INTRALIST SIMILARITY, INTERNAL STRUCTURE, AND FREE RECALL

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CHAPTER I

THE PROBLEM

Background of the Problem

One of the most significant variables in verbal learning, both in terms of its heuristic value and its effects on learning, is intralist similarity. Largely through the efforts of Underwood and his associates the influence of intralist similarity has been systematically investigated in both the paired-associate and serial learning situations. More recently, some investigators have utilized the free recall situation for the analysis of intralist similarity. Free recall is established when a subject is instructed to study the stimuli as they are presented and then recall them without regard to order. Generally, it has been found that high intralist similarity interfers with performance on paired-associate and serial tasks (e.g., Underwood, 1954) but facilitates performance with free recall (Aborn and Rubenstein, 1952; Miller, 1958; Rubenstein and Aborn, 1954; Underwood, 1964).

The facilitation effect in free recall does not consistently occur, and some investigators (e.g., Horowitz, 1962) have found better recall of high similarity items only on early trials. There are two general approaches with regard to this situation. One stresses concepts which are part of the traditional learning area, such as stimulus generalization. The other position stems from information theory, specifically from the work of Garner and his co-workers. When a subset of stimuli are chosen out of the total set of stimuli that could be generated, a relatedness between stimuli exists. This relationship, which is referred to as internal structure, has been shown to have a significant influence in free recall of geometric figures (Whitman and Garner, 1962) and nonsense "words" (Garner and Whitman, 1965). The form of internal structure is defined by contingencies between the stimulus dimensions so that simple contingencies between the stimulus dimensions, which produce easy recall, are designated as good form. It has been suggested that form must be considered in manipulating similarity if a consistent relationship is to be found. Although the concepts of Garner seem applicable to the investigation of intralist similarity and free recall, nothing has been done in this area. It is the purpose of this study to extend Garner's concept of internal structure to the problem of intralist similarity and free recall.

Hypotheses Pertinent to the Problem

In considering the possible relationship between intralist similarity, internal structure and free recall the following questions arise:

1. What is the role of form in free recall? Are high similarity lists with good form learned consistently better than high similarity items with poor form? Do high similarity lists with good form lose this superiority on later trials?

2. How much importance can be attached to the idiosyncratic features of the items? Will different lists yield similar results?

3. To what extent is the superiority of high similarity items a function of the number of trials? Will there be a significant interaction of similarity with trials?

CHAPTER II

REVIEW OF THE LITERATURE

The current study is concerned with the role of two variables, intralist similarity and internal structure, in free recall. Empirical and theoretical findings related to intralist similarity will be discussed first. Next, the experimental and theoretical positions with regard to internal structure will be presented. Finally, the relationship of intralist similarity and internal structure will be explained.

Intralist Similarity and Free Recall

Although there are many operations by which similarity can be defined, most definitions may be subsumed under four headings: figural similarity, structural similarity, similarity of meaning, and conceptual similarity. Figural similarity is defined by judges rating the similarity of figures in relation to each other or by the number of shared figural elements. Structural similarity is manipulated by varying the number of common letters or numbers. For a list of trigrams of given length, intralist similarity is defined by the number of letters used in constructing the list; the fewer the letters, the higher is the intralist similarity. Intralist similarity may also be manipulated by varying the number of synonyms in a list; this is what is meant by similarity of meaning. Finally, conceptual similarity refers to words which belong to the same class (e.g., countries, colors).

Empirical Findings - Structural Similarity

One group of studies took root in information theory, and the free recall lists are referred to as "redundant" or "highly organized". For example, Miller (1958) employed the finite state generator to produce redundant lists. The item length varied from four to seven letters. From the same pool of four letters, he combined letters randomly to produce another class of lists. In this manner, Miller produced two sets of lists: lists generated from the explicit rules provided for the finite generator, and lists composed from the same letters combined at random. Lists were presented in random order, and after each presentation Ss recalled items by the method of free recall. Recall of redundant lists (high similarity) was superior to the recall of random lists. Miller suggested that the intralist similarity of redundant strings is greater than that of random strings. His Ss were presented with lists of either 30 or 60 redundant strings or 30 or 60 random strings and were instructed to search through the list for redundant items. Miller says: "It took about twice as long to search through the redundant strings, and it is in this sense that the redundant strings have a greater degree of similarity" (p. 487).

Aborn and Rubenstein (1952; Rubenstein and Aborn, 1954) found essentially the same results as Miller. They generated 16 CVC trigrams from a pool of 19 letters. The letters were combined by various techniques to form lists ranging from random to those which were "highly organized". The greater the organization or redundancy the higher was the mean recall score.

If high redundancy is considered equivalent to high intralist similarity, as this term has been understood in serial and paired-associate learning, then these studies may be said to show the higher intralist similarity the better the free recall.

