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Eight sentences with high associative connections between their major elements (hi-m sentences) were generated from the Michigan Restricted Association Norms (Riegel, 1965a, b). Eight additional sentences with no or low association connections (lo-m sentences) were derived from the hi-m sentences by a scrambling procedure. All sentences were of the form subject-verb-object or subject-verb-location, and were presented to eight male and eight female undergraduates in a learning task. Hi-m sentences were recalled significantly more often than lo-m sentences. The interaction, but not the differences, between the first and second trials were significant. There was an increase in the recall scores from trial to trial for the hi-m sentences but a decrease for the lo-m sentences. Generally, the results confirmed that it is possible to construct sentences with predictable recall scores on the basis of restricted and free association norms. This paper comprises a report in Development of Language Functions, A Research Program-Project (Study B: Developmental Studies in Semantics). (Author/DO)

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Center for Human Growth and Development

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The Recall of High and Low Meaningful Sentences Generated from the Michigan Restricted Association Norms

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Since Miller's discussion of psychological aspects of grammar (1962), a number of studies on the perception, recall, and matching of sentences has been reported in the psychological literature. In many of these studies (Mehler, 1963; Gough, 1965; Savin and Ellen Perchonock, 1965; Salzinger and Carol Eckerman, 1967) Ss had to identify syntactically transformed sentences. The most comprehensive comparisons of this type have been made by Clifton and Penelope Odom (1967). Other studies compared the perception or retention of grammatical, anomalous and ungrammatical sentences (Epstein, 1961, 1962; Miller and Isard, 1963; Marks and Miller, 1964), or analyzed the recall of various parts of sentences as dependent on such factors as word frequency (Johnson, 1965a, b, 1966a; Suzanne Salzinger, Salzinger and Sally Hobson, 1966; Martin and Jones, 1965; and Martin, Judy Davidson, and Myrna Williams, 1965), of association strength (Johnson, 1966b, d; Joan Prentice, 1966; and Rosenberg, 1966d).

The last mentioned studies are closely similar to the present one, but these authors used associative information merely for the purpose of strengthening or weakening certain word pairs within or between phrases. In contrast, the purpose of the present investigation is to determine which of a variety of restricted and free associations predicts best the recall of various parts of the recall of the whole sentences. Stated differently, the present study is an exploration of the correlation between different types of associations and different relations within sentences, and thus, can be regarded as a validation study of restricted and free associations.

For the purpose of our exploration we constructed highly meaningful sentences in which each of the elements elicits and is elicited by the other elements of the sentence. Afterwards these sentences were scrambled to generate low meaningful sentences with little or no associative connections among elements. Both types of sentences were applied

in a learning task and it was predicted that highly meaningful sentences would be easier to recall than low meaningful sentences. Moreover, differences in strength and types of association were expected to predict the efficiency of learning and the types of errors encountered.

Procedures

Eight highly meaningful (hi-m) sentences were constructed from stimuli of the Michigan Restricted Association Norms (Riegel, 1965a, b). All stimuli were of either A or AA frequency (Thorndike and Lorge, 1944). Four sentences of each of the following types were used:

animate noun (person)--transitive verb--direct object (not a person)

inanimate noun--intransitive verb--location (including the prepositions "in" or "on")

Each hi-m sentence was generated by selecting three stimuli from the Michigan Norms (Riegel, 1965a, b) that elicit each other as responses at frequencies of two or higher under one or more types of restriction. Hence, for the sentence "The thief steals the bread," the word "thief" elicits "steal" as a response and the word "steal" elicits "thief" and "bread". The sentences differ in the number, strength, and types of associations among their elements.

The eight hi-m sentences (numbered 1-8) were arranged in a list so that each of the two sentence types appeared in alternate locations. A scrambling procedure was applied to produce eight new sentences which do not have high associative connections between the three major elements. These sentences, called low meaningful (lo-m) sentences, were generated by arranging the hi-m sentences into two blocks of four. The first lo-m sentence was obtained by taking the subject from the first, the verb from the second and the object from the third hi-m sentence of the first block, etc. In the lo-m sentences no associative connections were found except for those in sentences (13) and (15) where there are connections between "eats" and "table", and "sees" and "lamp", respectively. Below are the 16 sentences which were constructed:

hi-m Sentences

List B

(1) The candle glows in the darkness.
(2) The boy climbs the mountain.
(3) The river flows in the country.
(4) The thief steals the bread.

List A

(5) The light shines in the lamp.
(6) The man eats the food.
(7) The top spins on the table.
(8) The woman sees the window.

lo-m Sentences

List A

(9) The candle climbs the country.
(10) The boy flows in the bread.
(11) The river steals the darkness.
(12) The thief glows in the mountain.

List B

(13) The light eats the table.
(14) The man spins on the window.
(15) The top sees the lamp.
(16) The woman shines in the food.

