



PART-WHOLE TRANSFER EFFECTS IN FREE
RECALL LEARNING

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THESIS



Part-Whole Transfer Effects
in Free Recall Learning

by

Dorothy Clark

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Tulving (1966) found in free recall learning that a group with no prior practice on a list of familiar words recalled more items on the last few trials of practice than a group which had previously practiced half of the list. The present study is a replication and extension of Tulving's experiment. Subjects learned two lists of 15 words each followed by a 30-word list which contained all, some or none of the items previously learned. The previously learned parts were presented either separately or mixed on the final list. For the separate groups, the final list consisted of all of the items from one of the first two lists followed by all of the items from the other list. For subjects who had practiced only some of the items, either the first or last half of the final list contained unfamiliar items. For the mixed groups, the final list consisted of an alternation of items from lists 1 and 2 or an alternation of items from one of the first two lists with new items. One hundred twenty-six students from the introductory psychology course at Michigan State University participated in the experiment. Lists 1 and 2 were presented in booklets, with a new page for each of the five trials, and the final list was presented by a slide projector for 10 trials. After each presenta-

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tion, subjects wrote the items they could recall in answer booklets, with a new page for each trial.

The groups did not differ in total number of words recalled on the final list, but the conditions by trials interaction was significant. The reason for the interaction was not clear. The effect of final list presentation order was isolated, but the difference between mixed and separate order was not significant. To the extent that the manipulation of order influenced organization, this finding cast doubt on Tulving's explanation that the groups in his experiment differed in final list learning because of organizational factors. The effects of prior practice and final list order were analyzed separately on trial 1 of the final list, and both effects were found to be significant. Prior practice on all of the final list items resulted in better recall than did prior practice on only some of the items. The significantly poorer recall on trial 1 of the final list by the mixed groups was interpreted according to Tulving's explanation of subjective organization.

The order of recall on the last trial of list 3 demonstrated the persistence of previously learned organization. The mixed groups recalled items together on the last trial which they had learned together on list 1 or 2, rather than associating items from both parts which were presented consecutively on the final list. This finding indicated that the mixed groups were unwilling or unable to abandon

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their previously learned organization. However, failure to reorganize did not appear to have a significant effect on the number of words recalled on the last trial.

Approved: Gordon Wood
Committee Chairman

Date: Nov. 21, 1967

Thesis Committee:

Gordon Wood, Chairman
Abram M. Barch
David C. Raskin

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Dorothy Clark

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Introduction

Tulving (1966) found in free recall learning that a group with no relevant prior practice on a list of familiar words recalled more items on the last few trials of practice than a group which had previously practiced half of the list. The experiment was performed twice. In the first experiment the final list of 36 words was presented for eight trials. In the second experiment the final list of 18 words was presented for twelve trials. In each case prior to learning the final list the part group practiced half of the list for eight (Experiment 1) or twelve (Experiment 2) trials, while the control group practiced irrelevant items for the same number of trials. On the final list in the first experiment, the control group passed the part group in number of words recalled on the 4th trial, and in the second experiment the crossover came on trial 7. The slopes of the curves were significantly different in both experiments. The mean difference between groups on the last trial was approximately 1.5 to 2 items. Tulving concluded that the organization of the part which was established during prior practice interfered with organization of the whole and therefore hindered the performance of the part group on later trials of final list learning. He suggested that insofar as Ss were unwilling or unable to reorganize the familiar part on the final list, their performance would remain below that of the control group.

Organization of items during part learning is an instance of subjective organization (Tulving, 1962), which is a measure of the difference between order of input and output in free recall learning. If no two words in a list are ever presented together on more than one trial, any repetitions in the order of recall across trials must have been contributed by the Ss since there were no repetitions in successive presentations. Subjective organization is measured by comparing the number of repetitions of pairs (or longer sequences) which would be expected by chance with the actual number of repetitions in the order of recall over trials.

In Tulving's earlier studies of subjective organization (1962, 1964), the only constraint on final list order was that no two words should be presented consecutively on more than one trial. In a later study (1965) Tulving compared the effect of different presentation orders (constant over trials) on free recall. He found that Ss reached criterion significantly faster with a high organization order than with a low organization order of presentation. The high organization order was established by presenting words in succession which Ss had frequently recalled together on the last several trials in a previous free recall experiment (1962). The low organization order presented words in succession which had rarely been recalled in succession in the previous experiment. From the results Tulving concluded that when material is presented in an order that keeps subjectively related subsets of words intact, it can be learned more readily than when the order is antagonistic to the inherent structure of the total set.

