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ASSOCIATIVE FACILITATION IN THE RECALL OF CONNECTED DISCOURSE.

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THE POSSIBLE EFFECTS OF ASSOCIATIVE CONSTRAINTS BETWEEN WORDS UPON THE RECALL OF CONNECTED DISCOURSE ARE DISCUSSED IN THIS ARTICLE. THERE IS REASON TO BELIEVE THAT ASSOCIATIONS WILL AFFECT BOTH STORAGE AND RETRIEVAL. FOUR STUDIES ARE DISCUSSED IN WHICH WORDS VARYING IN FREE ASSOCIATION STRENGTH WERE EMBEDDED IN CONNECTED DISCOURSE. LEARNING WAS TESTED BY IMMEDIATE WRITTEN RECALL AFTER A SINGLE PRESENTATION OF THE PASSAGES. IN ALL OF THESE STUDIES, RECALL OF ASSOCIATIVELY RELATED ITEMS WAS SUPERIOR TO RECALL OF ASSOCIATIVELY UNRELATED ITEMS. IN ADDITION, THE PRESENCE OF ASSOCIATIVELY RELATED WORDS IN A PASSAGE TENDED TO INCREASE THE RECALL OF THE REST OF THE PASSAGE. CLOZE DATA WERE COLLECTED ON THE PASSAGES USED IN THESE STUDIES SO AS TO HAVE SOME IDEA OF THE CONSTRAINTS EXISTING WITHIN THE PASSAGES BETWEEN ASSOCIATES AND BETWEEN THE CONTEXT OF THE PASSAGES AND THE ASSOCIATIVE MATERIALS. SOME PRACTICAL IMPLICATIONS OF THESE STUDIES ARE DISCUSSED. THIS PAPER IS PUBLISHED IN "STUDIES IN LANGUAGE AND LANGUAGE BEHAVIOR, PROGRESS REPORT IV," BY THE CENTER FOR RESEARCH ON LANGUAGE AND LANGUAGE BEHAVIOR, UNIVERSITY OF MICHIGAN, 220 EAST HURON STREET, ANN ARBOR, MICHIGAN 48108. (AUTHOR/AHM)

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Associative Facilitation in the Recall
of Connected Discourse¹

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The possible effects of associative constraints between words upon the recall of connected discourse are discussed in this article. There is reason to believe that associations will affect both storage and retrieval. Four studies are discussed in which words varying in free association strength were embedded in connected discourse. Learning was tested by immediate written recall after a single presentation of the passages. In all of these studies, recall of associatively related items was superior to recall of associatively unrelated items. In addition, the presence of associatively related words in a passage tended to increase the recall of the rest of the passage. Cloze data were collected on the passages used in these studies so as to have some idea of the constraints existing within the passages between associates and between the context of the passages and the associative materials. Some practical implications of these studies are discussed.

The basic assumption that has guided my research in recent years is that verbal learning is mediated by natural language habits which are aroused by the phonological, morphological, syntactic, and semantic structure of the material to be learned, and utilized selectively in relation to such factors as motivational states, habit strength, information processing capacities, encoding and decoding strategies, and conditions of presentation, practice, and recall. Since my thinking about verbal learning has been influenced greatly by recent developments in linguistic and psycholinguistic theory (e.g., Miller, Galanter, & Pribram, 1960; Chomsky, 1965; Johnson, 1965), I have tended to think of language habits as being hierarchically organized and varying greatly in complexity. The hierarchic structure of language habits is reflected by (among other things) the fact that our ability to understand a sentence depends on our ability to identify its grammatical structure. For example, knowledge of syntactic subject-object relationships is essential in the understanding of the sentence "John hit Mary" as opposed to the sentence "Mary hit John". As for the complexity of language habits, it is evident that they vary all the way from simple

sequential dependencies to the abstract "competence-performance" dependencies that permit us to generate and understand novel utterances, and to discriminate between sentences whose observable syntactic characteristics are identical on the basis of differences in underlying structure.

By "competence" is meant the knowledge that underlies language ability, and by "performance," actual language behavior as it is influenced by, for example, short-term memory constraints, noise, past experience, motivation and reinforcement (Chomsky, 1965).

Traditionally, psychologists have attempted to determine the presence of such habits and estimate their strength from, for example, statistical studies of language usage, word counts, measures of the content of connected discourse, and word association norms. In recent years, however, psychologists have begun to derive hypotheses from linguistic theory (e.g., Miller, 1962) about some of the complex language habits that might influence verbal learning and verbal behavior.

In recent years, I have attempted to study the role of normative associative habits in the recall of phrases (Rosenberg, 1965a), sentences (Rosenberg, 1966c) and, in a preliminary study, connected discourse (Rosenberg, 1966a), meaning by "connected discourse" two or more interrelated sentences. I would like to discuss here the work on associative facilitation in the recall of connected discourse, most of which has not appeared elsewhere.

The Role of Associations

What the origins of verbal associations are and what verbal associations reveal about language processes are questions of considerable interest. Unfortunately, definite answers are still forthcoming. Deese (1966) has recently summarized most of the work on the structure of free associations, and McNeill (1963) has reported the results of experimentation on the origin of word associations in the same grammatical class. However, regardless of the answers to these questions, it is safe to assume that once a language has been acquired and used to interact with the world associations are available to be aroused and utilized as constraints upon performance in the memorization of verbal materials (most often connected discourse).