This evidence led Horowitz (1961) to believe that high intralist similarity might facilitate free recall. He studied the effects of intralist similarity on free recall with two lists, each containing 12 CCC trigrams. The high similarity trigrams were generated from four letters; low similarity items came from a pool of 12 letters. Subjects were 14 and 15 year-old British high school boys. Two groups of matched Ss recalled as many syllables as they could, without regard for order, after seeing the entire stimulus list. The result is that high similarity facilitated free recall early in learning, but this superiority was lost on later trials. In a replication, Carterette (1963), using American college students, found no improvement over trials in the recall of high similarity items, although initially high similarity items were recalled better than the low similarity trigrams. The initial superior recall of high similarity trigrams appears to be based on guessing by rearranging the four letters used in the list. Nevertheless, Carterette found the same loss of superiority of recall of high similarity items as did Horowitz, although it occurred sooner than in the Horowitz study.

Empirical Findings - Conceptual Similarity

Bousfield and his students at Connecticut (1961) have produced a wealth of data on clustering of conceptually related items in recall. The source of these stimuli is taxonomic norms which were developed, at Connecticut, on 400 undergraduate students. Subjects wrote their first four specific responses to 43 categories of items such as animals, professions and cloths. Within each category, the frequency of occurrence for each response was calculated resulting in high and low frequency items. In the context of intralist similarity, high frequency items are also high in similarity. A study by Bousfield, et al (1958) can be interpreted as offering support for this premise. Four stimulus lists were randomly assigned to four different groups of Ss. The lists were constructed so that comparisons could be made between the same categories at high and low frequency. Results showed that the high frequency items - those which possess high conceptual similarity - were more readily recalled than the low frequency words.

Underwood (1964) reports a study in which 64 nouns from the Bousfield and Cohen lists (1955) were used as stimuli. Half of the stimuli were assumed to be unrelated to each other and to the other set of 32 words. The other 32 items were divided into eight groups each containing four words designating the same concept. Hence, these words possessed high conceptual similarity. The stimuli were presented verbally by E, who repeated one word twice during a one minute period. The instructions gave no hint that concepts were involved. Each list was presented once and Ss were given 2.5 minutes to write all the words they could recall. Directions made it clear that words could be recalled in any order. It was found that the mean number of items recalled was greatest for conceptually related words. Ekstrand and Underwood (1963) investigated free recall as a function of intralist similarity and paced or unpaced recall. Similarity was again defined in terms of the Bousfield stimuli. Specifically, 12 countries from those most frequently named by college students made up the high similarity list, while low similarity items came from the same table but were taken from diverse categories. Items were presented on a memory drum and each S was given three study and three recall trials. The important finding here is that high similarity items were recalled better than low similarity items.

Theoretical Position

Underwood (1959) has proposed that a two-stage process is operative in paired-associate learning. The first is the response learning phase, during which responses are learned as such and become available in a recall sense. The second stage is the hooking-up phase or associative stage wherein the already-learned response is connected with the appropriate stimulus. There is some experimental evidence to show that high similarity facilitates response learning while it hinders associative learning (Underwood, Runquist, and Schulz, 1959; Horowitz, 1962).

If free recall is regarded as a special case of paired-associate learning in which all responses become associated with a single stimulus, with this stimulus being the free recall instructions, the experimental situation or whatever, then free recall may be considered as an instance of response learning. If free recall is equated with response learning, then Underwood's paired-associate model predicts that high intralist similarity will facilitate free recall. During free recall the various responses become available for recall, but there is no requirement that these responses become hooked up with particular stimuli. Within the theoretical framework of Underwood and his associates, there is a basis for the generalization that free recall should be facilitated by high similarity.

Internal Structure and Free Recall

Garner (1962) has emphasized the relationship between items within stimulus groups. This interrelatedness is referred to as structure. Structure has both an amount and a form. The amount of structure is determined by the size of the subset relative to the total set. When the number of actual stimuli equals the number of stimuli in the complete set, there is no internal structure. On the other hand, as the difference between the subset size and total set increases the amount of internal structure increases. Therefore, the difference between the complete set of stimuli and the size of the actual subset used is directly proportional to the amount of structure.

Consider for example the situation in which sequences of three numbers are used as stimuli, and the complete set consists of all possible combinations when numbers 1-3 are used in each letter position. In this case the complete set of stimuli would contain 27 trigrams. In the free recall situation when all stimuli in the complete set are used, there is no internal structure. On the other hand, if some fraction of the items in the complete set is used as stimuli, then internal structure exists and Ss must learn which of the stimuli actually appear. This leads to the generalization that the fewer the number of stimuli in the subset, the greater the amount of structure.

By contrast, form of internal structure is a function of the particular subset of stimuli used. Referring to the example of number sequences, we can pick two subsets from the same total set which possess the same amount of structure yet differ in form. Two possible subsets each containing nine items appear in Table I.

TABLE I

ILLUSTRATION OF GOOD AND POOR FORM

Good Form	Poor Form
111	111
112	123
113	132
221	213
222	222
223	231
331	312
332	321
333	333

Although the amount of structure is constant, the form is good for only one subset. Good form is defined when a direct contingency exists between two positions. If the first and second positions are correlated, then everytime a 1 appears in the first position a 1 also appears in the second position for instance 111, 112, 113. In the poor subset a 1 in the first position may be followed by one of three numbers in the second and third positions for example 111, 123, 132. The correlation between letter positions thus defines the form of structure in verbal learning. The best form results from simple pair contingencies in which a high correlation exists between specified letter positions.

