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ABSTRACT

This study investigated subjects' ability to combine and organize information from different sentences, as well as their ability to retain that information. Ninety-six college undergraduates were given three trials to learn the characteristics of ships from a text. Attributes of each ship were clustered together (name organization), or sentences describing one attribute for all ships (e.g., their speeds) were clustered together (attribute organization). It was found that organization affected (1) level of recall, (2) subjective organization of recall, and (3) apprehension of certain relationships. Subjects tested for attribute organization, who had errorless recall, had difficulty answering questions that required combining information about each ship. Attribute organization produced the lowest free recall and caused subjects to impose a new order on sentences within clusters. The position of names and attributes was varied in the text sentences and learning objectives given to subjects. It was also found that the number of sentences incorrectly recalled increased if position was in some way incompatible with text organization. (Author/DI)

Learning, Organization, and the Integration of Written Prose

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Prose research has tended to emphasize the verbatim retention of text, yet some of the most intriguing and difficult problems involve the combination, transformation, and utilization of text information. The present study explored the effects of several variables upon Ss' ability to combine and organize information from different sentences, as well as their ability to retain that information.

Several closely related studies (Frase, 1969; Myers, Pezdek, & Coulson, 1972; Perlmutter & Royer, 1972; Schultz & Di Vesta, 1972; Friedman & Greitzer, in press) have examined the learning of texts generated from a matrix in which names (N) and attributes (A) were superordinate lexical items, and the attribute values (V) were the tabular entries. The usefulness of such a matrix is that it permits one to specify the content of a text, and hence to generate instructional and testing procedures which map clearly upon the content. The matrix shown in Table 1 was used to generate the materials of this study.

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Insert Table 1 about here

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Three different paragraph organizations have been studied: a) a Random Organization (RO) in which the sentences were presented in scrambled order; b) a Name Organization (NO) in which the sentences (see numbers of sentences in Table 1) were presented in the sequence 1, 2, 3, 4, 5, 6, etc.; and c) an Attribute Organization (AO) in which the sequence of sentences in the text was 1, 5, 9, 13, 2, 6, etc. Thus, either the rows or columns of the matrix provided the basis for text organization. In general, RO yielded poor learning and lower organization in recall output.

Myers, et. al. (1972), using a matrix in which there was equal statistical uncertainty in the rows and columns (as in Table 1), found some superiority for AO over NO, but the reasons for this were unclear. One possible factor might be syntax. In the Myers, et. al. (1972), and Perlmutter and Royer (1972) studies the text sentences had a predominant form, A-N-V; e.g., "The hull construction (A) of the Shark (N) was wood (V)." It is possible that the form of the sentence provides a cue to the storage and/or retrieval of the content to be learned. This cue might be congruent or incongruent with cues obtained from paragraph organization. For instance, in the example sentence, "wood" is attributed to "The hull construction of the Shark...". In the sentence, "The Shark had a hull construction of wood.", "a hull construction of wood" is attributed directly to

"The Shark..." In addition, A or N occurs early in the sentence and position might affect the salience of A or N. We know from the studies cited above that NO and AO affect how Ss organize text sentences, and if sentence form influences whether A or N cues are salient then compatibilities between sentence and paragraph structure should affect recall. One purpose of the present study was to explore the effects of sentence/paragraph compatibilities.

But such compatibilities might also exist between the text characteristics and the phrasing of written learning objectives which tell Ss explicitly what to learn from the text. The N and A emphasis of learning objectives was also varied in this study.

The amount of information that is given before reading is another variable related to learning objectives. Frase (1969) found that telling Ss that they were going to learn eight attributes of six chessmen, and then naming the attributes, improved learning. The present study varied whether names and/or attributes were listed in the learning objectives. The expectation was that performance would improve as more items were listed.

Several studies (Frase, 1969; Myers, et. al., 1972; Schultz & Di Vesta, 1972; Perlmutter & Royer, 1972) indicate that Ss prefer to use NO in written recall, although they can adopt AO if the passage is so structured. In addition, Myers, et. al. (1972) and Perlmutter and Royer (1972) have

shown that, when Ss learn AO passages, a) sentence order in recall output is highly correlated with the order of input, and b) learning is impaired if the order of information (the order of names) is not constant within paragraphs. Myers, et. al. (1972) concluded that NO and AO result in different learning strategies. Name organization seems to be more natural for these passages in the sense that Ss who learn an NO passage need not bother with serial order redundancies (which may be uncommon in ordinary discourse), although seriation might be an effective learning strategy, especially for AO Ss. The present study further explored these serial order and organizational effects.

