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A DIRECT TEST OF THE HYPOTHESIS THAT AMOUNT RECALLED IS DETERMINED BY DEGREE OF CLUSTERING

by

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B. A., Kansas State University, 1969

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1973

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ACKNOWLEDGMENTS

The author wishes to express gratitude to Sam C. Brown for his encouragement and advice throughout the progress of this research. Gratitude is also extended to Charles P. Thompson and Thaddeus M. Cowan for their many helpful comments in the preparation of this manuscript.

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INTRODUCTION

Much research in free recall has been directed toward the investigation of clustering, i.e., the tendency for subjects (Ss) to recall together items which share obvious relations (e.g., members of the same taxonomic category) even though the related items appear noncontiguously at input (Bousfield, 1953). Considered one of several empirically defined indices of organization (e.g., subjective organization, priority), clustered output order is believed to result from processes or strategies which allow S to overcome presumed limitations on the retrieval of information from memory (e.g., Mandler, 1967a; Tulving, 1968; Wallace, 1970). Thus, most theorists who support an organizational view of memory explicitly or implicitly assume that amount of clustering in output directly determines amount recalled (Bousfield & Cohen, 1953; Mandler, 1967a; Norman, 1969; Sakoda, 1956; Tulving, 1968; Wood, 1972). Although some of the empirical evidence is consistent with this notion (e.g., Thompson, Hamlin, & Roenker, 1972), there are data which question the causal influence of clustered output order on amount recalled (e.g., Dallett, 1964). Because the present study focuses on the clarification of the relationship between clustered output order and amount recalled, it is fruitful at the outset to review clustering studies which both support and question the causality of the relationship.

LITERATURE REVIEW

If clustering determines amount recalled then clustering and recall should covary positively in both single trial and multiple trial free recall studies. The failure to find such a relationship may be considered evidence against the hypothesized causal influence of clustered output order on amount recalled. As performance on a single trial may be influenced by variables which do not affect multitrial performance (e.g., recency), single trial and multitrial data will be discussed separately in the following review.

Single Trial Data

Several studies using variables which emphasized the organizational structure of the list have produced both positive and negative evidence. One series of studies concerned the blocked or random presentation of categories. Tulving & Patterson (1968) reported a study in which four related words were presented either in a blocked or random fashion within a list of unrelated words. Clustering scores and probability of recall were significantly higher for blocked relative to randomly presented related words. Similarly, Cofer, Bruce, & Reicher (Exp. III, 1966), using two lists containing either high frequency or low frequency category exemplars demonstrated that blocked presentation of high frequency category items improved both clustering and recall scores relative to random presentation of the list. However, within the low frequency list, mode of presentation influenced amount of clustering but not amount of recall. Moreover, both Dallett (Exp. I and II, 1964) and Wood & Underwood (1967), using categorized word lists, reported a similar lack of covariance between clustering and recall scores (i.e., blocked presentation increased clustering but not recall scores relative to random presentation of the categorized word list). The reason for the occurrence of both positive and negative evidence within the same general paradigm is not readily apparent.

A second series of studies involved presentation of category names prior to list presentation (Hudson, 1969) and, in addition, following list presentation but before recall (Pollio & Gerow, 1968). The presence of category names may enable Ss to more readily discover the nature of the interitem relationships in the list and may, therefore, influence clustering. In both instances there was enhanced clustering but no effect on recall relative to control groups which were not shown the category names.

Several other studies also indicate a lack of covariance between clustering and recall scores. Cofer (1967) examined a number of studies in which presentation of a categorized list was followed by two successive recall trials separated by a five minute filled retention interval. In general, the data showed that clustering increased from the first to the second recall; however, more than half of the recall scores decreased from the first to the second recall trial. Finally, Puff (1970) divided Ss into high clusterers and low clusterers and found no difference in amount recalled between the two types of Ss.

Other investigators have examined the clustering-recall relationship by computing the correlation for individual Ss between number of items recalled and amount of clustering. These studies have reported both positive and negative correlations between clustering and recall with no apparent explanation for the difference in results (Hudson, 1969; Cofer et al., 1966; Pollio & Gerow, 1968). Thus, single trial free recall data provide evidence which casts doubt on the hypothesis that degree of clustering in output determines amount recalled.