The present study combines the variables investigated separately by Tulving, presentation order (1965) and prior practice on part of a list (1966). Subjects practiced none, half or all (in two parts) of the items before learning the final list. Since Tulving suggested that inappropriate organization of half of the list had hindered whole list learning, it was predicted that inappropriate organization of both halves should be a greater hindrance. In addition, on the final list items from a previously learned part were either presented consecutively or were alternated with previously practiced or new items requiring different levels of reorganization for groups with equal amounts of relevant prior practice. It was predicted that consecutive presentation would require little or no reorganization while alternate presentation would require more reorganization. Furthermore, if reorganization (or lack of it) is the cause of poorer recall, the groups with the alternate order of presentation on list 3 should recall fewer items than the groups with consecutive order. Finally, since Tulving claimed that poorer recall by the part group on the last few trials was caused by failure to reorganize the previously learned part, there should be evidence that previously learned organization is maintained throughout list 3 learning; that is, items learned together during part practice should have a greater than chance tendency to be recalled together on the final list.

Method

Subjects. Subjects were 61 men and 65 women from the introductory psychology course at Michigan State University. Eighteen Ss were assigned randomly to each of seven groups.

Design. All Ss practiced the same final list of 30 words for ten trials, using a free recall procedure. Prior to learning the final list (list 3), Ss practiced two lists of 15 items each, with five trials on each list. The groups differed in the amount of relevant prior practice and in the arrangement of the previously practiced part(s) on the final list. In lists 1 and 2, Ss practiced all (A), part (P) or none (C) of the items from list 3; and on list 3, items from lists 1 and 2 were either separate (S) or mixed (M). For Groups AM and AS, lists 1 and 2 were both included in the final list. For Groups PM₁ and PS₁, the final list contained all of the words from list 1 and none from list 2. For Groups PM₂ and PS₂, list 3 contained all of the words from list 2 and none from list 1. Group C learned irrelevant items on both lists 1 and 2. The order of items on the final list for the mixed groups (AM, PM₁ and PM₂) consisted of an alternation of items from lists 1 and 2 or an alternation of items from the familiar part with new items. The order of the final list for the separate groups (AS, PS₁ and PS₂) consisted of all of the items from one list followed by all of the items from the other list. Either the first or last 15 items on list 3 were new to the part-separate groups.

Materials. The final list of 30 words was composed of two 15-word lists which had been evaluated by Deese (1959) for inter-item associative strength (lists 9 and 15). Both lists had zero inter-item associative strength; that is, no item in the list was given as a response to any other item in the list in a free association test. Two other lists (lists 3 and 12) from the same study, with zero or low inter-item associative strength, were practiced by the part and control groups in lists 1 and/or 2 but did not occur in list 3. All four lists were matched for frequency in the Thorndike-Lorge count (Thorndike and Lorge, 1944) and ranged from AA to 1 per million.

The presentation order of list 3 was the same for all conditions, but the order relative to lists 1 and 2 was different for the mixed and separate conditions. For convenience, the effect will be referred to as final list order. However, it should be remembered that the order effect was achieved by manipulating the content of lists 1 and 2, not the presentation order of list 3. The relationship of the final list to lists 1 and 2 was established in the following manner. List 9 (Deese, 1959) was designated as the odd list and list 15 as the even list. These lists constituted the parts practiced by the mixed groups on lists 1 and 2. Items were selected alternately from these two lists to make up the first presentation order of list 3. The first and second halves of this combined list constituted the parts to be learned by the separate groups on lists 1 and 2. The material presented in lists 1 and 2 was counterbalanced within each condition. Two more orders of the final list were prepared, with

the same items always in even (or odd) positions and in the first half (or second half) of the list. These three orders of list 3 were rotated during final list learning. There were also three random orders of each part for lists 1 and 2.

Procedure. Subjects were run in groups. They were given standard free recall instructions and were told at the beginning of the session that they would be learning three lists. Because Ss from all conditions were run at the same time, they were not informed about the relationship of lists 1 and 2 to the final list. Lists 1 and 2 were presented in booklets, with a new page for each of the five trials. Subjects had one second per item to read the list and 45 seconds for written recall. An example was given of the rate at which the list should be read in order to finish in 15 seconds. At the end of each presentation, Ss closed their study booklets and wrote the items they could recall in their answer booklets. A new page in the answer booklet was used for each trial. The final list was presented by a slide projector for 10 trials at the rate of two seconds per item, with 90 seconds for written recall after each presentation.

Results and Discussion

Performance on lists 1 and 2 was analyzed to determine whether the groups differed before the experimental treatments. Each S's score consisted of the sum of his scores on trial 5 of both lists. Only one S recalled all items on the last trial of both lists, while 15 Ss recalled all items on one of the two lists. Since the combined group means, which ranged from 22.78 to 24.17, were well below the maximum possible mean of 30, it appears that none of the groups had reached asymptote. The means of the combined scores were not significantly different, $F < 1$.