What consequences might different text organizations have upon the higher level knowledge that Ss acquire from reading? Accounts of human learning which utilize the assumption that human memory is limited suggest one analysis with testable predictions (see, e.g., Bower, 1972). Suppose that we assume that short-term memory is limited and that only a few items can be retained at one time. For text, these items may be individual sentences. Assume further that associative linkages are likely to form among items that occur together in short-term memory, perhaps because they are transferred together to long-term storage. If several sentences intervene between two sentences in a text they are not likely to occur together in short-term memory, hence associations between them would be unlikely. One consequence would be that, given the recall of item n,

the next most probable item to be recalled would be item n+1. Serial order in free recall would tend to match the order seen in the text. We know from previous text research (e.g., Perlmutter & Royer, 1972) that the serial order of recall output tends to match the serial order of input.

But these memory effects might also be reflected in Ss' ability to integrate the separate sentences in a text. For instance, consider the effects of organization upon Ss' ability to answer the question, "What was the sail plan of the brigantine?" (See Table 1). For AO, the sentences stating that, a) the Shark had a fore-and aft rig and that, b) the Shark was a brigantine, might be separated by anywhere from 7-10 sentences. For NO, only one or two sentences would intervene. Even if both groups recalled the text perfectly, AO Ss should experience more difficulties in retrieving the information about "a brigantine" given the information about the "fore-and-aft rig". This difficulty might be reflected in the tendency for AO Ss to make more errors in answering questions which require the integration of information about each ship.

Method

Subjects

Ninety-six paid undergraduate volunteers from Montclair State College, New Jersey, participated.

Materials

The text sentences were generated from the matrix shown in Table 1. Sentences were in the form N-A-V (NS) or

A-N-V (AS). For instance, NS = "The Shark had a hull construction of wood."; AS = "The hull construction of the Shark was wood."

The sentences were sequenced to produce an NO or AO passage. The NO sentences were in the order (see Table 1) 1-16, the AO sentences were in the order 1,5,9,13, 2,6, etc. There were no paragraph indentations and letters were all upper case. Numbers were spelled out. There was no irrelevant information in the passage, and the order of names or attributes within consecutive sets of four sentences varied from set to set.

Written learning objectives directed Ss to learn all of the text, but the form of the objectives listed either the names of the ships (N), the attributes (A), both the names and the attributes (NA), or neither (O). For instance, N = "Learn the Shark, Squid, Ray and Swordfish attributes."; A = "Learn the sailing vessels' sail plan, hull construction, design and speed."; NA = "Learn the Shark, Squid, Ray and Swordfish sail plan, hull construction, design and speed."; and O = "Learn the sailing vessels' attributes."

Learning objectives were also ordered N-A (NB) or A-N (AB); e.g., "Learn the vessels attributes." or "Learn the attributes of the vessels."

Procedure

Subjects (randomly assigned to experimental conditions) were run in small groups. Each S was given an 11-page

booklet. The first page introduced the task of learning nautical information from a text, and it directed him to turn each page on signal from E. The second page stated the learning objectives (three times), and it described the sequence of testing and reading which S would encounter. Subsequent pages included the text followed by two blank pages (one for counting backwards and writing free recall, the other to mask the next occurrence of the text).

Subjects were given three trials of 3 min. each for reading. Each reading was followed by 2 min. of counting backwards by threes to dissipate recency effects. After counting backwards, S was allowed 6 min. for written recall. Subjects were instructed to write in complete sentences and not to use abbreviations or ditto marks. As each page was completed, S placed the page upside down on the floor.

The final page was the answer sheet for the prompted recall test. Thirty-two prompted recall items were recorded on tape. These short answer response items required the recall and integration of recalled information about a particular ship (I items), e.g., "What was the cement vessel designed as?", or they required recall of a text sentence (T items), e.g., "What was the hull of the Swordfish made of?" The number of each question was read, then the question was read slowly twice. After the second reading Ss were given 10 seconds to write their response. Total time for each item averaged 23 sec. Items were sequenced to minimize redundancies within N and I categories. Every other item was T.

