantitative continuity between serial learning and paired-associate learning can be maintained on the basis of the argument that no essentially different processes are represented by the two forms of learning." To test this hypothesis Underwood used different values of intralist similarity with his pairs of nonsense syllables. The results favor no support to generalization as a critical process in learning paired-associate lists by massed or distributed practice and no differences in retention occurred as a function of either intertrial rest

or similarity.

Experiments on Associated Variables

Thune's study (44) is not concerned specifically with reminiscence but is worthy of comment. He was interested in the effect of different types of preliminary activities on subsequent learning of paired-associate material. The study follows from Irion (25, 26, 27) and Ammons (1) on the "warm-up" factor (the reinstatement of set lost during the rest interval). The results showed that the facilitating effects of preliminary warm-up practice are most prominent during the first few learning trials following the rest interval. The implication for the present research is that any reminiscence effect may well be obscured by a loss of "set." Rockway (42), in a more recent study, has failed to confirm the beneficial effects of a "warm-up" period. It may be well to emphasize here that the present study is concerned with reminiscence in verbal learning and is not to be confused with reminiscence studies in a motor tasks such as bi-lateral transfer situations.

The experiments of Withey, Buxton, and Elkin (51), and Hovland (18), show that the speed of color-naming during the rest interval has relatively small effect upon amount of reminiscence.

Hovland's Paired-Associate-Experiments

The basic exploratory experiments in paired-associate learning as those of Hovland (14, 15). These and five other experiments (11, 12, 13, 16, 17) on serial learning are the

empirical basis of the theoretical monograph of Hull, et al (24) which appeared in 1940.

In the latter of the two experiments on paired-associate learning (15) Hovland concludes (p. 161) that "...learning by distributed practice resulted in a pronounced reduction in the number of trials required for mastery in the case of serial material. No superiority of distributed over massed practice was found in the case of paired-associates." In other words, with massed practice of serial materials progressively more trials are required to reach successive criteria of performance. This is due to the increasing number of incorrect remote associationswhich occur as learning progresses. With distributed practice of serial materials, however, these incorrect responses diminish in strength during the intertrial period according to the differential forgetting hypothesis (figure 2). Therefore, with distributed practice of serial material the learning curve is more nearly linear. On the other hand, since paired-associate material is presented in a different random order on each trial it is expected that the occurrence of remote associations is much less frequent. The curves for paired-associates were nearly identical (i.e., linear) for massed and distributed practice; which is what would be expected by the differential forgetting theory.

From the above, it seems to follow logically that the serial presentation of paired-associates (rather than random presentation on successive trials) would enhance the possibility

of the formation of remote associational bonds between pairs of syllables.

Hovland's other early experiment on paired-associate learning was directly concerned with reminiscence (14). The experiment was designed so that results might be directly compared with earlier studies (11, 12) on serial learning. Hovland reports (14, p. 467) that:

> "...to equate the number of trials required for learning by the two methods (serial and paired-associate), a preliminary experiment was run. The results showed that Ss require as many trials to learn a list of nine paired-associates as a serial list of eleven syllables, and ten paired-associates require more trials than twelve serial syllables. The paired-associate lists were, therefore, made up of nine paired nonsense syllables so as to permit the closest comparison with the results obtained previously (12) on twelve-unit lists."

The assumption he is making therefore, is that results from a nine-unit paired-associate list are directly comparable with twelve-unit serial lists. Hovland's 32 Ss had six practice day sessions to teach Ss how to "learn-how-to-learn" the task and so reduce within group variability. Reminiscence was measured by a comparison between groups of the percentage of Ss that showed increased recall over the learning criterion. No significant results were obtained.

Hypotheses for the Present Experiment

In the light of the design and results of previous experiments the present experiment proposes the following hypotheses:

1. That reminiscence will occur, as determined from a comparison between single-trial recall scores of immediate

and delayed recall groups after reaching a criterion on an interupted learning task.

2. That, on comparable trials (determined by the time since reaching the learning criterion) there will be no difference in recall trial scores in the immediate recall group and the delayed recall group.

Experimental Method

Subjects

Thirty-two Ss (fourteen men and seventeen women) were employed in the total experiment. The Ss were University of British Columbia Summer Session students enrolled in undergraduate psychology courses. Subjects were volunteers. Most of the Ss were school teachers by profession and their average age was about 22 years. They had not previously been employed in memory experiments and were not aware of the purpose of the experiment.

Stimulus Materials

Two paired-associate lists were prepared from Melton's list (19, p. 545) of nonsense syllables of low association value. As far as possible the standard rules for the construction of nonsense syllable lists were followed (19, p. 540). The two lists are reproduced below:

Practice List		Experimental List	
G I T	Y U K	T I V	P O B
Z A L	R I X	L E B	N U K
K E B	D A Q	M O J	Z I R
F E G	N I S	Y E D	F U P
B E J	V U R	B O F	V A H
M I P	T O V	J A T	G O X
Y I B	Q A D	Z U D	K I F
R U Z	P A F	G I C	M E J
W U C	G A X	D A X	R U V

Lists were typed on heavy bond paper in "pica" type.

Design

Subject Groups

The Ss were divided on a random basis into two groups of 16 each: an immediate recall group and a delayed recall group.

Procedure

Reminiscence was studied by subjecting the E group to two minutes of color naming after reaching the learning criterion of 6/9 correct anticipations previous to recall. The C group began recall trials immediately following the learning criterion. The reminiscence measure was taken as the difference between E and C groups on the first recall trial. The Ss in both groups participated in the experiment on two successive days. The second days' data were those used in the calculation of the results. The first of the two days served as a practice day in which Ss learned how to learn this type of task and thus reduced the variability within groups on the second day. The design of the experiment is summarized in table 2.

The Learning Task. The Ss learned by the anticipation method. That is, the first syllable of a pair was presented by itself for two seconds, then both the stimulus syllable and its associate were shown together for two seconds. This continued until all nine pairs had been exposed. On the second and subsequent trials the Ss, upon presentation of the single syllable alone, tried to anticipate its associate before the correct pair was shown. After the single stimulus syllable had been shown and the S responded with a guess as to the correct associate, the correct associate was shown and the S corrected his guess, or repeated the pair if he had guessed correctly. The interval between one exposure and the next was negligible. The interval between trials was altern-

ately four and six seconds (an unavoidable variation due to the circumference of the drum). Learning, then, was by massed practice since only a few seconds separated successive trials.

The Retention Task. On the first trial on which six or more syllables were correctly anticipated the following occurred: the Ss in C group saw the slide in the apperature of the apparatus move one space to the left and were then shown, at intervals of four seconds (the rate at which they had been shown single syllables during learning), just the first syllable of each pair. This continued without interuption for nine trials (six minutes). The apparatus did not stop between learning and recall trials - the transition from learning to recall trials was completely continuous.

In the E group, on the other hand, the Ss, upon reaching the learning criterion, were told by means of a red signal light to cease the learning task and begin an interpolated activity. After two minutes of this interpolated task the light went off again and the Ss returned to the memory apparatus activity and were given six successive recall trials (four minutes) in the same manner as described for C group. The transition from learning to the interpolated task was made as simple as possible since the Ss had only to turn left in the same chair in which they were sitting during the memory task. The memory apparatus was turned off during the interpolated task.