Performance on the final list is shown in Figure 1, and results of the trend analysis are presented in Table 1. Although Group AS had the highest score on trial 1 and kept the lead for 10 trials, Group AM with the second highest score on trial 1 was later surpassed by several groups, including Group C which had had no prior practice. There was no difference as a function of conditions, but the trials by conditions interaction was significant, indicating that the groups differed over trials. From Figure 1 it appears that the significant differences among groups over trials could be attributed primarily to differences on the first three trials. To examine this possibility a trend analysis was performed on trials 4 to 10. The trials by conditions interaction was not significant, $F(36, 714) = 1.11$, $p > .25$. An analysis of the slopes of the curves, following Tulving's (1966) procedure, revealed a significant difference, $F(6, 714) = 2.54$,

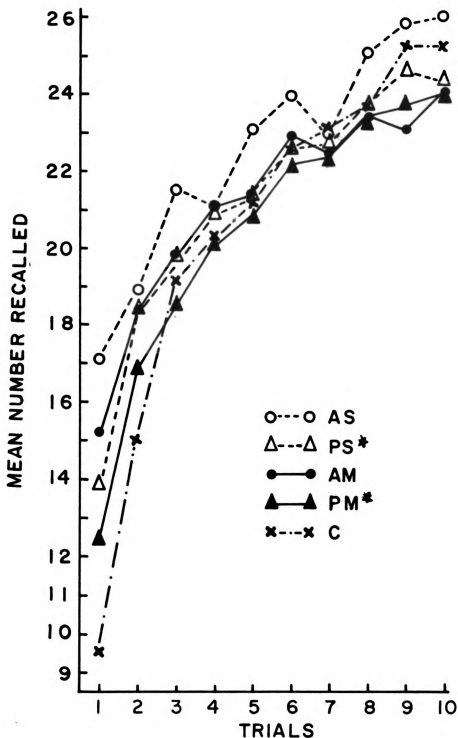


Fig. 1. Mean number of items recalled by each group across trials on list 3.

* Groups PS₁ and PS₂ were combined for graphic presentation, as were Groups PM₁ and PM₂.

Table 1

Analysis of Variance: List 3

Source	df	MS	F
Conditions (C)	6	112.93	.99
<u>Ss/C</u>	119	114.03	----
Trials (T)	(9)	(1,527.33)	(2,296.74**)
Linear (L)	1	11,916.97	2,889.66**
Dev. from L	8	228.62	55.44**
T x C	(54)	(13.19)	(3.20*)
L x C	6	68.96	16.72**
Dev. from L x C	48	6.22	1.26
T x <u>Ss/C</u>	1071	4.13	----

* $p < .01$

** $p < .001$

$p < .025$, even though the differences in number of items correctly recalled were small.

The reason for the difference in slopes, particularly over trials 4 to 10, was difficult to identify. One potential source of difference, the order effect, was isolated by combining Groups AS, PS₁ and PS₂ into the separate condition, and Groups AM, PM₁ and PM₂ into the mixed condition. Since Group C fit neither condition, it was omitted from this analysis. The learning curves for the combined mixed and separate conditions are shown in Figure 2. Although the performance of the combined separate group was consistently superior to the combined mixed group, the F ratios for conditions, trials by conditions interaction, and slopes were not significant. To the extent that the manipulation of order influenced organization, the results do not support Tulving's claim that organizational factors accounted for the differences among groups over trials. The group requiring more reorganization (mixed group) did not recall significantly fewer items and did not learn at a significantly lower rate than the group requiring less reorganization (separate group).

As evidence of reorganization Tulving (1966) cited the difference in slopes. The reason why this measure was used can be seen by examining the design of his experiment. Organization was established by prior relevant practice. Consequently, on the final list the facilitating effect of prior practice was combined with the hindering effect of reorganization, and the advantage of prior practice may have masked any effect due to reorganization on earlier trials. The comparison of slopes was intended to establish the