My present interest in the role of associations in learning does not stem from a belief that an associative account of language acquisition,

sentence generation, and sentence understanding is possible. There appears to be no support (as Chomsky and many others have pointed out) for such a view. The fact, for example, that we are able to generate and understand novel utterances is clearly at odds with an associative theory of basic language processes. However, since sentences (and passages) that are identical in grammatical structure and equally understandable may differ appreciably (as revealed by norms) in the strength of association between their word constituents (e.g., The old king ruled wisely as contrasted with The poor king dined gravely), it is important to consider the role of associative constraints in the memorization of natural language materials.

Pairs and groups of associatively related words occurring in sentences and in connected discourse may influence learning, and the influence may be either a storage or a retrieval phenomenon or both. In the discussion that follows, the learning task that should be kept in mind is one in which, in the high association (HA) condition, pairs or groups of associatively related words are embedded in sentences in connected discourse, and learning is tested by written recall. In the low association (LA) condition, the stimulus words (S-words) are retained, but the HA response words (R-words) are replaced by associatively unrelated items. The discussion is limited to the case of nouns, although in two of the studies to be reported, some other classes were included.

With respect to storage, there are three ways in which associative constraints may influence performance. The first of these will be referred to as the "construction hypothesis", the second as the "frequency hypothesis" and the third as the "recoding hypothesis". The construction hypothesis is that in processing a sentence or a discourse, items (words, phrases, etc.) that are missing or unintelligible will be filled in on the basis of the remaining context. During the storage phase of verbal learning, construction is likely to operate in the case where some portion of the material that is being presented is unintelligible. For example, during presentation of a sentence such as The old king ruled wisely, if the verb is, for some reason, unintelligible, the associative constraints exerted by the remaining items are likely to lead to the construction of the correct word. Such would not be the case if a similar situation existed in the string The poor king dined gravely.

The associate selected, of course, is bound by form-class, i.e., the S must first make a decision as to the grammatical class of the unintelligible item. This choice is made on the basis of the grammatical constraints created by the intelligible context. We have here another example of the hierarchic nature of language habits.

With care in the preparation and presentation of auditory and visual materials, construction should contribute little to the effects of associative constraints during storage. That construction could operate under appropriate conditions is a very reasonable guess, if we consider the results of the familiar "cloze test". Although not necessarily with the same degree of accuracy, construction during storage should occur both from left-to-right and from right-to-left. Studies (e.g., Aborn, Rubenstein, & Sterling, 1959) of the predictability of words deleted from various sentence positions offer support for this hypothesis.

According to the frequency hypothesis, in decoding a sentence we tend to anticipate, implicitly, subsequent items, with the items anticipated being, in part, constrained by the decoded items. Now, if a high strength response of some S-word is anticipated, and that response actually occurs later on in the string, the item in question will, theoretically, have occurred twice instead of once. The increased frequency could result in a higher level of recall of HA than LA responses. Some evidence for the operation of "implicit associative responses" in verbal behavior has been presented recently by Underwood (1965).

The importance of linguistic recoding in verbal learning was first emphasized by Miller (1956a, b) and has since been demonstrated in, for example, numerous studies of clustering in recall. In the case of sentence or discourse learning, according to this hypothesis, individual words are recoded into chunks (the chunks then becoming the unit of memory), some of which are the result of grammatical structure and some the result of other sources of constraint, such as associative habit. In the case of two associatively-related words embedded in a sentence, the words would be recoded and stored as a pair (along with other information about the sentence). The facilitating effect of associative recoding would come not from an increase in the number of units stored but from an increase in the number of items included in each memory unit or chunk. Some evidence for associative recoding in the recall of sentences has appeared recently (Rosenberg, 1966c).

It must be remembered, of course, that in the learning of connected discourse, performance is heavily constrained by serial organization. In the case where the words in an HA pair are separated by a number of sentences, recoding might interfere with the requirement that sentences be learned in some particular order. Weingartner (1963) has shown that the order of associatively-related words in a serial list-learning task contributes significantly to performance. The problem raised here is only part of the general question of the degree to which associative facilitation in the memorization of connected discourse is a function of contiguity of S-words and R-words, the syntactic relationship between S-words and R-words, and related factors. For example, associative facilitation is not likely to occur in a discourse that contains such sentences as The man called the tiger and The lion saw the woman, where the object in the first sentence is the R-word for the subject of the second sentence, and vice versa. What we have here, clearly, is an interference paradigm, one which is very familiar to students of paired-associate learning.

While factors presumed to operate during storage may, taken together, contribute considerably to recall scores, one of these factors--construction--is also likely to operate during retrieval. Specifically, when a word from a sentence is not recalled outright, the subject is likely to use the constraints (from left-to-right and from right-to-left) created by the items that have been recalled to help construct it. In the present series of studies, an attempt was made to demonstrate that construction could contribute to recall through the use of a cloze test in which either the S-words or the R-words were deleted. Deese (1961) and many others have emphasized the importance of construction in the recall of structured verbal materials.

The effects, then, of associative constraints in the recall of connected discourse are likely to be mediated by storage factors, retrieval factors, or both. It would be of considerable interest to determine whether the effects are due solely to storage factors or solely to construction during recall. A technique used by Lachman and Tuttle (1965) for the comparison of recognition and recall with materials varying in approximation to English might prove to be useful for this purpose. The studies that follow, however, were designed primarily to determine whether associative facilitation can be demonstrated to occur reliably in the recall of connected discourse.

For this purpose an attempt was made to avoid arrangements of key words that might create conditions of interference.