The interpolated task for the E group consisted of

naming colors (figure 3). Eighteen pieces of paper 3/4 x 2 with different shades of colors such as are found in paint advertizing brochures were pasted in two columns on a 14" x 8½" peice of paper and stapled inside a large filing folder. The Ss were also given a sheet of paper with instructions to choose an appropriate name for each color from a list of 26 names at the right hand side of the answer sheet and to write their choices in the appropriately numbered space on the left hand side of the sheet which corresponded to the numbers of the colors on the color sheet. The color naming task was sufficiently difficult and long enough so that no S was quite able to complete the task. This activity effectively prevents rehersal of the syllables and gives little retroactive inhibition. Different colors were used on the practice day and on the experimental day.

Apparatus. The apparatus was an electrically driven memory drum. Several of the details of the design were taken from MacPhee (32), Schlosberg (43), and Winter (50). The front of the apparatus consisted of a black metal surface 22" x 38". The aperture through which the Ss viewed the syllables was 1 3/4" x 7/16". The Ss sat at a comfortable distance in front of the apparatus and were able to see no more of the apparatus, recording material, or experiment, than the front of the apparatus (see figures 4, 5, 6, 7, 8, and 9).

Instructions to the Subject. All Ss were given the following instructions and the instructions were repeated

on both the practice and experimental day:

"This is an experiment in learning nonsense syllables, and not a psychological test. We are interested in certain complex relationships of the learning process common to all people, and are not specifically concerned with your personal reactions.

"When the light at your left goes off the apparatus will begin. Shortly after the apparatus starts you will see a three letter syllable in the window. After a few seconds this syllable will move down and two syllables will appear. That is, a single syllable will always be followed by a pair of syllables. This single syllable will always be the same as the first syllable of the pair which follows it. You are to learn to associate the two, so that when the first appears you can give the second before it appears. You are to pronounce each of these syllables as you see it. The beginning of each successive trial is denoted by three typewritten asterisks.

"Following the first complete exposure of the entire series of pairs you are to begin to anticipate the second syllable of the pair, in other words, you are to pronounce the second syllable of the pair before it appears while the single syllable is still exposed. Always pronounce the single syllable first; then anticipate its pair; and then, when the correct pair is shown pronounce both the syllables of the pair.

"If, when you are anticipating, you think you know what the syllable is, but are not sure, guess, because it will not hurt your score any more than to say nothing and if you get it right it will count as a success. Try always to speak the syllables as distinctly as possible.

"Please do not try to think ahead more than one step at a time; or to count; or to make up fanciful connections between the syllables to assist the learning process: simply learn each syllable with its associate.

"After quite a number of the trials which have just been described, the slide in the aperture will move to the left one space, and you will be shown just the stimulus, or first syllable of the pairs which you have just learned. You are then to recall the response which you have learned by anticipation to associate with the first syllable. Pronounce each of these single syllables as you see them and then recall and pronounce the syllable which you have learned to associate with it.

"If the light at your left goes on again during the experiment the apparatus will stop and you are then to turn to

the table at your left. Open the folder which is there and carry out the instructions which are on the sheet inside the folder. When this light goes off again, cease this task and return again to the learning task which was interupted.

"Do not ask questions about the purpose of the experiment until the study is over. Are there any questions about the instructions?"

If the S was in doubt about any part of the procedure then the instructions were repeated. The instructions were recorded.

Recording of the data. All responses of the Ss were recorded (sample record sheet: figure 10). Responses were counted correct on a phonetic basis, i.e., "ZIR" = "ZER" = "ZUR," that is, a response was counted correct during recall if it was pronounced the same way as that S had pronounced it during learning.

The Results and their Statistical Treatment

Serial Effect in Learning

It was pointed out earlier (p. 6, and figure 1) that the deduction of reminiscence by the differential forgetting theory follows from the occurrence of a serial effect during learning. That is, the syllables at the extremes of the serial list are more easily learned since there are fewer remote forward and backward associations attached to them, while the syllables at the center of the list are most difficult to learn. That serial effect is present in these learning data is evident by comparison of the number of correct associations of syllables at the extremes of the list with syllables at the center of the list. The chi^2 technique is applicable here. There are nine pairs of syllables in the list. The extremes may be compared to the center by comparing pairs 1, 2, 8, and 9, with pairs at the center: 3, 4, 6, and 7. That more correct associations were made on paired-associates at the extremes of the serial list is shown by a chi^2 of 220.21 (table 3).

Reminiscence Measures

A tabular presentation of last learning trial scores and raw recall trial scores is given in table 4. The grossest measure of reminiscence is that which may be deduced from computing the significance of the difference between the means of recall trials E-1 and C-1 (E-1 refers to the first recall trial in the delayed recall group, and C-1 refers to the first recall trial of the immediate recall

group as shown in table 4). The "t" here, with 30 d.f., is equal to .42; which is not significant at the .05 level of confidence. There are, in fact, approximately 65 chances in 100 that the observed difference is due to chance.

A much more sensitive measure of reminiscence is one based on the difference between percentages of Ss showing improvement in recall performance. In this case the last learning trial score is taken as the value from which improvement, equality, or decrement of the recall score is measured. The rationale of the method is that reminiscence is not a group affair but is rather a phenomenon of individual Ss. Some people may be "reminiscers;" other, not. The use of group averages often tends to obscure the fact that several people have shown some improvement, while a few have shown marked decrease in retention. In the present data two Ss in each group showed absolute increase in recall scores on the first recall trials as compared with the last learning trial. There is no difference, then, between percentage of Ss showing improvement in recall performance. In the E group 10/16 Ss showed decrement on the first recall trial; in the C group, 11/16 showed decrement on the first recall trial. The difference in percentage of Ss showing decrement in retention on the first recall trial is obviously not significant. A "t" test of significance of difference in decrement yields a value of .411, which,with 19 d.f., is not significant.

Retention Curves During Recall

The second hypothesis to be tested (p. 17) is that, on comparable trials (determined by the time since reaching the learning criterion) there will be no difference in recall trial scores in the C group and the E group. To test this hypothesis trials E-1 to E-6 are compared with trials C-4 to C-9.

It should be noted that the hypothesis as stated above would not be rejected under several extremely different data conditions. That is, both E and C groups might show retention curves which could theoretically fall anywhere along the continuum of complete forgetting to complete retention. This will be discussed in the next chapter. Here it is proposed that the statistical method of comparison will show any difference in comparability of the retention curves for the two groups. Figure 11 shows mean recall scores on successive retention trials for both E and C groups.

The method of analysis is that described by Edwards (9, p. 288) for repeated measurements on several independent groups and is similar to the method described by Lindquist (31).

Since the method employs analysis of variance, it is desirable to begin with a demonstration of homogeneity of variance. Bartlett's chi^2 test for homogeneity of variance (9, p. 196) was used. In order to apply the test, the variances on similar trials between groups were combined.

In other words, the variance in trial C-4 was combined with the variance in trial E-1; C-5 with E-2; etc. The resultant chi^2 was 0.1932. This is not significant with 5 d.f.

Since the obtained value of chi^2 is not significant, the data offer no evidence against the hypothesis of random sampling from a population or populations with a common variance. Therefore, if the F test, as applied below, results in the rejection of the hypothesis of random sampling from a common population, we will have every reason to believe that the significance of the value of F is the result of the differences in the means.