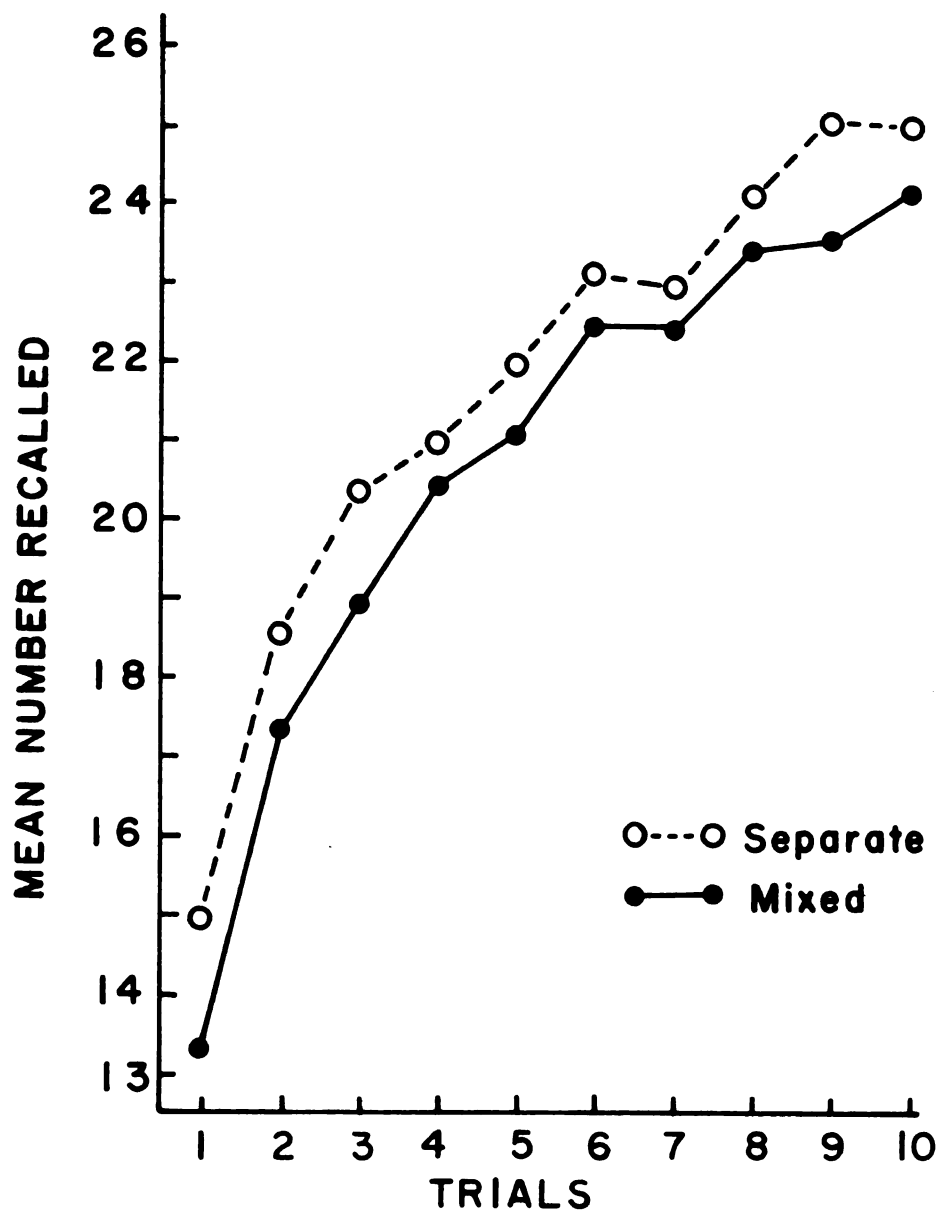


Fig. 2. Mean number of items recalled by the mixed and separate conditions across trials on list 3.

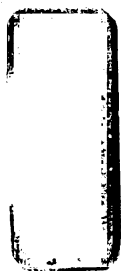
effect of reorganization. However, one obvious reason for the difference in slopes in Tulving's experiment is the better performance of the experimental group on the first several trials because of prior relevant practice. It is conceivable, therefore, that the difference in slopes could be explained without reference to reorganization. If the mean recall of the control group had been significantly higher than the experimental group (relevant prior practice) at the end of final list practice, the evidence for organizational effects would have been more convincing. Tulving did not report an analysis of difference on the last trial, but in the present experiment the differences on the last trial yielded an F of less than 1.

Another source of difference among groups, amount of prior relevant practice, could not be examined in the same way as the order effect because of the unequal numbers of S s receiving different amounts of practice. Comparisons were made between groups which were least likely to yield significant results and also between groups most likely to yield significant results. Scores were collapsed across trials. Groups AS and AM were compared with Groups PS_1 and PS_2 (the parts groups with the highest total scores across trials), and the difference was not significant, $F(1, 70) = 1.71, p > .10$. However, the difference between Groups AS and AM and Groups PM_1 and PM_2 (the parts groups with the lowest total scores across trials) was significant, $F(1, 70) = 6.10, p < .05$. In comparing the effect of prior



practice on part of the list with no prior practice, Groups PS_1 and C were not significantly different, $F(1, 34) = 2.44$, $p > .05$, nor were Groups PM_1 and C, $F < 1$. In general, it appears that amount of prior practice accounted for some of the difference among groups across trials. However, in the present experiment more prior practice did not produce a consistent advantage.