The first half of the lo-m sentences is grouped with the second half of the hi-m sentences to produce List A. The remaining sentences are grouped to form list B. Within both lists the order of the eight sentences was randomized with the constraints that no more than two hi-m or lo-m sentences appear in sequence and that if a list begins with a hi-m sentence it must end with a lo-m sentence and vice versa. This procedure was followed twice for arranging two sets of eight sentences from each list (A1, A2, B1, and B2). Each set from each list was combined with each set from the other list in all possible orders. Each order was applied to one male and one female S.

The first lists of eight sentences were presented on a memory drum at two-second between-item intervals. Ss were asked to recall whole sentences and to record them at the end of the presentation of the list. After Ss had completed eighteen addition problems the second list of eight sentences were presented on the memory drum. Ss were eight male and eight female University of Michigan summer school undergraduates. They were paid for their participation.

Results and Discussion

In evaluating the data, sentences were either counted as completely correct (all three words were correct and in their proper places) or as partially correct (one or two words were correct and in their proper places). As shown in Table 1, hi-m sentences are more often fully recalled than lo-m sentences ($t = 4.0$; $p < .01$). However, the latter are more often partially correct than the former ($t = 2.1$; $p < .05$). Sex differences were found to be negligible.

Insert Tables 1 and 2 about here

A second form of evaluation consists in listing the number of words correctly recalled irrespective of their place in the sentences. As shown in Table 2, for hi-m sentences this number increases markedly from the presentation of the first to that of the second list, but for lo-m sentences it decreases. A variance analysis indicates significant differences between hi-m and lo-m sentences and a significant interaction effect (both $p < .01$). At both presentations more words are intruded into the lo-m than into the hi-m sentences. Here again, the differences between hi-m and lo-m sentences and the interaction effect were found to be significant (both $p < .01$). Since in only four cases were words correctly recalled, but placed into the wrong slots, one can regard the number of words recalled as a performance measure equally appropriate to the number of sentences recalled.

In order to analyze whether association strength between sentence parts predicts recall, we divided those ten sentences which have some associative connections between their elements into the six with recall scores of 30 words or higher (Group 1; including sentences 1, 2, 3, 4, 5, and 7) and four with recall scores below 30 words (actually below 24 words) (Group 2; including sentences 5, 8, 13, and 15). The remaining six sentences without associative connections also have recall scores below 30 words (actually below 24 words) (Group 3). Each of the three groups includes, in equal numbers, sentences with or without prepositions. Due to this classification procedure, the recall scores differ markedly between the first and the second two groups, but not between the second and the third. There are also no marked differences between sentences with or without prepositions.

The restricted and free association strengths between any pair of the three key words of each sentence were summed separately for the first and second groups of sentences as well as for those with and without prepositions. The elements of the third group of sentences are not associatively connected and thus, are of no interest for the

following analysis. Below all 16 types of restricted associations are listed, for explanatory purposes, together with their primary responses to the stimulus CHILD:

Logical Relations		Grammatical Relations		Infralogical Relations	
Superordinates	(Human)	Nouns	(Boy)	Locations	(School)
Coordinates	(Adult)	Verbs	(Play)	Wholes	(Family)
Subordinates	(Baby)	Adjectives	(Small)	Parts	(Youth)
Similars	(Youngster)	Foregoing Words	(Small)	Precedings	(Baby)
Contrasts	(Adult)	Following Words	(Play)	Contemporaneities	(Mother)
				Succeedings	(Adult)

Table 3 lists the differences in associative strengths between the first and the second groups of sentences that exceed 5%. Of all the possible combinations of elements, the combination object-subject has been omitted because notable associations occur for one sentence only and, thus, cannot be regarded as sufficiently reliable. Table 3 shows that of all associative connections only those between adjacent elements in the forward or backward directions but not between the distant elements of the subjects and objects, are of significance. Furthermore, none of the logical relations predicts the recall of sentences and also the tasks Adjectives (there were no adjectives in the sentences), Wholes and Succeedings had to be excluded. The significance of most of the remaining predictors can be readily explained.

Insert Table 3 about here

The tasks of associating verbs or of finding words following the stimuli in connected discourse together with free word associations are good predictors representing the subject-verb pairs. When the reverse relation is considered (between verbs and their preceding subjects), Nouns, Foregoing Words and Free associations (together with Locations and Contemporaneities, for whose inclusion a rationale is less readily available) are found to be good predictors. The tasks of Nouns, Following Words, Parts and Free associations predict the verb-object sequences and are supplemented by the tasks of Precedings and Contemporaneities. As should be expected, the reverse relations (between object and its preceding verb) is best predicted by the tasks of Verbs and Foregoing Words.

In some instances, particular types of restricted or free associations seem to predict the fact whether a sentence includes a preposition to almost the same extent to which they predict their recall. In order to explore this problem, we computed phi-coefficients for the first two groups of sentences using association strength as the first and the dichotomy of preposition versus no-preposition as the second variable. Only for the verb-object pairs was a very low negative correlation obtained (-.06). In all other instances, the prediction of the recall was more successful than the prediction of the prepositions, but the correlations were low (range .17 to .30). In other words, the restricted and free association strengths between the parts of the sentences were more equally distributed across sentences with or without prepositions than across sentences with high or low recall scores. There was one notable exception, however. The difference in restricted association strengths for the subject-object sequence on the task of locations (6.7%) predicted successfully the occurrence of the preposition. The occurrence of this preposition may in turn, facilitate the recall of the sentences of which it is a part. Note, that previously and as shown in Table 3, we have not been able to utilize the relation between subject-object for the prediction of the recall.