The result of the analysis of variance of the six comparable recall trials is shown in table 5. As shown in the table, the variation between the method of immediate recall and the method of delayed recall was less than the variation between Ss in the same group. With 1 and 30 d.f. this results in a rejection of the hypothesis of significant differences between methods of recall. So we may infer that the two methods are equally effective, since the differences between them can be accounted for in terms of random sampling from a common population.

Similarly, the F for trials is given by .608/.145, and for 5 and 5 d.f. this is not significant. Therefore, the test of significance indicates that this variation is not greater than can reasonably be attributed to random sampling from a common population and any difference between

trials is no greater than can reasonably be attributed to chance.

Stereotypy of Recall Responses

It is quite possible that the rejection of the test of significance for differences between trials is due to stereotypy of correct recall responses due to overlearning of these particular paired-associates. That there is no doubt that this is the case is shown by a comparison of the response sequences during recall in each group. A stereotyped response sequence is defined as successive correct association of the same paired-associate on all of the recall trials.

With the delayed recall group a total of 65 stereotyped response sequences occurred. This accounts for 65 x 6, or 390 correct responses out of the absolute total of 531 correct responses in the E group. An average of slightly more than six correct associations during learning of the same associations was necessary to produce a stereotyped response sequence during recall.

With the C group a total of 60 stereotyped response sequences occurred. This accounts for 60 x 9, or 540 responses out of the absolute total of 750 correct responses during recall. Again, an average of slightly more than six correct associations during learning of the same associations was necessary to produce a stereotyped response sequence during recall.

From the above results it may be inferred that those

associations which were correctly learned less than six times might be more amenable to reminiscence effects. The previous examination of the data for reminiscence was in terms of group averages and in terms of increment and decrement of recall of individual Ss. The present proposal makes reminiscence a phenomenon of individual associations. Figure 12 is a scattergram of the increase of one or more correct recall associations compared with the same association during learning when this association has been learned 5 or less times.

Fifth-four paired-associates in the E group show an increase on recall trials of one or more correct pairings compared to the number of correct pairings during learning. On the first six trials of recall the C group had 56 paired-associates which showed an increase over the number correct during learning. It is obvious that no indication of reminiscence is given with this statistic. However, it is interesting to note from the scattergram that seven Ss in the E group made two or more correct recalls of responses which they had not "learned," whereas only one S in the C group made more than two correct recall responses to a stimulus association which had not been "learned."

The number of items which were never learned but which were successfully recalled at some time during recall is an interesting statistic but one which is difficult to evaluate. The total number of these corredt pairings of unlearned responses (including repetitions of the same response on

different recall trials) was 18 in the C group and 32 in the E group.

It was mentioned previously that the reminiscence effect might be negated by a loss of "set" during the shift from the learning task to the interpolated task and back again to the recall task. If one trial can be assumed to be sufficient time to regain lost "set," then the second recall trials in each group (E-2 and C-2) might be taken as a measure of reminiscence. However, from figure 11 the difference between means of these two trials is less than the difference between the means of the first trials.

Discussion

The results show clearly that the E group exhibits no statistically significant superiority of retention of the learned material. With successively finer analyses of the data in terms of group indices, individual indices, and item indices, no differences in retention statistics were found which could be called "reminiscence effects." This finding is, nevertheless, in agreement with reminiscence experiments using paired-associate learning. It might have been suspected that the undoubted demonstration of serial effect during learning would be conducive to reminiscence; although this was not the case. An attractively tenable position here is that, in effect, the serial learning phenomenon has not been demonstrated. Because the first and last pairs of a serial list are learned before the center pairs of a serial list are learned is no reason to deduce that this is due to the interfering effects of first and last pairs. That the first and last pairs of the serial list are, in fact, learned first may well be related to rehersal by the subject during the very short time during intertrial interval. Between trials the Ss have a few seconds in which they may practice the temporally recent associations and in which they may also direct their thinking towards the next-to-be-presented first pairs of the list.

Although there is no statistically significant measure of reminiscence, it may be observed from figure 11 that, on

a group basis, there is better retention on trial E-1 then on trial C-1. With a larger number of Ss a statistically significant difference might have been found.

A more interesting practical observation from figure 11 is one concerning retention trials subsequent to the first recall (reminiscence) trial. It was noted previously (p. 27) that the retention hypothesis under test was stated ambiguously. That is, the hypothesis states an equality among temporally comparable retention trials but does not state the direction of this equality. Either complete forgetting or complete retention or any slope of the curve between these two extremes would result in non-rejection of the hypothesis of no difference as long as the same retention curve occurred in both recall groups. That this is a legitimate hypothesis and one which follows from the differential forgetting theory may be seen if we reason thusly: it is noted that the test of significance is between temporally comparable retention trials (i.e., trials E-1 to E-6 compared with trials C-4 to C-9). If it can be shown that the first three trials of the C group (the trials comparable to the interpolated activity of the E group) had no effect on later recall trials in the C group then there would be no reason to expect a difference between groups. Since Ss are shown only the stimulus syllable on these first three trials, as on other recall trials, and are given no direct verification of the correctness of their response, there should theoretically be no reason to expect

that interfering responses (remote anticipatory responses) would not be "dropping out" at the same rate as those during the interpolated activity of the delayed recall group. The only variables which are "anchored" during these first three recall trials in the immediate group are the stimulus syllables: the response syllables - most particularly the low-level-of-learning response syllables and the incorrectly learned responses - are given no experimental manipulation, and, as it were, are allowed to arrange themselves as they will in the S's organizational processes. With this interpretation the non-significant difference between temporally comparable retention trials is entirely in agreement with the predictions of the differential forgetting theory.

A distinctly different question is that concerning the curve of successive retention trials (figure 11). It should be made clear that the hypothesis makes no prediction concerning this. However, from an examination of figure 11, and from the results of the analysis of variance in table 5, the differences in retention values between trials is not significant. In fact, the scores from trial to trial are remarkably consistent. The differential forgetting theory would predict some falling off of the retention curves on later recall trials (p. 8). In fairness to the Hullian viewpoint it may be argued that the present experiment does not continue recall trials for a sufficient length of time to make an adequate test of the theory. That is, the deduced retention values (p. 8) at a time interval of two to

six are only slightly less than the values at the learning criterion.

The consistency of response from trial to trial may be due to the high percentage of stereotyped response sequences during recall produced by overlearning of the same syllable pair during learning.

The correct appearance during recall of associations which were never correctly learned is an interesting phenomenon, althought one for which no statistical evaluation is given. An empirical explanation for the appearance of these correct responses may be found in the nature of the last learning trial. For example, the subject may make an incorrect anticipation during the last learning trial; he is then shown the correct pair. On this last presentation he may learn the correct response. Whether or not he has learned this would not be shown until the first recall trial. At the termination of learning, then, the subject may actually have learned more correct pairs than he has responded. This would account for the seeming appearance during recall of previously incorrect responses.

There is the possibility that "set" may be lost during the interpolated activity which would negate the positive effects of the reminiscence phenomenon. The finding by Irion (26, 27) that "warm-up" on related tasks has a beneficial effect on later performance has implications for the present material. If it is the case that the first recall trial of the E group suffers as a result of loss of "set,"

it might be hypothesized that a more valid test of reminiscence would be a comparison of trial E-2 with trial C-2. That no reminiscence was found by this measure, may, or may not, be taken as an indication of no loss of "set."