Studies of Associative Facilitation

Study I

In the first study that was conducted (see Rosenberg, 1966a, for a fuller report) both HA and LA passages were prepared. Both passages contained the same S-words (these were stimulus words selected from the new Minnesota Norms of Palermo and Jenkins, 1964), and both shared a portion of the remaining context in common. What remained were words that in the HA discourse were high-strength responses of the S-words, and in the LA discourse were low-strength responses of the S-words. The LA responses were matched as closely as possible on Thorndike-Lorge (1944) frequency and on length, and they were semantically and grammatically appropriate in the context of the discourse. Thus, the two passages differed with respect to those items that were designated as R-words. Over 60 per cent of the discourse (i.e., the content words) consisted of S-words and R-words, which were mostly nouns and adjectives. No attempt was made to be systematic with respect to location of S-words and R-words, but in most instances an S-word occurred earlier in the passage than its R-words, and in the same sentence as its R-words.

The passages were recorded on tape and the data were collected in a group-testing situation with two sessions for each condition. The Ss--college undergraduates--listened to the passage once, and were then given a written recall test. They were instructed beforehand to try to learn as much of the passage as they could. For the recall test, they were asked to write down as much of the passage as they could remember and to guess at items they could not. They were given seven minutes for the recall test. The location of an item was not considered in scoring the recall protocols.

Table 1 contains the means for various measures of recall.

 Insert Table 1 about here

The R1-word for each of the S-words in the HA discourse was the strongest of the responses, and in the LA discourse it was the low-strength counterpart. The R2's were the R1's plus the remaining responses, and credit was given for a pair whenever an S-word was accompanied by its R1-word on the recall

sheet. It can be seen in Table 1 that the performance of the group that was exposed to the HA discourse was superior to the performance of the LA group on all measures of recall. Since there were an equal number of S-words and R1-words, the data were tested for significance by an analysis of variance. The difference in favor of the HA discourse was revealed to be highly significant, as was the difference in favor of S-words over R1-words. By "highly significant" is meant beyond the .01 level. The differences between Groups HA and LA on the other measures of recall were also found (on the basis of t-test analyses) to be highly significant. It is important to note here that the mean recall dependency between S-words and R1-words was also found to be significantly higher in Group HA than in Group LA. By "recall dependency" is meant the probability of recall of one word in a pair, given that the other has been recalled.

Is it safe, then, to conclude that associative constraints can increase the likelihood of occurrence of specific content-words in the recall of connected discourse? While the answer would appear to be yes, there is one problem. Is it not possible that the context common to the HA and LA passages was prepared in such a way as to favor the HA responses? Such an explanation has been suggested by Lachman, Dumas, and Guzy (1966). For a number of reasons, most of which are discussed in my reply to their suggestion (Rosenberg, 1966b), I believe that, while context can certainly be made to play a critical role in determining the effects of associative constraints, the present results (as well as the results of the other studies reported here) cannot be accounted for to any significant extent in these terms. For one thing, the context in question accounted for only approximately one-third of the total discourse, and, for another, if their argument has any merit, how would one account for the fact that the recall scores for the S-words (the S-words, it should be remembered, were identical in both passages) were on the average lower for the LA discourse than they were for the HA discourse. The context that they talk about was the same for both passages.

Nevertheless, as an additional precaution, and, of course, to guard against the case in which the noncritical context occupies a large portion of a passage, I have, as a matter of routine in all subsequent studies, pulled the critical S-words and R-words out of context and presented them as a list of words to be learned. In addition, cloze data have been obtained on the passages, with all the associated material deleted.

As a test of the possibility that recall scores may have been partly a function of construction during recall, the HA and LA passages were reproduced on paper, and in each either the S-words or the R1-words were deleted. These passages were given to four groups of undergraduates as a cloze test, i.e., they were instructed to try to guess, on the basis of the remaining contexts, the items that had been deleted. None of these Ss had participated in the learning study. Table 2 contains the means for the number of S-words and

Insert Table 2 about here

R1-words guessed correctly for each of the passages.

There were 16 S-words and 16 R1-words. It can be seen in Table 2 that construction was clearly more successful in the case of the discourse that contained HA items than the discourse that contained LA items.

As a further indication of the possible contribution of construction to the recall scores, it was noted that LA Ss produced during recall a mean of 3.30 HA responses. According to the present way of thinking, the intrusion errors may have been the result of constraints created by the prior recall of S-words.

Study II

Study II was a modified replication of the first study, with the following changes: (1) a visual presentation procedure was used; (2) there were some minor changes made in the context of the passages; (3) recall data were collected with the S-words and R-words being presented as a list without context; and (4) cloze data were collected on the discourse with all the S-words and R-words deleted.

For the visual presentation procedure, the HA and LA passages were reproduced on mimeograph paper, triple spaced. The Ss in each group were given one minute to read through the passage and to study it. All Ss indicated afterwards that they were able to read through the passage at least once during the exposure interval. Presentation time on the tape recorder in Study I had been approximately 63 sec. A sheet of lined paper was stapled to the back of the sheet on which a given passage was printed, and was used for the recall test. The HA and LA conditions are reproduced below.

High association passage. *The tall man sat on a chair in front of a low table, while a woman played soft music on the piano. A cart was piled high with things. There was cheese and crackers, bread and butter and some cold fruit and a hot vegetable as well. A young girl sat on the floor on the yellow carpet reading a book, while a small boy played with some toys on a blue rug in the middle of the room. The guy was a soldier in the army and had just returned from the war that day. Although there had been much to eat on the train, the sight of all that food made him hungry again. The atmosphere was one of joy. They were all happy to be together again. Outside the moon and stars shone brightly in the June sky, and the green grass sparkled in the night.*

Low association passage. *The dark man sat on a pillow in front of a small table, while a lady played good music on the organ. A cart was piled high with things. There was cheese and salad, bread and juice and some cold fruit and a dry meat as well. A fine girl sat on the blanket on the yellow carpet reading a book, while a small dog played with some toys on a purple cloth in the middle of the room. The guy was a soldier in the draft and had just returned from the field that day. Although there had been much to taste on the train, the sight of all that dinner made him hungry again. The atmosphere was one of joy. They were all relieved to be together again. Outside the moon and lake appeared clearly in the June evening, and the green house sparkled in the valley.*

Table 3 contains a listing of the critical HA and LA words.