For scoring free recall the same procedure was used as in earlier experiments (Frase, 1969). Subjects were given one point for each assertion which correctly filled in a cell of Table 1, i.e., for each correct association of a name and attribute value. Organization of sentence output was scored by recording the serial order in which Ss made such assertions (both correct and incorrect assertions were used). Runs of assertions about one topic (e.g., about the Shark or about the speeds) could be used to assess differences in subjective name and attribute organization. The ARC clustering measure was used (Roenker, Thompson, & Brown, 1971). This index represents the proportion of organization obtained in relation to the amount expected by chance for a given level of recall. A chance score would be zero and the upper limit would be perfect clustering (1.0). These scores were converted to percentages by multiplying by 100 in the present study.

The design was a 2 × 2 × 4 × 2 × 3 ANOVA for free recall. The factors were a) sentence order (NO or AO), b) sentence structure (NS or AS), c) objective information (O, N, A, or NA), d) objective structure (NB or AB), and e) Trials (1-3). Recall clustering and recall level were the dependent measures.

For the analysis of prompted recall the type of item (I, T) was substituted for the trials factor in the analysis.

Results

Written Recall

Sentences correctly recalled and confusions.--Group NO produced more correct sentences (of 16 possible) in recall (67%) than Group AO (53%); $F = 22.8$, $df = 1/64$, $p < .001$. This finding is consistent with the data of Myers, et. al. (1972) for passages in which the order of names within paragraphs was varied. Sentences correctly recalled on trials 1-3 averaged 34%, 67% and 79%, respectively; $F = 254.7$, $df = 2/128$, $p < .001$. No other factors were significant.

The total number of cells mentioned in Table 1 was also analyzed. For instance, if S made an assertion about the speed of the Shark, he was given a point regardless of whether his assertion was correct or not. The average number mentioned was higher for Group NO (76%) than for Group AO (66%); $F = 7.53$, $df = 1/64$, $p < .01$. The question arises as to whether NO Ss scored higher on recall simply because they generated more alternatives (both correct and incorrect). The percentage correct of the sentences which Ss mentioned was 85% for NO and 72% for AO; $F = 12.24$, $df = 1/64$, $p < .001$. Thus, NO Ss remembered more of the text and were more accurate in their recall.

The analysis of the number of confusions (incorrect assertions in written recall) revealed that Group No produced 1.45 incorrect assertions, AO produced 2.22; $F = 7.4$, $df = 1/64$, $p < .01$. Sentence order interacted with the structure of the sentences ($F = 6.1$, $df = 1/64$, $p < .025$)

and the structure of the objectives (F = 10.3, df = 1/64, $p < .005$). Figure 1 displays these two interactions.

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Insert Figure 1 about here

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The left half of Figure 1 indicates that confusions were likely to result if there were incompatibilities between paragraph and sentence emphases. This result is consistent with tendencies in the analysis of sentences correctly recalled and with initial predictions.

The data in the right portion of Figure 1 suggest that compatibilities between objective and sentence order may relate to Ss' attempts to comply with the learning objectives. For instance, the instruction to "Learn the hull construction, speed...." may direct Ss to learn the different attributes for each ship. This information was located in consecutive sentences for Group NO, but not for Group AO. A similar analysis could account for the increase in confusions for Group NO when Ss were instructed to learn "The Shark, Squid, Ray...." The implication is that Ss may have matched the list of items stated or implied in the first half of the sentence with items encountered in the text. Matching the NB instruction would be easiest for Group AO, matching the AB instruction would be easiest for Group NO. This analysis presumes that a match is attempted using the first part of the learning objective just as the compatibility

between the form of the sentence and paragraph organization relates to which element (name or attribute) comes first in the sentence.

There was also a five-way interaction indicating that the interaction between organization and phrasing of objectives depended upon sentence structure, whether or not the attributes and names were listed in the learning objectives, and upon learning trial; $F = 3.1$, $df = 6/128$, $p < .01$. It would be presumptuous to attempt to explain this interaction (in which the means were based on $N = 3$) in any complete sense, but it demonstrates that the effect of learning objectives can depend upon the relationship between several semantic characteristics of the task; i.e., the phrasing and completeness of the learning objectives, and the organization and phrasing of the text sentences.

Subjective Organization.-- Over all conditions, the subjective organization by name was 57.6% and organization by attribute averaged 0%; $F = 38.34$ $df = 1/64$, $p < .001$. For Group NO, organization by name was 84% and organization by attribute was .21%.[2] For Group AO, organization by name was 31% and organization by attribute was 27%. This interaction between organization of recall and organization of text was significant at the .001 level; $F = 33.1$, $df = 1/64$. These data confirm earlier research showing that input order influences output order, but that Ss have a tendency to adopt name organization with the type of materials used here.