Hovland's experiments (14, 15) have taken the number of trials following recall to proceed to mastery as a measure of reminiscence. In this case the delayed recall group would be expected to require fewer trials to proceed to mastery since incorrect responses have dropped out during the interpolated activity. It can be maintained that this measure is confused with distributed learning effects.

Several comments are appropriate concerning the design of the present experiment:

First, the nonsense syllables employed were of approximately equivalent association value. These association values were, however, determined for single syllables - not for pairs of syllables. Pairs of syllables may have entirely different association values.

Secondly, it was noted previously (p. 14) that Underwood found similarity of syllables a non-critical factor in learning. It may therefore be presumed that the differences between lists with regard to similarity and resultant generalization processes is of no consequence.

Thirdly, a valid criticism of the present experiment is that the Ss were not sufficiently well practiced in paired-associate learning. Hovland's (14) Ss had six practice sessions: Ss in the present experiment had one practice session.

It may be that Ss in the present experiment were still "learning-how-to-learn" on the experimental day. What effect would this have on the appearance of reminiscence? There may be great individual differences in the rate of "learning-how-to-learn" which would account for the heterogeneity of the number of learning trials to the criterion and for the amount of learned material which was retained. If this factor were more highly controlled, as in the Hovland experiments, the difference in results due to difference in recall methods might be more easily isolated.

Fourthly, a presumably "controlled" variable in the present experiment is the learning criterion of six out of nine syllables. The selection of this criterion is traditional; which, of course, is no valid reason to perpetuate it. With higher degrees of learning before recall there is less chance of improvement on recall trials. With a lower degree of learning, and more incorrect associations, there may be more possibility of reminiscence effects.

Fifthly, it is assumed that motivation is constant from learning to recall. This may not be the case. During learning the Ss know that, after they have made an anticipation, they will be shown the correct response. It also appears to the Ss that there is no limit to the number of trials which they may have to learn the task. A different situation exists during recall. The Ss are given only the stimulus syllables and must make an active attempt to recall what they have learned. It is quite possible that motivation is increased

during the recall trials. The present experiment provides no control for this; nor is increased motivation during recall suspected since there was a general but consistent decrement in recall performance as compared with last learning trial performance.

Conclusions

It is concluded that the use of paired-associate nonsense syllables is an inadequate procedure in experiments designed to demonstrate the empirical phenomenon of reminiscence in human serial rote learning.

Furthermore, two conclusions may be made concerning the use of successive retention trials as a test of the Hullian differential forgetting theory. Firstly, Hull's prediction of reminiscence is based on serial lists of single nonsense syllables as in the reference study by Ward (48). The Hullian theory extended to paired-associate syllables, as in the experiments by Hovland and the present experiment, is a rather gross and probably unwarranted extrapolation. The extrapolation is not one which can be phrased in mathematical or logically rigorous form in a specific application to paired-associates. Secondly, the present experiment employs successive retention trials in an effort to provide data consistent with Hull's prediction of the retention curve over a considerable interval of time following learning. The experiment probably does not continue retention trials over a sufficient period of time to permit demonstration of a noticable decline in retention as predicted by the theory.

A corollary is proposed to the general conclusions already stated. The tone of the comments to this point has implied that the inconsistencies in results in attempts to verify theoretical predictions have resulted from inability

to gather the appropriate kind of data. That is, it may be argued that the theory predictions are not verified by the data simply because the theory makes no predictions about the kind of data that are being collected. The problem, then, has appeared to be a problem of data. The suggested corollary is that the present problem is one of theory construction rather than data collection. Thus, those experimenters who have attempted to demonstrate reminiscence with paired-associates and who fall in line with the Hullian theory, have, of course, assumed that the Hullian theory is adequate to predict the occurrence or non-occurrence of reminiscence with paired-associates. The findings of the present experiment are consistent with the findings of all other paired-associate experiments in that reminiscence was not found. Similarly,, the theory has not given reliable predictions about reminiscence when serial lists of single nonsense syllables have been used; since approximately one-half of the experiments designed to demonstrate reminiscence with serial lists of single nonsense syllables have failed to demonstrate the phenomenon. There is no doubt that part of the inadequacy of the Hullian theory is due to its unintentional dependence on terminology and theory constructs which, unfortunately, have been inherited from outmoded and unscientific mentalistic psychologies. Thus, the incorporation of constructs such as "interferences" which "drop-out" over the passage of time, and "inhibitions" which prevent the occurrence of other responses, only contributed to confusion in theorizing rather

than to clarification of the observable relationships. It may be that consistent and reproducable results in reminiscence experiments, as in many other types of learning experiments, will not be obtained until a theoretical model is developed which makes no causal assumptions about stimulus response relationships, which does not regard stimuli and responses as discrete, irreducible entities, and which does not attempt to predict single response occurrences with a dichotomous 'either-or' probability. A more adequate theory of reminiscence, and other learning phenomena, may proceed from quantifiable, manipulable, and reproducable data which are dependably and systematically recurrent over a passage of time and which can be predicted with analytically derived statistical probabilities.

Summary

The purpose of the present experiment is to attempt to obtain reminiscence with paired-associate nonsense syllables, and to determine a forgetting curve based on a continuous measure of retention in the human verbal serial rote learning situation. The experiment is designed to give an empirical demonstration of reminiscence phenomena as predicted by the rote learning theory system of C. L. Hull, and the experimental work of C. I. Hovland. The proposed hypotheses are: (1) that reminiscence will occur, as determined from a comparison between single trial recall scores of immediate and delayed recall group after reaching a criterion on an interupted learning task, and (2), that, on comparable trials (determined by the time since reaching the learning criterion) there will be no difference in recall trial scores in the immediate recall group and the delayed recall group.

In the present experiment 32 Ss are used: 16 in an immediate recall group and 16 in a delayed recall group. The immediate recall group is subjected to nine recall trials; the delayed recall group is subjected to six recall trials subsequent to two minutes of color naming. The stimulus materials are paired-associate nonsense syllables presented in a <u>serial</u> order; the anticipation method of learning is used; the criterion of learning is 6/9 correct anticipations; and, the time between reaching the learning criterion and the last recall trial is six minutes.

From the results, a serial effect is demonstrated during

learning and it is expected that this will enhance the possibility of reminiscence. With analyses of the data in terms of group indices, individual indices, and item indices, no difference between retention measures is found which could be called reminiscence.

Successive trial retention measures are compared between the two recall groups by the use of an analysis of variance technique for successive measures on non-independent trials. The Hullian theory predicts a general decrement in retention performance on successive trials following any reminiscence effect. The results show that overlearning of some responses results in a stereotypy of retention responses which obscures reduction in strength of the less well learned responses and results in no significant decline in retention on successive trials. In consideration of the Hullian theory and alternative contiguity theories, several ad hoc comments are made concerning the interpretation of the results. Five specific comments are made concerning inadequacies of the design of the experiment.

It is concluded that the use of paired-associate nonsense syllables is, at present, an inadequate procedure in experiments designed to demonstrate the empirical phenomenon of reminiscence in human serial rote learning. The suggestion is made that the present hypotheses are an unwarranted extrapolation from Hullian theory and a corollary is appended that Hullian theory may be inadequate to deal with these learning data.

