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RETENTION OF FREE RECALL LEARNING: THE WHOLE–PART PROBLEM [1]

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This experiment was a test of the organization theory assumption that optimal memory units are acquired in the context of an entire list. The acquisition and retention of 30-item free recall lists learned under the Whole and Part methods were compared. The Part lists were learned in two successive halves which were then combined so as to maintain (Blocked) or disrupt (Unblocked) part-based organization units. There were two Whole procedures: standard free recall (Unblocked) and a whole list presented in two parts (Blocked). Retention was tested immediately after learning or 1 wk. later. The results did not support predictions based on organization theory: Learning time was equivalent under all conditions and an overall comparison failed to show differences in recall while internal analyses suggested superior retention for Part. Poorest performance was found in Whole Blocked where a recency deficit effect was also isolated.

Organization theory argues that a major component of performance in a free recall (FR) task is the development of units of subjective organization (Mandler, 1967; Tulving, 1962). The theory also assumes that there is an optimal way of organizing materials given the total list of words to be learned, the language habits of *S*, and his perception of the structure of the list. Accordingly, the potential for the development of good organizational units should play an important role in determining the speed of learning and, in fact, the level of retention, since these packages of items are the units of storage in memory.

One may consider the traditional Whole–Part problem in light of this analysis.[3] The Whole method allows for the discovery and development of cohesive groupings of items from the beginning of learning. In the Part method, the list is first learned in successively mastered segments which are then combined. On the strong assumption that optimal units are determined by all of the items to be learned, part-based units will be inferior. This is not a necessary assumption of the theory; one could hold the position that part-based units may be stored as efficiently as any others given that they are well learned. The present experiment is a test of the more stringent assumption. Here, the Whole and Part methods are compared on an FR task, a learning procedure which allows *S* to search for and arrive at his own associative organization of the materials. This is a task in which the ease, and in fact even the possibility, of arriving at optimal organizational units should play a major role in determining speed of acquisition and level of retention.

In this experiment, Part *S*s learned the list in halves before proceeding to the combination stage while Whole *S*s learned the entire list from the beginning of training. Retention was tested either immediately after learning or 1 wk. later. For the Part *S*s, what happens in the combination stage is critical; this is their only opportunity to adopt whole-based units. It is possible that they will not succeed in changing part units and at best, they will have less practice on the new, whole-list

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[3] For a historical review of the Whole–Part problem, see McGeoch (1931). For a more recent review, see McGeoch and Irion (1952).

units than will Whole *S*s. It is also possible that Part *S*s will not give up their old units, as they are thought to in Part-to-Whole transfer tasks (Tulving, 1966), because in the present situation, no new items are added during the combination stage. Because of the critical importance of the fate of part-based units, the nature of the combination stage was manipulated. In one procedure the parts remained intact during the combination stage; they were simply blocked together. Blocking should enable and perhaps encourage *S*s to maintain their part-based units. In a second procedure, the parts were intermingled. Intermingling should encourage rearrangement of units to a whole-list basis.

In addition to the standard Whole method used in this experiment, there was a condition in which the entire list was presented in the segments learned by Part *S*s. This was done to have a Whole condition in which part-like units could be formed. On the assumption that optimal storage units are based on the whole list, retention should be superior for those conditions which allow for the development of such units.

Method

Design

Three variables were factorially combined in this study. The first was the learning method, Whole or Part. Thirty words were learned by Whole *S*s as a single list. The Part *S*s learned the list in two successive parts of 15 items each. The parts were then combined into a whole list for study until a common criterion was reached. The second variable was the sequential order of items in the total lists, Blocked or Unblocked. Under the Blocked procedure, the list was divided into two parts. Within each part, words were free to vary position from trial to trial; they could not cross the part boundary. In the Unblocked procedure, words were free to vary position on each trial. For the Whole method, Blocking refers to the presentation of words in the entire list. For the Part method, Blocking refers to the way in which the parts were combined. The third variable was the time of the retention test, either Immediately after the end of learning, or Delayed by 1 wk. These variables, learning method, sequential ordering, and retention interval, were factorially combined to produce eight conditions: Whole Unblocked Immediate, Whole Unblocked Delayed, Part Unblocked Immediate, Part Unblocked Delayed, Whole Blocked Immediate, Whole Blocked Delayed, Part Blocked Immediate, Part Blocked Delayed. Nested within the Part Blocked conditions was an additional variable, the order in which the parts were combined. For half of the *S*s, Part 1 (P_1) occurred first, followed by Part 2 (P_2); this condition was called P_1P_2. For the other *S*s, the order was reversed, P_2P_1. This manipulation was included to monitor possible interference effects in the part conditions.