Maximum organization score was also analyzed, i.e., the highest organization score obtained by S, regardless of whether it related to organization by name or by attribute. Group NO (92%) showed higher subjective organization than Group AO (85%); $F = 4.3$, $df = 1/64$, $p < .05$. Organization increased over trials 1-3 (78%, 93%, 95%, respectively); $F = 15.3$, $df = 2/128$, $p < .001$.

There was some relationship between recall and organization. The correlations between number of sentences recalled and organization over trials 1-3 was .40, .31 and .48 for Group AO. For Group NO the correlations were .29, .27 and .18. All of the correlations (except $r = .18$) were significantly different from zero.

Myers, et. al. (1972) found that the serial order of sentences within paragraphs was preserved in the serial position of sentence output for Group AO only if the sentences (names) within paragraphs occurred in the same position from paragraph to paragraph. Myers et. al. (1972) and Perlmutter & Royer (1972) found that the output of NO Ss did not preserve the serial order of input as strongly as AO Ss. Figure 2 plots the relationship between input and output order for Groups NO and AO in the present study. Numbers in the figure refer to the serial position of the

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Insert Figure 2 about here

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group of four sentences (corresponding to paragraphs in Myers,

et. al., 1972) in the text, the numbers on the abscissa refer to the order of sentences within each group of four. The plots above "input" replicate the results of Myers, et. al., (1972) showing that there was no relationship between order within paragraphs and output order. Myers, et. al. (1972), argued that AO Ss used a serial learning strategy which was not available if the order of information within paragraphs varied. A reasonable strategy would be for the AO Ss to impose some order upon the materials within paragraphs. The curves above "reordered input" in Figure 2 plot each point in the serial order in which that name or attribute occurred in the first four sentences of the text. For example, although the sentences relating to the four ships names were presented in different orders in each consecutive group of four sentences for Group AO (and are so plotted above "input" in Figure 2), they are plotted in the order Shark, Squid, Ray and Swordfish (for each group of four) above "reordered input". In effect, the numbers 1,2,3 and 4 above "reordered input" imply a reordering strategy in which Ss impose the order of the first four sentences upon the subsequent clusters of four sentences. Group AO clearly reordered subsequent information to correspond to the order of earlier information. For Group NO, the curves tend to be flat. These data confirm that Group AO used a serial order learning strategy, as Myers, et. al. (1972) proposed, but they go beyond the earlier data in showing how the text might suggest to Ss an order which was not nominally present throughout the text. Page's L statistic (1963) was

used as an approximate test of the hypothesis that the order of information in the last three sets of four sentences reproduced the order in the first set of four. For Group AO, $L = 90$ ($N = 4$, $M = 3$), $p < .001$. For Group NO, $L = 77$, which was not significant.

Sentence structure. -- The form of the sentence adopted by Ss reflected the text. The percentage of sentences mentioned which began with a name was 95% for Group NS, for Group AS it was 66% $F = 25.4$, $df = 1/64$, $p < .001$. The percentage beginning with an attribute was 2% for Group NS, 32% for Group AS; $F = 34.7$, $df = 1/64$, $p < .001$. For both groups the preference was to use the N-A-V structure. Subjects in Group NS averaged only 2% A-N-V structures on trials 1-3. Group AS, on the other hand, gradually adopted the A-N-V structure across trials; interaction $F = 5.14$, $df = 2/128$, $p < .01$. Means for Group A for trials 1-3 were 25%, 30% and 40%, respectively.

Prompted Recall

Figure 3 summarizes the four-way interaction between

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Insert Figure 3 about here

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sentence order, sentence structure, objective information and type of test item; $F = 3.4$, $df = 3/64$, $p < .025$. This interaction confirms the analysis of free recall indicating the interactive effects of the semantic components of the

reading task. The performance of Group AO seemed more affected by these interactive effects than Group NO performance, i.e., group means varied from 15% to 65% errors in Group AO; in Group NO the means varied from about 6% to 25% errors.

Group NO made significantly fewer errors (12.8%) than Group AO (32%); $F = 21.1$, $df = 1/64$, $p < .001$. Fewer errors were made on text recall items (19%) than on integration items (26%); $F = 31.6$, $df = 1/64$, $p < .001$.