 Insert Table 3 about here

The visual presentation procedure was in general found to be more convenient to administer than the auditory procedure, and has been used in all subsequent studies. The data were again collected in a group-testing situation in two sessions, using undergraduate students. Since the learning and recall instructions were identical for the HA and LA passages, it was possible to administer both conditions simultaneously in each session.

No interaction was found between sessions and the independent variables; therefore, the data for the two sessions were combined for analysis. Table 4 contains the means for the various measures of recall. However, this time,

Insert Table 4 about here

instead of combining the R1-words with the additional R's to produce the R2 measure, the additional R's (AR) were treated separately. It can be seen in Table 4 that recall scores were on the average higher for the HA discourse than for the LA discourse, and that, at least for Group LA, more S-words were recalled than R1-words. An analysis of variance of the S-words and R1-words revealed a highly significant main effect for association, and for S vs. R, and a significant interaction. These results, then, were identical with those found in Study I, with the exception of the significant interaction. The reason for the interaction is the lack of difference between S-words and R1-words for Group HA, and Group LA's recall of more S-words than R1-words. The reason for this discrepancy is not known, but might be related to the use of a visual presentation procedure.

The differences in favor of Group HA on the other measures of recall were found to be highly significant (t-test comparisons). In addition, the results for intrusion errors and for recall dependencies were similar to those found in Study I.

To determine whether the effect of associative habit might have been the result of characteristics of the common context, the S-words and R-words were pulled out of each passage and printed (single spaced and in capital letters) in a single column on sheets of paper in the order in which they appeared in the connected discourse. There were an HA list and an LA list. The words were printed one after another single-spaced, in capital letters. Using a group-testing procedure, with two sessions for each condition, Ss were given one study trial (one minute exposure), followed immediately by a written recall test. They were instructed to read through the list and to try to learn as much of it as they could. An attempt was made to make the general procedure as comparable as possible to the procedure used to collect the recall data on the passages.

The results of the word-list study can be found in Table 5. There

Insert Table 5 about here

was no interaction found between sessions and the independent variables. Table 5 shows that recall scores were, on the average, higher in Group HA than in Group LA. The results of the analysis of variance of the S-words and R1-words revealed a highly significant F for association, but non-significant F 's for S vs. R1 and for interaction. The difference in the recall of pairs between HA and LA was highly significant. The difference in the recall of AR's was significant at the .05 level. Clearly, with respect to the critical variable of associative habit, these results are identical with those of the connected discourse study.

As a final item in the present study, cloze data were collected with blanks in all the positions occupied by S-words and R-words. What the S s received, in other words, was the context common to the HA and LA passages. The data from a single group of S s was used to compute the various cloze scores.

The mean number of S-words, HA R1-words and LA R1-words guessed correctly were, respectively, 1.40, 1.75 and .05. It will be recalled that the highest score possible for each of these measures was 16. If these results are compared with the data summarized in Table 2, it will be seen that while the common context might have exerted some slight degree of constraint upon HA items, the effect does not even approach that produced by, for example, the presence of the HA responses. As a matter of fact, cloze scores for S-words were, on the average, higher when LA responses were present than when only the common context was given.

These data appear to offer additional support for the contention that associative constraints contributed significantly to the differences in recall scores between Groups HA and LA that were observed in Studies I and II.

Study III

For a number of reasons, it was felt that the passages used in Studies I and II might have been too complicated for use in certain studies. For example, the stimuli and responses belonged to a mixture of grammatical classes, in some instances a response preceded its stimulus and the number of responses varied from stimulus to stimulus.

With a view toward simplicity, then, a passage was developed (using the Palermo-Jenkins norms) with the following characteristics: (1) only a single response for each stimulus; (2) an S-word always preceded its R-word; (3) the members of a given associative pair appeared in the same sentence; and (4) all of the

S-words and R-words were nouns. This passage was somewhat longer than the previous ones, but only approximately one-third of the content words were critical S-words and R-words. The HA and LA passages are reproduced below. The S-words have been underlined and the R-words placed in parentheses for the reader's convenience. The response is always the item that immediately follows the underlined stimulus in a given sentence.

High association passage. The man walked to the corner to meet the (woman). When he got there, they went together to a restaurant. As they entered, they noticed that the waiter was working at a table that was painted to match the (chair). After they ordered, there was time to look at a newspaper. There was a human interest story about a king who had to travel abroad to find a (queen), and one about a priest who worked hard for his (church). There was also a brief note about a lion that got into a fight with a (tiger) at a local carnival. Their order arrived, and they were happy to find that the bread was served with a lot of (butter). They had to call the waiter back, however, because there was no salt on the tray on which the (pepper) had been placed. He finished off the meal with an assortment of fruit, and she with an (apple). After they finished, they took off for the city that was located just beyond the next (town). When they got there, they went to examine a house that they were considering turning into a (home). The place was not too far from a river and off in the distance they could see the (water). The owner was outside with a hammer trying to remove a (nail) from a tree. His head was large and his (hair) was dirty. There was a carpet on the ground and a (rug) on the front steps, and someone had left a needle and some (thread) on the porch. Some kittens were in the front yard and two (cats) as well. In general, they found the place to be just what they wanted, although they felt that the grounds would probably need a lot of work.

