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Meaningfulness and Similarity as Determinants of Verbal Retention

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MEANINGFULNESS AND SIMILARITY AS DETERMINANTS OF VERBAL RETENTION

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THE PROBLEM

Statement of the problem. The purpose of this study was to ascertain the relationships and interaction between two factors--meaningfulness (*m*) and similarity (*s*)--as these factors affect the retention and recall of high and low *m* consonant-vowel-consonant (CVC) trigrams. The variable *m* is herewith defined in terms of the mean ratings of association frequency (*a'*) as determined by Noble (1961). High *m* CVC trigrams are those which have an *a'* value between 3.0 and 3.5 on a five point rating scale. Low *m* CVC trigrams have an *a'* value between 1.06 and 1.5 on the same scale.

The variable *s*, as defined herein, refers to the extent to which the units of the original learning activity (target material components) resemble the units of the interpolated activity occupying the retention interval. High *s* refers to learning units which belong to the same category (CVC's), while low *s* refers to units representative of two categories (CVC's and symbols).

Retroactive inhibition and verbal retention. Factors influencing the retention of verbal materials have long been of general interest to learning theorists. The Law of Proactive and Retroactive Inhibition (McGeoch, 1932) states that retention is a function of the activities occurring prior and subsequent to the original learning activity. Retroactive inhibition (RI) is said to be operative if material introduced subsequent to the original learning activity interferes with or produces a decrement in the retention of the target material. The paradigm for RI is A-B-A, where learning the interpolated material B interferes with the recall of the target material A.

Hellyer (1962) demonstrated that a correspondence exists between the amount of recall and the amount of rehearsal or experience with the target material prior to the interpolated activity, i.e., the more rehearsal, the better the retention. Thune and Underwood (1943) investigated the effects of varied amounts or degrees of interpolated learning on RI build-up. With increasing amounts of interpolation up to ten repetitions of an interpolated list, they found that RI was a function of the degree of interpolated learning and hypothesized that the amount of unlearning of the original list was constant after a "few trials" on the interpolated list.

Müller (1937) sought to determine at what point in the interval between learning and recall the RI from interpolated material was the greatest. He concluded that the disturbance of retention was not due to RI alone. Hilgard and Bower (1966) suggest that Müller's findings support the view that RI is at a maximum near the point of reproduction, thus indicative of proaction rather than retroaction. Bigge (1964) states that some writers prefer not to distinguish between retroaction and proaction, but rather to use the term interactive inhibition to describe any negative transfer effect of intervening events. McGeoch and Irion (1952) capsulized the issue:

> Different experimenters with different conditions have found each of the three points of interpolation (just after learning, just before recall, and intermediate) to yield the greater amount of retroaction. The relationships between point of interpolation, length of interval and the other variables of this type of experiment have not been sufficiently worked out to permit any generalized statement concerning point of interpolation (p. 427).

Koffka (1935) outlined a form of RI theory in his proposal that forgetting may be due, in part, to the disappearance of memory traces through assimilation to new traces or processes. Brown (1958) and Broadbent (1963) found evidence to support a trace theory of RI wherein a memory trace decays autonomously in the absence of rehearsal. Brown's results suggest that decay of the trace is not affected by its relative similarity to the interpolated material. Melton (1940) offered a two-factor theory of RI in which he postulated a direct "unlearning" of the original responses during the learning of interpolated material. The second factor was competition of original and interpolated responses at the point of recall. Response competition is the basis for the interference theory of RI, a theory which has broadened to include unlearning, proaction and spontaneous recovery.

<u>Meaningfulness and verbal retention</u>. The extent to which the target material is meaningful greatly influences how well it is retained and recalled. Studies of verbal retention demonstrate rather conclusively that meaningful material is recalled much more easily than nonsense material. Bigge (1964) suggests that m consists of relations between facts--generalizations, rules, principles--for which students see some use. Bigge identifies solitary facts as having essentially the same m as nonsense syllables, and suggests that approximately the same forgetting curves apply to both. Katona (1940) concluded from his experimentation that learning with understanding (involving principles of perceptual organization) enhances recall to a much greater degree than does rote memorization.