As predicted, the difference between T and I items was larger for Group AO (28% vs. 37%, respectively) than it was for Group NO (11% vs. 15%, respectively); interaction $F = 4.86$, $df = 1/64$, $p < .05$. For Ss with perfect free recall, there was no difference in scores on T items between Group AO and NO. For I items, 33% of Group AO scored less than 75% correct, while only 4% of Group NO scored less than 75%; $\chi^2 = 4.47$, $df = 1$, $p < .05$. There were 15 Ss with perfect free recall in Group AO and 26 in Group NO.

Discussion and Summary

The present study showed that the ability to integrate information from separate sentences was a function of the proximity of that information at input. This result could occur because only a few items can be represented simultaneously in short-term memory during acquisition, or it could result from such memory limitations at the time of testing; i.e., Ss might search through a large number of sentences stored serially in memory before finding the second

member of a sentence pair. The probability of stopping a memory search or making an error might increase as the number of intervening sentences increased. In any case, the data of the present study suggest some overlap between short-term memory and retrieval studies and the way in which text organization might control the acquisition of different cognitive structures.

The order of text sentences strongly influenced the organization of recall. It was clear, however, that Group AO did not adopt the text organization to the same extent as Group NO. Several results suggest that the attribute organization of the text created problems for Ss. Attribute organization resulted in lower recall, lower organization scores, it led to the production of more erroneous sentences, and it caused Ss to reorder subsequent information in terms of the order of that information as encountered early in the passage. In addition, the prompted recall performance of NO Ss was less subject to incompatibilities among learning objectives, sentence structure and sentence order. It is also true that Ss preferred the N-A-V sentence structure, and that Group AS only adopted the A-N-V structure over trials. The data suggest that the name organization and sentence structure might be a more natural strategy. If so, the question arises as to what was in a name that made Ss less dependent upon serial order cues, less vulnerable to interference (confusions) in recall, etc.

The answer to this riddle must lie in the semantic characteristics of the text, particularly in the associations among the attributes of the matrix shown in Table 1. An important distinction must be made between the statistical uncertainty in the rows and columns of Table 1 and semantic uncertainty. It is true that there are four different responses in each row and column, but the columns contain highly similar and perhaps confusable responses. One can imagine another matrix in which the same four responses compose each row and column. For instance, four ships might fly four colors from four masts, each ship flying a different color from a particular mast. With such a matrix there would be no reason to prefer one organization over another, indeed, S might even use the colors (rather than the names of ships or their masts) to organize recall.

Also, pre-experimental associations would suggest to Ss that "20" refers to speed and not to a sail-plan. Thus, the cluster "Ray-square-steel-bark-20" contains all of the elements needed to associate the terms correctly since the superordinate attribute labels are prompted by the attribute values. The cluster "Hull-wood-fiberglass-steel-cement" is clearly vacuous as it stands. Thus, possibilities for compressing the information exist if one adopts a name organization (Frase, 1969; Schultz & Di Vesta, 1972).

Data from this study show that the characteristics of sentences, text organization and learning objectives are

highly dependent. The level of performance of NO and AO Ss in previous experiments (Frase, 1969; Myers, et. al., 1972; Perlmutter & Royer, 1972) probably was influenced by the predominant sentence form. Results contradicted the hypothesis that listing the names and/or attributes necessarily improves learing. Rather, the form of this information was seen to interact with Ss ability to match the learning instructions with the text as a consequence of text organization.

If anything, this study shows how complex a phenomenon learning from written materials can be. Specifically, the data confirm that recall organization tends to match input organization, but Ss prefer to cluster materials (similar to those used in this study) by name. The superiority of Group NO replicates the results of Myers, et. al. (1972); but the results also indicate that performance depends upon sentence form. For the present materials, AO seemed to result in a learning strategy which made Ss' performance pervious to the several mismatches that could occur among the sentences, organization and learning objectives. In general, the present study indicates that learning difficulties increase as the number of mismatches between various task characteristics increases.

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Notes

1. Requests for reprints should be sent to Lawrence T. Frase, Bell Laboratories - 1E331, Murray Hill, N.J. 07974.
2. Negative values resulting from the ARC formula (Roenker, Thompson and Brown; 1971; Myers, et. al., 1972; Perlmutter & Royer, 1972) do not represent percentage clustering below chance. It is possible, for instance, to obtain clustering scores which exceed -100%, whereas positive scores never exceed 100%. The reader is admonished to interpret negative scores cautiously. Thanks are due to Mr. Barry Schwartz for working out these systematic confusions in the ARC measure. The measure is reported here for comparability with other research, and because all clustering measures suffer from one deficiency or another.