Low association passage. The man walked to the corner to meet the (parent). When he got there, they went together to a restaurant. As they entered they noticed that the waiter was working

at a table that was painted to match the (door). After they ordered, there was time to look at a newspaper. There was a human interest story about a king who had to travel abroad to find a (nurse), and one about a priest who worked hard for his (friend). There was also a brief note about a lion that got into a fight with a (hound) at a local carnival. Their order arrived, and they were happy to find that the bread was served with a lot of (coffee). They had to call the waiter back, however, because there was no salt on the tray on which the (olives) had been placed. He finished off the meal with an assortment of fruit, and she with an (egg). After they finished, they took off for the city that was located just beyond the next (road). When they got there, they went to examine a house that they were considering turning into a (bar). The place was not too far from a river and off in the distance they could see the (forest). The owner was outside with a hammer trying to remove a (bell) from a tree. His head was large and his (skin) was dirty. There was a carpet on the ground and a (kid) on the front steps, and someone had left a needle and some (metal) on the porch. Some kittens were in the front yard and two (girls) as well. In general, they found the place to be just what they wanted, although they felt that the grounds would probably need a lot of work.

With the exception of a longer exposure interval (1.5 min.), the procedure used in Study III in learning the passages was identical to the procedure used in the previous study.

Table 6 contains the means for Groups HA and LA on the various measures

 Insert Table 6 About here

of recall. No interactions were found between sessions and the independent variables. It can be seen that there was very little difference between groups in the recall of S-words vs. R-words, but the superiority of Group HA on all measures of recall is evident. Analysis of variance of the S-words and R-words revealed only one significant F, that for association, which was significant beyond the .025 level. Group HA recalled on the average significantly (beyond the .01 level) more S-R pairs than Group LA. By "pair," it

will be recalled, is meant co-occurrence on the recall sheet. As in the previous studies, a t-test was used to evaluate the difference on this measure.

Unlike the results of the previous studies, HA responses did not tend to intrude into the recall protocols of Ss in Group LA, a fact which suggests that construction during retrieval might have contributed little to the recall scores for items in the present discourse. In addition, Groups HA and LA did not differ significantly on the recall-dependency measure, a fact which indicates that the proportion of the total number of S-words and R-words recalled that consisted of pairs was the same for both groups. One possible explanation for these findings might be that Ss in both groups, because of some characteristic of the syntactic structure of the sentences in the passages, tended to store items in pairs. For example, unlike the first two studies in which items in the various pairs and groups were intermixed, the pairs in the present passages occurred in isolation from each other. The facilitating effect of associative habit might have been the result of increasing in some manner the number of pairs that could be stored.

Some evidence for this notion can be found in the fact that over 20 per cent of the S-words and R-words recalled by Group LA in the word-list presentation of the critical words from Study III were not accompanied by their paired items, as contrasted with a figure of one per cent for Group HA. The absence of the common context, then, in the word-list condition tends to decrease the tendency for LA items to be recalled in pairs. A summary of the word-list data can be found in Table 7. The results of the analysis

Insert Table 7 about here

of variance for the S-words and R-words and the t-test for the pairs were identical with the results of the discourse study.

The cloze data for the passages used in Study III have been summarized in Table 8. The data for the "S and R deleted" category indicate the constraint

Insert Table 8 about here

upon the construction of S-words and R-words exerted by the common context. It can be seen that the addition of S-words to the context had a greater effect upon the occurrence of HA responses than LA responses, and the addition of HA responses to the context had a greater effect upon the occurrence of S-words

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than the addition of LA responses. As a matter of fact, the addition of LA responses resulted in a slight reduction in the occurrence of S-words. It is to be noted, however, that the context alone did contribute something to the occurrence of HA responses (mean = 1.85) as contrasted with LA responses (mean = .05).

It should be mentioned that all of the results in Table 8 for "S and R deleted" are based upon data from the same group of Ss, since, when these items are deleted, the HA and LA passages are identical. Similarly, the results for "R deleted" under R-words are based upon data from a single group of Ss, since the S-words are identical in the HA and LA passages. Different groups of Ss, however, had to be used to obtain the data for "S deleted" under S-words, since HA and LA responses differ.

Study IV

In Study IV, an attempt was made to develop a passage within which one could vary the number of associates of an S-word, while holding the total number of words in the passage constant. For this purpose, I took the passage used in Study III, modified it, and added additional R-words and context. The end result was a narrative with the following characteristics: (1) 16 S-words; (2) three R-words for each S-word; and (3) an S-word always preceded its R-words. The associative materials were again selected with the assistance of the New Minnesota Norms (Palermo and Jenkins, 1964). The HA responses were selected from the top of the associative hierarchies. The LA counterparts were either idiosyncratic responses or words that did not occur at all as responses to the S-words. The norms used were, of course, those for college students. The LA responses were matched with the HA responses on length, Thorndike-Lorge (1944) frequency and grammatical class.

In one passage--a control (C) passage--the S-words were replaced by items that did not elicit, and which were not elicited by, the HA responses to determine to what extent the presence of the S-words contribute to recall scores. The HA responses for a given S-word were associatively interrelated; hence it was anticipated that the presence of inappropriate S-words might have little or no effect upon the recall of HA responses. However, since the C-words were not strong associates of the HA responses, they should not be recalled as well as the S-words in the HA passage. The HA, C and LA passages are

reproduced below. For the reader's convenience the S-words are underlined and the R-words are in parentheses. The R-words for a given S-word are the three items in parentheses that follow the S-word. Approximately 44 per cent of each passage was made up of the critical S-words and R-words.