Table 1

Riley's (41) Experimental Design

Experiment	Prelearning task	Experimental task	Interpolated task	Reminiscence task
1	Ss learn wrong responses for four trials.	Ss learn correct responses to the same stimuli for six trials.	Experimental gr: two minute rest. Control gr: no rest.	Learning to mastery.
2	- - - - - - - -	Ss learn correct responses for six trials.	Experimental gr: two minutes rest. Control gr: no rest.	Learning to mastery
3	Ss learn correct responses for four trials.	Ss learn incorrect responses to the same stimuli for six trials.	Experimental gr: two minute rest. Control gr: no rest.	Learning to mastery.

Table 2

Experimental Design*

Task	Control Group	Experimental Group
1. Learning to criterion of 6/9 correct anticipations.	Yes	Yes
2. Interpolated activity (color naming)	No	Yes
3. Number of recall trials:	Nine	Six

* The same design was employed on the practice day and on the experimental day.

Table 3

Chi^2 for Serial Effect during Learning

Pair	Number of times correctly associated		Total
	Control Group	Experimental Group	
T I V P O B	158	138	296
L E B N U K	82	78	160
M O J Z I R	67	65	132
Y E D F U P	9	14	23
B O F V A H	(omit)	(omit)	
J A T G O X	28	39	67
Z U D K I F	6	13	19
G I C M E J	27	33	60
D A X R U V	75	104	179
		Total:	936
		Mean:	117

Table 4

Last Learning Trial and Recall Trials Raw Scores

Subject		Trial								
Experimental Group	Last Learning Trial	E-1	E-2	E-3	E-4	E-5	E-6			
1	6	4	4	4	4	5	4			
2	7	6	6	6	6	5	6			
3	7	3	5	4	3	4	5			
4	6	5	5	5	5	5	5			
5	6	6	7	7	7	7	7			
6	6	5	5	5	5	6	6			
7	8	7	8	7	8	7	5			
8	6	4	4	5	5	4	5			
9	6	4	5	5	5	5	5			
10	6	3	5	4	4	5	5			
11	6	8	8	8	8	8	8			
12	6	6	5	6	6	6	6			
13	6	6	6	7	6	7	7			
14	6	7	7	6	6	6	2			
15	6	5	4	3	3	3	6			
16	6	6	8	7	7	7	7			
Control Group		C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9
1	7	6	8	7	7	7	7	7	7	7
2	6	4	5	4	5	4	4	5	4	3
3	6	5	7	6	5	6	6	6	5	6
4	7	6	8	7	7	5	7	8	8	8
5	8	9	8	6	6	7	7	8	7	7
6	6	2	2	2	2	2	2	2	2	2
7	6	4	4	5	4	6	5	5	5	5
8	6	3	7	3	4	4	4	4	4	4
9	6	6	5	3	3	4	3	3	3	2
10	7	7	7	7	7	7	7	7	7	7
11	6	6	5	4	5	5	5	5	6	5
12	6	7	6	6	6	6	5	6	6	6
13	6	5	5	5	5	5	5	5	5	5
14	6	5	5	4	4	5	5	3	5	4
15	6	2	3	4	5	6	6	6	6	6
16	6	4	4	4	4	4	6	5	5	5

Table 5

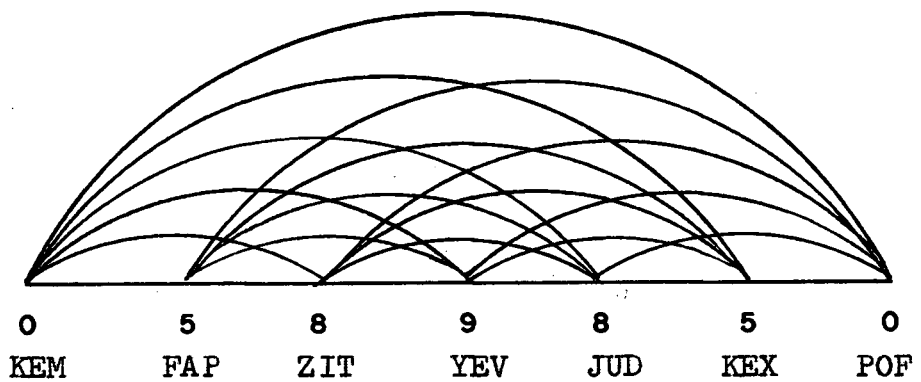
Analysis of Variance of Performance Scores of Two Groups of Subjects Tested under Different Conditions, with Six Trials for each Group

Source of variation	Sum of Squares	d.f.	Mean Square	F
Between methods: E,C.	4.083	1	4.083	...
Between subjects in the same group:	343.062	30	11.435	
Total between subjects:	347.145	31		
Between trials: E-1 to E-6; and, C-4 to C-9:	3.041	5	.608	1.256*
Interaction: Trials x methods	.729	5	.145	...
Interaction: Pooled subjects x trials:	72.564	150	.484	
Total within subjects:	76.334	160		
Total:	423.479	191		

*Not significant at the .01 level of confidence.

Figure 1

Hull's Theory of Interference in Serial Learning

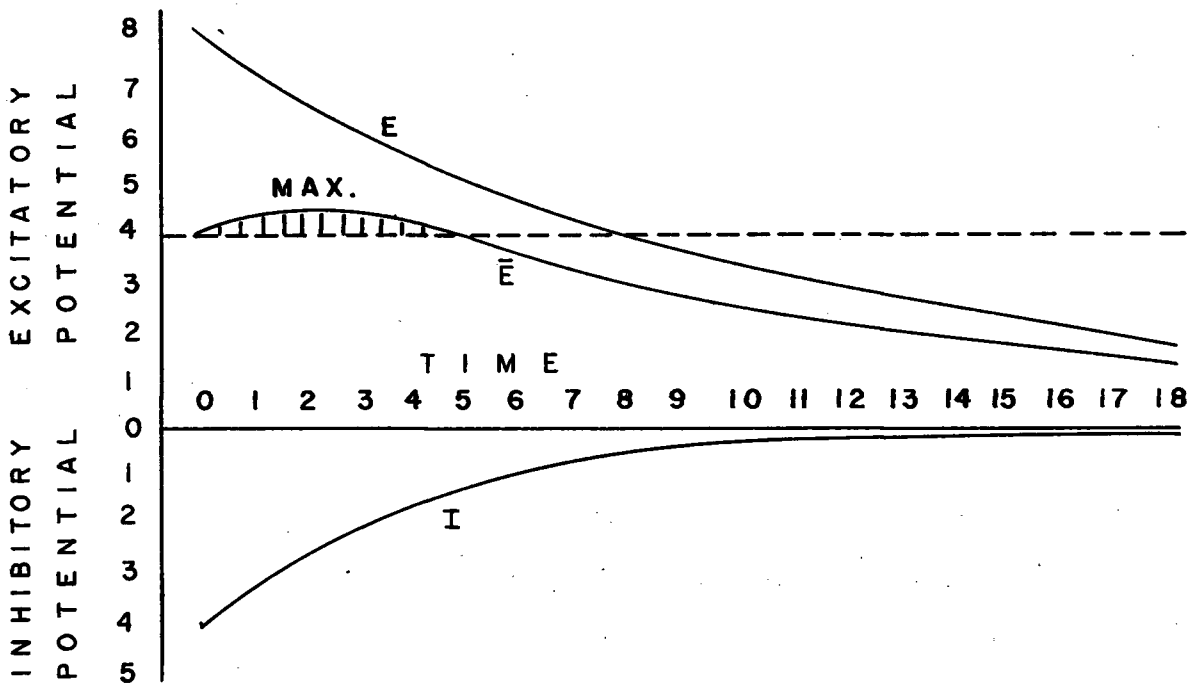


"An explanation in terms of inhibition of delay for the difficulty in memorization at the middle of a series of nonsense syllables.

