PART II. EXPERIMENTAL STUDIES

CHAPTER V

EXPERIMENT 1

Experiment 1 was conducted to investigate the effect of the number of encoding sentences and the effect of the variability of semantic information on memory for sentences.

In the Introduction it was suggested that one of the major features of 'deeper' or 'elaborative' processing could be the process of activating or employing a greater amount of information from our semantic memory in our attempt to encode the stimuli properly. This activation of a greater extent of semantic information can be experimentally induced by increasing the length of a sentence (the number of words in a sentence)---as Craik & Tulving(1975) did---, or by asking subjects to rate the target words on a few semantic differential dimensions---as Klein & Saltz(1976) did. Yet these ways of activating a greater amount of semantic information are very limited in nature; they do not provide an account of deeper processing as would be elicited a wide

range of information on different occasions or through different encodings. In this experiment, it is assumed that the encoding elaboration achieved through activation of a greater extent of semantic information depends not only upon the number of words in a single sentence and upon the number of semantic dimensions rated at a single encoding, but also depends upon the number of times the target item is experienced or encoded and upon the variability of the information activated during different encodings. This assumption is tested in this experiment by controlling the number of sentences a target word appears in, and whether it appears in the same repeated sentences or in several different sentences.

METHOD

Subjects. The subjects were 12 Introductory Psychology students at Queen's University, they served as part of a course requirement. They were run individually.

Design. The experimental design was a 3X2 within-subjects design. The number of input sentences for each target word, and the types of sentences were the two within-subjects factors. The number of input sentences per

target word was either 2, 3, or 4; and the types of sentences were either SAME(repeated encodings) or DIFFERENT(varied encodings).

Materials. The stimuli were 48 nouns embedded in sentences. The nouns were selected from Paivio's(1968) imagery norms; most of the nouns had imagery values of more than 6.00, and they were high frequency words (words with a frequency of AA or A). For each target word, 4 sentences were generated by the Experimenter. Each sentence(about 8 to 10 words long) told something about a target word in a simple description of a fact or an event (see Appendix I). There was no coherent relationship among the 4 sentences containing the target word, except that the same target word was embedded in each of them. They could not be easily connected into a coherent story. From each set of 4 sentences, 2, 3, or 4 different sentences were presented for the DIFFERENT (varied encoding) sentence condition(see Appendix I), while one of the 4 sentences was repeatedly presented ---2, 3, or 4 times---for the SAME(repeated encoding)sentence condition(see Appendix I). The repetition of content words other than the target word across different sentences was kept at a minimum. The sentences were typed on IBM cards, one sentence per card.

Procedure. Subjects were given a deck of 144 cards.

On each card a sentence appeared with the target word underlined. The cards with the same target word were placed next to each other. The total of 144 sentences(cards) for the 48 target words were presented as follows; first, a sentence about a target word was repeated twice (a1, a1: SAME encoding condition with 2 input sentences), then 3 different sentences about another target word were presented (b1, b2, b3 : DIFFERENT encoding condition with 3 input sentences), then a sentence of another target word was repeated 4 times(c1, c1, c1, c1 :SAME encoding condition with 4 sentences), then 2 different sentences about another target word were presented (d1, d2 : DIFFERENT encoding condition with 2 input sentences), then, a sentence containing another target word was repeated 3 times (e1, e1, e1 : SAME encoding condition with 3 input sentences), and finally 4 different sentences about another target word were presented (f1, f2, f3, f4 :DIFFERENT encoding condition with 4 input sentences). This procedure of presentation was repeated for other target word sentences until all the 48 target words were presented.There were 8 different target words for each of the 6 different experimental conditions. Given a deck of 144 cards in the above presentation order, subjects were instructed to turn over and read silently a card at each sound of a 'click'. A Hunter timer was set up so that it sounded 'click' every 5 sec.. Subjects were