The proponents of the organizational view of memory have offered several explanations for the negative results. First, single trial studies may be inadequate for the study of the relationship between degree of clustering and amount recalled (Tulving, 1968; Weist, 1970). This is because single trial data may reflect primary modes of organization, for example, serial position effects (Tulving, 1968). That is, early and late input items have a higher probability of recall than middle input items regardless of their categorical relationship to other items in the list (Tulving & Patterson, 1968; Wood & Underwood, 1967). Thus, on Trial 1 recall may be influenced more by serial position effects than interitem relationships (i.e., secondary organization; Tulving, 1968). Secondly, and related to the first point, S may not discover the nature of the categorical relationships among the items in the list on a single trial and/or not learn how to use those relationships to increase recall (Mandler, 1967b; 1969). Therefore, on Trial 1 S may not use experimenter determined units (i.e., categories) as the basis of retrieval but, rather, serial position cues or an idiosyncratic output order. In any instance where clustering does not serve as the basis of retrieval, a clustering measure would be inappropriately used as the index of organization (Mandler, 1967a; Roberts, 1968). In such cases, the clustering measure would underestimate the actual degree of organization in S's recall protocol. Thus, due to serial position effects and to S's unfamiliarity with the list structure on Trial 1, several trials may be required for clustering to effectively increase recall (Hudson, 1968; Weist, 1970).

Multitrial Data

For the above reasons, a more sensitive test of the clustering-recall relationship should be obtained from multitrial free recall. There are a number of studies which lend support to the notion of a causal relationship between clustering and recall. Specifically, it has been shown that clustering and recall vary together (e.g., Mandler, 1969) and increase concomitantly as number of trials increase (e.g., Bousfield, 1953; Tulving, 1968). In addition, Weist (1970) varied the number of categories (either 2, 4, or 12) with list length held constant (24 items). After the third trial, the results showed a direct relationship between number of words recalled and amount of clustering although this relationship held only for the condition in which the number of categories and the number of items within each category did not exceed the hypothesized limited capacity retrieval system (i.e., 5 ± 2 items, Mandler, 1967a). Furthermore, Thompson et al. (1972) demonstrated that individuals attaining high clustering scores recalled significantly more items than individuals attaining low clustering scores. Although these results contradict Puff (1970) who found no difference in recall between high and low clusterers, Puff's single trial procedure may have been insensitive to detecting these differences. Lastly, correlational data from multitrial studies indicate a positive correlation between clustering and amount recalled (e.g., Mandler, 1967a; Sakoda, 1956; Weist, 1970).

There are two studies, however, which question the clustering-recall hypothesis. As previously cited, Pollio & Gerow (1968) presented the category name of the items in the list either prior to list presentation or following presentation but before recall in a single trial free recall experiment. The same procedure also was followed in a multitrial free recall learning task (i.e., two or three successive presentations followed by a single recall trial). As in the single trial experiment, presentation of the category names enhanced clustering but not recall. A similar lack of correspondence between clustering and recall comes from a study by Dong & Kintsch (1968) wherein Ss were allowed to form their own categories using the Mandler-Pearlstone (1966) sorting technique. Specifically, Ss sorted a deck of 25 cards containing single words into two to seven subjectively determined categories. Following the criterion of two successive identical sorts, Ss were instructed to assign names to their subjective categories. The Ss who were shown their idiosyncratic category labels at recall demonstrated higher recall scores than Ss who were not shown the labels. However, the better recall was not accompanied by more clustering in output. In summary, as with single trial data, there exists both positive and negative evidence with respect to the clustering-recall relationship.

Unlike single trial studies, multitrial studies which do not support a direct relationship between clustering and recall cannot be dismissed on the basis of serial position effects or inadequate time for the development of clustering. Some theorists have suggested, however, that Ss are in fact using some form or forms of organized output other than or in addition to clustering in order to overcome the limits of memory (e.g., Mandler, 1967a; Puff, 1970b; Roberts, 1968; Wood, 1972). Alternative forms of organization may be idiosyncratically based, dependent on the alphabet, influenced by priority, and so forth. Thus, again, the degree of organization in output that S is actually using will be inaccurately estimated by the experimenter's clustering measure if Ss organize the list on some other basis.

In the final analysis, however, even if the studies assessing the clustering-recall relationship had not produced conflicting results, they would not have constituted a direct test of the causal relationship between degree of clustering in output and amount recalled. This is because the evidence for the clustering-recall relationship is inferred from studies in which both clustering and recall scores are dependent variables (Tulving, 1962). In other words, amount of clustering and amount recalled could be parallel but independently occurring phenomena, both being related functionally to a third or more unknown factors (Tulving, 1968). To specify more accurately the nature of the relationship between clustering and recall, the present study treated clustering as an independent variable. This was accomplished by using a recall (cueing) procedure where the order in which Ss recalled words depended upon the order in which they were given the category name as cues at the time of recall. Thus, recall could be structured either to maximize or minimize clustering. Prior to the manipulation of clustering in recall (List 2), Ss received three free recall trials on a practice list (List 1). The practice list was used to allow Ss to become familiar with a categorized list and to minimize the contamination of List 2 data with learning-to-cluster effects (Thompson & Roenker, 1972).

METHOD

Subjects

One hundred students from introductory psychology classes at Kansas State University participated for extra class credit. Twenty Ss were assigned randomly to each of five groups. All Ss were run in groups of 10 to 20 individuals.