Underwood and Schulz (1960) stress the importance of m as a determinant of verbal retention and mention three criteria used to assess the m of verbal units:

1. the number of <u>associations</u> elicited by the unit within a specified period of time,
2. the rated <u>familiarity</u> of the unit, or
3. the <u>pronunciability</u> of the unit.

They hold that pronunciability of verbal material, rather than associative frequency, is more closely related to rate of learning. The results of several studies (McGeoch, 1930; Noble, 1952; Underwood and Richardson, 1956) suggest that as m of verbal material increases, rate of learning increases.

Gibson, Bishop, Schiff and Smith (1964) determined the perceptual thresholds for items high in either pronunciability or m, but low in the other, and for control items which were low in both. They found that while pronunciability was more effective in structuring units for reading, m was more effective in structuring units for retention. Structuring refers to grouping the letters into a single item.

McNulty (1965) used four methods to measure the retention of two lists of dissyllables (two-syllable units). Each list contained high, medium and low m units. The methods were: (a) serial anticipation, (b) unaided recall, (c) reconstruction and (d) recognition. McNulty found that as m of the learning material increased, the percentage of correct items also increased for all methods except recognition. The easier recognition of low m items was explained in terms of their contrast to the other, higher m items in the list.

Underwood (1964) identified the three most important variables influencing the rate of learning in long-term memory (LTM) as: (a) meaningfulness, (b) intralist similarity and (c) ability level of the subjects. He pointed out that the aforementioned variables have been shown to exert no influence on retention measures once differences in degree of learning were equated for the various experimental conditions. Underwood (1966) measured degree of learning in terms of the number of repetitions of a given association.

Underwood highlighted some of the complex issues involved in neutralizing degree of learning in order not to bias measurements of retention.

Similarity and verbal retention. Another factor of concern to theorists investigating memory for verbal material is the nature of the activity and/or material occupying the retention interval. The Law of Context (McGeoch, 1932) asserts that the degree of retention, as measured by performance, is a function of the similarity between the original and the interpolated learning activity. The Skaggs-Robinson hypothesis (Hilgard and Bower, 1966) states that:

> As similarity between interpolation and original memorization is reduced from near identity, retention falls away to a minimum and then rises again, but with decreasing similarity it never reaches the level obtaining with maximum similarity (p. 313).

Robinson's experimentation, however, showed that when the interpolated material was totally dissimilar, retroactive inhibition (RI) was at a maximum. Hilgard and Bower (1966), on the other hand, state that one can reasonably expect a maximum of RI at some intermediate point of similarity between the target and interpolated material. If there is very little similarity, there should be very little RI.

Brown (1958) noted little difference in RI between similar and dissimilar interpolated material, i.e., the percentage of correct recalls did not vary appreciably in relation to the similarity of the interpolated to the target material. Brown observed that the recall errors tended to be mainly overt intrusions when the materials were similar and omissions when the materials were dissimilar. Wickelgren (1965) found that the absolute level of recall was lower when similar material (8-letter lists) was interpolated between the target items (4-letter lists) and the point of recall. The findings of Murdock (1961) and Waugh and Norman (1965) suggest that the amount and nature of the interpolated material, rather than the time involved per se, affects the recall of the target item. Hilgard and Bower (1966), however, cited evidence which supports the contention that recall is poorer when it is delayed than when it is not.

Broadbent (1963) suggests that in short-term memory (STM-under 30 sec.) interference from activity interpolated between presentation of the target material and recall is essentially independent of the nature of that activity so long as the activity prevents rehearsal for the same period of time. Keppel (1965) reviewed methodological problems which occur in the study of STM. He states that rehearsal during the retention interval may be minimized by stressing the importance of the interpolated activity occupying the interval. Ceraso, Schiffman and Becker (1965) observe that recall interference should depend upon the amount and strength of the interpolated material that can potentially interfere at the point of recall, i.e., the more learning of interpolated material, the more RI.