Empirical Evidence

There are three experiments which relate internal structure to free recall (Whitman and Garner, 1962; Garner and Whitman, 1965; Whitman, 1966). Whitman and Garner (1962) manipulated form of internal structure with visual figures. Three subsets each consisting of nine figures were used out of a total set of 81. More specifically, figures were composed of four factors - shape, lines, spaces, and dots - each at three levels. If all levels of all factors were combined in a manner analogous to a complete factorial arrangement, a potential set of 81 would result. The three subsets corresponded to good, medium, and poor form. For example, whenever a circle (dimension one) appeared it could be predicted that there would be no bisecting line (dimension two) and no opening or space in the figure (dimension three). With these three correlated stimulus characteristics present, only one dimension, that regarding the appearance of a dot, was uncorrelated. Thus the good form subset was formed so that three of the variables were perfectly correlated. In like manner, two of the variables were perfectly correlated for the medium form stimuli. The principal finding was that stimuli with direct contingencies, and therefore good form, were learned most rapidly.

Garner and Whitman (1965) have investigated the effect of form and amount of internal structure in verbal learning. Four letter nonsense "words" were generated so that both amount and form of structure could be analyzed. With respect to form of structure, it was found that good form stimuli were recalled more readily than the poor form items to the extent that in no case did the median trials to criterion for a poor form list fall within the alloted ten trials. In regard to the amount of structure, it was found that the total set and the good form subset of eight items were learned equally well supporting Garner's hypothesis that stimulus subsets with low redundancy will be learned more quickly than highly redundant items. However, amount of structure was defined in such a way that it was not equivalent to intralist similarity. Therefore, the Garner and Whitman study did not clarify the relationship of intralist similarity and internal structure.

More recently, Whitman (1966) has investigated the effects of form and association value on free recall. CVC trigrams were selected to produce four different lists: good form, high association value; good form, low association value; poor form, high association value; poor form, low association value. The good form lists had the first and third letter positions correlated and the amount of structure held constant. With low association, good form stimuli facilitated free recall. At high association value, however, no significant difference was observed, indicating perhaps that high association value obscures the influence of form. Although these studies are not directly related to intralist similarity, they do indicate that structure is an important variable in the free recall situation.

Theoretical Position

When similarity is structurally defined, it becomes synonymous with redundancy in Garner's general theoretical scheme and leads to the generalization that free recall is facilitated by low redundancy while discrimination learning is facilitated by high redundancy. Free recall is roughly equivalent to response recall and discrimination to associative phase. At this point then - viewing the problem from different perspectives and using different constructs - Garner and Underwood both predict that high similarity (low redundancy) should facilitate free recall. Garner, however, goes a step farther and proposes that form is also an important variable in free recall such that simple contingencies (good form) facilitate free recall while complex relations among variables (poor form) diminish free recall.

Horowitz, working within the Underwood theoretical framework, has confounded the effects of similarity and form. In Garner's system an explicit separation is made. Horowitz noted that intralist similarity has two functions: (1) It is the extent to which the items of a list share letters in common with each other; (2) It is expressed in terms of ". . . The sequential restrictions between the letters of items." Although he noted the difference between similarity and form, he proceeded to confound them in his experimentation. Similarly, Miller's (1958) redundant lists are referred to as highly similar using Underwood's definition. Here again form and similarity are confused. The lists, in Underwood's terms, are all highly similar since all items are generated from a pool of four letters. They differ in form.

Miller's use of the search technique to define similarity also shows why a distinction must be made between form and similarity. If intralist similarity is defined in terms of the extent to which lists share the same letters, then all lists were high in similarity. Differences in search time must be a function of form.

The review of the literature leads to one conclusion: similarity and form are both important variables in verbal learning, but the effects of these two variables must be separated in order that a clearer analysis can be made. The loss of superiority of the high similarity items on later trials is such an example. Horowitz used good form with his low similarity items while using poor form with the high similarity list. According to Whitman and Garner, if Horowitz had used a good (or random) form of structure with the high similarity lists, he would have obtained consistent superiority of the high similarity lists in free recall.

Two problems are inherent when form and intralist similarity are jointly manipulated. First, when low similarity is structurally defined the form is indeterminate. Many letters are used in constructing a low similarity list, which means that a particular first position letter may appear only once in the entire list. Form is indeterminate in this case since the first letter does not appear more than once in the list. A second problem arises in the high similarity lists where the amount of structure is, by the operations which define high similarity, lower than that in low similarity lists. Since high similarity is defined by using a few letters to generate the list, the size difference between the subset used and total set will necessarily be smaller than for the low similarity lists. In spite of this difference, the influence of form is expected to be a significant element in the free recall situation (Whitman and Garner, 1962).

The general purpose of this investigation is to separate the effects of similarity and form and show their relative importance in the free recall situation.

CHAPTER III

METHOD

Stimulus Materials

There were three sets of stimulus materials, one for each replication. Each set contained the following lists: high similarity, good form (G), high similarity, poor form (P), and low similarity, indeterminate form (L) (see Table II).