Materials

All Ss learned in succession two nonoverlapping lists of 42 words each. Each list contained seven taxonomic categories of six items each taken from the Battig-Montague category norms (1969). The category names in one list (A) were Cloth, Weather, Transportation, Kitchen Utensils, Money, Human Dwellings, and Body Parts, and in the other list (B) Weapons, Diseases, Sports, Reading Materials, Birds, Occupations, and Metals. A complete listing of the items within each list is given in Appendix I. The items encompassed a range of word frequencies from 11 to 295. The mean total word frequency for the 14 categories was approximately equal, ranging from 87.8 to 97.7. An attempt also was made to match individual word frequencies between categories. The order of list learning (A and B) was counterbalanced across Ss.

List 1 Procedure

The procedure was identical for all Ss in List 1. Prior to the beginning of learning, Ss were told they would learn two lists of words. The Ss were also informed about the categorical nature of the list. The experimenter first defined what was meant by a category and then read aloud the names of the categories that comprised List 1. This was done to encourage Ss to attend to the categorical nature of the list. The complete instructions are reproduced in Appendix II. The Ss practiced the first list for three trials. Each trial consisted of two parts, study and test. On the study part of the trial, Ss were shown each of the 42 words, contained on 2x2 slides, one at a time at a two-second rate. The words were randomly presented with the restriction that no two items from the same category appeared successively in the list. Five seconds after the completion of list presentation Ss were tested for recall. The Ss were told to write down all of the words they could remember in any order they chose. For this purpose, all Ss were provided with a separate recall booklet on each trial. Each booklet contained 43 pages--a cover page indicating the list and trial number and additional pages for each word in the list. The Ss were instructed to write only one word on each page of the recall booklet to prevent them from looking back at previous recalls. The Ss also were instructed not to begin recall nor turn any page until a tone sounded. The first tone sounded five seconds following the end of list presentation and thereafter at five-second intervals. The tones were delivered via a tape recording. The final tone signified the end of the recall period at which time Ss closed the recall booklet and placed it on the desk next to them. Since it was necessary to use paced recall in List 2, it was deemed desirable to use the same procedure in List 1 so as to give Ss practice with this method of recall. Approximately 15 seconds elapsed between the end of recall and the beginning of list presentation on the next trial.

List 2 Procedure

The procedure used in List 2 learning was identical to that in List 1 except that there were five trials and Ss were provided on each trial with category names as cues at the time of recall. Specifically, there were five different recall conditions represented in the learning of List 2, four Unmixed and one Mixed List conditions. The Unmixed List conditions will be described first.

1. Condition N (noncontiguous cued recall).-The Ss in this condition were required to recall the words in a specified order which was dictated by a single category name printed at the top of each page of the recall booklet. In this way Ss were prevented from looking back and thus being idiosyncratically cued by previously recalled words. Each category name appeared on six of the forty-two pages. When Ss saw a category name they were required to write down a different one of the members of that category. The order of cueing in this condition was random with the restriction that no item from the same category be cued consecutively.

2. Condition PB (partially blocked cued recall).-The procedure used for Ss in Condition PB was exactly the same as for Ss in Condition N except that cueing was not random. Rather, Ss recalled some items from the same category contiguously. Specifically, the categories were subdivided such that at any one time only three items from the same category were cued contiguously. Thus, during a single recall trial Ss recalled for each category two subsets consisting of three category members each. At least one different category cue intervened between the occurrence of subsets from the same category.

3. Condition B (blocked cued recall).-These Ss were cued to recall contiguously all items from the same category before going on to recall items from other categories.

4. Condition FR (free recall).-The Ss in this condition were allowed to recall items in any order they chose following the same procedure as in List 1. However, all seven category names were typed at the top of each page of their recall booklets. The category names were provided so as to make the conditions of recall comparable to the other four recall conditions. The category names were randomly ordered on each page and Ss were instructed that the names were provided in case they should forget the category composition of the list.

5. Condition M (mixed list group).-This group of Ss received cues which combined the N, PB and B recall conditions on each recall trial. Recall from two of the seven categories was cued in blocked fashion; two categories were noncontiguous; and the remaining three categories were cued in partially blocked fashion. The assignment of specific categories to type of recall condition was random across trials with the restriction that a given category not be tested under the same recall condition on two consecutive trials.

The specific order of appearance of category names under each of the five recall conditions was determined from a table of random numbers. Two restrictions were imposed on the randomization. First, on any given trial at least five items either in input (study) and/or output (test) intervened between an item's presentation and the appearance of its category name as a cue in recall. This procedure was designed to minimize recency effects. Secondly, the first three category cues did not correspond to the categories of any of the first three items shown on the presentation part of that trial. The latter restriction was intended to minimize primacy effects. Both of these restrictions were imposed to minimize effects in recall due to primary modes of organization (Tulving, 1968).