asked to repeat the process 'turn over a card and read the sentence' until all the cards were read. They were given a practice trial with a deck of 12 cards before they started to read the main deck of 144 cards. The total time spent reading all the cards was 12 minutes. After the subjects had finished reading the last card, they were given 30 seconds of a number counting task (counting numbers backward by three starting from 97), and then they were asked to recall, by writing, the underlined target words. They were given 5 minutes to complete the recall. They were told to write down the words even if they were not sure whether the words were presented underlined or not. The total time elapsed between the offset of card reading and the onset of the free recall test was about one and half minutes. The number of correctly recalled target words was taken as the score. If there were any non-target words recalled, subjects were further tested immediately after the recall test to see if they could recall the target words appearing in the same sentences as the non-target words they had recalled. If subjects could recall the target words, given these non-target words, these were included in the number of correctly recalled target words;but if subjects could not recall the target words, the non-target words recalled were excluded from the score. The reason for employing this lenient scoring method was that some subjects were not sure

about whether certain words they retrieved had been presented underlined or not.

RESULTS

The mean number of correctly recalled target words as a function of the number of input sentences and the types of sentences is shown in Table 1-1. An analysis of variance of the data is presented in Table 1-2. This analysis shows that the types of encoding sentences had a significant effect on the recall of target words; varied (DIFFERENT) encoding sentences resulted in better recall of the target words than did the repeated(SAME) encoding condition ($F(1,11)= 16.57$, $p<.01$). The main effect of the number of input sentences did not reach statistical significance(($F2,22)= 2.82$, $.05<p<.10$). Nevertheless, its linear component showed a significant trend; the amount of recall increased, in general, with an increase in the number of input sentences ($F(1,11)= 5.50$, $p<.05$). Figure 1 also shows that there was a significant linear trend in the interaction effect between the number of input sentences and t' types of sentences ($F(1, 11) = 5.50$, $p<.05$). As shown in Figure 1, when

Table 1-1.

The mean number of target words recalled as a function of the number of input sentences and the types of input sentences (Same-Different), for Experiments 1 and 2.

Experiments	Types of input sentences	Number of input sentences		
		2	3	4
Experiment 1	SAME	1.00	1.50	2.33
	DIFFERENT	2.58	2.41	2.58
Experiment 2	DIFFERENT	1.80	3.00	3.40

Table 1-2.

An Analysis of Variance of the Correctly Recalled Target words as aFunction of the Number of Input Sentences and Types of Sentences in Experiment 1.

Source of Variance	Sum of Squares	df	F	p
Types of Sentences(T)	15.13	1	16.57	p.<.01
Error(a)	10.04	11		
Number of Sentences(N)	5.78	2	2.82	.05<p<.10
Error(b)	22.56	22		
linear	5.33	1	5.50	p<.05
error(b1)	10.67	11		
quadratic	0.44	1	0.41	---
error(b2)	11.89	11		
Interaction : T X N	5.33	2	2.55	.05<p<.10
Error(c)	23.00	22		
linear	5.33	1	5.50	p<.05
error(c1)	10.67	11		
quadratic	---	1	---	---