Similarity was defined (Underwood, 1954) as the extent to which stimuli on the list share the same letters. High similarity lists were generated from a pool of 9 consonant letters randomly selected from a population of 19 possible letters. Three letters were assigned to each of the letter positions. In the low similarity lists, letters for position one and two were randomly drawn from the pool of 19 consonants without replacement, insuring that no letter would fall in both positions. The third position letters were chosen from the set of 19 thus repeating some letters which had previously been assigned to the first or second position.

The criterion for form was taken from Whitman and Garner (1962) where good form is identified with simple pair contingencies. Poor form is represented by uncorrelated pairing of letters.

Procedure

Subjects were tested individually. The lists were presented one

TABLE II

LISTS OF TEST STIMULI

REPLICATION 1

G	P	L
BFG	CWP	SFK
KHD	MWR	GPC
ZJL	NXR	PTR
KHL	CXQ	DGM
ZJG	NTP	THL
KHG	NWQ	LWD
BFL	MTQ	FZX
ZJD	MXP	HQJ
BFD	CTR	BTF

G	P	L
FKZ	QDM	BLZ
FKW	GXM	NFX
RCW	GJS	KCS
HLW	PXB	HTJ
HLT	PDS	XDL
RCZ	QJB	JGN
RCT	QXS	ZMT
FKT	GDB	RPF
HLZ	PJM	QWB

REPLICATION 3

G	P	L
JZR	HDT	RHK
JZB	XLN	WBJ
FCR	XDM	KGC
FCW	HKN	FXD
JZW	HLM	XRL
GPB	QKM	DNP
FCB	QDN	MHT
GPR	XKT	CWS
CPW	QLT	HMQ

at a time on a Lafayette memory drum. Subjects practiced each list to a criterion of two successive perfect trials or 10 consecutive trials, whichever occurred first. Intersubject counterbalancing of lists was employed. With three lists, six counterbalancing conditions resulted. The rate of presentation was four seconds. After S was seated approximately 18 inches from the memory drum, the experimenter read the following instructions:

> This is an experiment in verbal learning. You are to memorize the nonsense syllables which you will see in the window of the memory drum. The nonsense syllables will appear one at a time. When the last syllable has disappeared from the window, you are to write all the nonsense syllables you have just seen. The order in which they are recalled is not important. Just write as many syllables as you can remember after each time you see the complete list. When you have written all the syllables you can recall, we will start the next trial. Do you have any questions?

This procedure was exactly the same for all three replications. Answers were recorded by S in a booklet so arranged that there was no visible access to previous responses.

Subjects

Subjects were 36 women selected from classes in introductory psychology at Oklahoma State University in the spring semester of 1966. All subjects were naive with respect to participation in verbal learning experiments. Twelve subjects were assigned to each replication and the counterbalancing sequences were randomly assigned within each replication.

CHAPTER IV

RESULTS

General Statistical Procedure

The data was cast into a double split plot, and the statistical analysis on the number of correct syllables was performed by the corresponding analysis of variance. One difficulty resulted from the presentation of G, L, and P lists to all subjects. While this repeated measurement technique reduces the variance due to inter-subject differences, it also makes the assumption of a homogeneous variance-covariance matrix quite hazardous. Since violation of this assumption generally produces a positive *F*-test bias, the conservative *F*-test suggested by Geisser and Greenhouse (1958) was used for all tests of significance resulting from the analysis of variance.

The Influence of Similarity and Form

The raw data used in the analysis may be found in Appendix A.

Figure 1 indicates the general relationship of the G, P, and L lists when responses are averaged over replications: G produced the best performance followed by L then P. This relationship was statistically explored by an analysis of variance (Table III) followed by several multiple comparisons which were given by the Newman-Keuls test. Table III reveals that lists ($p < .01$) and trials ($p < .01$) were both statistically significant. The interactions for lists x trials and