RESULTS

List 1 Performance

The two dependent variables of interest were number of words recalled and amount of clustering. Recall will be considered first and then the relationship between recall and clustering.

Recall.-For each S a tabulation was made of the number of words recalled correctly on each trial. As expected, the mean number of words recalled increased across the three trials of learning (17.4, 27.1, and 30.8, respectively) leading to a significant main effect of Trials by analysis of variance, F (2, 180) = 792.60, at the .05 level, the criterion of significance for all analyses to be reported. Neither differences between the five recall conditions nor the Trials x Recall Conditions interaction were significant (both Fs < 1) thereby indicating approximate equivalence in initial learning ability of Ss in each recall condition prior to the learning of List 2. Although the categories comprising Lists A and B were matched for word frequency, the amount recalled from List A was consistently greater than the amount recalled from List B, leading to a significant main effect of Lists, F (1, 90) = 8.53. Neither the Lists x Recall Conditions interaction, $F < 1$, the Lists x Trials interaction, F (2, 180) = 2.38, nor the three way interaction involving Lists, Recall Conditions and Trials, F (8, 180) = 1.47, were significant.

Relationship between recall and clustering.-The Adjusted Ratio of Clustering (ARC score) was used as the measure of clustering (Roenker, Thompson, & Brown, 1970). This measure expresses for each S the proportion of actual category repetitions above chance to the total possible category repetitions above chance on any given trial. ARC is invariant with respect to total number of words recalled, number of categories recalled, and the distribution of the total items recalled across categories. The ARC score ranges from zero to one with a score of zero representing no clustering and a score of one representing perfect or maximum clustering. As with amount recalled, there was an increase in clustering across the three trials (.472, .714, and .789, respectively), indicating a direct relationship between amount recalled and degree of clustering. These results are in accordance with previously cited findings (e.g., Tulving, 1968).

Pearson product moment coefficients of correlation (r) also were computed based on the recall and clustering scores of each S. The r's were as follows: Trial 1 (.202); Trial 2 (.554); and Trial 3 (.537). These results replicate the findings of other experiments mentioned earlier which reported positive but moderate correlations between clustering and recall (e.g., Pollio & Gerow, 1968; Weist, 1970). To obtain an overall measure of the relationship between recall and clustering, average ARC scores based on the three trials of learning were correlated with total amount recalled over the three trials. The correlation was .553, accounting for 30.6% of the total variance.

As previously noted, it is necessary to manipulate directly degree of clustering to determine if the relationship between clustering and recall is causal. Thus, List 2 data, which show the effect of manipulation of amount of clustering, will be examined next.

List 2 Performance

The results for the four Unmixed List conditions will be considered first, then the results for the Mixed List condition, followed by a comparison between Unmixed and Mixed List conditions.

Unmixed lists.-To render the recall scores of the Unmixed comparable to those of the Mixed List condition, these scores were converted into probability of recall scores (i.e., proportion of total possible correct recall). Probability of recall on each of the five trials of List 2 learning for each of the four recall conditions is presented in Figure 1. Pooled across trials performance was best under Condition B (.791), poorest under Condition N (.709), and intermediate for Conditions FR (.735) and PB (.744). Analysis of covariance (using unitized deviation $\underline{z}$ List 1 scores as the covariate) showed significant differences in amount recalled between the four recall conditions, $\underline{F}$ (3, 71) = 6.36.

Again, significantly more words were recalled from List A than List B, $\underline{F}$ (1, 71) = 8.23, and there also was a significant Lists x Recall Conditions interaction, $\underline{F}$ (3, 71) = 3.90. Examination of the data indicated that for all conditions except FR, List A was easier to learn than List B. For Condition FR, List B was easier. However, regardless of list (A or B), performance under FR did not exceed that under Condition B nor fall below the performance level of Condition N. Thus, the interaction had minor influence on the results.