To summarize the analysis thus far, it is apparent that the groups differed over trials and that the slopes of the curves differed over trials 4 to 10. However, the differences could not be attributed to the effect of mixed versus separate order, and it is unlikely that amount of prior practice had a lasting effect. Since the design of the present experiment separated the effects of prior practice and order, it was not necessary to confine the analysis to an evaluation of the slopes of the curves. A simple analysis of variance of performance on trial 1 of the final list confirmed the observation that there were significant differences among groups on the first trial, $F(6, 119) = 8.62$, $p < .01$. To evaluate simultaneously the effects of amount of prior practice and order on trial 1 in a factorial design, Group C was omitted. Both main effects were significant (see Table 2). Prior practice on both parts ($\bar{X} = 16.1$) resulted in better performance than practicing one part on list 1 or 2 ($\bar{X} = 12.9, 13.3$). Since the interaction of prior practice and order was not significant, $F < 1$, it appears that inappropriate organization of both halves was not



more of a hindrance to recall than inappropriate organization of half of a list. The order effect can be interpreted by reference to Tulving's (1962) explanation of subjective organization. In the course of free recall learning, the organization of recalled items becomes increasingly stable as associations are formed among items. Accordingly, in the present study practice on lists 1 and 2 should have produced separate organization of one or both parts of the final

Table 2

Analysis of Variance: List 3, Trial 1

Source	df	MS	F
Practice (P)	2	112.58	9.02**
Order (O)	1	65.33	5.24*
P x O	2	9.53	.76
Error	102	12.48	----

* $p < .05$

** $p < .01$

list. If it is assumed that items presented consecutively have a tendency to become associated, then mixing the parts together in presenting the final list may have disrupted previous associations by giving the opportunity for new associations to be formed. The resulting response competition may have led to the observed decrement in recall on trial 1. On the other hand, presenting the parts intact should have provided less opportunity for conflicting associations to be formed, and therefore less reorganization should have been required in learning the final list.

Because Groups PM_2 and C duplicated the conditions in Tulving's (1966) study, they were compared separately. The curves were similar to those obtained by Tulving. The trials by conditions interaction was significant, $F(9, 306) = 4.52$, $p < .01$, and so was the difference in slopes, $F(1, 306) = 28.45$, $p < .01$. The analysis was repeated for trials 4 to 10 to determine whether the difference between groups resulted primarily from the difference on trials 1 to 3. The conditions by trials interaction was no longer significant, $F < 1$. The slopes were significantly different, $F(1, 204) = 3.94$, $p < .05$, with Group C surpassing Group PM_2 on trials 9 and 10. However, since the order effect did not yield significant results in the previous analysis, the reason for the difference in slopes and the crossover of curves is not clear.

Tulving argued that one reason why the group with prior practice fell behind the control group on the last few trials is that they



were unwilling or unable to abandon or modify the organization formed during part learning. Implicit in this argument is the assumption that there is one optimal organization of items for any given list and that any other organization will result in poorer recall. In the present experiment, the order of recall on the last trial demonstrated the persistence of previously learned organization. For the mixed groups, list 3 consisted of an alternation of items from lists 1 and 2 or an alternation of items from list 1 or 2 with new items. For the separate groups, list 3 consisted of all 15 items from one of the previous lists followed by all 15 items from the other list, with new items on one half of the list for the parts groups. Thus, there were two constraints on the otherwise random order of the final list. A given item was always in an even (or odd) position across all 10 trials, and it always appeared in the first (or second) half of the list. It can be seen that practice on such a list should have the effect of increasing organization into clusters of first or second half items. Further, clusters of odd or even items should be less likely to occur, since odd (or even) items were never presented consecutively on list 3.

To compare organization of recall on trial 10 with previously learned organization from lists 1 and 2, Bousfield and Bousfield's (1966) measure of stimulus category repetition (SCR) was employed. Each previously learned part was viewed as a category. For example, the categories for Group AM were odd and even, while the categories for Group AS were first half and second half. Groups PM_1 and PM_2

learned odd or even items plus new items, while Groups PS_1 and PS_2 learned first or second half items plus new items. The difference between the obtained and expected (chance) value of SCR was computed for each $\underline{S}$ (see Table 3). Two scores of SCR were computed for each $\underline{S}$ in Groups AM, PM_1 , PM_2 and C, one based on odd and even categories and the other based on first and second half categories.