Lists

Four lists of 30 nouns were used. Similarities among the words in a list were minimized. The lists were equated for Thorndike-Lorge frequency, concreteness (Paivio, Yuille, & Madigan, 1968), number of syllables, initial letters, and length. The lists were then divided into two parts of 15 words each. The parts were equated as closely as possible for the same characteristics as were the whole lists. The whole lists were then constructed as follows: for the Unblocked conditions, the two parts were completely intermingled; for the Blocked conditions, the two parts were combined with the juncture clearly distinguished by red lines. Each list had 10 orders of presentation. Items were free to vary position from trial to trial with the constraint that an item in a whole list could occupy the first or last position only once and in a part list, not more than twice. In addition, care was taken to minimize across orders of presentation the number of pair-wise repetitions of items.

Procedure

The experiment had three phases: learning, recall, and relearning. All *S*s were fully instructed about the course of the learning phase. The instructions were accompanied by diagrams using geometric forms to represent words in the lists. The study-test method was used with the words presented on a memory drum at a 2.5-sec. rate. Recall was oral, lasting 1 min. for the short lists and 2 min. for the long lists. The intertrial intervals for the short and long lists were .5 min. and 1 min., respectively. Learning continued to a criterion of 26/30, when the retention interval began. The Immediate groups were tested for recall 1.5 min. after the criterial trial, the Delayed conditions, 7 days ± 4 hr. The recall test was the same for all conditions: A 2-min. oral recall was followed by 2 additional min. in which *S*s looked over what they had recalled and made additions. The final phase of the experiment consisted of three study-test trials on the original list for the Whole *S*s and on the appropriate combination-stage list for the Part *S*s. The following specific procedural variations occurred in each condition.

Part conditions.—There were three stages in the Part method: (*a*) Part Learning, (*b*) Part Recall, and (*c*) Combination Stage. In the Part-Learning Stage, each of two parts was learned to a criterion of 13/15 with a 30-sec. interval between the end of P_1 and the beginning of P_2. Each of the four lists had two parts called A and B. Half of the *S*s in each condition learned them in Order AB, half in BA. A 1-min. interval elapsed between Part Learning and the Part Recall test where *S*s were allowed 2 min. to recall the items from both parts. If criterion was reached on Part Recall, learning was terminated and the appropriate retention interval begun.[4] A 1-min. interval elapsed before the beginning of the combination stage in which all 30 words were presented and the Blocking variable was introduced.

Whole conditions.—The *S*s in the Whole conditions learned the same lists, in the same order, with the same timing, as did Part *S*s in the Combination Stage. Half of the *S*s in the Whole Blocked conditions had a list order conforming to the P_1P_2 Combination list and half, to P_2P_1.

Subjects

There were 16 *S*s in each of eight groups. The *S*s were undergraduates at the University of California who were naïve to FR learning. The *S*s were assigned to conditions in blocks of eight. Twenty-three *S*s had to be replaced, 15 for alphabetizing the list during learning and 8 for failure to return for the delayed retention test. Of the *S*s who failed to return, 1 was in Part Blocked, 2 each were in Whole Unblocked and Whole Blocked, and 3 were in Part Unblocked.

Results

Acquisition

Total learning time.—Time to reach criterion was used as the measure of learning speed because trials were not comparable for the Whole and Part conditions. These values are presented in Table 1. The total time for the Part conditions is the sum of the time taken to learn P_1, P_2, and the Combination Stage. It includes also the time for the Part Recall trial, 2 min. Because of distortion introduced by a few slow *S*s, all learning time analyses were done on the log-transformed values. There were no significant differences in total learning time among the conditions. The Part versus Whole comparison yielded an F (1, 118) of 1.22, while all other effects showed Fs of 1 or less.

Part conditions: Learning time.—For the Part conditions, total time was divided into its components. There were four questions of interest: (*a*) How great was the saving that resulted from learning a long list in parts; (*b*) were there differences in Part-Learning time; (*c*) were there differences in time taken to learn successive parts; (*d*) were there differences in Combination-Stage time.

