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A group of 20 subjects learned sentences that contained associatively related words while another group of 20 subjects learned low association sentences. The probability of a transitional error was used as a measure of the tendency to integrate the words within the sentences into phrase units. The results suggest that phrase structures may have contributed to the organization of low association sentences for recall, but there was no evidence to suggest a similar process for high association sentences. For both between- and within-phrase transitions, the probability of a transitional error was greater for low association than for high association sentences. (Author/JD)

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ASSOCIATION AND PHRASE STRUCTURE IN SENTENCE RECALL: A REPLICATION[1]

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A group of subjects (N = 20) learned sentences that contained associatively related words while another group (N = 20) learned low association (LA) sentences. The probability of a transitional error (TE) was used as a measure of the tendency to integrate the words within the sentences into phrase units. The results suggest that phrase structure may have contributed to the organization of LA sentences for recall, but there was no evidence to suggest a similar process for high association (HA) sentences. For both between- and within-phrase transitions, the probability of a TE was greater for LA than for HA sentences.

Johnson (1965) has presented evidence to support the hypothesis that in learning a sentence, subjects tend to recode individual words into linguistic phrase units. He had reasoned that if the phrase is a psychologically-real unit, the probability of a transitional error (TE) in recall, i.e., the probability of failing to recall a word correctly, given the previous word in a sentence is recalled correctly, should be greater for a between-phrase word-to-word transition than for a within-phrase transition. Based upon a theory of the cognitive operations involved in sentence generation, Johnson (1966) argued further that simple word-to-word associative dependencies could not account for his earlier results. More specifically, the theory predicted that the cognitive operations in question would lead subjects to use an association within a phrase unit but not an association between words at a phrase boundary. He attempted to evaluate this hypothesis by establishing adjective-noun (within-phrase) associations and noun-verb (between-phrase) associations prior to learning sentences that contained the same word pairs. The hypothesis was supported.

Johnson's (1966) results have been questioned onthe grounds that experimentally established associations at phrase boundaries may not be as strong as the normative associations that exist in natural language materials (Rosenberg,1967). In Rosenberg's investigation it was discovered, among other things, that the probability of a TE at the phrase boundary was not greater than the probability of a within-phrase TE when the sentences contained associatively related (normative controlled associations) content words, that the

probability of a between-phrase TE was lower for high association (HA) sentences than for low association (LA) sentences, and that subjects were more likely to use a between-phrase association than a within-phrase association. Rosenberg (1967) suggested that associatively integrated sentences may be processed in units larger than the phrase.

A difficulty with Rosenberg's study is that he used sentences that differed in length and in syntactic structure from Johnson's. It was deemed advisable, therefore, to replicate his study using sentences of the type Johnson used. The present study was designed for this purpose; however, an interference condition included in the original study, was not included in the present one.

Method

Subjects. Forty paid volunteer subjects from introductory undergraduate courses in psychology were assigned alternately as they appeared for the experiment to an HA (N = 20) and an LA (N = 20) group. The sample was tested in groups of three to eight subjects.

Material. There were four HA sentences (e.g., The brave soldier fought the cruel war) and four LA sentences (e.g., The rich soldier liked the green house). The HA and LA sentences contained the same subject nouns and the other content words were equated on Thorndike-Lorge (1944) frequency (primarily AA and A words). The HA and LA sentences were also comparable in length (average number of letters). The basic sentences (e.g., The soldier fought the war) were constructed from the controlled association norms of Rosenberg and Koen (1968), and adjective responses were obtained from a different sample of subjects. The HA and LA sentences were constructed so as to avoid intralist associative relationships.

The sentences were printed in booklets, one sentence to a page, and each booklet contained four repetitions of a list. The page that followed the last item in a list was blank and lined and was used for the written recall test. Four orders of each list were constructed so that the order of sentences from trial to trial could vary, and each order occurred equally often on each of the four trials within each condition. Exposure intervals were timed with a metronome and the retention tests with a stopwatch.

Procedure. The data were collected in a classroom in a group-testing situation. The exposure interval for each sentence was five seconds, each study trial was followed immediately by a one minute written recall test,

and the interval between the end of the recall test and the beginning of the next study trial was five seconds. The subjects were given detailed instructions in the use of the booklets. They were told that their task was to try to learn as many of the sentences as they could. They were told, in addition, that the order of sentences within a list was not important. However, it was emphasized that the order of words within each sentence was important. For the recall task, they were urged to write down as much of each sentence as they could remember and to try to guess at items they could not remember. Any position within a sentence for which a word could not be supplied was to be filled in with a dash. The signal to turn each page was delivered verbally by the experimenter to the beat of a metronome.