There appears to be widespread agreement among authors of verbal learning studies that, as meaningfulness (m) of the target material increases, the rate of learning and degree of retention also increases. Disagreement is evident, however, as to whether or not similarity (s) of the interpolated material affects retention of the target material. Brown (1958) and Broadbent (1963) propose that RI build-up during interpolation is not affected by the s of the interpolated to the target material, whereas the findings of Robinson (1932) and Wickelgren (1965) demonstrate that similar interpolated material engenders increased RI.

The diverse findings of the aforementioned experimenters may stem from different theoretical orientations. Brown and Broadbent advocate a trace theory of RI, while Robinson and Wickelgren lean toward an interference theory of RI. The present study was an attempt to produce evidence favorable to either a trace or interference theory of RI within an a-theoretical framework. In a systematic review of the literature to date, the experimenter failed to find any studies designed to systematically assess the specific relationships obtaining between s of the interpolated material and m of the target material.

<u>Experimental design and hypothesis</u>. The present study featured an RI paradigm designed to assess the relationships obtaining between *m* of the target material (CVC trigrams) and *s* of the interpolated material (CVC trigrams and symbols) under conditions of high and low *m* and *s*. The ensuing relationships were examined in light of the findings outlined above. Specifically, it was hypothesized that there would be no significant difference (.05 level) in the recall performance of subjects engaged in a similar interpolated activity (perceptual coding of CVC trigrams) and subjects engaged in a dissimilar interpolated activity (perceptual coding of symbols).

METHOD

Subjects

The subjects (Ss) were 23 male and 37 female student volunteers enrolled in an undergraduate psychology course at Central Washington State College. The mean age for all Ss was 20.2 years, with the age range extending from 18 to 32 years.

Apparatus

The target material consisted of two lists, one of eight high meaningfulness (m) and one of eight low m CVC trigrams. The trigrams were selected from Noble's (1961) list of 2100 possible CVC trigrams in the English language. To insure minimal intralist similarity:

1. no two trigrams began with the same letter,
2. no letter occurred more than twice within each list, and
3. all trigrams which formed English words were omitted.

The high m list of CVC trigrams consisted of: JOL, MAX, GIT, BAM, SIL, PUD, CEN and RUF. The low m trigram list consisted of: XUP, SIJ, ZOX, QEH, VAH, GIQ, WOJ and YEF. Each list was centered on an 8 x 11 inch transparency.

The two lists were shown via an overhead projector (Besseler Master Vu-Graph - Cat. No. 6600) placed approximately six feet from a standard movie screen. A trigram perceptual coding task (PCT) was used which contained nine CVC trigrams selected from the same divisions of Noble's (1961) list as those used in the high and low m lists. A symbol perceptual coding task (PCS) was also employed. The PCS task contained nine symbols which were somewhat more complex than the symbols found in the Coding B subtest of the Wechsler Intelligence Scale for Children. The data were collected in individual test booklets (see Appendix I and II, respectively).

Procedure

The Ss were randomly divided into two groups of 30 Ss each. All Ss were asked to read the instructions on the test booklet cover. Group I viewed the high m list of CVC trigrams for two minutes; two days later, Group II viewed the low m list of CVC trigrams for two minutes. Prior to viewing the trigrams (Part One), the Ss were instructed:

> When the list of trigrams appears on the screen, study it carefully and memorize as many of the trigrams as you can. Do not write any of the trigrams down until you are asked to do so.

After viewing the trigrams, all Ss engaged in a perceptual coding task (Part Two) for three minutes. One-half of the Ss in each group coded CVC trigrams (PCT) while the other half of each group coded symbols (PCS). Written instructions for the PCT task were:

> Match as many of the trigrams as you can with their appropriate numbers as shown in the key. Fill in the squares from left to right until you are asked to stop.