The advantage gained from learning short as compared to long lists can be measured by the difference between Whole-Learning time and Part-Learning time. For the Blocked conditions, the value of this difference was 9.34 min.; for Unblocked, it was 9.19. For these materials there was a large saving when the long lists were learned in parts. The saving was equivalent under the Blocked and Unblocked conditions.

Analysis of Part-Learning time revealed no differences among the Part conditions, although Part Blocked had a slight advantage over Part Unblocked. With regard to the learning of the successive parts, a repeated-measures analysis showed a significant main effect for Parts, F (1, 58) $= 5.31$, $p < .025$. This difference reflects a learning-to-learn effect in transfer from P_1 to P_2. The apparent Parts × Blocking interaction was also significant, F (1, 58) $= 4.79$, $p < .05$. As can be seen in Table 1, most of the benefit from learning to learn was located in the Blocked condition, with Unblocked showing little or no saving in transfer to P_2. Since the Blocking variable had not yet been introduced, these differences must represent the effects of the instructions given at the beginning of learning.

The Unblocked condition, which took longer to learn the parts, took slightly less time to learn the Combination list than the Blocked condition. An analysis of Combination time showed that this difference did not reach significance, F (1, 58) $= 3.10$. No other effects were significant. Thus, whatever slight advantage Part Blocked might have held at the end of the Part Stage was lost during the Combination Stage, resulting in an invariance in learning time. If the Unblocked combination list encouraged rearrangement of organization units, this was not reflected in learning time scores; rather, any differences present were in the opposite direction.

For the Part Blocked conditions, the order in which the two parts were com-

[4] This occurred in only three instances, twice in Part Unblocked Immediate, and once in Part Unblocked Delayed. For these *S*s, the Combination-Stage manipulation was invalid. When mean recall of these conditions was calculated without these *S*s, the values were 26.9 for Part Unblocked Immediate and 16.0 for Part Unblocked Delayed. These values were close to the group means with these *S*s included, and it was decided not to discard them.

TABLE 1

LEARNING TIME (IN MIN.)

Cond.	Time Whole	Time Part[a]	Time (P_1)	Time (P_2)	Time ($P_1 + P_2$)	Time combination
Whole Unblocked Immediate	23.1					
Whole Unblocked Delayed	23.3					
X	23.2					
Part Unblocked Immediate		23.7	6.2	7.2	13.4	8.3
Part Unblocked Delayed		24.1	7.8	6.8	14.6	7.5
X		23.9	7.0	7.0	14.0	7.9
Whole Blocked Immediate	23.3					
Whole Blocked Delayed	21.7					
X	22.5					
Part Blocked Immediate		23.8	7.3	5.4	12.7	9.1
Part Blocked Delayed		25.1	7.6	6.1	13.7	9.4
X		24.5	7.4	5.8	13.2	9.3
P_1P_2		23.6	7.0	5.5	12.5	9.1
P_2P_1		25.3	7.8	6.1	13.9	9.4

[a] The Time Part score includes 2 min. for Part Recall.

bined varied in the Combination Stage. This variable had no effect on any measures of part performance.

Part conditions: *Part Recall trial.*—The mean number of items recalled from each part is shown in Table 2. The retroactive interference (RI) acting on P_1 during the acquisition of P_2 produced a substantial loss, about 4 or 5 items from a criterion of 13. Analysis showed that the slight tendency for better recall in the Unblocked condition was not significant, $F\ (1, 58) = 2.95$. The advantage in recall of P_2 items over P_1 was significant, $F\ (1, 58) = 69.88$, $p < .01$. In addition, the higher order interaction, involving parts, blocking procedure, and time of recall was significant, $F\ (1, 58) = 4.94$, $p < .05$. This interaction must represent sampling fluctuation, since the time variable had not yet taken effect.

Recall and Relearning

Comparability of degree of learning.—To determine whether the conditions were equated at the end of learning, a comparison was made of performance on the criterial trial (Table 2). The analysis used was a nested design for factorial experiments (see Marascuilo & Levin, 1970) which compared the Blocked and Unblocked conditions with the Time and Part versus Whole variables nested within each of these two treatments. This design was used because it enabled a comparison of Whole and Part performance in what was thought to be the purest condition, the Unblocked method. The sole significant difference was between Part and Whole in the Blocked condition, $F\ (1, 118) = 7.64$, $p < .01$. The Part Blocked conditions overshot criterion and began the retention interval with an advantage of three-fourths of an item over Whole Blocked. This difference in the Unblocked procedure did not reach significance.