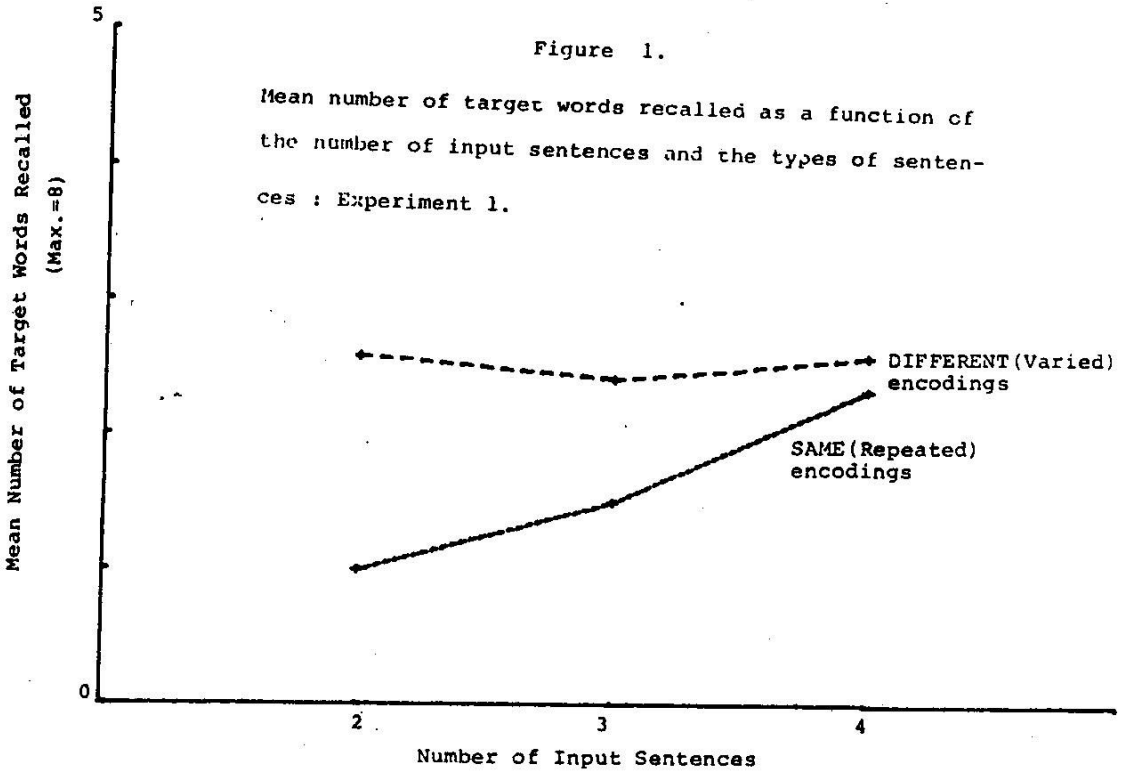

Figure 1.

Mean number of target words recalled as a function of the number of input sentences and the types of sentences : Experiment 1.

the target words were encoded in the SAME sentences, the amount recalled was an increasing function of the number of input sentences, whereas with the target words encoded in DIFFERENT sentences the number of input sentences had almost no effect.

DISCUSSION

The results of this experiment suggested that encoding a target word in DIFFERENT(varied) sentences entails a better retention of the target word. Since encoding a target word in varied sentences can be seen as activating a greater amount of semantic information (word concepts, or propositions), we could interpret the above results as support for our assumption that a spreading elaboration process, possibly activating a greater amount of information from our semantic memory, leads to a more elaborate memory trace and better memory performance.

The effect of the number of encoding sentences ,however, was significant only in the SAME encoding condition; the effect was not present in the DIFFERENT(varied) encoding condition. This contradicts the prediction of the spreading elaboration assumption which would expect better retention performance with a greater number of different encoding sentences since a greater

number of different encoding sentences should lead to the processing of more different semantic (sentential) items of information than the repetition sentences would do. Why, then, did the number of input sentences fail to produce a positive effect in the varied encoding condition? We may search for an answer to this question in the procedural characteristics of this experiment. In this experiment, the varied encoding sentences were presented always in between the repetition sentences: these last are much easier to process since, once subjects have processed a sentence at its first appearance, they do not have to do further processing on its second, third, or fourth appearance. This absence of the necessity for further processing beyond the first appearance of the repeated sentences might have had some negative effect on the processing of DIFFERENT encoding sentences. It is highly possible that this processing strategy of 'fully processing the first sentence, but not the next one, two, or three sentences' could have persisted even for the processing of the DIFFERENT encoding sentences; thus subjects might not have exerted themselves to fully process the second, third, or fourth input sentences. They may not have been able to profit, therefore, from the availability of the greater number of different encoding sentences and resulting increase in information.

This possibility, that the absence of the effect of the number of input sentences in the DIFFERENT sentence condition might have been produced by some negative effect of presenting the DIFFERENT encoding sentences in between the repeated sentences, will be investigated in the next experiment.