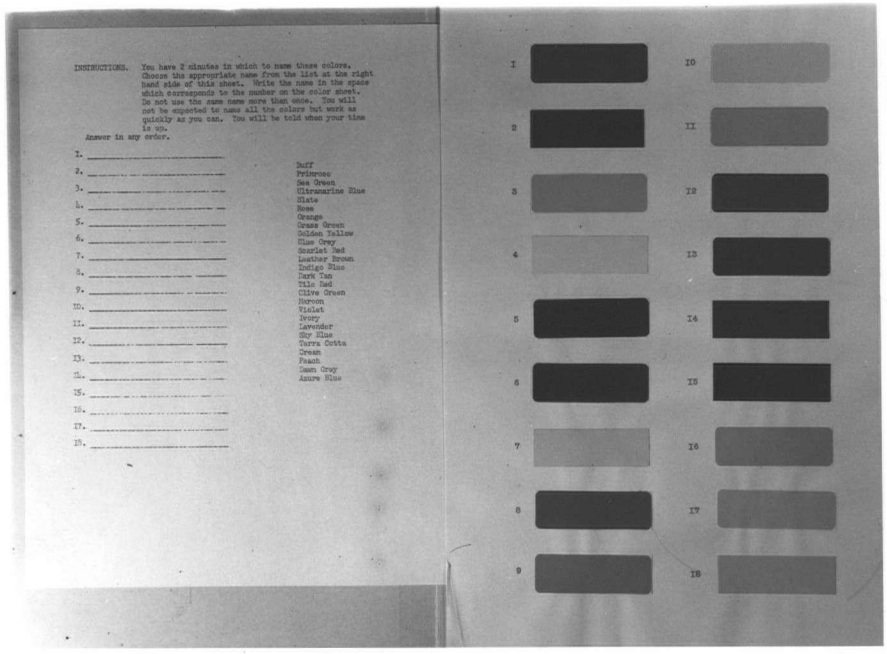
"The figure, which is taken from Hull (23), shows remote associations in the forward direction by curved lines. Backward associations are neglected for purposes of simplicity. The amount by which an intervening item is interfered with ('inhibited') may be determined by counting the number of lines spanning each item. The numbers are presented above the syllables. It is evident that the ends of the list will be favored in memorization, while items toward the middle will be progressively more difficult to learn." (10.)

Figure 2

Hull's Prediction of Reminiscence



"Diagram showing the theoretical relationship of Ward's (48) reminiscence phenomenon to the differential rate of decay of excitatory and inhibitory potentials at a given point of final conditioning. ...the effective excitatory potential is simply the excitatory potential less the inhibitory potential, i.e., $\bar{E} = E - I$. The area representing the reminiscence effect is hatched." (from Hull, et al (24)).



INSTRUCTIONS. You have 2 minutes in which to name these colors. Choose the appropriate name from the list at the right hand side of this sheet. Write the name in the space which corresponds to the number on the color sheet. Do not use the same name more than once. You will not be expected to name all the colors but work as quickly as you can. You will be told when your time is up.

Answer in any order.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____

Buff
Primrose
Sea Green
Ultramarine Blue
Slate
Rose
Orange
Grass Green
Golden Yellow
Blue Gray
Scarlet Red
Leather Brown
Indigo Blue
Dark Tan
Tile Red
Olive Green
Maroon
Violet
Ivory
Lavender
Sky Blue
Terra Cotta
Green
Peach
Taupe Gray
Azure Blue

Figure 3. Interpolated task activity

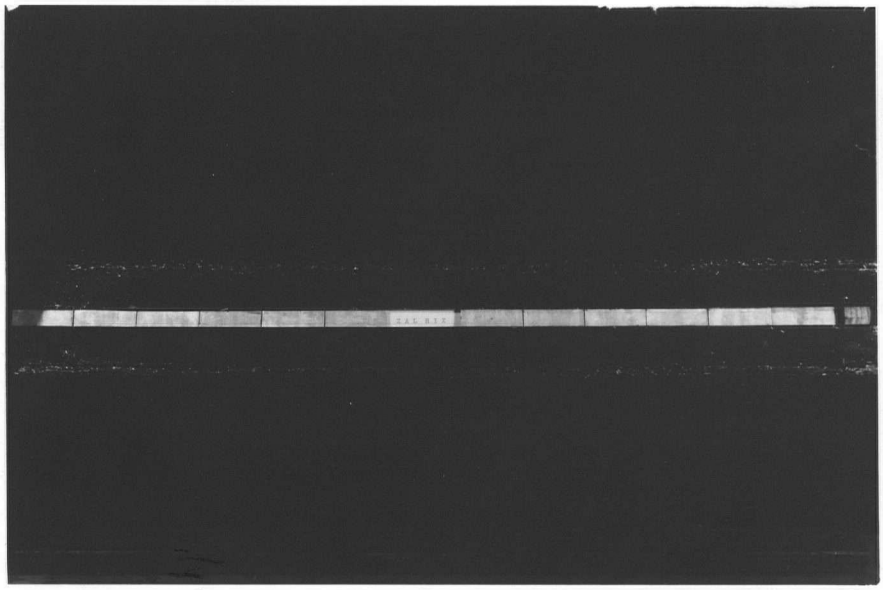


Figure 4. Subject's view of apperature of the memory apparatus.

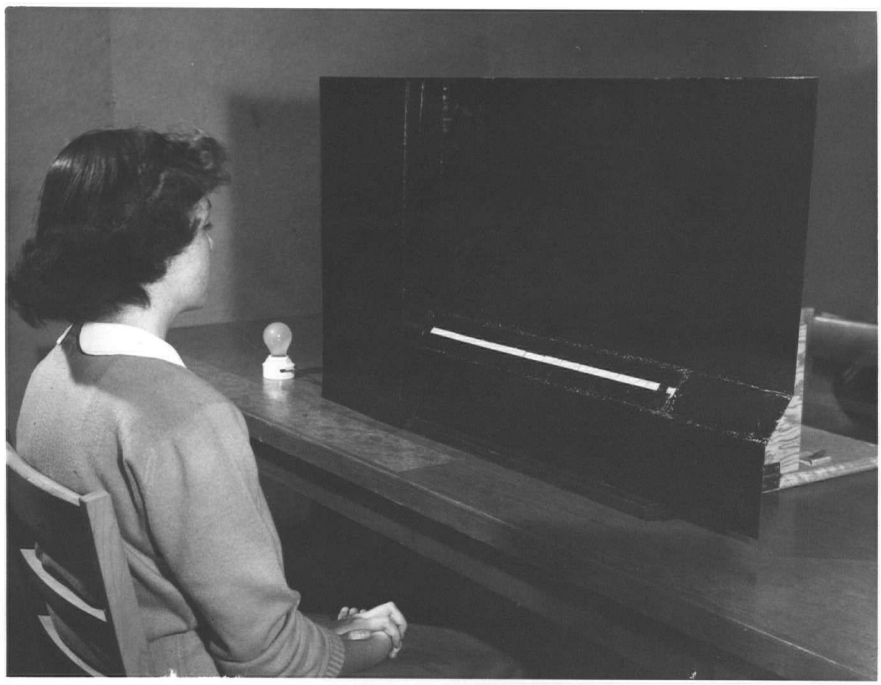


Figure 5. Subject seated and ready for the learning task. The light to the left signals the start and end of the learning task and the interpolated task in the E group.