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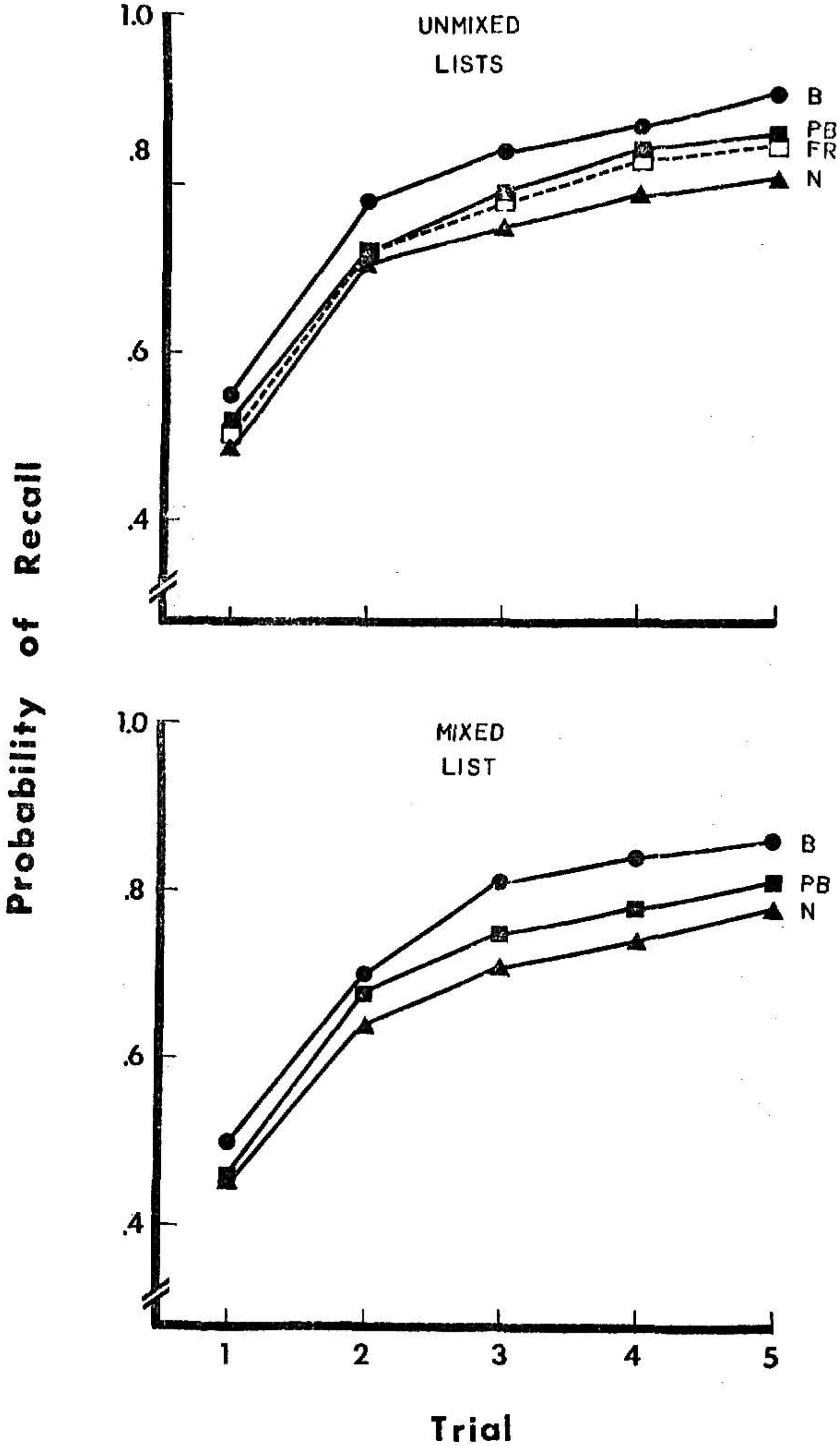

Figure 1. Comparison of List 2 performance for Blocked (B), Partially Blocked (PB), and Noncontiguous (N) recall under Mixed and Unmixed List conditions. Free Recall (FR) data are also presented for the Unmixed List condition.

As in List 1 the number of words recalled under all conditions increased significantly over trials, F (4, 288) = 554.44. In addition, the difference in difficulty of learning Lists A and B increased across the five trials leading to a significant Trials x Lists interaction, F (4, 288) 3.58. All other interactions involving Trials, Recall Conditions, and Lists were nonsignificant (all Fs < 1).

As noted in the method section, the order of item recall in Conditions B, PB, and N was arranged to minimize primary organization (i.e., the testing early in recall of items which appeared in beginning and end input (study) positions). Under the FR condition, no such restriction on order of recall could be imposed however. Therefore, recall under the FR condition could have been augmented by the early recall of items from beginning and end input positions. To assess the contribution of primary organization in the FR condition the number of words recalled in the initial five output positions on each of the five trials of List 2 learning was compared across all Unmixed List conditions. The average amount recalled per trial was as follows: Condition FR = 4.8; N = 4.9; PB = 4.8; and B = 4.4. Clearly, FR Ss did not show an advantage in recall attributable to primary organization. The relative decrement in recall in the initial five output positions under Condition B was probably due to the requirement that Ss in this condition recall all items from a category before proceeding to the next category. Particularly early in learning Ss cannot remember all of the items in a category. Therefore, a certain number will not be recalled. In contrast, Ss in Conditions FR, N, and PB were not required to recall items from the same category in the first five output positions. Instead, they could skip from one category to another and, therefore, recall those items from each category which they had learned. Analysis of variance did reveal a significant main effect of Recall Conditions, F (3, 76) = 11.21, attributable entirely to the poorer performance of Condition B relative to the average of performance under Conditions FR, N, and PB, F (1, 76) = 32.81. The difference between Conditions FR, N, and PB were nonsignificant (F < 1). There was also a significant Trials x Recall Conditions interaction, again due entirely to the relatively poorer performance of Condition B on early but not on later trials, F (4, 304) = 11.53.