Table 1

Matrix from which Text Sentences were Generated

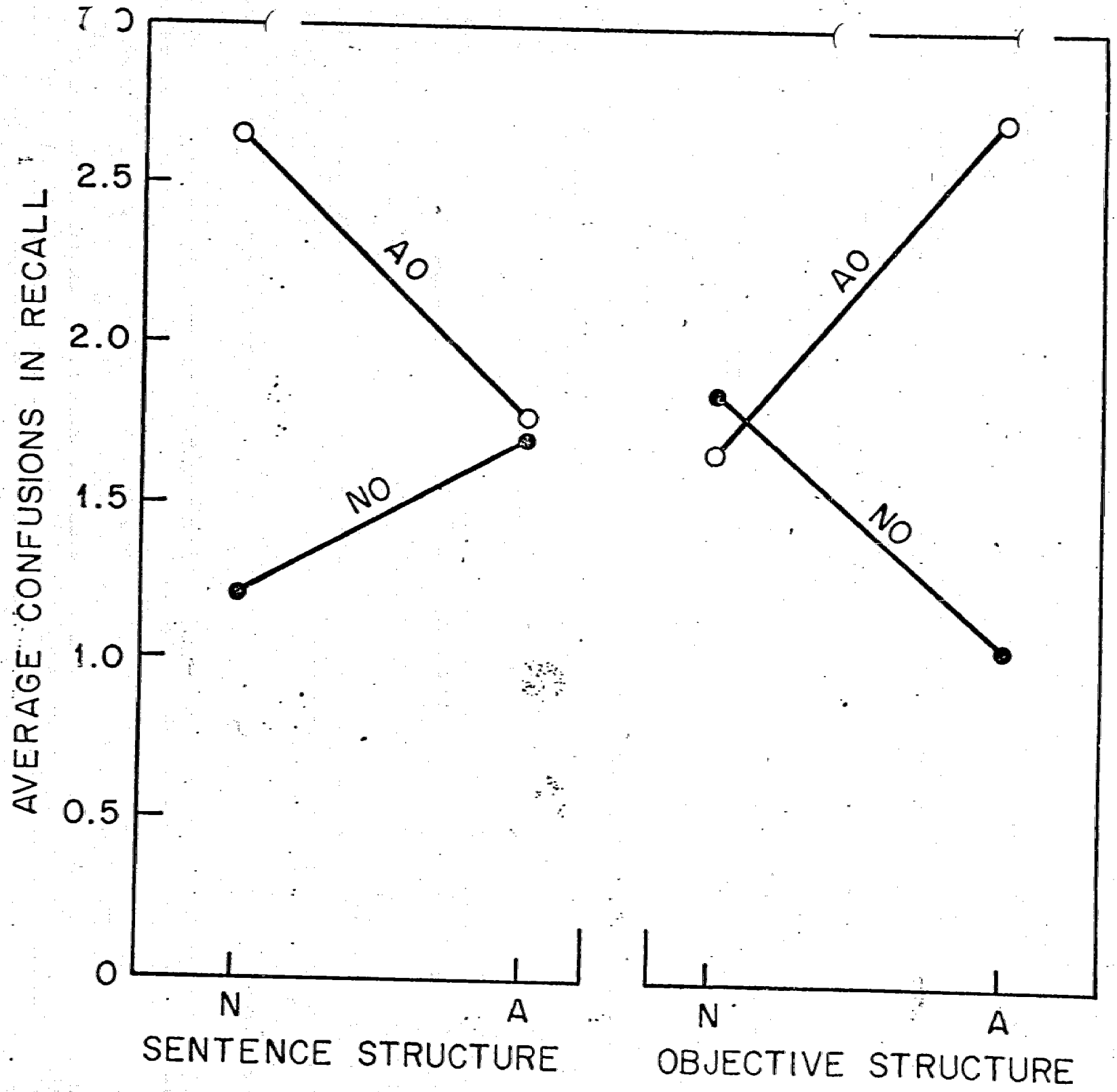
e of nip	Attribute Sail Plan	Hull	Design	Speed
rk	1) fore-and-aft	2) wood	3) brigantine	4) 14 kn
ıd	5) gaff-rigged	6) fiberglass	7) schooner	8) 18 kn
	9) square	10) steel	11) bark	12) 20 kn
dfish	13) marconi	14) cement	15) sloop	16) 12 kn

Figure Captions

Fig. 1. Interactions between sentence organization and the structure of the sentences and objectives.