Recall.—Recall scores were used because loss scores showed marked heterogeneity of variance (see Table 2). On the Immediate test of retention, each Part condition was superior to its comparable Whole condition. If one compares absolute retention, the conditions line up in the following decreasing order: Part Blocked, Part Unblocked, Whole Unblocked, and Whole Blocked. There were substantial losses for all conditions over a week but the relative ordering of the four conditions remained the same. The overall difference between Blocked and Unblocked was not significant. Within the Unblocked condition, the only significant effect was for Time, $F\ (1, 118) = 149.74$, $p < .01$. Time was again significant in the Blocked condition, $F\ (1, 118) = 175.03$, $p < .01$, as was the difference between Whole and Part, $F\ (1, 118) = 10.88$, $p < .01$. The Whole versus Part $\times$ Time interaction did not approach significance for either Blocked or Unblocked conditions.

Recall of parts.—The number of items re-

TABLE 2

MEAN NUMBER OF WORDS RECALLED

Cond.	Part Recall trial			Criterion trial	Recall trial		
	P_1	P_2	Total		P_1	P_2	Total
Whole Unblocked Immediate				26.9			25.9
Whole Unblocked Delayed				26.9			15.2
X				26.9			
Part Unblocked Immediate	8.4	12.7	21.1	27.1	13.2	13.6	26.8
Part Unblocked Delayed	9.1	12.1	21.2	27.4	7.9	8.1	16.0
X	8.8	12.4	21.2	27.2			
Whole Blocked Immediate				26.4	13.0	11.9	24.9
Whole Blocked Delayed				26.9	6.9	5.6	12.5
X				26.6			
Part Blocked Immediate	8.9	11.4	20.3	27.4	13.1	14.1	27.2
Part Blocked Delayed	7.1	12.1	19.2	27.3	8.3	7.9	16.2
X	8.0	11.8	19.8	27.4			
P_1P_2 Immediate	8.9	11.1	20.0	27.6	13.6	13.9	27.5
P_1P_2 Delayed	7.5	11.6	19.1	27.1	9.0	7.9	16.9
X	8.2	11.4	19.6	27.4			
P_2P_1 Immediate	9.0	11.6	20.6	27.1	12.5	14.2	26.7
P_2P_1 Delayed	6.6	12.8	19.2	27.5	7.5	8.0	15.5
X	7.8	12.0	19.9	27.3			

called from each part was determined for Part Blocked, Part Unblocked, and Whole Blocked (Table 2). A repeated-measures analysis showed a significant Parts × Learning Conditions interaction, F (2, 88) = 5.22, $p < .01$. No other effects were significant. Inspection of Table 2 shows that this interaction was the result of the poor recall of P_2 items shown by Whole Blocked. For the Part conditions, there was equivalent retention of the two parts.

Item strength and the probability of recall.—Two important effects were pursued by means of probability analyses. The first was the apparent superiority in recall shown by the Part procedure, a difference which was significant under the Blocked condition. The second was the differentially poor recall of P_2 words by Whole Blocked.

The first analysis compared the probability of recall for Strong versus Weak words in the Blocked conditions. Items were divided into Strong and Weak categories on the basis of the number of times each had been recalled during learning. The probability of retention was estimated by the percentage of items in each category which were recalled. The functions are shown in Fig. 1. Compared to comparable Whole items, there is an advantage in retention for both Strong and Weak items learned under the Part method. Strong items have a higher probability of recall than Weak items in both the Part and Whole conditions. Note that for well-learned items an interaction with time becomes apparent. On the Immediate retention test, Part and Whole Strong items are equally well recalled. A week later, the Part Strong items have a clear advantage. This same interaction, though of a lesser magnitude, was also obtained for the Unblocked conditions. This is evidence that superior retention actually obtained under the Part method.