High association passage. *The man walked to the corner to meet the (woman) who was looking at a (boy) standing in front of a (girl) across the way. When he got there, they went together to a restaurant. As they entered, they passed a waiter who was moving a table up to a (chair), and someone who was examining a (cloth) on a (desk). After they ordered, there was time to look at a newspaper, where there was a story about a king who was looking for a (queen). He was a (ruler) who had just been given his (crown). There was also a story about a priest who worked hard for his (church), which went on to discuss the importance of (God) and (religion). There was a brief note on the front page about a lion that had a fight with a (tiger) in a (zoo) and had his (mane) pulled, and an article on justice, (law) and (peace), written by a former (judge). Their order arrived, and everything looked good, the cheese, the (bread), the (crackers) and the (milk). He finished up with a nice fruit, and she with an (apple), an (orange) and a (banana). After they finished, they took off for the city that was located just beyond the next (town) in the middle of the (state). They passed through some nice (country) on the way. They were going to look at a house that they were considering turning into a (home). Since the (roof) and the (garage) were in bad shape, it was priced low. The place was located near a river and off in the distance they could see the (water). A (lake) and a (stream) were nearby also. When they arrived, the owner was outside with a hammer, trying to remove a (nail) from something. A (tool) of some kind and a (saw) were on the ground. The owner's head was large and his (hair), (face) and (neck) were dirty. The shoes that they noticed on his (feet) were old, and his (socks) and (laces) were discolored. Someone had left a needle, some (thread), a (pin) and their (sewing) about, and there were some kittens, two (cats), two (dogs) and some (mice) outside as well. After looking the place over, they decided it was just what they wanted.*

Low association passage. The man walked to the corner to meet the (parent) who was looking at a (car) standing in front of a (pipe) across the way. When he got there, they went together to a restaurant. As they entered, they passed a waiter who was moving a table up to a (door), and someone who was examining a (glass) on a (box). After they ordered, there was time to look at a newspaper, where there was a story about a king who was looking for a (nurse). He was a (chief) who had just been given his (staff). There was also a story about a priest who worked hard for his (friend), which went on to discuss the importance of (life) and (industry). There was a brief note on the front page about a lion that had a fight with a (hound) in a (pit) and had his (fuzz) pulled, and an article on justice, (age) and (fear), written by a former (sailor). Their order arrived, and everything looked good, the cheese, the (corn), the (lettuce) and the (fish). He finished up with a nice fruit, and she with an (egg), an (olive) and a (muffin). After they finished, they took off for the city that was located just beyond the next (road) in the middle of the (valley). They passed through some nice (fields) on the way. They were going to look at a house that they were considering turning into a (store). Since the (gate) and the (plaster) were in bad shape, it was priced low. The place was located near a river and off in the distance they could see the (forest). A (bar) and a (school) were nearby also. When they arrived, the owner was outside with a hammer, trying to remove a (bell) from something. A (stem) of some kind and a (pan) were on the ground. The owner's head was large and his (knee), (ring) and (side) were dirty. The shoes that they noticed on his (porch) were old, and his (fists) and (veins) were discolored. Someone had left a needle, some (metal), a (nut) and their (violin) about, and there were some kittens, two (guns), two (rocks) and some (oars) outside as well. After looking the place over, they decided it was just what they wanted.

Control passage. The quest walked to the corner to meet the (woman) who was looking at a (boy) standing in front of a (girl) across the way. When he got there, they went together to a restaurant. As they entered, they passed a waiter who was moving a wire up to a (chair), and someone who was examining a (cloth) on a (desk). After they ordered, there was time to look at a newspaper, where there was a story about a poet who was looking for a (queen). He was a (ruler) who had just been given his (crown). There was also a story about a mayor who worked hard for his (church), which went on to discuss the importance of (God) and (religion). There was a brief note on the front page about a goat that had a fight with a (tiger) in a (zoo) and had his (mane) pulled, and an article on success, (law) and (peace), written by a former (judge). Their order arrived, and everything looked good, the juice, the (bread), the (crackers) and the (milk). He finished up with a nice dish, and she with an (apple), an (orange) and a (banana). After they finished, they took off for the camp that was located just beyond the next (town) in the middle of the (state). They passed through some nice (country) on the way. They were going to look at a station that they were considering turning into a (home). Since the (roof) and the (garage) were in bad shape, it was priced low. The place was located near a circle and off in the distance they could see the (water). A (lake) and a (stream) were nearby also. When they arrived, the owner was outside with a jacket, trying to remove a (nail) from something. A (tool) of some kind and a (saw) were on the ground. The owner's form was large and his (hair), (face) and (neck) were dirty. The spots that they noticed on his (feet) were old, and his (socks) and (laces) were discolored. Someone had left a mirror, some (thread), a (pin) and their (sewing) about, and there were some novels, two (cats), two (dogs) and some (mice) outside as well. After looking the place over, they decided it was just what they wanted.

The procedure used in Study IV was identical to the procedure used in Studies II and III, with the exception of a longer exposure interval (two min.) and a longer recall test (10 min.).

The data were again collected in two sessions and combined after noting that there was no interaction between the independent variable and sessions for the various measures of recall. The means for the recall measures can be found in Table 9. The measures of recall that were used were the total number

Insert Table 9 about here

of S-words, the total number of R-words (out of a possible 48) and the total number of instances in which an S-word that had been recalled was accompanied by at least one of its R-words.