Written instructions for the PCS task were:

> Match as many of the symbols as you can with their appropriate numbers as shown in the key. Fill in the squares from left to right until you are asked to stop.

When the time limit had been reached, the *S*s were asked to stop. All *S*s were then given a recall test (Part Three) to determine how many of the trigrams from Part One they could recall, in any order, within a two-minute time limit. The written instructions for the recall test were:

> Write down in the spaces below as many of the trigrams shown on the screen as you can recall, in any order you wish.

The trigrams recalled by each *S* were scored on a 0-8 point scale, with one point credited for each trigram correctly recalled.

RESULTS

The primary objective of this experiment was to determine whether or not a similar interpolated activity (CVC trigram coding) would effect a significant decrement in the recall of high and low meaningful CVC trigrams. To this end, the data were analyzed in terms of a 2x2 factorial design (Edwards, 1960). Such a design allows one to conveniently assess the degree of treatment (m and s) and treatment-interaction (m x s) variability. The findings supported the null hypothesis that no significant difference in recall performance exists between Ss engaged in a similar (CVC trigram coding) and Ss engaged in a dissimilar (symbol coding) interpolated activity.

Table 1 presents a summary of the analysis of variance.

Table 1

Analysis of Variance

Source	df	MS	F
Meaningfulness (m)	1	132.01	153.5*
Similarity (s)	1	.42	
m x s	1	.42	
Error	56	.86	
Total	59		

* $p < .05$

The effect of meaningfulness (m) upon recall of CVC trigrams was clearly significant ($p < .05$). However, neither the effect of similarity (s) nor the interaction m x s was significant.

The mean number of trigrams recalled by Ss in each of the four experimental conditions is given in Figure 1. The mean number of trigrams recalled by the 30 Ss in Group I was 6.7, as compared to 3.8 for the 30 Ss in Group II. Twelve