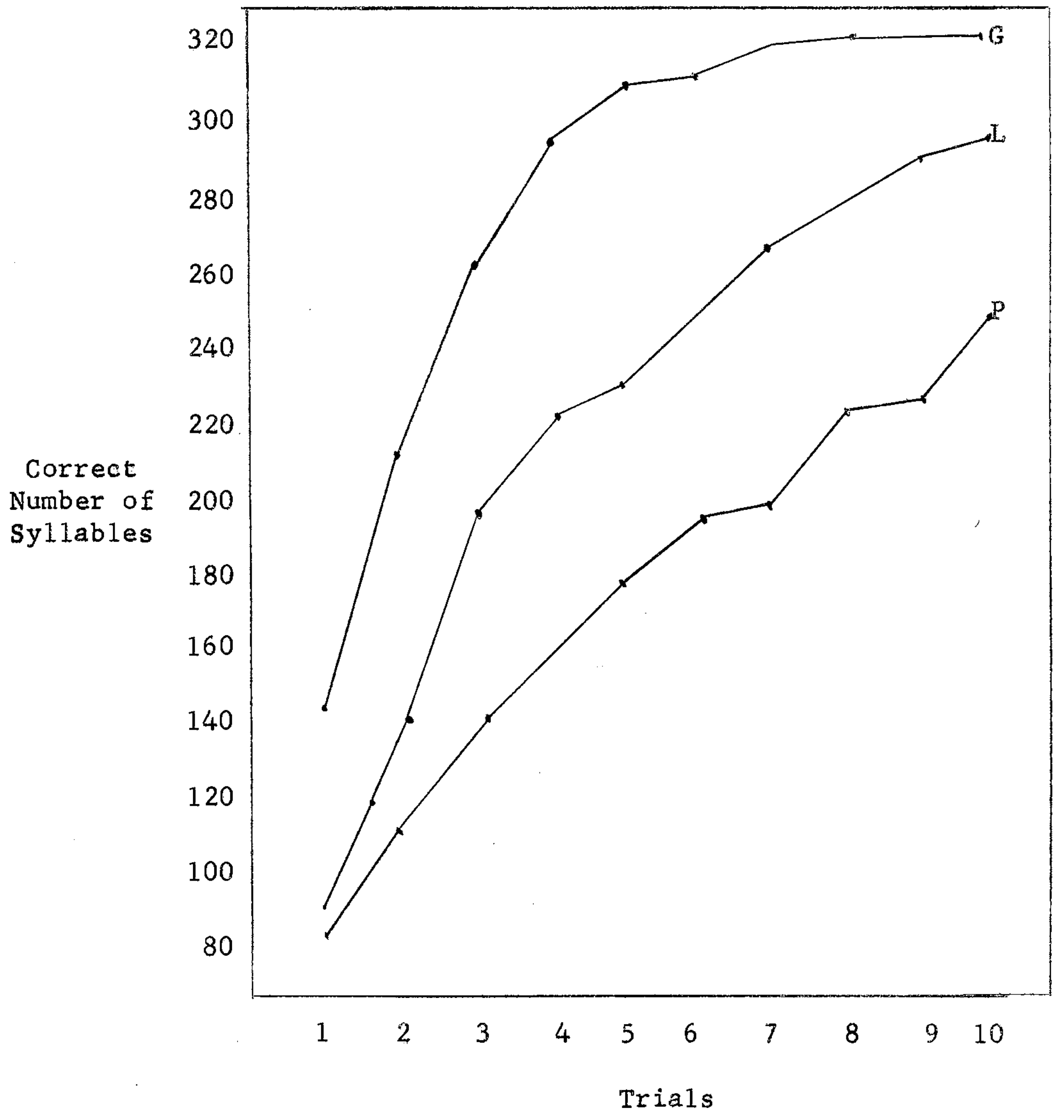

Figure 1. Number of Correct Syllables for all Ss on G, P, and L Lists.

TABLE III

ANALYSIS OF VARIANCE OF CORRECT
SYLLABLES RECALLED

Source of Variation	Degrees Of Freedom	Sum of Squares	Mean Square	F
Total	1079			
Between Subjects (Ss)	35			
Replications (Reps)	2	51.201	25.601	<1
Ss in Reps	33	880.561	26.684	
Within Subjects	1044			
Lists	2	1572.291	786.145	44.453**
Reps x Lists	4	78.471	19.618	1.109
Lists x Ss in Reps	66	1167.239	17.685	
Trials	9	2649.685	294.409	271.145**
Reps x Trials	18	22.298	1.239	1.141
Trials x Ss in Reps	297	322.483	1.086	
Lists x Trials	18	112.987	6.277	8.681**
Reps x Lists x Trials	36	58.196	1.617	2.235**
Lists x Trials x Ss in Reps	594	429.550	.7231	

** $p < .01$

for reps x lists x trials were also significant ($p < .01$). Although the overall mean score for replication 1 was higher than that for replication 2 and 3, the replication differences were not statistically supported.

Analyzing the list effect in more detail with the Newman-Keuls technique revealed that G was statistically superior to both the P and L lists ($p < .01$) while low similarity items were recalled more readily than items with poor form ($p < .01$). This relationship tends to hold for analysis of early and late trials as well. On early trials (1-5) G was statistically superior to both the L and P lists ($p < .01$) and the L list produced better recall than the P list ($p < .05$). However it may be noted (Table IV) that the initial means for the P and L lists are strikingly similar. It appears that the significant difference between these lists came from the greatly enhanced performance of the L list subjects after trial 2. On later trials (6-10) there is a significant separation among all lists ($p < .01$). It is evident that the shape of the response curves are quite different. The G list became negatively accelerated on trial 3 and reached an apparent asymptote on trial 8. On the other hand the curves for L and P appear more or less linear.

The reps x lists x trials interaction was also investigated by multiple comparison techniques. This analysis indicated significant differences ($p < .05$) among all lists, over all replications, for both early and late trials. Thus the relationship among the G, P, and L lists is not substantially altered.