The second analysis compared the probability of recall of words in Whole lists. For Whole Blocked, interest centered on a comparison of P_1 and P_2 items. For each S in the Whole conditions, the 30 words were divided into three levels of difficulty according to the number of correct recalls during learning. For the Whole Blocked conditions, the percentage of P_1 and P_2 items at each level was then determined. From the lowest to the highest category, that is, least recalled to most, these values were 51.8, 51.9, and 46.6 for P_2. Thus, a higher proportion of relatively weak items came from the second half of the list. The next step in the analysis was the tabulation of the frequency of recall of items at each of the three levels of learning. These were

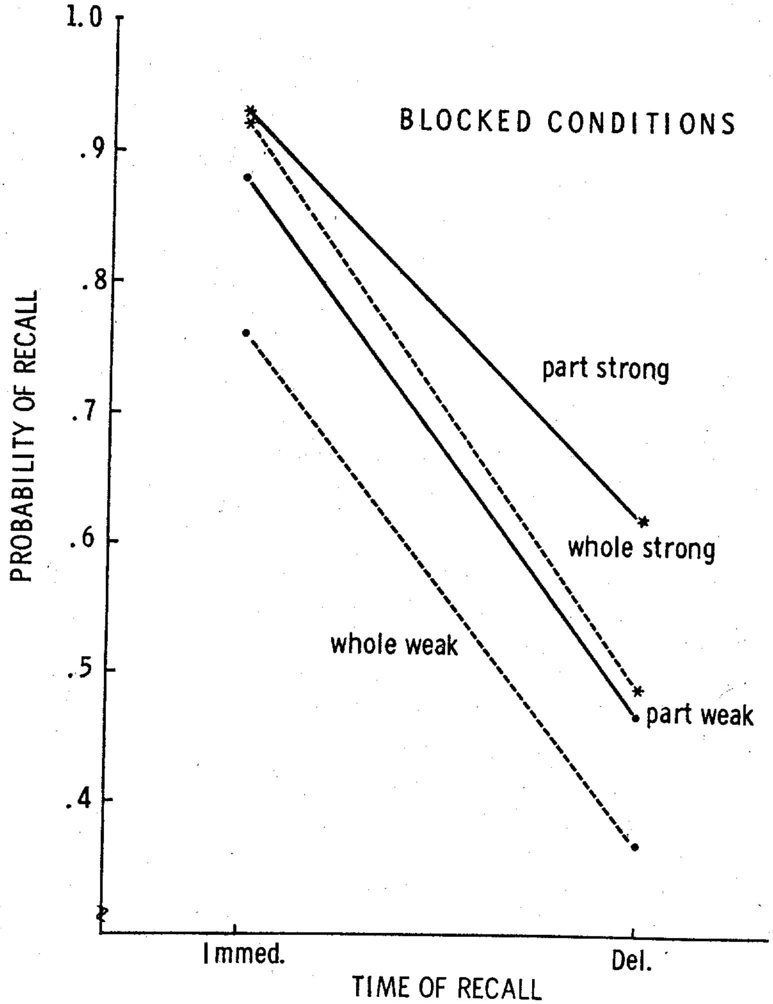

FIG. 1. Probability of recall of strong and weak items in Part Blocked and Whole Blocked conditions.

averaged across *S*s and expressed as probabilities. The function relating level of learning to probability of recall is shown in Fig. 2. For all conditions, probability of recall increased with level of learning. The functions were negatively accelerated except for P_2 of Whole Blocked Delayed. For these items, an increase in the level of learning did not have so great an effect on retention as was the case for other items. Words in P_2 of Whole Blocked appear to be differentially learned and recalled.

Relearning.—On the first of three relearning trials, there was a substantial difference between Immediate and Delayed recall conditions. This was reduced by the third trial. In general, the Whole Blocked conditions did less well than others.

Measures of Organization and Clustering

Pair-wise intertrial repetitions (ITRs) in both forward and backward directions were used as the measure of organization (Bousfield, Puff, & Cowan, 1964). Interest centered on the relative number of ITRs between the criterial trial and the recall trial. If what is recalled are words from good units, nonassociated words having been forgotten, then the relative ITR scores should increase over the retention interval.