Comparison of the two sets of scores for Group C permitted an evaluation of the effect of presentation order apart from the effect of prior practice. Clusters of odd or even items occurred less frequently than chance (-43.0), while clusters of first or second half items occurred more frequently than chance (85.9). In order to distinguish the effect of prior practice from the effect of presentation order, the mixed groups were compared with the odd and even clustering of Group C, and the separate groups were compared with the first and second half clustering of Group C. The mixed groups and Group C differed significantly in the number of odd and even category repetitions, $F(3, 68) = 8.60$, $p < .01$. This suggests that the prior organization of the mixed groups was maintained throughout final list learning. However, the separate groups and Group C did not differ significantly in first and second half category repetitions, $F(3, 68) = 1.02$, $p > .25$, indicating that when prior organization and presentation order did not conflict, their effect was similar in direction and magnitude.

First and second half SCR's were computed for the mixed groups

Table 3

SCR Scores*: List 3, Trial 10

Categories	Groups						
	AM	PM ₁	PM ₂	C	PS ₁	PS ₂	AS
Odd/even	17.5	-14.2	24.00	-43.00			
SD	2.47	2.34	2.26	2.84			
First half/ second half	51.50	51.70	59.90	85.90	113.40	109.10	90.80
SD	2.83	2.44	1.92	2.45	3.03	3.81	3.18

* Sums of individual SCR scores

to determine to what extent they developed the organization which was favored by the presentation order of list 3. The effects of amount of prior practice and order on repetitions of first and second half items were analyzed. The mixed groups, which had previously learned odd and even categories, had significantly fewer repetitions of first or second half items than the separate groups, which had previously learned those categories, $F(1, 102) = 24.36$, $p < .01$. The effect of amount of prior practice was not significant, $F(2, 102) < 1$. In summary, the mixed groups retained the organization they had learned previously and failed to learn the new organization which was favored by the presentation order of list 3. This result supports Tulving's contention that the mixed groups were unwilling or unable to abandon their previously learned organization, but failure to reorganize did not appear to have a significant effect on the number of words recalled on the last trial.

In conclusion, the present study found that although reorganization did not influence recall across trials, recall did differ as a function of reorganization on the first trial of final list learning. This finding supports Tulving's contention that organization of items takes place during free recall learning and that inappropriate organization of part of a list retards subsequent whole list learning. The use of slopes as evidence for reorganization in Tulving's (1966) study was questioned, since the slopes could have differed because of prior practice, without regard to reorganization. Although reorgani-

zation did not significantly hinder recall across trials, the mixed groups tended to recall items on trial 10 in the order learned on lists 1 and 2 rather than in the order of presentation of list 3. This finding suggests that subjective organization is a persistent and important effect in free recall learning.

REFERENCES

- Bousfield, A. K., & Bousfield, W. A. Measurement of clustering and of sequential constancies in repeated free recall. Psychological Reports, 1966, 19, 935-942.
- Deese, J. Influence of inter-item associative strength upon immediate free recall. Psychological Reports, 1959, 5, 305-312.
- Thorndike, E. L., & Lorge, I. The teacher's word book of 30,000 words. New York: Bureau of Publications, Teachers College, Columbia University, 1944.
- Tulving, E. Subjective organization in free recall of "unrelated" words. Psychological Review, 1962, 69, 344-354.
- Tulving, E. Intratrial and intertrial retention: notes towards a theory of free recall verbal learning. Psychological Review, 1964, 71, 219-237.
- Tulving, E. The effect of order of presentation on learning of "unrelated" words. Psychonomic Science, 1965, 3, 337-338.
- Tulving, E. Subjective organization and effects of repetition in multi-trial free-recall learning. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 193-197.

APPENDIX A

Number of words correct per trial for each subject on list 3

GROUP AM

Trial									
<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
11	14	12	17	18	20	23	20	21	21
13	16	16	17	17	13	15	21	18	20
17	17	18	19	19	23	19	23	22	23
15	19	20	20	19	22	21	22	24	24
16	20	21	21	23	24	22	26	22	26
17	18	19	24	22	22	24	26	24	28
16	21	21	23	21	23	24	24	26	30
18	23	24	25	26	26	26	26	25	24
24	22	22	23	23	27	26	23	27	27
11	15	21	16	19	23	22	21	16	18
14	17	18	23	24	22	20	21	24	22
15	17	20	21	21	25	21	25	20	26
15	20	24	24	26	26	26	29	28	26
13	12	12	15	17	18	19	17	20	19
19	20	22	21	21	23	19	22	22	22
14	23	24	24	28	24	26	24	27	27
12	16	19	23	22	27	27	29	28	27
13	21	24	24	19	24	25	22	21	23