Since some <u>S</u>s under all stimulus conditions did not reach criterion within the allotted ten trials, median in addition to mean values

TABLE IV

MEAN CORRECT RECALL SCORES AND MEAN TOTAL RESPONSE SCORES FOR G, P, AND L

TRIAL	MEAN NUMBER OF SYLLABLES CORRECTLY RECALLED			MEAN NUMBER OF RESPONSES GIVEN		
	G	P	L	G	P	L
1	4.03	2.25	2.50	4.97	4.08	3.61
2	5.92	3.11	3.72	6.61	5.33	5.36
3	7.31	3.73	5.39	7.75	5.89	6.81
4	8.17	4.42	6.11	8.42	6.83	7.31
5	8.58	4.92	6.39	8.75	6.94	7.58
6	8.67	5.36	6.94	8.75	6.94	7.58
7	8.86	5.50	7.33	8.92	7.22	8.14
8	8.92	6.19	7.75	8.97	7.75	8.47
9	8.92	6.25	8.06	8.94	7.94	8.72
10	8.92	6.97	8.22	8.94	8.42	8.72

should be noted. When the median number of trials to criterion is computed (Table V), the differences in recall are substantial and are in the same direction as the previous analyses.

TABLE V

MEDIAN TRIALS TO ONE OR TWO CONSECUTIVE PERFECT RECITATIONS

	List		
	G	L	P
First Perfect Recitation	3.50	7.17	9.33
Second Perfect Recitation	4.80	8.83	10+

CHAPTER V

DISCUSSION

The current results will be discussed as they relate to other empirical findings and to the theoretical formulations of both Underwood and Garner.

Comparison of G and P Lists

The comparison of the G and P lists produced results which are in good accord with previous investigations. In general, G lists are more readily recalled under a variety of stimulus conditions including visual figures (Whitman and Garner, 1962), four letter nonsense "words" (Garner and Whitman, 1965), CVC trigrams of low association value (Whitman, 1966) and redundant strings of letters (Miller, 1958).

The superiority of good form items is predicted by Garner from his assumption that good form produces better performance than that associated with poor form stimuli. Though the underlying process which is responsible for this increase in recall is not specified by Garner, one possible candidate might include a recoding process such as that contained in Miller's chunk hypothesis. In this case the units of memory span in free recall are the labeling units of chunks which are more or less constant in number but which can increase in size. Consequently, the number of chunks available are limited but the amount of information contained in each chunk continually expands. A recoding process is assumed by Miller to be involved in the expanding content of the chunks.

The inclusion of such a process would be consistent with the prediction of superior recall for G items. In the G list, only three recoded units are necessary to generate the bigrams for letter positions one and two. The P list contains nine bigrams each of which must be separately recoded. Since G subsets require less recoding, recall should be better than with P items.

Comparison of P and L Lists

The present finding, that L items are recalled consistently better than P items, is in partial agreement with the results of Horowitz (1961) and Carterette (1964). They found that L items were more readily recalled than P items only on later trials. This difference may be due in part to the greater probability of guessing a correct item in the Horowitz study. Since he used a subset of twelve poor form stimuli out of a total set of 24, the probability of correctly guessing an item is 1/2. In the current study the probability of guessing a correct item is 1/27. On this basis it can be expected that the P stimuli used by Horowitz will be recalled more readily simply because of the higher probability of guessing a correct arrangement. On the other hand, the L stimuli in the present study were generated from a pool of 19 consonants while the L items in the Horowitz investigation were generated from a pool of 12 consonants. Since a larger total set is possible with a pool of 19 consonants, it follows that the L items in the current study would be more easily guessed and hence more readily recalled. Carterette (1964) using the stimuli from the Horowitz investigation found a more pronounced superiority of the P items on early trials when subjects were explicitly instructed to guess. This lends support to the notion that the superiority of recall of P items is a function of probability of correctly guessing the stimulus items either because of the nature of the items, the instructional set of the Ss, or both.

This result, that L items are recalled more readily than P items, apparently contradicts Underwood's general hypothesis that high similarity items will be recalled more readily than low similarity stimuli. In the present situation high similarity stimuli with poor form are not as easily recalled as the low similarity items.

Garner's predictions in this case are unclear, but two possibilities emerge. First, low similarity items can be considered unique pairings of letters so that pair contingencies are necessarily high (Whitman and Garner, 1962). Thus low similarity subsets are regarded as possessing good form. In this manner it can be predicted that low similarity stimuli will be recalled better than poor form items. One basic fact argues against this interpretation: Low similarity items simply do not possess good form as it is now defined. Contingencies between letter positions exist only when a letter appears in the same position more than once, and low similarity items as presently conceived do not meet this requirement. Unless a letter is repeated in the same position a contingency does not exist, and form can not be specified.

Another possibility is that the form of the L items, though actually indeterminate, may be estimated as falling between good and poor form thereby yielding items of medium form. Previous experimentation has shown that visual figures of medium form are recalled better than poor form stimuli (Whitman and Garner, 1962). It might be argued then that L items are functioning as items with medium form and should be recalled more readily than P items. However, to define stimuli as possessing medium form without reference to an independent measure, but simply because Ss respond to them as we would predict on the basis of form, involves a great deal of circularity.

These results can be explained without recourse to the concept of form. One alternative involves the mechanism of stimulus generalization. In the case of poor form, highly similar items may generalize to the same erroneous response. For example, CWP can be erroneously reported as CWR or CWQ for example when generalization occurs between CWP, MWR, and NWQ. This suggests that good form allows the high similarity of stimuli to be used for efficient recall while poor form only produces greater confusion with highly similar stimuli. This is not a problem with low similarity stimuli since the items are not sufficiently similar to each other to produce this confusion. Thus, good form translates the high similarity of stimuli into an effective mnemonic device while poor form produces so much interference that even low similarity items are more easily recalled.