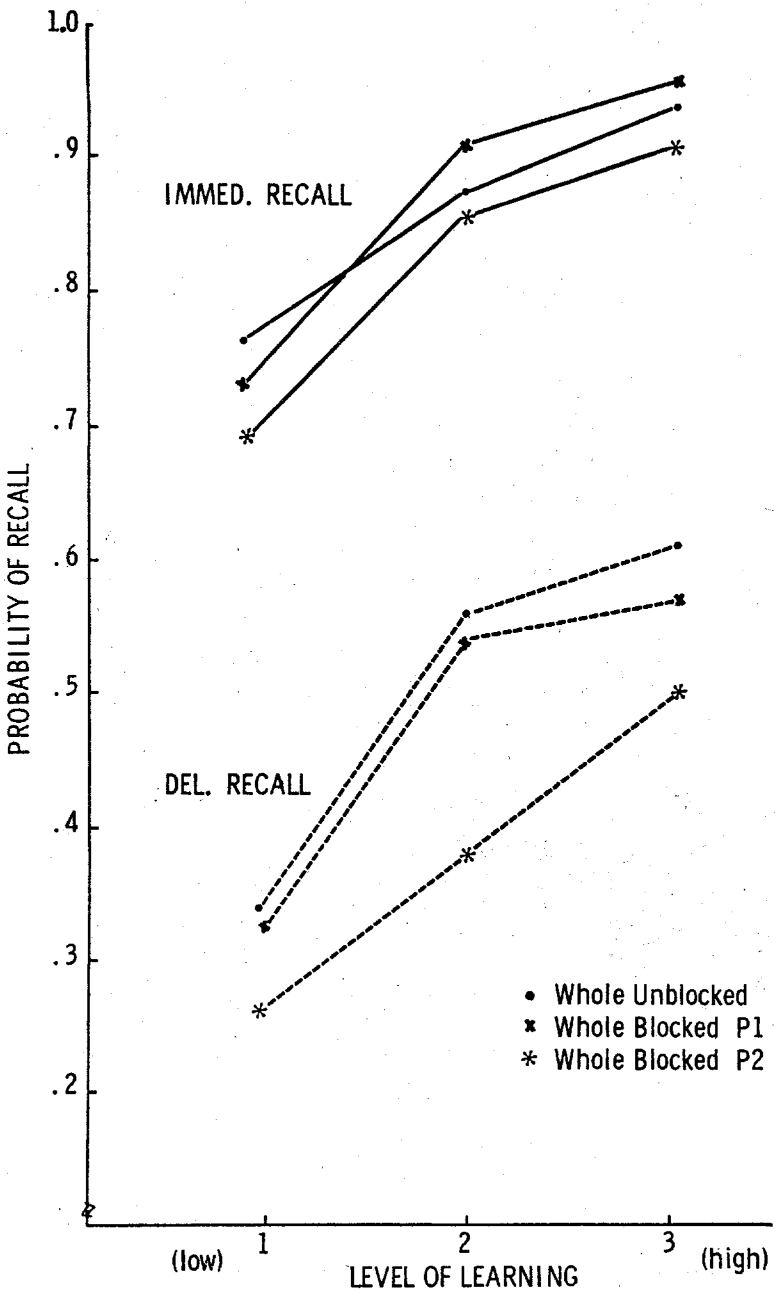

FIG. 2. Probability of recall of words in Whole conditions as a function of level of learning.

These scores are shown in Table 3. The only significant effect was found for time in the Unblocked conditions, F (1, 118) = 6.45, $p < .025$. In the Blocked conditions, the ITRs also fell but this difference was not significant, F (1, 118) = 1.91.

Clustering was used to index the extent to which items from the same part were recalled together. Clustering values are presented in Table 3. On the Part Recall trial, the tendency for Part Unblocked to produce more clusters was not significant,

TABLE 3

Measures of Clustering and Organization

Cond.	ITRs retention	Clustering		
		Part Recall	Criterion	Recall
Whole Unblocked Immediate	.207			
Whole Unblocked Delayed	.178			
$\bar{X}$				
Part Unblocked Immediate	.309	5.446	5.446	.244
Part Unblocked Delayed	.239	6.035	6.035	.194
$\bar{X}$		5.740	5.740	
Whole Blocked Immediate	.236		3.730	.126
Whole Blocked Delayed	.188		3.321	.026
$\bar{X}$			3.526	
Part Blocked Immediate	.253	4.476	7.206	.225
Part Blocked Delayed	.208	4.191	7.095	.160
$\bar{X}$		4.334	7.150	

Note.—The relative ITRs are between the criterion trial of learning and the recall test. The clustering measures are absolute values for Part Recall and Criterion trials. For the Recall trial, relative value is given.