Conclusions

Our study has shown that it is possible to generate sentences with predictable levels of recall on the basis of restricted as well as free word associations. Sentences well recalled have association strengths equal to or higher than those listed in Table 3. Sentences poorly recalled are those with association strengths below 5% on any tasks and any combinations of sentence parts. Of course, our conclusions are valid only for the types of sentences considered, namely subject-verb-object sequences.

The above analysis is a very crude one taking only into account the direct associations between the key elements of sentences. For a more complex analysis, we may consider intervening words or concepts that are associatively shared by the elements of the sentences. Thus, we may regard each element as a stimulus eliciting any one or several of the restricted or free response distributions. In such an analysis, the de-

gree of meaningfulness or the strength of the sentence structure could be inferred by enumerating the shared responses to any two of the three elements of the sentences.

The enumerations involved in such an analysis are of course, exceedingly cumbersome As a shortcut method, we compared the primary responses of the seventeen distributions. Again, the six sentences best recalled shared the greatest number of primary responses, namely 36; the second group of sentences shared eleven responses, and the third group shared one response. Of these shared responses, 46% established a linkage between the subject and verb, 33% between verb and object and only 21% between subject and object.

Thus, the above results confirm the previous ones based on the direct associations between the parts of the sentences. Potentially, the proposed analysis may provide for more detailed predictions, especially when all and not only the primary responses are being considered. Such an investigation has to wait however, until a more comprehensive analysis of the Michigan Restricted Association Norms has been completed.

Summary

Eight sentences with high associative connections between their major elements (hi-m sentences) were generated from the Michigan Restricted Association Norms. Eight additional sentences with no or low association connections (lo-m sentences) were derived from the former by a scrambling procedure. All sentences were of the form: subject-verb-object and were presented to eight male and eight female undergraduates in a learning task. Hi-m sentences were significantly more often recalled than lo-m sentences. The interaction, but not the differences, between the first and second trials were significant. There was an increase in the recall scores from trial to trial for the hi-m sentences but a decrease for the lo-m sentences. Generally, the results confirmed that it is possible to construct sentences with predictable recall scores on the basis of restricted and free association norms.

Table 1

Number of sentences fully or partially recalled and number of words recalled in hi-m and lo-m sentences*

		Sentences Correct		Words
		Fully	Partially	Correct
hi-m Sentences				
(4)	The thief steals the bread.	11	2	37
(2)	The boy climbs the mountain.	11	1	34
(1)	The candle glows in the darkness.	6	7	32
(7)	The top spins on the table.	10	1	31
(3)	The river flows in the country.	10	-	30
(6)	The man eats the food.	6	6	30
(5)	The light shines in the lamp	4	6	24
(8)	The woman sees the window.	5	4	20
	Sum	63	27	238
lo-m Sentences				
(12)	The thief glows in the mountain.	5	6	24
(11)	The river steals the darkness.	5	5	23
(13)	The light eats the table.	3	8	22
(10)	The boy flows in the bread.	4	5	20
(15)	The top sees the lamp.	4	4	18
(14)	The man spins on the window.	1	7	16
(16)	The woman shines in the food.	2	4	12
(9)	The candle climbs the country.	-	6	9
	Sum	24	45	144

* Highest possible number of sentences recalled equals 16; highest possible number of words recalled equals 48.

Table 2

Number of correct, intruded and missing words
in the recall of hi-m and lo-m sentences at two trials

	Correct	Intruded	Missing
hi-m Sentences			
1st Trial	97	8	87
2nd Trial	141	15	36
lo-m Sentences			
1st Trial	80	20	92
2nd Trial	64	26	102

Table 3

Percentage Differences between sentences with high and low recall scores in free and restricted association strengths exceeding 5%.

	Noun	Verb	Fore.	Foll.	Loca.	Part	Prec.	Cont.	Free
Subject-Verb		17.0**		5.0					7.2
Verb-Subject	13.8		11.7		14.2			6.2**	11.2
Verb-Object	20.7			11.5		5.7	8.0	10.9	12.7
Object-Verb		9.7*	5.2						

* The association strength for sentences with low recall scores equals 12.5%. Thus, when generating sentences to be well recalled, the association strength between the objects and verbs should exceed the latter value rather than 9.7%. The percentage differences listed in all other cells exceed the absolute percentages observed for sentences with low recall scores.

** The association strength for sentences with low recall scores for Verbs equals 7.2%, and for Contemporaneities, 5.5%. Thus, when generating sentences to be poorly recalled, the association strengths may be below these values rather than below 5%. All other associations for sentences with low recall scores have absolute strengths below 5%.

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