GROUP PM₁

Trial									
<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
9	14	15	18	18	20	18	19	19	21
6	8	8	10	8	13	7	9	11	10
10	17	18	17	20	20	21	21	25	25
13	20	23	22	25	23	25	25	28	27
12	17	16	18	22	21	21	24	24	26
17	24	28	29	25	27	29	29	30	29
11	19	19	23	25	26	25	28	27	30
15	21	23	24	21	24	22	25	26	26
15	16	18	22	22	21	24	25	24	25
7	11	13	17	19	20	26	24	24	28
11	14	12	14	16	18	20	19	19	19
8	12	12	14	14	16	14	16	15	14
12	17	21	24	17	21	21	24	26	25
9	13	12	13	19	18	20	22	23	25
12	15	20	22	21	26	26	28	24	25
19	22	23	23	27	28	27	27	29	29
8	13	17	21	21	20	21	24	19	25
17	21	26	26	30	30	26	30	30	28

GROUP FM₂

Trial

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
13	14	19	21	21	25	27	28	29	27
13	13	15	17	17	17	19	20	21	20
11	15	18	18	17	25	22	23	23	23
15	19	19	21	22	23	22	23	23	24
15	20	25	26	24	26	24	28	29	28
10	17	23	23	23	25	25	27	28	24
13	17	19	20	19	21	26	24	21	26
21	22	25	24	26	28	28	28	30	30
7	13	13	13	17	17	15	17	11	15
14	17	18	18	21	19	20	19	20	20
11	12	13	13	11	15	16	18	16	14
14	16	20	19	23	21	25	22	23	23
13	18	15	17	19	20	17	20	24	21
14	21	25	28	25	27	27	27	28	28
17	23	22	25	24	28	27	27	30	30
11	21	17	22	25	24	26	26	28	27
15	17	19	21	22	24	23	20	26	23
9	14	17	19	26	20	23	27	20	26

GROUP AS

Trial									
<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
14	17	19	20	21	19	23	23	24	24
26	25	24	25	28	30	28	30	30	30
15	16	19	19	20	20	20	21	23	25
16	18	20	22	25	24	21	27	27	25
17	26	28	25	29	27	29	30	30	30
12	17	21	23	24	24	25	28	30	29
21	20	26	20	24	24	26	25	28	25
14	18	20	18	24	26	25	27	26	25
22	23	25	25	23	29	25	29	29	29
15	13	19	20	20	22	20	24	24	25
18	17	18	20	21	21	20	23	22	21
12	10	12	15	18	19	15	19	18	23
19	19	18	18	21	21	20	22	24	26
15	20	22	22	22	23	23	25	24	25
18	23	26	24	26	26	23	24	27	27
16	15	14	18	20	20	20	22	23	24
17	17	27	21	24	27	21	26	28	25
21	26	29	27	26	29	28	27	28	30

GROUP PS₁

Trial									
<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
15	21	19	23	24	24	25	26	25	26
15	18	18	21	18	21	22	19	24	23
13	18	19	19	19	20	21	20	21	20
10	16	17	19	19	20	22	22	27	23
15	21	21	23	21	26	27	25	28	25
12	18	17	18	22	24	23	22	21	25
10	19	24	25	27	27	22	26	28	26
13	13	17	19	16	21	16	20	19	24
17	25	24	26	24	26	27	28	28	29
12	16	19	20	19	20	20	23	24	23
11	15	16	15	16	17	21	17	20	22
11	19	18	20	23	24	23	24	25	26
14	15	17	21	22	26	26	28	27	25
19	22	19	25	25	26	28	25	26	28
15	21	21	22	19	22	21	21	25	23
17	18	19	20	23	24	19	26	26	23
16	20	21	23	24	24	24	27	27	28
18	18	22	24	27	28	25	28	28	29

GROUP PS₂

Trial									
<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
11	15	14	20	16	22	22	23	20	18
14	22	22	25	23	24	25	25	26	25
11	19	21	25	22	20	27	22	24	23
16	22	27	24	28	27	28	28	28	27
10	13	15	19	21	18	20	21	24	20
15	23	24	28	27	27	27	27	30	29
27	28	30	30	30	29	30	30	28	30
14	18	15	15	15	18	21	19	19	17
13	22	21	25	27	28	29	28	30	30
15	15	21	15	16	22	18	20	22	22
8	12	16	13	16	19	19	21	20	20
11	15	17	12	12	13	14	17	15	17
8	16	16	15	17	17	17	22	24	24
16	19	24	22	25	22	22	26	23	25
12	15	19	19	19	23	18	21	24	25
8	15	14	15	16	16	19	19	22	24
17	18	24	25	26	28	28	29	29	25
17	20	21	18	23	22	26	26	27	26