Fig. 2. Relationship between input and output order for Groups NO and AO. "Reordered input" refers to the order of names or attributes that occurred in the first four sentences.

Fig. 3. Interaction between sentence structure, sentence order, objective information and type of prompted recall test item.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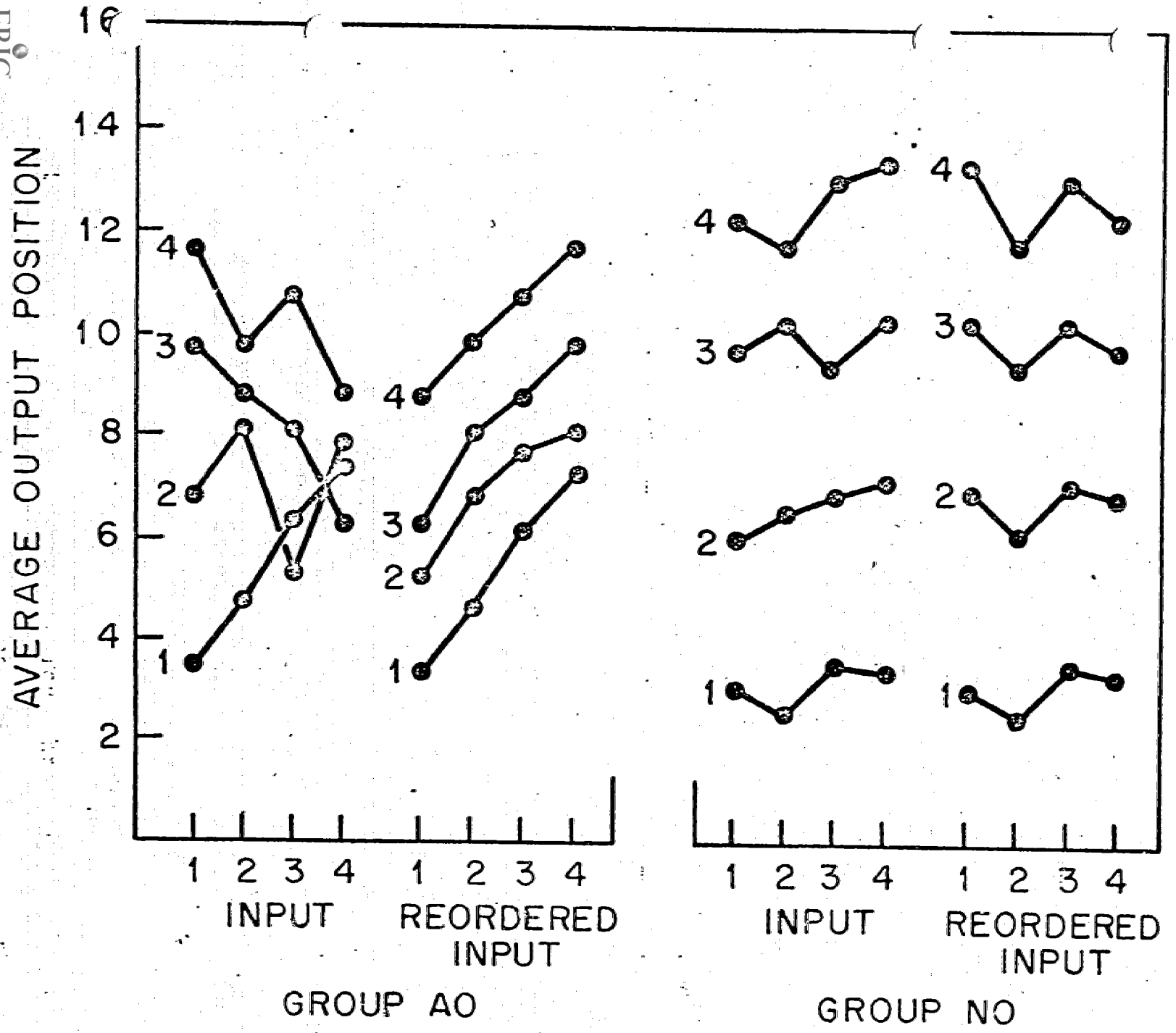
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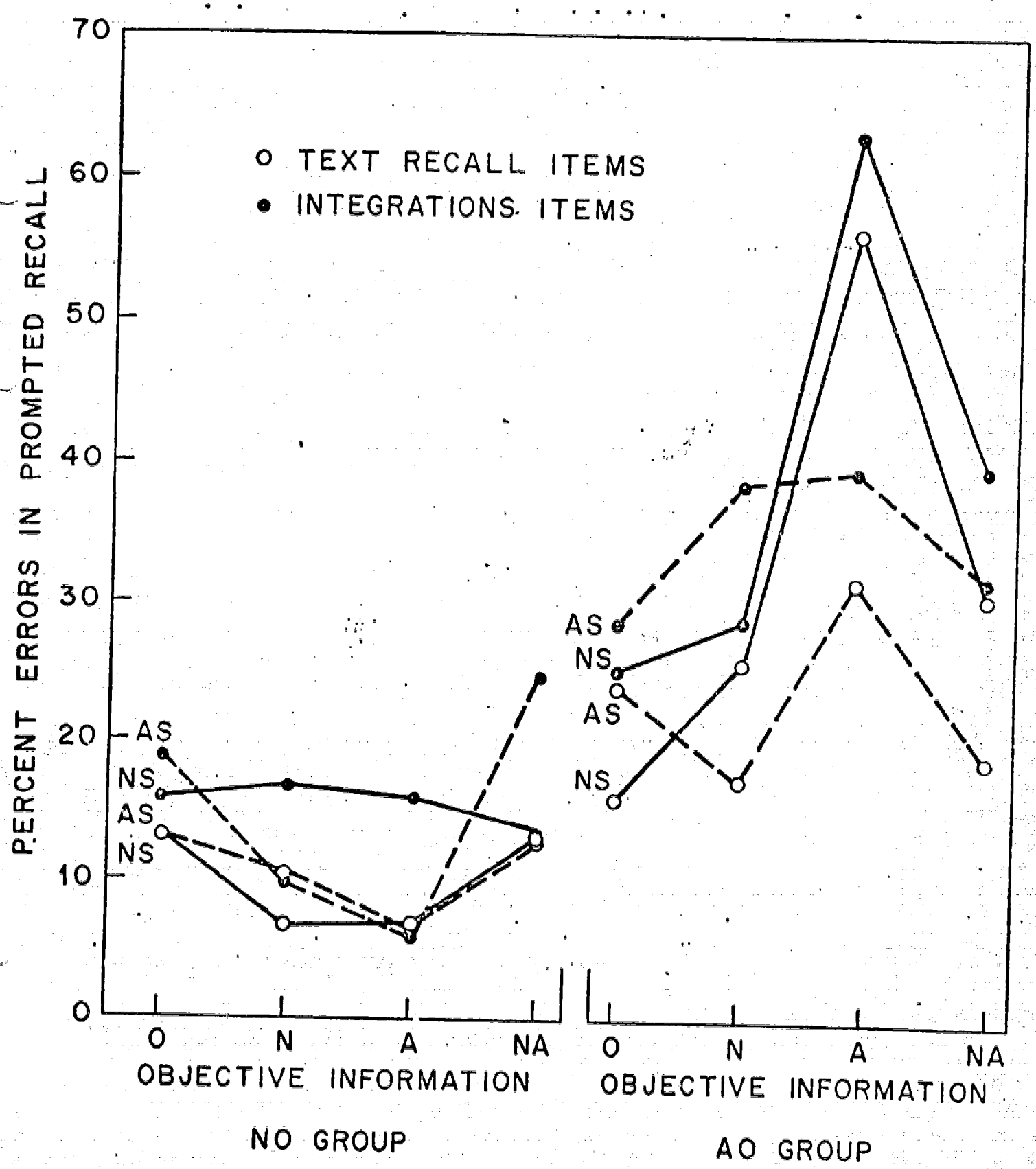
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NPS CS

ABSTRACT

College undergraduates (96) were given three trials to learn the characteristics of ships from a text. Attributes of each ship were clustered together (Name Organization), or sentences describing one attribute for all ships (e.g., their speeds) were clustered together (Attribute Organization). Organization affected; a) level of recall, b) subjective organization of recall, and c) apprehension of certain relationships. Attribute Ss, with errorless recall, had difficulty answering questions that required combining information about each ship. Attribute organization produced lowest free recall and caused Ss to impose a new order on sentences within clusters. The position of names and attributes was varied in the text sentences and learning objectives given to Ss. Sentences incorrectly recalled increased if position was in some way incompatible with text organization.