F (1, 58) = 3.09. At criterion, the Part conditions clustered more than Whole Blocked with the Part Blocked condition above Part Unblocked. Statistically, these effects were significant with the value of F (1, 88) for the Whole versus Part comparison being 11.93, $p < .01$; for the Part Blocked versus Part Unblocked comparison, F (1, 88) was 4.92, $p < .05$. This latter result suggests that the Unblocked Combination Stage induced *S*s to give up part-based organization units.

For the recall trial, an analysis was done on the relative clustering scores. Here, the Bousfield and Bousfield measure (1966) was used. There was more clustering immediately after learning than there was after a week's interval. The Part conditions continued to show some clustering after a week, whereas for Whole Blocked Delayed, clustering was near zero. Statistical analysis confirmed these observations with the Whole versus Part difference yielding an F (1, 88) of 14.11, $p < .01$; for Immediate versus Delayed, the value of F (1, 88) was 4.86, $p < .05$. Thus, part-based organization persisted over a week's interval for the Part conditions but not for Whole Blocked.

Discussion

The results of this study contradict predictions made on the basis of organization theory: (*a*) Acquisition did not take longer under the Part method than under the Whole. Rather, in roughly the same amount of time, Part *S*s reached a higher level of learning than did Whole *S*s. (*b*) The Whole method did not result in superior retention. The overall statistical tests did not reveal differences in retention, while an item-strength analysis suggested superior retention for the Part method.

The invariance in learning time may be understood as the product of several factors. The short lists resulted in a saving for the Part conditions, but substantial interference reduced the availability of Part items, particularly those in P_1. This was compensated for in the Combination Stage, which took sufficient time to negate the short list advantage of the Part conditions, but not so much time that the Whole list was learned faster. Similar effects have been found in Whole–Part comparisons using the paired-associate method (Postman & Goggin, 1966).

It is possible to account for whatever time is spent in the Combination Stage as being due to the process of rearranging part-organization units. However, the notion of rearrangement becomes untenable in light of the Combination-Stage performance of Blocked and Unblocked *S*s. Unblocked *S*s showed less clustering at criterion than did Blocked *S*s, indicating that the former had adopted a more wholistic organization. If anything, Unblocked *S*s spent less time in the Combination Stage than did Blocked *S*s. This result calls into question two assumptions: (*a*) that part units will be rearranged more or less automatically when whole-list units become available; (*b*) that if rearrangement does take place, it necessarily slows down learning. This result raises the possibility that the negative transfer found in Part-to-Whole studies (Novinski, 1969; Tulving, 1966) was not the result of the rearrangement of organizational units.

Even more profoundly opposed to the assumption of whole-list "optimal" units of organization are the retention results of this study. Although overall retention did not differ significantly for Part and Whole *S*s, an item analysis showed superior retention for well-learned Part items. Forgetting was equivalent for Weak items under the Part and Whole methods, while the Strong, well-learned items were better retained under the Part method. Additional evidence that well-learned part items were better recalled came from a further analysis of the Part conditions themselves. If strong part units favor superior retention, one would expect there to be a difference in recall performance associated with *S*s' showing different levels of part learning. Performance on the Part Recall trial was used as an index of the strength of part learning and *S*s were divided into two groups on this basis. Immediately after learning, the mean recall for *S*s with high and low Part Recall in Part Unblocked was 27.6 and 26.3, respectively. For Part Blocked, these values were 27.6 and 26.4. These small differences were considerably enlarged after a week. For Part Unblocked, recall was 18.6 and 14.1 for high and low *S*s, respectively. For Part Blocked, these values were 18.1 and 14.2. Along with the item analysis, this evidence suggests that well-learned parts resulted in superior retention. It is important to note that this effect cannot be attributed to a difference between Fast and Slow *S*s. Partial correlations for individual *S*s between Part Recall and retention with total learning time held constant confirmed these subgroup differences: For Part Blocked Delayed, the correlation was .321, while for Part Unblocked Delayed, it was reduced but remained positive, .152.