The superiority of Group HA as compared to Group LA is evident on all measures of recall. As anticipated, the average number of S-words recalled by Group C was lower than Group HA. Recall of R-words by Group C was somewhat higher than it was in Group HA, but, as it turned out, not significantly so. A one-way analysis of variance was used to analyze the results for each of the dependent variables, and, in all instances, the value of F was highly significant. The Tukey Gap Test (Edwards, 1954) was used to test the significance of the differences between adjacent means for the various measures of recall. For S-words, there was a significant gap between HA and C (as had been anticipated), but not between C and LA. For R-words, there was a significant gap between HA and LA, but not between C and HA (again, as had been anticipated). For the last measure of recall, there was a significant gap between C and LA, but not between HA and C. This last finding can be seen to be the result of the high level of recall of responses in Group C.

The constraint exerted upon the recall of S-words by the recall of R-words is evident in the results for the recall-dependency measure. The average probability of occurrence of an S-word, given that one or more of the R-words in the cluster had been recalled in Groups HA, LA and C, was, respectively, .78, .62, and .59. The value of F for this analysis was highly significant. Group HA was significantly superior to both of the other groups, but the difference between Groups LA and C was not significant. The groups did not differ from each other when recall dependencies were computed in the S \longrightarrow R direction.

These results (i.e., those for R \longrightarrow S dependencies) do not conform to the findings of Study III for the recall-dependency measure. I have no explanation for this discrepancy, except to suggest that it might have been related to the fact that the HA sentences in Study IV contained a larger number of associatively-related items than the HA sentences of Study III.

It should be mentioned here that the reason why total responses was used as the measure of R-word recall, instead of considering the first, second and third R-words separately, was that the pattern of differences between groups from one response to the other was very similar.

Intrusion errors in the recall of R-words did not occur to any appreciable extent in Group LA. However, in Group C there was a mean of 3.06 intrusions of S-words appropriate to the HA responses, a finding which is consistent with the recall data.

As had been done in the previous two studies, the S-words and R-words were taken out of the HA and LA passages and presented as word-lists for learning. Each list was exposed for one minute. It will be noted that this interval was shorter than the exposure interval used for the passages, whereas in the two previous studies the exposure intervals for the passages and the word lists were identical. Since the word-lists contain fewer items than the passages, it was felt that conditions would be more comparable if the exposure interval was reduced for the word-list presentation. The results of interest have been summarized in Table 10 for both sessions combined, since there were no sig-

Insert Table 10 about here

nificant interactions between sessions and the independent variable. The superiority of recall under the HA condition is clearly evident in Table 10, and the results of t-tests have shown the observed differences to be highly significant.

Cloze data were collected with S-words, R-words, or both deleted from the HA, C and LA passages, using Ss who had not participated in the learning studies. Table 11 summarizes these data.

Insert Table 11 about here

These results were, in general, similar to those reported for the passages used in the previous study. The addition of S-words or high strength R-words to the common context resulted in an appreciable increase in the construction of high-strength associates. Neither the context alone nor the context plus HA responses exerted any constraint upon the occurrence of S-words in the C discourse. The context alone, however, did appear to exert some influence on the occurrence of HA R-words.

The fact that the presence of the S-words used in the HA and LA passages increased appreciably the probability of construction of HA responses on the cloze test would appear to be inconsistent with the results for passage recall, namely, that the presence of these same S-words was not needed to produce facilitation in the recall of HA R-words, and that Groups HA and LA did not differ from each other on the S→R recall-dependency measure. What is suggested by this inconsistency is that construction during recall, if it did operate, may have operated in the R→S direction only. The fact that intrusion errors occurred only in the recall of S-words from the control passage offers some support for this hypothesis.

Additional Results

While the results of the passage-recall studies appear not accounted for, apparently, in terms of the notion that the common contexts may have favored high-strength items, it is conceivable that the associative items in the various passages influenced recall of the common contexts. One might go so far as to suggest that the presence of associatively-related materials in connected discourse makes the discourse a "more integrated" unit. If this is the case, one would expect to find recall of content words (adjectives, nouns, verbs, adverbs) from the common contexts of HA passages to be superior to recall of the same words for LA passages.

As a test of this hypothesis, all the passage-recall protocols of Ss in Studies I, II, III and IV were reanalyzed for recall of context content words. The results of these analyses have been summarized in Table 12, in which it

Insert Table 12 about here

can be seen that, in all instances, context recall was highest in Group HA. For each of these studies, the difference between Groups HA and LA was found to be significant. The mean for the control condition of Study IV was almost identical to the HA group mean. The passages containing associatively related items, then, appear to have been easier passages to process all around.

Discussion

The present studies were designed to determine whether associative habits can facilitate the recall of words embedded in connected discourse. The answer to this question appears to be, yes, they can, and, in addition, they appear

to make the contexts in which they are embedded easier to process. On the basis of the latter finding, one would predict that, with an arrangement of associatively related items that is likely to lead to interference, the interference should extend to the rest of the passage. Research is underway to evaluate this hypothesis.

It is to be noted here that the facilitating effect of associative habit in all of the passage-recall studies conducted thus far was found to be bi-directional; that is, the recall of S-words that were accompanied by HA responses was superior to the recall of the same words when they were accompanied by LA responses. This may have been the result of the fact that normative bi-directionality was the rule for the associatively-related items used here. To evaluate this possibility, it will be necessary to embed uni-directional associates in connected discourse. These, however, are hard to come by when common words are used, especially if one tries to eliminate indirect, as well as direct, associative linkages in one direction.

There was evidence in these studies to suggest that both storage and retrieval factors may have contributed to the facilitating effect of associative habit. To determine, for example, whether some of the effects could have been due entirely to construction during recall, it will be necessary to compare written recall scores with those on a task which makes construction very difficult, such as a paced recognition task (Lachman & Tuttle, 1965) in which key words and filler items are randomized.