GROUP C

Trial

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
9	16	19	18	19	15	17	16	18	21
10	13	21	19	21	22	22	22	24	27
5	14	17	17	17	17	22	24	21	28
15	21	23	21	21	25	21	25	28	25
12	15	24	26	28	28	28	27	30	28
4	12	15	18	18	20	22	24	23	23
12	20	25	26	27	29	28	30	28	30
10	15	20	20	24	23	27	23	24	24
8	16	16	20	22	19	16	21	21	23
7	8	14	13	12	19	21	17	24	22
11	17	19	21	25	22	27	28	28	23
8	12	16	20	19	23	24	23	24	22
4	10	15	20	18	17	21	23	25	27
12	14	19	21	22	26	27	26	25	27
12	19	21	21	20	24	19	22	26	22
6	13	17	19	22	27	22	23	30	28
11	18	20	18	18	23	24	24	26	26
15	17	25	26	28	28	30	26	28	28

APPENDIX B

Total correct per subject across trials on list 3

	Group					
AM	PM ₁	PM ₂	C	PS ₁	PS ₂	AS
177	171	172	168	228	181	204
166	90	224	201	199	231	276
200	194	195	182	190	214	198
206	231	211	225	195	255	225
221	201	245	246	232	181	271
224	267	225	179	202	257	233
229	233	206	255	234	292	239
243	227	262	210	178	171	223
244	212	138	182	254	253	259
182	189	186	157	196	186	202
205	162	139	221	170	164	201
211	135	206	191	213	143	161
244	208	184	180	221	176	208
162	174	250	219	243	224	221
211	219	253	206	210	195	244
241	254	227	207	215	168	192
230	189	210	208	234	249	233
216	264	201	251	247	226	271

APPENDIX C

SCR scores (O - E) for each subject, list 3, trial 10

Categories: "first half" and "second half"

Group						
AM	PM ₁	PM ₂	C	PS ₁	PS ₂	AS
5.5	1.9	5.0	3.3	11.9	6.0	3.0
4.3	.2	3.5	4.3	2.5	9.0	0.0
-1.2	5.3	1.0	9.0	2.9	4.3	8.5
.9	1.4	-1.1	6.5	4.3	11.5	.5
5.0	.7	5.3	3.9	11.3	2.6	2.0
1.1	7.5	3.7	6.3	5.5	13.5	5.5
1.0	4.0	4.9	6.0	8.0	4.0	3.3
3.0	2.3	6.0	6.0	2.9	2.5	5.5
.5	.3	4.1	3.5	11.5	-2.0	6.5
1.9	2.9	1.9	7.0	4.3	6.0	5.4
1.9	3.5	1.4	3.3	5.6	3.0	.5
5.9	3.4	1.9	2.9	9.0	2.7	7.3
6.9	3.0	1.5	1.3	5.5	7.7	3.9
2.5	2.9	3.9	7.5	5.9	7.5	6.5
6.0	3.5	4.0	- .8	4.3	10.3	12.4
-3.5	1.5	2.5	6.0	3.5	5.0	6.7
3.5	8.5	4.5	7.0	8.0	9.5	5.3
6.3	-1.1	5.9	2.9	6.5	6.0	8.0

Categories: even, odd

Group			
AM	PM ₁	PM ₂	C
-2.5	-1.7	-1.0	-2.5
2.0	- .8	1.5	1.5
-1.7	-2.7	- .7	-3.0
.9	2.5	2.9	- .5
5.9	-2.1	2.9	-7.0
0.0	- .5	2.9	-4.7
4.0	0.0	0.0	-3.0
4.0	-1.1	0.0	-1.0
3.4	4.3	2.1	-5.7
-1.0	-2.0	2.9	-2.1
- .1	-1.5	.9	-4.7
2.9	-2.1	- .5	-4.1
-1.0	-2.0	- .5	-2.5
-3.5	-1.7	6.0	- .5
.9	-4.5	0.0	- .1
1.5	4.5	4.4	1.0
1.5	- .7	3.3	2.9
.3	-2.1	-3.1	-7.0

APPENDIX D

Computing stimulus category repetition (SCR) (Bousfield & Bousfield, 1966)

$$E(SCR) = \frac{(m_1^2 + \dots + m_k^2)}{n_j} - 1$$
 where m_k equals the number of items recalled from the k^{th} category on trial j , and n_j equals the total number of items recalled on trial j .

$O(SCR)$ is obtained by counting the number of times a word from any category is followed by another item from the same category.

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