For the Blocked condition, Part Recall was a good predictor of retention. It is not surprising that the correlation was lower under an Unblocked procedure in which the Combination Stage list obscured the part origins of items and made difficult the preservation of part-based units. Partial correlations between learning time and retention, with Part Recall held constant, support this interpretation. For Unblocked Delayed, the correlation was −.403. Thus, the longer the time spent in learning, at whatever level of Part Recall, the poorer was long-term recall. For Part Blocked Delayed, this correlation was .092. Under the Blocked procedure, learning time and recall were independent. This is in contrast to usual results in which, with level of learning disregarded, slow *S*s show poorer recall than fast *S*s. With a Blocked combination list, slow *S*s can gain from continuing to study the list. In contrast, slow *S*s in the Unblocked Combination Stage will be confronted with a whole list which interferes with part-based organization. In fact, Unblocked *S*s who spent a higher percentage of total learning time in the Combination Stage recalled two fewer words after a week than did *S*s who spent relatively less time in the Combination Stage.

Superior retention appears to result when part lists are learned under conditions which allow for the maintenance of part-based units. Two possible interpretations may be offered. The first is resistance to interference. The Part procedure subjects words to retroactive and proactive interference effects. Relearning during the Combination Stage may reduce the impact of subsequent interference effects (Abra & Roberts, 1969). Alternatively, it may be the case that when lists of unrelated words are learned, shorter lists offer the opportunity of easily finding ways to group the words (Miller & Selfridge, 1950). Thus the arbitrary nature of parts may not impede learning if the only alternative is a long whole list.

Poorest recall in this experiment was shown by the Whole Blocked condition. This may have resulted from the use of irrelevant organizational dimensions, such as position, or from the difficulty of finding stable associations in such a long list. Much of the differentially poor recall of this condition was located in the second half of the blocked list. These items were less stably recalled during acquisition. This suggested the possibility of a deficit associated particularly with recent words. Perhaps a recency recall carries with it little or no increment to "learning strength" because such a word gets little rehearsal (Rundus & Atkinson, 1970). Compared to Whole Unblocked, the Whole Blocked condition had fewer items free to rotate into recency positions. Thus, any deficit associated with recency recalls would be exaggerated for Whole Blocked. This could then account for the unstable learning of items in P_2.

It was reasoned that if a recency item accumulates learning strength like any other item, its probability of recall would be accurately predicted by the recall of nonterminal items which are equally well learned. If, on the other hand, a recency recall does not result in any increment to "strength," items at equivalent learning levels will overestimate the retention of recency items. A stringent test of the "Recency Deficit" hypothesis was conducted by attempting to predict the level of recall of the item in Position 30 on the terminal trial of learning. The "expected" probability of recall was obtained as follows: First, for each Whole *S*, the level of learning of that terminal item was determined. Then, for each *S*, the probability of recall of all nonterminal items at the same level of learning was recorded. A mean probability of recall of these nonterminal items was determined by averaging across *S*s in a condition. The "obtained" probability of recall was determined by counting the number of *S*s out of 16 who had in fact recalled the item in Position 30. Immediately after learning, the expected level of recall overshot the obtained by .15 for Unblocked and .25 for Blocked. After a week, the overprediction still obtained for Blocked, .23. For Unblocked, however, the difference reversed itself so that recall was greater than predicted by .09. With the exception of Whole Unblocked Delayed, the level of recall of the terminal item was less than predicted and this difference was greater under the Blocked conditions in which fewer items occupied the terminal positions. It is possible that the poor recall of the Whole Blocked condition was due to the accumulated effect of this recency deficit, which must operate in all FR tasks.

The recency deficit hypothesis does not immediately account for the failure to find the effect for the Whole Unblocked Delayed condition. If one assumes that the deficit is minimal when items are well learned, as they must be at criterion, then it should be very difficult to measure the deficit, except in unusual situations, as in the Whole Blocked condition. This recency effect is similar to one found in single-trial FR tasks with multiple lists (Craik, 1970).

In summary, the results of this study show an invariance in learning time under the Part and Whole methods of practice with superior long-term retention for the Part methods when the part units of organization were maintained throughout learning. These results do not support the assumption that optimal units of organization result only when all of the items to be acquired are simultaneously available. Rather, short-range and well-learned associative connections, which can be easily acquired under the Part procedure, appear to result in superior retention. In addition, a recency deficit was isolated in a multitrial FR task.

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