Results

Verbatim recall was scored. The mean number of sentences recalled correctly over the four trials in Group HA was 12.90, and in Group LA the mean was 7.50. This difference in favor of Group HA is highly significant; $t(19) = 6.37$, $p < .001$, one-tailed. The df were reduced by half due to heterogeneity of variance (Edwards, 1960). Similar results were found for total content-word recall.

The mean TE probabilities over trials and sentences for the six, word-to-word transitions within the sentences can be found in Table 1. To compute

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Insert Table 1 about here

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a TE probability, the frequency with which a word following a correct word is wrong (a wrong word or no word at all) is divided by the frequency with which the preceding word is correct. It can be seen that in general the LA TE probabilities are higher than the HA TE probabilities. The Friedman two-way analysis of variance was used to determine whether the six TE probabilities in each group were significantly different from each other. The value of $\chi r^2(5)$ for Group HA does not even approach significance, but for Group LA it is 35.29, $p < .001$.

Since there is no overall effect of transition number in Group HA, no further comparisons were made within this group. To determine whether there was a tendency to recode words into phrases in Group LA, the TE probability for Transition 3 (noun phrase-verb phrase) was compared with the mean of the other transitions using a Wilcoxon matched-pairs signed-ranks test. The

between-phrase transition is significantly higher ($p < .005$, one-tailed) than the mean of the other transitions. However, if there was a strong tendency to recode the words into phrases, the within-phrase Transitions (1-2 and 4-5-6) should not differ. The Wilcoxon test for Transitions 1 and 2 reveals a significant ($p < .01$, two-tailed) value as does the Friedman two-way analysis of variance ($p < .05$) for Transitions 4, 5 and 6. These results are not consistent with the phrase-structure hypothesis.

To determine the effect of normative associative strength for a given transition, Group HA was compared with Group LA on the first adjective-noun (A-N) Transition (2), the noun-verb (N-V) Transition (3) and on the second A-N Transition (6), using the Mann-Whitney U Test. The results indicate $p < .05$ (one-tailed) for Transition 2, $p < .001$ (one-tailed) for Transition 3 and $p < .01$ (one-tailed) for Transition 6. Thus, the probability of a TE decreases as a function of normative associative strength for both within- and between-phrase transitions.

The TE probabilities on Trial 1 were examined to determine whether there was any initial tendency to recode the words in HA sentences into phrase units. However, with only two exceptions, the statistical results for Trial 1 are identical to the results for overall performance. The exceptions are (a) associative strength did not affect TE probability for the first A-N transition, and (b) the two Phrase I Transitions (2 and 3) did not differ significantly for Group LA. It is to be noted, of course, that the analysis of the Trial 1 data for each transition is based upon four observations only.

Discussion

There was no evidence in the present study to suggest that in learning HA sentences, subjects recode adjacent words into phrase units. The results suggest, rather, that associatively integrated sentences are processed in units larger than the phrase. These results are consistent with the results of the previous study (Rosenberg, 1967). There was some evidence for phrase chunking, however, in the case of LA sentences. But, it is clear that the phrase in LA sentences is not a totally-integrated unit, as was indicated by the results for the within-phrase comparisons.

Taken together, what these results suggest is that in learning a sentence, the words are recoded into the largest chunks possible, based upon the syntactic and associative-semantic structure of the sentence. Such a strategy would

insure a minimum number of memory units with a maximum amount of information per unit.

Contrary to Johnson's (1966) findings, the probability of a TE at the phrase boundary is influenced by associative strength. It is possible, therefore, that Johnson's failure to find a significant effect of association at the phrase boundary was due to the fact that he used experimentally-established associations. The fact that his experimentally-established associations were effective for a within-phrase transition can be accounted for by assuming that if there is a strong tendency toward phrase chunking, it may take the strength of a normative association to overcome it, whereas the strength of an experimentally-established association may be adequate to facilitate a within-phrase transition. Unfortunately, this assumption would not account for the earlier (Rosenberg, 1967) observation of normative associative facilitation between phrases but not within phrases for sentences of the form article-adjective-noun-verb-adverb (e.g., The old king ruled wisely). There is obviously a need for research on the effect of such variables as sentence type, sentence length and intonation pattern upon syntactic and associative-semantic integration within a sentence.

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Footnote

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Table 1

Mean TE Probabilities Over Trials

	Transition					
	1	2	3	4	5	6
Group						
HA	.07	.02	.02	.01	.05	.02
LA	.23	.09	.22	.02	.07	.10