CHAPTER II

EXPERIMENT 2

Experiment 2 was conducted to see whether the absence of a positive effect of the number of input sentences in the DIFFERENT(variable) encoding condition was due to the negative effect of presenting those DIFFERENT encoding sentences with the easily processible repeating(SAME) sentences. The assumption is that if we present the DIFFERENT encoding sentences only, without any repeating sentences, then the number of input sentences in variable encoding sentences will have a significant positive effect on the amount of recall.

METHOD

Subjects. Fifteen Introductory Psychology students at Queen's University served as subjects.

Design. The number of input sentences was the within-subject variable with 3 levels(2,3, and 4 sentences).

Materials. The materials were the same as those of

Experiment 1, except that only the variable encoding sentences were used in this experiment. A total of 48 target words were presented in 144 sentences.

Procedure. The procedure was the same as that of Experiment 1, except that there was no repetition of any sentences. Five subjects saw, first, 2 different sentences about a target word(a1, a2), then 3 different sentences about another target word (b1,b2,b3), then 4 different sentences on another target word(c1,c2,c3,c4) . This process was repeated sixteen times to present all the sentences of 48 target words. Another five subjects saw 3 different sentences of a target word first (b1,b2,b3), then 4 different sentences of another target word (c1,c2,c3,c4), and then 2 different sentences of another target word (a1,a2). The remaining five subjects saw, first, 4 different sentences about a target word (c1,c2,c3,c4), then 2 different sentences of another target word (a1,a2), and then 3 different sentences of another target word (b1,b2,b3).

RESULTS

Table 1-1 and Figure 2 show the mean number of target words recalled as a function of the number of input sentences.

Figure 2

Mean number of target words recalled as a function of the number of input sentences : Experiment 2.