Mixed list.-This condition incorporated three recall conditions (i.e., B, PB, and N) within each recall trial. To adjust for the unequal number of categories in each recall condition, the total number of words recalled under each condition for each S was converted to probability of recall scores (i.e., proportion of the total possible correct recall for that condition). As shown in Figure 1, overall recall performance under Condition B (.743) was superior on each trial to recall under PB (.697) and N (.663). Analysis of variance for repeated measures showed the difference to be significant, F (2, 38) = 17.56. Computation of the strength of relationship between recall conditions and amount recalled (epsilon) (Welkowitz, Ewen, & Cohen, 1971) indicated that 47.7% of the total variance was accounted for by the manipulation of recall conditions. The comparable figure for these three recall conditions in the Unmixed Lists was 26.7%. The lower percentage of total variance accounted for by the manipulation of recall with Unmixed Lists is probably due to the relatively greater amount of S variability present in this as compared to the Mixed List design. Further analysis also showed that amount recalled increased significantly over trials, F (4, 76) = 147.88. The Trials x Recall Conditions interaction was not significant, ($F < 1$).

Comparison between unmixed and mixed lists.-A comparison of probability of recall scores for Mixed and Unmixed Lists is shown in Figure 2 (excluding the FR condition). As can be seen, Ss learning the Mixed List recalled proportionately less than their counterparts in each Unmixed List, F (1, 114) = 8.40. However, the pattern of performance across recall conditions was virtually the same under Mixed and Unmixed Lists, leading to a significant main effect of Recall Conditions, F (2, 114) = 8.36. The interaction between Mixed-Unmixed Lists and Recall Conditions was nonsignificant ($F < 1$).

DISCUSSION

The clustering-recall hypothesis of free recall proposes that amount of clustering directly determines amount recalled (e.g., Bousfield & Cohen, 1953). The present results provide support for this hypothesis. That is, for both Unmixed and Mixed List conditions, the recall condition which allowed for maximal clustering (Condition B) produced the greatest amount of recall, the condition which prevented clustering (Condition N) the poorest recall, and the condition which permitted an intermediate degree of clustering (Condition PB) an intermediate amount of recall. However, the strength of the relationship between type of recall condition and amount recalled was moderate, as was also the clustering-recall relationship in first list learning. Thus, although the results support the clustering-recall hypothesis, it seems that factors other than clustering have an important influence on amount recalled in free recall learning.