The likelihood of interaction between associative and syntactic relations was suggested by the results of Study III. This indicates a need for studies in which the location of associatively-related items (e.g., same phrase, same sentence, subject-object relation, different sentences, etc.) is manipulated. Related to this is the need for the manipulation of associative relationships between items in a variety of form classes. Recent attempts (Rosenberg, 1965b; 1966d) to generate associations to nouns embedded in sentence frames appear to have been successful. Such norms now make it possible to construct sentences in which it is possible to manipulate associative relationships between subject nouns and members of other content classes.

The whole question of the best way to proceed in the preparation of associative passages is an open one. One receives a hint of the great difficulty that is encountered in the construction of such passages by noting some of the

awkward phrasing in those that we have used. The difficulty encountered is, to a large extent, the result of the fact that one must control for word frequency, word and sentence length, grammatical structure, and the like, if differences in the recall of key words are to be attributed to differences in associative constraints. One possibility that should be explored is to have Ss write the passages from lists of high- and low-association words. The results of such a study would give us valuable information on the normative characteristics of passages that are generated from word pools which vary associatively.

Practical Implications

It is not clear at this point to what extent studies of associative factors in the recall of connected discourse--which are clearly studies of transfer--might contribute to our understanding of the variables that are involved in the strengthening of new associations in learning from written instruction. The recent work by Rothkopf (see Rothkopf, 1965, for a summary) is more directly concerned with new learning. However, four possibilities might be explored.

1. A knowledge of how previously established habits are likely to operate in a learning situation may help us to structure new materials in such a manner as to reduce possible interference from previous learning.
2. A knowledge of how previously established habits are likely to operate in a learning situation may help us to structure test items in auto-instructional programs in such a manner as to produce very low error-rates.
3. The identification of conditions that maximize the arousal and utilization of associative habits may suggest valuable ways in which new materials to be associated should be structured to facilitate learning.
4. The observation of a positive relationship between the recall of associative materials and the recall of context content suggests that learning of new materials might be enhanced by presenting them in a passage that contains associatively-related items.

An area in which passages with strong associative constraints might prove to be useful is reading instruction. The use of associative paragraphs for this purpose should result in a reduction in the number of errors that children make in learning to read. Of course, in the beginning, correct reading-responses will be partly a function of construction, but it should be possible to move critical words to contexts of decreasing associative facilitation so that the terminal responses will be perceptually appropriate reading-responses and not good guesses. There is some recent evidence of interest in the possible facilitating effects of word-associations in learning to read (Samuels, 1965).

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Footnote

¹This material will appear in a book by E. Z. Rothkopf (Ed.), *Verbal Learning Research and Written Instruction*. (In preparation).

Table 1

Means for Various Measures of Recall in Study 1

Group	Recall Measure			
	S-word	R1-words	R2-words	Pairs
HA	9.26	8.07	13.00	6.15
LA	7.22	4.78	7.85	3.04

Table 2

Mean Number of S-words and R1-words Guessed Correctly

Group	Measure	
	S-words	R1-words
HA	8.47	7.87
LA	4.00	.20

Table 3
S-words and R-words from Study II

<u>Stimulus</u>	<u>HA Responses</u>	<u>LA Responses</u>
man	woman tall	lady dark
table	chair	pillow
high	low	small
music	piano soft	organ good
cheese	crackers	salad
bread	butter	juice
cold	hot	dry
fruit	vegetable	meat
girl	boy young	dog fine
carpet	rug floor	cloth blanket
yellow	blue	purple
soldier	army war	draft field
hungry	food eat	dinner taste
joy	happy	relieved
moon	stars shone brightly sky night	lake appeared clearly evening valley
green	grass	house

Table 4

Means for the Recall Measures of Study II

Group	Recall Measure			
	S-words	Rl-words	AR's	Pairs
HA	10.46	10.75	4.54	7.88
LA	8.58	6.25	3.08	4.79

Table 5

Means for the Recall Data from the Word-List
Presentation of Study II

Group	Recall Measure			
	S-words	Rl-words	AR's	Pairs
HA	10.41	10.14	5.14	8.27
LA	8.36	7.64	4.23	5.68

Table 6

Mean Recall Scores for Various Measures from Study III

Group	Recall Measures		
	S-words	R-words	Pairs
HA	7.57	7.38	6.10
LA	5.90	5.33	4.10

Table 7

Recall Data (Means) for the Word-List Presentation of Study III

Group	Recall Measure		
	S-words	R-words	Pairs
HA	12.07	12.07	11.97
LA	9.87	9.43	7.43

Table 8

Cloze Data (Means) for Study III

Items	Measure			
	S-words		R-words	
	S Deleted	S and R Deleted	R Deleted	S and R Deleted
HA	7.19	2.25	4.67	1.85
LA	1.05	2.25	.05	.05

Table 9

Means for the Recall Measures of Study IV

Group	Recall Measures		
	S-words	R-words	S + 1R
HA	7.75	16.31	6.63
C	6.25	17.75	5.63
LA	5.06	11.75	4.13

Table 10
Recall Data for the Word-List Presentation of Study IV

Group	Recall Measures		
	S-words	R-words	S + 1R
HA	7.40	22.10	6.50
LA	4.30	12.60	3.20

Table 11
Cloze Data (Means) for Study IV

Items	Measure			
	S-words		R-words	
	S Deleted	S and R Deleted	R Deleted	S and R Deleted
HA	7.71	1.35	9.10	2.40
LA	1.44	1.35	.57	.25
C	.04	0.00	2.90	2.40

Table 12
Mean Number of Content Words Recalled Correctly from
Common Contexts of Passages Used in Recall Studies

Study	Associative Material	
	HA	LA
I	8.93	6.85
II	14.63	11.04
III	25.76	20.29
IV	29.56	24.19