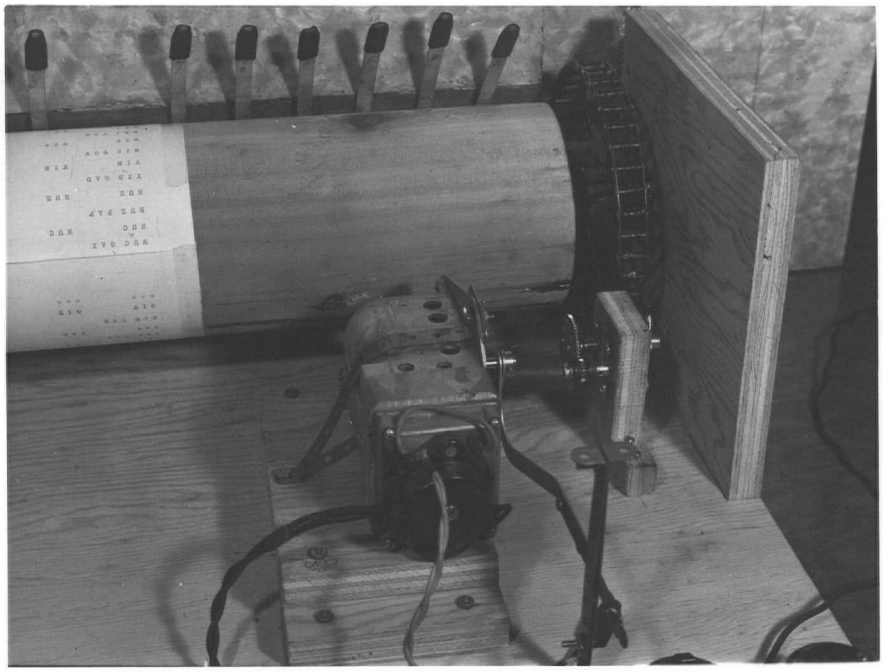


Figure 6. Timing mechanism for the revolving drum.

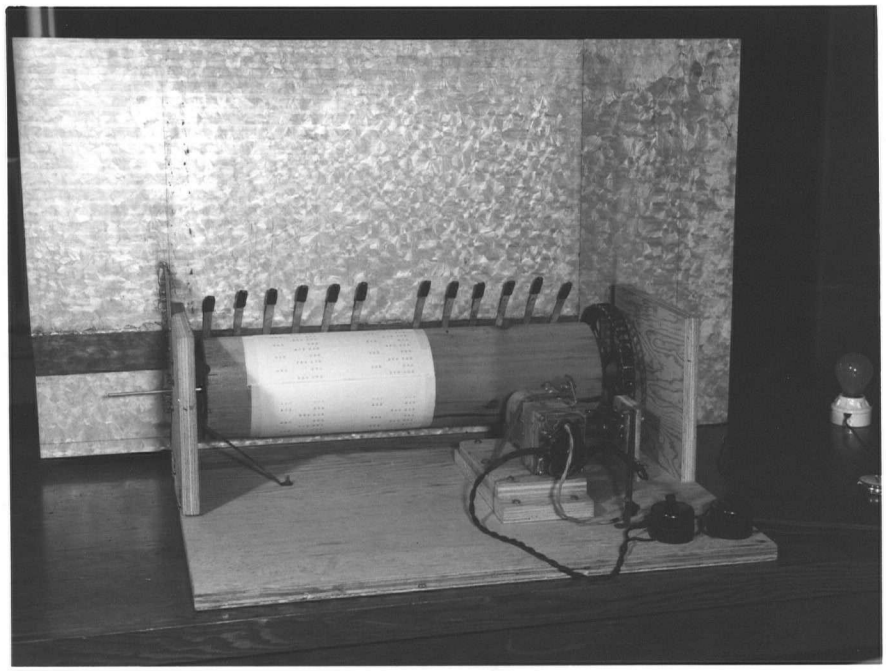


Figure 7. General rear view of the memory apparatus.

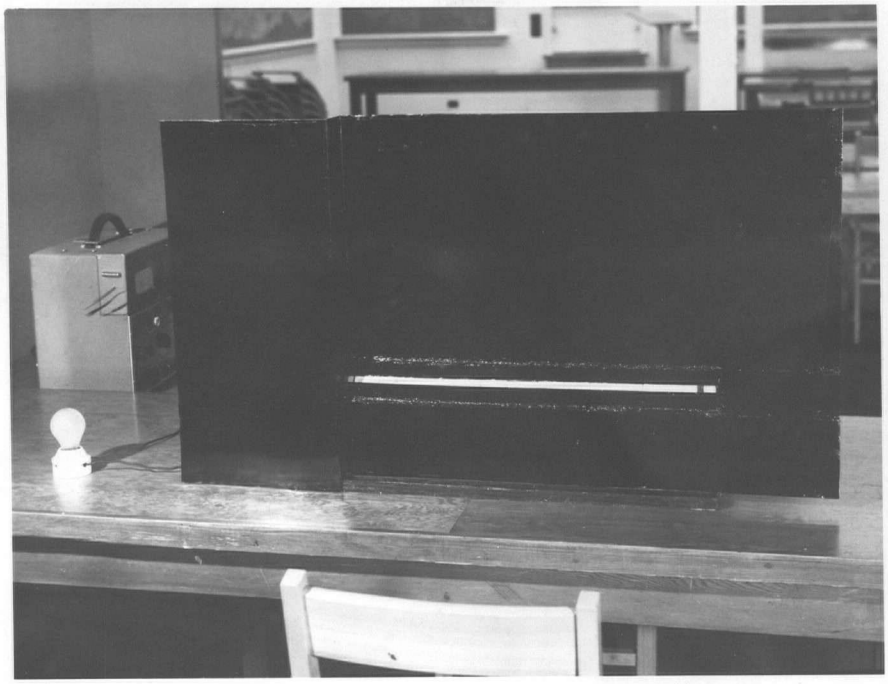


Figure 8. General front view of the apparatus.