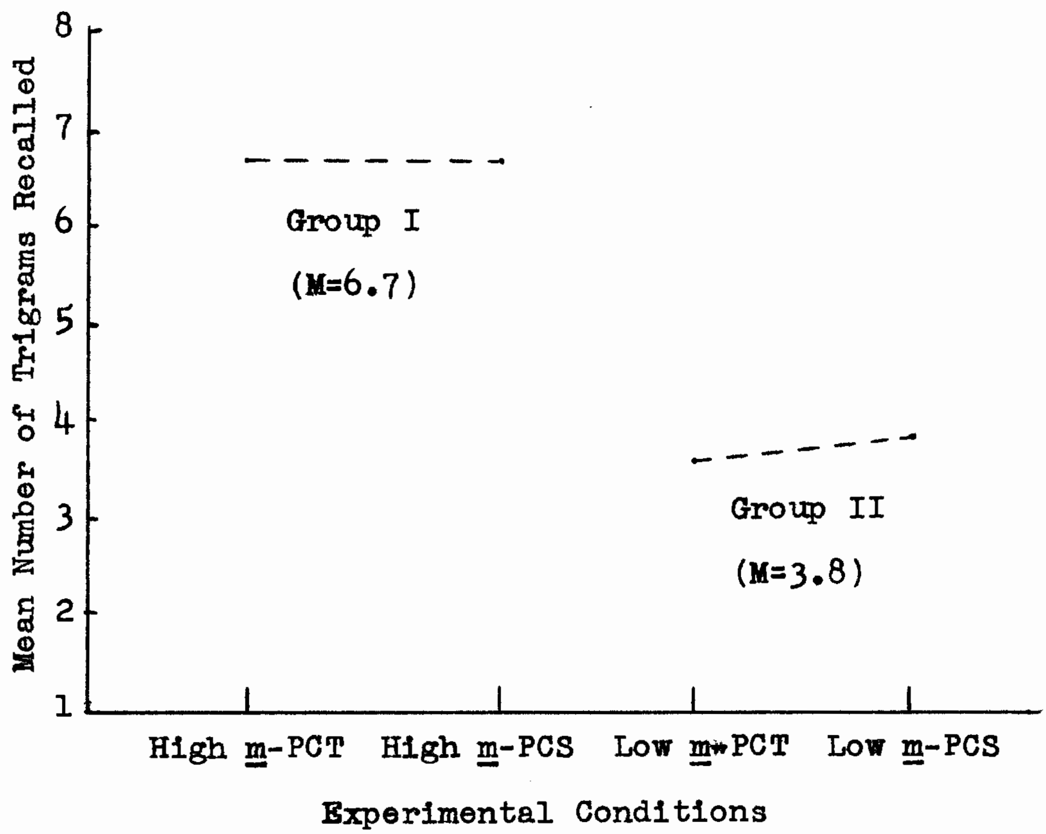

Fig. 1. Mean number of trigrams recalled by Ss in each experimental condition.

of the Ss in Group I and none of the Ss in Group II recalled all eight of the original trigrams. One S, in Group II, failed to recall any of the trigrams. Cochran's test (Winer, 1962) was used to determine whether or not the variance of the treatment groups was homogeneous. The results indicate that one can safely assume random sampling of Ss from a population with the same variance ($p > .01$).

The mean number of trigrams recalled by the male Ss was 5.1 and by the female Ss was 5.4. The number of symbols coded by Ss ranged from 41 to 123, with a mean of 86. The number of trigrams coded ranged from 16 to 104, with a mean of 62. Two of the 30 Ss who coded trigrams intruded one PCT trigram in their recall of the original trigrams. Intrusions refer to the inclusion of a coded trigram in the written recall of the original trigrams and are considered the primary indicators of response competition by proponents of an interference theory of RI.

DISCUSSION

The results of the present study supported the null hypothesis that there would be no significant difference in the recall performance of subjects engaged in a similar interpolated activity (perceptual coding of CVC trigrams) and subjects engaged in a dissimilar interpolated activity (perceptual coding of symbols). Therefore, the research hypothesis that high and low similarity (s) of interpolated to target material differentially affects recall of the target material was not confirmed. Minimal retroactive inhibition (RI) may be reflected in the mean recall score (6.7) for Group I, whereas substantial RI seems evident in the recall performance of Group II. However, the depressed mean recall score (3.8) of Group II may be due to the increased difficulty of learning and retention associated with the low meaningfulness (m) trigram list, rather than to any substantial increase in RI.

While the inter-group (m dimension) recall disparity was expected, the lack of intra-group (s dimension) recall disparity was somewhat puzzling. Contrary to the findings of Robinson (1932) and Wickelgren (1965), in this study high and low s of the interpolated material (trigrams and symbols) to the target material (trigrams) did not differentially affect RI build-up. The discrepancy most likely stems from different definitions of s and/or types of interpolated material. The emphasis in the present study was on conceptual s, whereas Robinson and Wickelgren both dealt with what Underwood (1966) calls formal s. The results of this study do not appear to support the Skaggs-Robinson hypothesis, since the amount of recall shown by Ss engaged in the dissimilar task equalled, in the case of Group I, and surpassed, in the case of Group II, the recall of Ss engaged in the similar task.

The results of the present study are consistent with the findings of Brown (1958) on two points. First, the mean recall score per experimental condition did not vary appreciably in relation to the s of the interpolated to the target material. Secondly, more omissions occurred in both Groups I and II when dissimilar interpolated material was used. Contrary to Brown's results, however, the occurrence of overt intrusions where the materials were similar was negligible in the present study. The extremely low number of intrusions occurring in the recall of the Ss who coded trigrams attests to the experimenter's assertion that trigram coding produced minimal RI.