Comparison of G and L Lists

The current results indicate that the G list is consistently superior to the L list in recall. In this situation, Underwood's assertion that high similarity items are recalled better than low similarity items is substantiated. Perhaps this analysis of form and similarity is applicable in the case of meaningful words as well.

When adjectives are used as stimuli, high similarity is defined when the items possess a similar meaning or designate the same concept, and good form defined as high contingencies between letter positions is not an appropriate concept. Nevertheless if the definition of form may be slightly adjusted to include high contingencies between word positions rather than letter positions, a similar analysis may be used. In this case good form occurs when a word denoting a particular concept is followed by a similar word. In contrast high and low similarity items can be presented in a mixed manner so that no predictable order of presentation exists. If the contingent relationship is redefined in the case of adjective stimuli so that good form exists when a word designating a particular concept is followed by a word indicating the same concept, then good and poor form may still be appropriate variables. The data of Weingartner (1964) lend support to this extension of the concept of form. He presented two sets of conceptually related words in either a random order (poor form) or a constrained order (good form) in which one complete set was presented before the other set was used. Results showed that a greater number of words were recalled in the constrained (good form) condition.

The present results support Underwood's prediction when high similarity items possess good form. If the extension of form to conceptually related words is valid, then Underwood's position may find even greater generality.

Again Garner does not make an explicit prediction; and if the L items are considered to possess good or medium form, the previously mentioned criticisms apply.

CHAPTER VI

SUMMARY

In general, free recall of high similarity items is superior to that of low similarity stimuli. There are however the exceptions of Horowitz (1961) and Carterette (1963) both of whom found that the facilitation effect associated with high similarity items was limited to early trials. One possible explanation is that the high similarity stimuli used by these investigators also possessed poor form. In the case of trigrams form refers to the contingencies which exist between letter positions, and good form is defined by a high correlation between letter positions. For this same situation intralist similarity refers to the extent to which items on a list share the same letters (Underwood, 1954).

Several investigators have failed to distinguish between these two concepts and consequently have confounded the effects of these variables in experimentation. Horowitz, for instance, has used the term intralist similarity to refer both to similarity as it is usually understood and to form. Conceptually and experimentally, then, Horowitz failed to distinguish between the effects of similarity and form. Likewise, Miller (1958) confused these two concepts reporting that he manipulated similarity when in actuality similarity was held constant and form was varied. The current study was designed to separate the effects of similarity and form as they relate to free recall learning.

The study consisted of three replications. In each replication three stimulus lists - G, P, and L - were presented to twelve female introductory psychology students in individual sessions. The rules from which the items were generated were the same for all replications thereby producing different yet comparable stimuli. Within each replication, each subject was shown the lists in counterbalanced order until two perfect recitations or ten trials were reached for each list.

Results indicated that the generalization that high similarity items are recalled better than low similarity stimuli must be qualified with respect to form. Thus, high similarity stimuli are recalled more readily than low similarity items when good form and high similarity are both present, but low similarity subsets are superior in recall when highly similar items also possess poor form. These results were similar over all replications. This suggests that items with high similarity have the potential for facilitating free recall, but whether or not better recall occurs depends on the form of the stimulus subset. It appears that good form aids recall while poor form, through the mechanism of stimulus generalization, produces interference effects thus hindering recall.

Theoretically, Underwood's position is supported in the case where high similarity and good form are combined. To this extent free recall learning appears to be a special case of the response learning phase of Underwood's paired-associate model. Garner's basic predictions with respect to good and poor form are also supported in the comparison of the G and P lists. However the concept of form may not be necessary or even appropriate in explaining comparisons involving low similarity stimuli.

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APPENDIX A

TABLE VI

RAW SCORE DATA

		Replication 1											
List	Trial												
G	1	8	6	2	2	2	4	2	6	6	1	1	4
	2	9	6	6	5	3	6	1	5	8	1	3	7
	3	8	7	6	5	9	7	4	9	9	5	5	9
	4	9	9	7	5	9	9	7	9	9	9	6	9
	5	9	9	8	6	9	8	9	9	9	9	9	9
	6	9	9	8	9	9	8	9	9	9	9	9	9
	7	9	9	9	9	9	9	9	9	9	9	9	9
	8	9	9	9	9	9	8	9	9	9	9	9	9
	9	9	9	9	9	9	9	9	9	9	9	9	9
	10	9	9	9	9	9	8	9	9	9	9	9	9
P	1	3	4	2	3	2	2	3	3	1	1	3	4
	2	4	6	3	5	2	3	2	2	3	4	5	8
	3	5	7	4	6	1	4	1	3	4	4	4	9
	4	5	8	5	5	3	5	2	6	3	3	5	8
	5	8	8	4	6	3	7	2	8	4	2	6	9
	6	9	8	5	7	3	7	3	6	6	1	7	9
	7	8	7	7	8	4	7	3	7	5	4	6	9
	8	9	9	7	8	3	6	4	8	6	6	6	9
	9	9	9	6	9	3	9	5	9	7	5	7	9
	10	9	9	7	9	6	8	6	9	6	6	8	9
L	1	4	2	2	1	4	4	4	2	2	1	6	6
	2	5	4	3	0	5	7	7	5	4	2	7	8
	3	6	4	7	2	6	8	9	5	4	1	9	8
	4	7	4	8	1	9	9	9	6	5	2	8	9
	5	7	4	7	2	8	8	9	7	7	3	9	9
	6	7	8	9	4	8	8	9	7	8	5	8	9
	7	9	8	7	2	9	8	9	8	8	6	9	9
	8	8	7	8	3	9	9	9	7	9	3	9	9
	9	9	9	9	4	9	9	9	9	9	5	9	9
	10	9	5	7	6	9	9	9	8	9	4	9	9