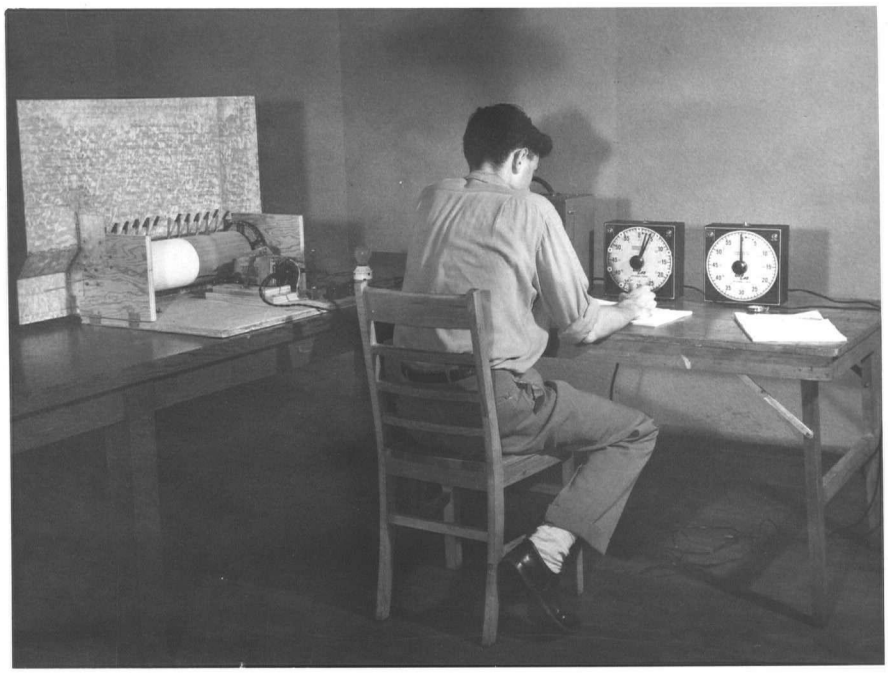


Figure 9. Recording of Ss responses.

Figure 10

Sample Record Sheet

Subject # 28 Day: experimental Learning Data

Sheet # 1 (immediate recall) (delayed recall)

TRIAL

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
TIV POB		POV	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
LEB NUK				NIR	ZIR	ZIR	+	ZAH	MIR	MIR	MIR	+	MEJ			ZIR		
MOJ ZIR		+	+			+	+	+	+	+	+	+	+	+	+	+		
YED FUP						NUK		GIC	VAH		MIR	NUK	NUK	NUK		GOC		
BOF VAH							ZAH	ZAH	ZAH		ZAH	ZAH	ZAH	+	+	+		
JAT GOX						NIX	NUK							+		+		
ZUD KIF							MEJ	RUV				PAF	MEJ					
GIC MEJ					RUV		+	RUV		+	+	+	+	+	+	+		
DAX RUV					+	POV		+	+	+	PAV	PAV	PAF	PAF	+	+		
correct anticip:		1	2	1	2	2	4	3	3	4	3	3	3	5	5	6		

Total correct: 47 Number of trials to criterion: 16

Remote anticipations: 15

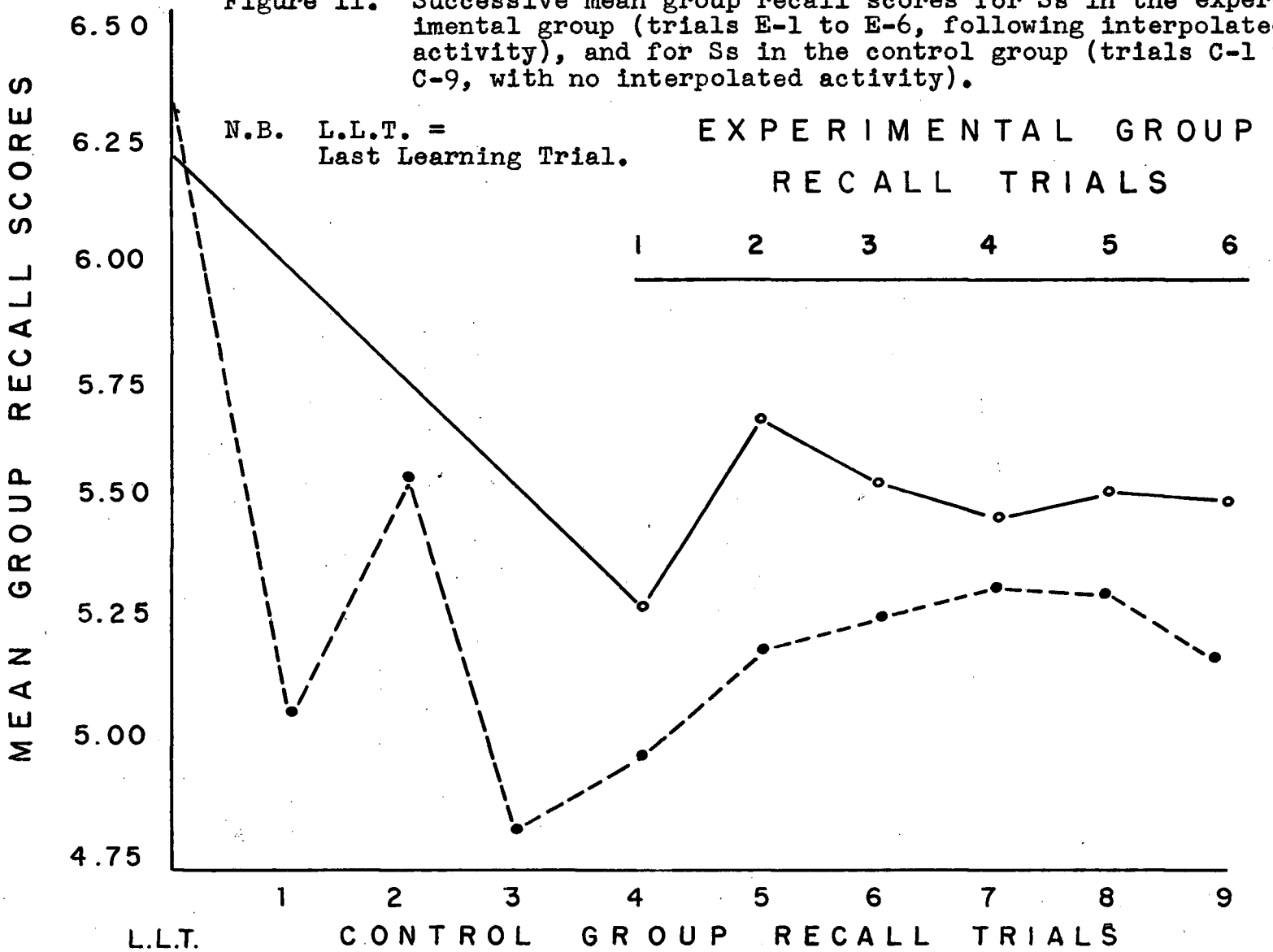


Figure 11. Successive mean group recall scores for Ss in the experimental group (trials E-1 to E-6, following interpolated activity), and for Ss in the control group (trials C-1 to C-9, with no interpolated activity).

N.B. L.L.T. = Last Learning Trial.

Figure 12

Paired-associates Correctly Recalled more Frequently Compared to Correct Associations During Learning

Immediate Group

Number of times pair correctly associated during recall.	5	4	3	2	1	0	
	5	9	5	7	4	1	6
		-	1	2	1	-	5
			3	2	2	-	4
1	4			-	3	-	3
2	1	-			3	-	2
3	1	-	-			5	1
4	2	1	1	-			
5	-	6	2	2	2		
6	3	6	4	2	5	12	
	0	1	2	3	4	5	

Delayed Group

No. of times pair correctly associated during learning.

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