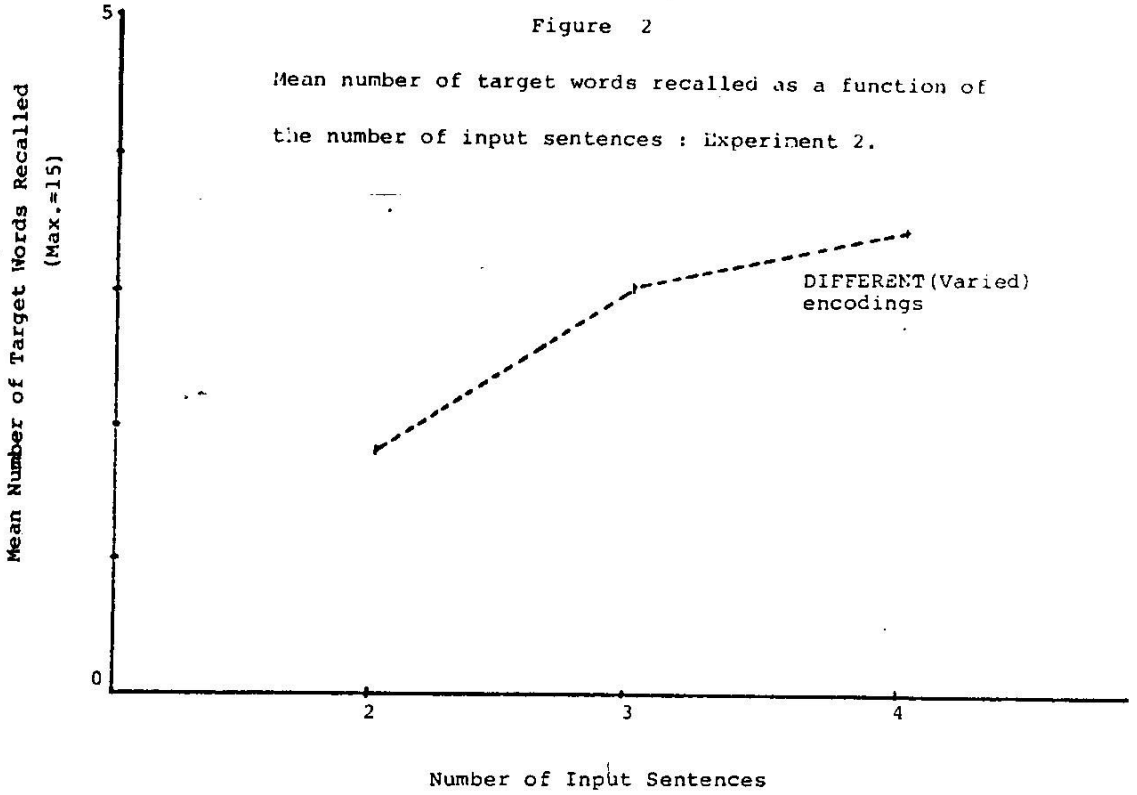

Table 2.

An Analysis of Variance of the Number of Target words Recalled as a Function of the Number of Input Sentences in Experiment 2.

Source of Variance	Sum of Squares	df	F	p
Number of Input Sentences	26.84	2	5.71	p<.01
Error(a)	65.82	28		
linear trend	26.13	1	10.20	p<.01
error(a1)	35.87	14		
quadratic trend	0.71	1	0.33	---
error(a2)	29.96	14		

An analysis of variance of these data indicates , as shown in Table 2, that the amount of recall is an increasing function of the number of target sentences($F(2,28)=5.71$, $p<.01$). Yet an increase in the number of input sentences does not always produce the same degree of increase in the amount of recall; an increase of the number of sentences from 3 to 4 produced only 13.3 % of the increase in the amount recalled, from the 3-sentence condition, whereas the increase in the number of sentences from 2 to 3 produced a 66.7 % increase in the amount recalled as compared with the 2-sentence condition.

DISCUSSION

The above results show that our interpretation of the absence of the effect of the number of input sentences in DIFFERENT encoding sentence condition of Experiment 1 was probably correct, and that the number of varied input sentences has a significant monotically increasing effect on recall performance when the negative effect of presenting the sentences with the SAME repetition sentences is removed.

On the basis of these results, and the results of Experiment 1 demonstrating that recall in the DIFFERENT

encoding condition was superior to the recall in the SAME encoding condition, we can safely conclude that the greater the number of input sentences, and the greater the variability among the encoded sentences,the better is the recall of the target words. Furthermore,since more semantic information is probably involved in or activated by the presence of a large number of encoding sentences, or by greater variability therein , we could conclude that the better memory performance under these circumstances was an outcome of this greater evocation of semantic information. But it remains to be asked why this superior memory performance should result from this extended method of encoding the contextual sentences.

On the reason for why this spreading elaboration entails better memory performance, several theories can be put forward. The early version of levels of processing view(Craik & Lockhart,1972) would have argued that the spreading elaboration produces, somehow, more durable traces. This interpretation, however, does not account for the growing body of evidence that shows no difference in trace durability among the items processed to different depths (Baddeley,1978). Furthermore it has to explain what 'durability of trace' really means.

The encoding variability theory, some early verbal

learning studies on stimulus characteristics(meaningfulness, frequency), and Anderson & Bower(1973) would have attributed the effect of spreading elaboration to a different cause, namely, that it results in 'the formation of many redundant interconnections' between the words in the different encoding sentences, thereby providing more alternative retrieval pathways for the retrieval search, and that this availability of a greater number of retrieval paths could, these theories argue, have caused the better retention performance. This interpretation sounds plausible,but it has several drawbacks. It rests on a simple view of memory as a static system of passive storage and retrieval. It does not properly explain the dynamic aspects of constructing the interpretations of the input materials at encoding and reconstructing the encodings at the time of recall. Nor does it properly explain the positive effects of integrative processing.