TABLE VI (Cont'd)

Replication 2													
List	Trial												
G	1	4	4	7	1	3	4	1	6	7	3	3	7
	2	6	9	9	5	5	3	2	9	7	6	4	6
	3	7	9	9	9	8	8	5	9	7	5	5	8
	4	8	9	9	9	6	9	6	9	9	9	6	7
	5	9	9	9	9	9	9	6	9	9	9	7	9
	6	8	9	9	9	9	9	9	9	9	9	7	8
	7	9	9	9	9	9	9	9	9	9	9	8	9
	8	9	9	9	9	9	9	9	9	9	9	8	9
	9	9	9	9	9	9	9	9	9	9	9	8	9
	10	9	9	9	9	9	9	9	9	9	9	8	9
P	1	1	4	2	3	1	4	0	3	1	2	1	1
	2	1	2	2	6	2	5	2	5	2	2	1	1
	3	3	3	2	7	1	6	4	9	1	3	2	1
	4	2	3	5	5	1	8	5	6	4	4	2	4
	5	2	5	6	4	2	8	6	8	3	5	3	4
	6	3	4	5	6	1	8	8	9	5	6	2	3
	7	4	5	5	6	4	9	5	9	5	6	1	2
	8	5	7	6	8	1	9	7	9	5	8	4	2
	9	5	6	7	9	3	9	8	9	5	9	1	2
	10	7	8	8	9	1	9	9	9	9	9	3	5
L	1	1	1	2	1	2	5	3	3	2	2	1	0
	2	2	1	3	3	3	6	5	4	2	2	3	0
	3	1	3	7	5	6	7	7	5	6	4	4	3
	4	1	2	7	6	6	9	5	6	6	3	8	3
	5	1	2	3	6	6	9	7	5	7	4	8	3
	6	3	4	9	7	7	9	9	5	8	4	8	3
	7	3	6	9	7	7	9	9	6	9	4	7	5
	8	4	8	9	9	9	9	9	7	9	5	9	5
	9	5	7	9	9	9	9	9	8	9	5	9	5
	10	6	8	9	9	9	9	9	9	9	5	9	8

TABLE VI (Cont'd)

Replication 3													
List	Trial												
G	1	5	4	1	4	4	6	5	5	6	2	7	2
	2	7	7	6	6	7	9	9	5	8	6	7	5
	3	8	7	7	6	9	9	9	8	9	6	7	6
	4	8	9	9	9	7	9	9	9	8	7	9	8
	5	9	8	9	9	8	9	9	9	9	9	9	6
	6	9	6	9	9	9	9	9	9	9	9	9	7
	7	9	9	9	9	9	9	9	9	9	9	9	5
	8	9	9	9	9	9	9	9	9	9	9	9	8
	9	9	9	9	9	9	9	9	9	9	9	9	7
	10	9	9	9	9	9	9	9	9	9	9	9	7
P	1	2	2	4	2	3	2	3	1	2	2	3	1
	2	2	2	3	2	5	3	2	2	4	4	3	2
	3	2	3	4	2	7	4	5	2	4	2	3	4
	4	3	2	3	5	9	6	4	3	4	5	3	5
	5	3	5	6	3	9	3	4	4	5	3	4	6
	6	3	5	6	5	9	4	6	5	5	4	3	7
	7	1	5	6	6	9	3	6	5	6	4	3	8
	8	5	7	6	5	9	5	7	6	5	4	5	7
	9	4	4	7	5	9	4	8	4	5	5	4	5
	10	5	4	9	5	9	4	9	8	5	4	4	7
L	1	2	2	5	1	3	2	3	2	1	2	2	4
	2	2	3	7	3	5	2	5	4	2	1	2	7
	3	6	5	8	6	7	6	7	3	4	2	4	9
	4	8	5	9	8	9	6	8	6	6	5	3	8
	5	8	7	8	8	9	8	8	5	5	4	5	9
	6	7	7	9	8	9	7	8	4	8	5	3	9
	7	9	8	7	9	9	6	8	6	8	7	5	9
	8	9	9	9	9	9	7	9	5	9	8	5	9
	9	9	8	9	9	9	9	9	4	8	8	7	9
	10	9	9	9	9	9	9	9	6	9	9	8	9

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