The effect upon recall of the number of units coded by the subjects was confounded by the variable learning difficulty of the original lists of trigrams. Such confounding could possibly be circumvented by using a pre-test of recall to assess degree of learning (of target material) prior to introduction of the interpolated activity. The nature (trigrams and symbols) and amount (number of units coded by each S) of interpolated material varied considerably over subjects, yet the influence of these two variables upon recall was apparently negligible. Therefore, Broadbent's (1963) suggestion that interference from activity interpolated between presentation and recall is essentially independent of the nature of that activity appears to be applicable to long-term memory as well as short-term memory. The findings of Murdock (1961) and Waugh and Norman (1965) are inconsistent with the above suggestion, since they imply that the amount and nature of the interpolated activity does have an effect upon the recall of the target material.

The crux of the issue--similarity (s) as a source of RI--seemingly lies in the definition and/or nature of s. Underwood (1966) delineates three types of s: formal, meaningful, and conceptual. Conceptual s refers to items that belong to the same category or represent the same concept. In the present study, there was no conceptual s between the trigrams and symbols, but there was high conceptual s between the trigrams in the target and interpolated activities.

Most investigations of retroactive inhibition (RI) and verbal learning, to date, have used interpolated material that was either partially identical or totally dissimilar (such as backward counting) to the verbal target material. When the interpolated material is identical to the target material, interpolation functions solely as rehearsal.

When the interpolated material is totally dissimilar, however, there appears to be little build-up of RI. Some rehearsal during interpolation may have occurred in the present study, due to an inadvertent "tip-off" concerning a test of recall (see Appendix I: Part One).

The key implication of this study is that the degree of conceptual s of the interpolated to the target material does not appear to differentially influence recall of the target material. Additional experimentation is needed to determine the effect of intermediate degrees of conceptual s in the interpolated material upon recall of various types of target material. The findings of this study failed to support an interference theory of RI in view of the lack of overt response competition. However, the findings appeared compatible with the prediction of a trace theory of RI that the target trace should decay at the same rate no matter whether similar or dissimilar material is interpolated. The results of this study may be relevant to subject-matter sequencing procedures within the classroom, i.e., conceptually dissimilar subjects would not appear to interfere with one another.

ABSTRACT

Meaningfulness (m) and similarity (s) were examined as determinants of verbal retention in a 2x2 factorial design. Group I (30 Ss) and Group II (30 Ss) memorized a high m and a low m list of eight CVC trigrams, respectively, for two minutes. One-half of the Ss in each group then coded CVC trigrams (similar task) while the other half coded symbols (dissimilar task) for three minutes, followed by a recall test of the original list. An analysis of variance showed m to be highly significant ($p < .01$) as a determinant of recall, whereas s and the interaction of m x s exerted no appreciable effect upon recall. The findings suggest that high and low degrees of conceptual s do not differentially influence the build-up of retroactive inhibition.

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APPENDICES

APPENDIX I

Trigram Coding Test Booklet

AN EXPERIMENT IN VERBAL LEARNING

Name: ______________________________ Sex: M F Age: _____

Instructions

You are about to participate in a verbal learning experiment. The experiment consists of three parts and will take about 15 minutes of your time. Please keep the following instructions in mind:

1. Keep your eyes on your own test booklet, except when viewing the three-letter trigrams on the screen.

2. Refrain from talking or asking questions once the experiment has begun.

3. Work carefully and accurately.

4. Fold each page underneath the test booklet when you are asked to proceed to the next part of the experiment.

Part One

When the list of trigrams appears on the screen, study it carefully and memorize as many of the trigrams as you can. Do not write any of the trigrams down until you are asked to do so.

Part Two

Directions: On the next page are some numbers and corresponding trigrams. You are to match as many of the trigrams as you can with their appropriate numbers as shown in the key. Fill in the squares from left to right until you are asked to stop.