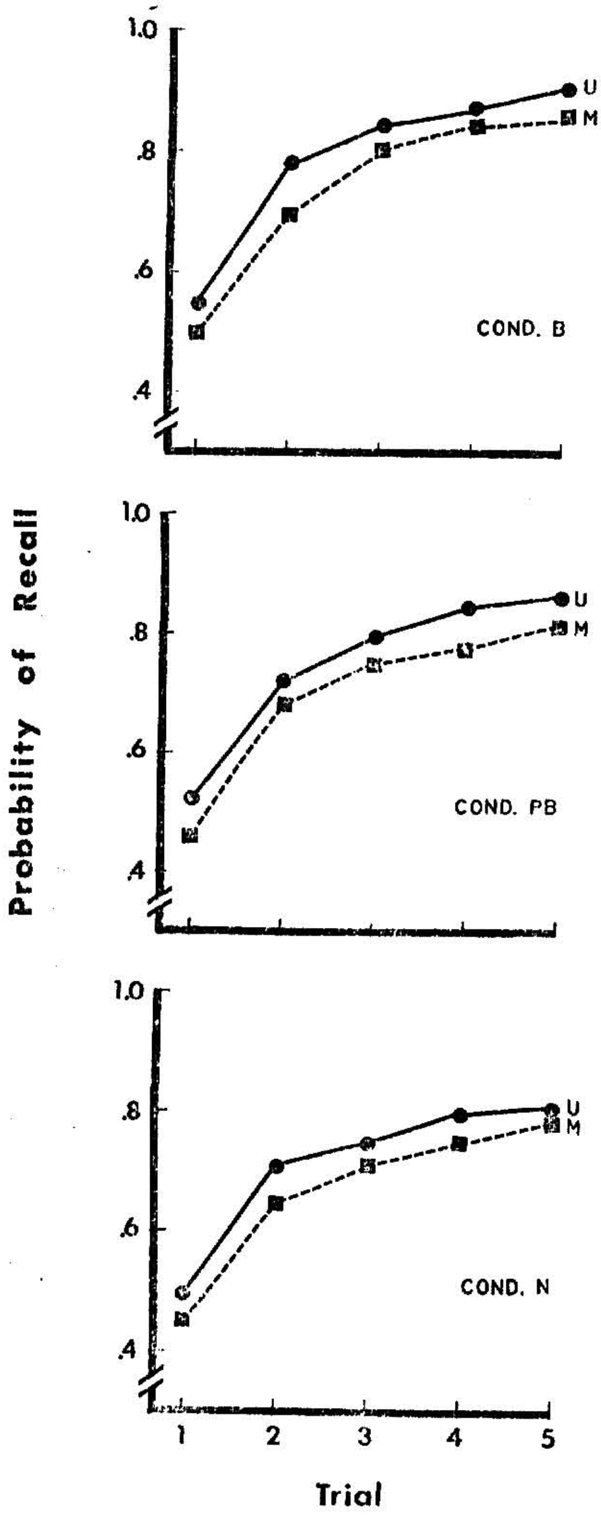

Figure 2. Comparison of List 2 performance between Unmixed (U) and Mixed (M) List conditions under Blocked (B), Partially Blocked (PB) and Noncontiguous (N) recall.

While the List 2 results were substantially the same under Mixed and Unmixed List conditions, performance in the Mixed List condition was consistently poorer than that in the Unmixed List conditions. One possible reason for the difference is predictability. The Ss in the Mixed List condition were responsible for recalling under three different recall conditions on each trial (i.e., Conditions B, PB, and N). Furthermore, the order of testing of these recall conditions was different on each trial, as was also the assignment of recall conditions to a particular word category on each trial. Consequently, Ss in the Mixed List condition could not predict, given a category cue, which recall condition was in operation. This lack of predictability may have impaired the efficiency of the recall process because the category cue provided little information about the identity of subsequent category cues. Thus, prior to the occurrence of the next cue, these Ss must be prepared to search for and retrieve an item from any category. In contrast, Ss in the Unmixed List conditions were responsible for recall under only one recall condition (i.e., either B, PB, or N). Thus, these Ss could limit their attention to words from the category or categories most likely to be cued and thereby reduce the search and retrieval time for items within a particular category.

An unexpected finding of the present experiment was that Ss in the free recall condition attained recall scores virtually identical to those in the partially blocked (Unmixed List) condition. Original expectation was that the free recall Ss would recall more. In this regard, it is interesting to note that the average clustering (ARC) score over the five trials of List 2 learning for free recall Ss was comparable to the maximum amount of clustering possible for the partially blocked Ss (i.e., .791 and

.767, respectively). Thus, simply on the basis of actual amount of clustering there is no reason to expect superior recall for free recall Ss. Moreover, these findings indicate that during the free recall of a categorized list Ss do not always adopt the strictly clustered output order which appears to accompany maximum recall (as evidenced by performance under the blocked recall condition).

A P P E N D I C E S

APPENDIX I

Word Lists

Listed below are the nouns selected from the Battig and Montague Norms (1969) which comprised Lists A and B, the individual word frequency of each noun, and the total frequency of the exemplars within each category.

<u>List A</u>		<u>List B</u>	
Cloth		Weapons	
225	rayon	163	rifle
142	linen	122	bomb
78	satin	110	sword
32	velvet	66	cannon
29	denim	34	stick
<u>19</u>	mohair	<u>27</u>	whip
529		527	
Weather		Diseases	
266	snow	210	tuberculosis
100	storm	168	measles
83	cyclone	71	smallpox
45	fog	48	flu
30	humidity	26	diabetes
<u>14</u>	rainbow	<u>13</u>	cholera
538		536	

APPENDIX I (continued)

List A		List B	
Transportation		Sports	
257	train	277	swimming
99	scooter	107	lacrosse
86	wagon	76	volleyball
47	ship	49	archery
34	auto	27	handball
24	streetcar	11	judo
550		547	
Kitchen Utensils		Reading Materials	
242	pan	295	newspaper
155	spatula	103	novel
74	stove	75	text
49	cup	39	journal
26	toaster	32	play
14	blender	28	essay
560		571	
Money		Birds	
243	pennies	237	sparrow
169	francs	149	crow
66	yen	77	oriole
46	shilling	56	pigeon
45	check	44	vulture
12	bonds	15	lark
581		578	

APPENDIX I (continued)

List A	List B
Human Dwelling	Occupations
189 tent	269 lawyer
155 cave	112 dentist
107 trailer	83 carpenter
75 mansion	60 salesman
33 apartment	37 accountant
22 bungalow	20 fireman
581	581

List A	List B
Body Parts	Metal
228 hand	259 aluminum
128 stomach	130 zinc
79 knee	78 bronze
77 chest	75 magnesium
49 elbow	41 sodium
25 lips	18 cobalt
586	581

APPENDIX II

Instructions

This is an experiment in learning and memory. You will be shown two lists of words and be asked to recall as many words as possible.