An alternative interpretation can be put forward in terms of 'specific descriptions.' As discussed earlier in the Introduction, Klein & Saltz(1976) have attributed the effect of deeper processing to the better specification, in cognitive space, of the deeply processed items. Recently, similar views have beeen put forward by Norman & Bobrow(1979), Lockhart et.al. (1976), and Jacoby & Craik (1979). Norman and Bobrow advance a 'levels of

descriptions' or 'levels of specification' theory, in which they argue that memory performance depends upon the specificity of descriptions of the target information and that the specificity of descriptions determines both the discriminability of the target items from all other possible records within the relevant subset of memories, and the reconstructability of the target encodings at the time of recall. Jacoby & Craik postulate that, "the fuller description would also serve to specify the objects among less similar sets of alternatives(within the same encoding dimension, at least). Thus, more complete descriptions confer both greater distinctiveness and greater generality as a basis for discriminating one object from others.(p. 4)." "...and the richer information may then provide more adequate feedback to guide further reconstruction (Lockhart, et.al.,1976)." Following this line, we could postulate that the spreading elaboration--by activating and engaging greater amount of information from semantic memory--entails richer, fuller, and more specific descriptions of the target information. This in turn makes the target encodings more distinctive and gives to the encodings a greater number of points or features on which to base the discrimination of the target information from others, and a great amount of content information which may be employed for the reconstruction of the original encodings at the time

of recall, thereby entailing better memory performance. This interpretation of the value of spreading elaboration still needs further conceptual refinement, and has to be experimentally tested.

There is one drawback in interpreting the results of the present experiment in favour of our spreading elaboration assumption. As Figure 2 shows, the effect of an increase in the number of input sentences did not always produce the same degree of improvement. The effect of an increase in the number of sentences from 3 to 4 was not as great as that produced by the increase from 2 to 3 sentences. One of the possible reasons for this relatively low increase in the amount of recall in the 4-sentence condition could be found in the lack of any coherent relationship among the input sentences. In constructing the stimuli, the sentences for each target word were generated so that there was little chance that subjects could, implicitly, connect and integrate the sentences into a coherent story or statement. Thus, it is quite unlikely that any of the subjects could have succeded in integrating the information activated across different sentences into a connected and coherent story or statement. This disadvantage could have reduced the effect of the number of input sentences in general and in particular in the 4-sentence condition. This possibility will be investigated in the next experiment.

CHAPTER VII

EXPERIMENT 3

Experiment 3 was conducted to see whether the lack of a strong effect of the number of encoding sentences in the 4-input sentence condition in Experiment 2 was due to the absence of coherence among the encoding sentences. It could be argued that if there were a certain degree of coherence among the encoding sentences, an increase in the number of input sentences would have steady positive effects on recall since it would allow subjects further opportunities for processing in terms of integrating the diffusely activated information into coherent units. This possibility is tested in this experiment by varying the degree of coherence among sentences in terms of 'same-themeness'. It was assumed that if several sentences are stating a coherent single story or theme, they could be considered as having a high degree of coherence; if they are descriptions of defining characteristics of word concepts, they can be seen as having some intermediate degree of coherence; and if those sentences are not any of the above but are simply unrelated(non-story, non-defining) sentences (such as those in the Varied condition of Experiments 1 and 2) we could

consider them as having no coherence. Furthermore, we could expect that, if the presence of coherence is a key factor that determines the effectiveness of the number of input sentences (which in turn should influence the amount of activated information), then a particularly strong effect of the number of input sentences should be obtained under the 'story' condition. That is, we could predict that the effect of the number of input sentences (i.e. spreading elaboration) would have the greatest effect with the story sentences(of high coherence), an intermediate effect with the definition sentences (of intermediate coherence), and the lowest effect with the unrelated sentences(of no coherence).

METHOD

Subjects. Eighteen Introductory Psychology students at Queen's University served as subjects.