KEY

Part Two

1	2	3	4	5	6	7	8	9
BEC	HUS	FON	WUJ	MIV	QOX	CIR	ZAV	KEJ

7	1	6	3	2	4	8	9	2	5	1	8	3	1	9

4	7	3	6	2	5	8	3	9	7	4	1	6	7	2

9	3	5	8	4	1	3	6	2	5	1	5	7	2	9

3	5	8	6	4	7	3	1	8	9	2	6	4	1	7

8	2	4	9	3	7	1	5	9	7	4	6	3	1	8

5	4	9	6	8	4	7	1	3	8	2	9	6	4	7

1	9	3	6	2	5	7	8	4	3	6	3	2	8	5

7	1	9	4	8	1	7	2	5	3	9	2	8	6	3

Part Three

Directions: Write down in the spaces below as many of the trigrams shown on the screen as you can recall, in any order you wish.

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APPENDIX II

Symbol Coding Test Booklet

AN EXPERIMENT IN VERBAL LEARNING

Name: ______________________________ Sex: M F Age: ______

Instructions

You are about to participate in a verbal learning experiment. The experiment consists of three parts and will take about 15 minutes of your time. Please keep the following instructions in mind:

1. Keep your eyes on your own test booklet, except when viewing the three-letter trigrams on the screen.
2. Refrain from talking or asking questions once the experiment has begun.
3. Work carefully and accurately.
4. Fold each page underneath the test booklet when you are asked to proceed to the next part of the experiment.

Part One

When the list of trigrams appears on the screen, study it carefully and memorize as many of the trigrams as you can. Do not write any of the trigrams down until you are asked to do so.

Part Two

Directions: On the next page are some numbers and corresponding symbols. You are to match as many of the symbols as you can with their appropriate numbers as shown in the key. Fill in the squares from left to right until you are asked to stop.

KEY

Part Two

1	2	3	4	5	6	7	8	9
N	ʒ	⊖	∧	⊐	∆	ȯ	Ч	$

7	1	6	3	2	4	8	9	2	5	1	8	3	1	9	4	7	3	6	2

5	8	3	9	7	4	1	6	7	2	9	3	5	8	4	1	3	6	2	5

1	5	7	2	9	3	5	8	6	4	7	3	1	8	9	2	6	4	1	7

8	2	4	9	3	7	1	5	9	7	4	6	3	1	8	5	4	9	6	8

4	7	1	3	8	2	9	6	4	7	1	9	3	6	2	5	7	8	4	3

3	6	2	8	5	7	4	1	9	4	8	1	7	2	5	3	9	2	8	6

6	3	5	7	6	1	8	4	6	3	5	1	6	9	2	8	9	3	7	4

2	4	8	1	9	6	3	1	7	2	4	5	4	7	1	8	3	6	2	9

Part Three

Directions: Write down in the spaces below as many of the trigrams shown on the screen as you can recall, in any order you wish.

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APPENDIX III

Procedure For Data Collection

Procedure For Data Collection

Students participating in Group II were dismissed from class during the testing session of Group I and vice-versa. The participants were asked to sit in the first four rows of the classroom (B-102). A monitor passed out the test booklets and the experimenter (E) said:

> "Please fill in your name, sex and age at the top of your test booklet and read the Instructions section over carefully. (40 sec. pause) Remember that a trigram is any sequence of three letters. Are there any questions? Does everyone have a pen or pencil?"
>
> "Now please read the directions for Part One at the bottom of the page." (15 sec. pause)
>
> The trigram list was flashed on the screen for two minutes, then E said:
>
> "Please turn to the next page and read the directions for Part Two. (15 sec. pause) Are there any questions? Now turn to the next page and begin Part Two." (3 minute interval)
>
> "Stop! Now turn to the next page and follow the directions for Part Three." (2 minute interval)
>
> "Stop! Please pass your test booklets to the right for collection."
>
> "You will be informed of the purpose and outcome of the experiment by Friday. Thank you."