During the presentation of the lists you will notice that each word belongs to a category. For example, if the list contained the words RED, GREEN, and YELLOW, these words would belong to the category COLORS. Similarly, if the words CANADA, ENGLAND, and FRANCE appeared, they may be said to belong to the category COUNTRIES. Each list you see will contain seven such categories with six items belonging to each category. The words will be projected on the screen one at a time. They will be shown randomly such that you will never see two words from the same category presented successively. The seven categories in List 1 are different from the seven categories of List 2. However, I will tell you the names of the categories before the presentation of each list.

Each list will be presented several times. Following each presentation of a list I will ask you to recall as many of the words from that list as possible. That is, you will see List 1 presented once and then be asked to recall. Following recall, you will see List 1 presented for the second time and again be asked to recall as many words as possible. You will see and recall List 1 three times before proceeding to List 2. You will see List 2 five times.

During recall you will be asked to write the words on the recall booklets provided. You will notice that there is a separate recall booklet for each trial (presentation) of each list. During the recall of items from List 1, write only one word on each page of the recall booklet. That is, each recall booklet contains 42 pages, one page for the recall of each word presented. Immediately before I instruct you to begin recall I will turn on a tape recorder which will play a tone every five seconds. At the first tone you will turn over the cover page and recall a single word on the first blank page of your recall booklet. At each sound of the tone turn the page and recall a single word. That is, you will have five seconds to recall a word before the next tone sounds and you turn the page and recall another word. Turn a page on every tone whether or not you have recalled a word. You may recall the words in any order they occur to you. Do not recall the same word twice. Please guess if you cannot recall a word during any five second interval. If you are in the process of writing a word and the tone sounds, stop writing that word and turn the page. Remember, you will recall only one word per page and you will turn to the next page upon the sounding of the tone. Do not write on the cover page of your recall booklets.

List 2 Instructions

Mixed and Unmixed List Conditions B, PB, and N. Upon completion of List 1 learning, E read the following instructions for the Mixed and Unmixed List conditions.

The recall procedure for List 2 is slightly different than that for List 1. It differs only in that a category name is printed at the top of each page of your recall booklets for List 2. Thus, I want you to recall any item from the list that belongs to the category appearing at the top of each page of your recall booklets. For example, if the category

COLOR had appeared in the list and the category name COLOR was printed at the top of one page of your recall booklet you would recall one item that belonged to that category--e.g., RED. At the sound of the tone, you will turn to the next page and recall a single item belonging to the category printed at the top of that page. Remember, recall only one item from the designated category on each page of the recall booklet. Again, you will begin recall at the sound of the tone and you will have five seconds to recall a word before the next tone sounds and you turn to the following page.

Unmixed List Condition FR. The recall procedure for List 2 is identical to that of List 1. That is, upon the first tone you will turn over the cover page and begin recall. You will write only one word on each page of the booklet. You may recall the words in any order that you choose. Do not turn to the next page until the tone sounds. You will notice, however, that all seven category names will appear at the top of each page of your recall booklets. The names are made available in case you should forget which categories comprised the list.

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A DIRECT TEST OF THE HYPOTHESIS THAT AMOUNT RECALLED IS DETERMINED BY DEGREE OF CLUSTERING

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AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

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1973

The clustering-recall hypothesis of free recall proposes that amount of clustering directly determines amount recalled (e.g., Bousfield & Cohen, 1953). Single trial and multitrial clustering experiments have produced results which both support and question the causality of the relationship. However, even if the studies assessing the clustering-recall relationship had not produced conflicting results, they would not have constituted a direct test of the causal relationship between degree of clustering in output and amount recalled. This is because the evidence for the clustering-recall relationship is inferred from studies in which both clustering and recall scores are dependent variables (Tulving, 1962). In other words, amount of clustering and amount recalled could be parallel but independently occurring phenomena, both being related functionally to a third or more unknown factors (Tulving, 1968). Thus, to specify more accurately the nature of the relationship between clustering and recall, the present study treated clustering as an independent variable. If amount of clustering directly determines amount recalled, then independent manipulations of the degree of clustering in output should produce concomitant changes in amount recalled. Independent manipulation of clustering was accomplished by using a recall (cueing) procedure where the order in which Ss recalled words depended upon the order in which they were given the category names as cues at the time of recall. In accordance with the clustering-recall hypothesis, it was found that the recall condition which allowed for maximal clustering (Condition B) produced the greatest amount of recall, the condition which prevented clustering (Condition N) the poorest recall, and the condition which permitted an intermediate degree of clustering (Condition PB) an intermediate amount of recall. However, the strength of the relationship between type of recall condition and amount recalled was moderate. Thus, although the results support the clustering-recall hypothesis, it seems that factors other than clustering have an influence on amount recalled in free recall learning.