Materials. In addition to the list of unrelated Varied sentences used in Experiments 1 and 2, two new lists of sentences were generated for the 45 target words used in Experiment 3. The reason we used only 45 target words instead of the 48 words of Experiment 1, was because there were 9 within-subjects condition in this experiment--- (3 different number of input sentences) X (3 different types of

sentences)---instead of the 6 within-subjects conditions of Experiment 1. In the DEFINITION sentence list, the sentences for each target word were generated so that each set of 4 sentences for each target word told something about the word by giving a description of the defining characteristics of the meaning of the word (see Appendix I for an example). Beyond this there was no coherent thematic relationship among the 4 sentences about a target word. An example of a set of DEFINITION sentences is as follows;

"A horse is controlled with a harness.
Leather is used to make a harness.
A harness is for a carriage horse.
A harness makes a squeaky noise."

In the STORY list, there was a coherent single story theme connecting the elements of each set of 4 sentences. Subjects could easily connect these story sentences, sequentially, into a meaningful coherent story (see Appendix I). An example of a set of STORY sentences is as follows;

" A leather harness was fastened to a horse.
The harness was very stiff.
The horse bit the harness into pieces.
The rancher put a new harness on the horse."

Additional care was given to generate similar sentences across the STORY sentences, DEFINITION sentences, and UNRELATED sentences; therefore one or two sentences were

common to the list of story sentences, definition sentences, and unrelated sentences all containing the the same target word. To counter the word specific effect, 3 different counterbalancing lists were constructed so that a target word which appeared in a STORY sentence in one counterbalancing list(List A) appeared in the DEFINITION sentences in another counterbalancing list(List B), and in UNRELATED sentences in the third counterbalancing list(List C). Each subject saw either List A, ListB, or List C, with each of six subjects seeing the same list. In each counterbalancing list, 15 target words were presented embedded in STORY sentences(5 target words in 2 sentences, 5 target words in 3 sentences, 5 target words in 4 sentences), another 15 target words were presented in DEFINITION sentences, and the remaining 15 sentences were presented embedded in UNRELATED sentences.

Procedure. The procedure of Experiment 1 was employed again, except that the presentation rate was increased from 5 seconds to 7 seconds---to allow the subjects enough time to find the coherent relations among the sentences---, and that the free recall test was given either immediately(10 seconds) after the presentation or after a delay of 90 seconds (about 30 seconds for reading the number counting task instruction , 30 seconds of the number counting task,

and 30 seconds of reading the recall test instruction). Subjects were given 5 minutes to free recall the target words and write them on a response sheet.

Design. The experimental design was a 3x3x2x3 factorial design. The types of encoding sentences (STORY, DEFINITION, or UNRELATED) and the number of the input sentences(2,3, or 4) were two within- subjects factors;the recall interval (10 or 90 seconds) and the lists (A,B, or C, counterbalancing lists) were between-subjects factors.

Results

The number of correctly recalled target words was taken as the score. Table 3-1 shows the mean number of recalled target words as a function of the number of input sentences, types of encoding sentences and retention intervals. An analysis of variance was conducted on these data, and a summary of the analysis is given in Table 3-2. The analysis shows that the types of encoding sentences and the number of input sentences had significant effects on the amount recalled, whereas the retention interval and the lists had little effect on recall performance. The types of encoding sentences (the degree of 'same-themeness') has a significant overall effect on the amount of recall($F(2,24)=5.978$, $p<.01$), and the effect has a positive linear

Table 3-1.

Mean number of target words recalled as a function of the number of input sentences, types of sentences, and retention intervals : Experiment 3.

Retention interval	Types of sentences	Number of input sentences		
		2	3	4
IMMEDIATE	UNRELATED	1.111	1.556	2.000
	DEFINITION	1.000	1.222	2.778
	STORY	1.444	2.111	2.556
DELAYED	UNRELATED	1.778	1.778	1.556
	DEFINITION	1.556	2.222	1.222
	STORY	1.556	2.111	3.000

*** The mean number of target words recalled for each counterbalancing list was 1.944, 1.778, and 1.704 for List A, List B, and List C, respectively.

Table 3 - 2.

An Analysis of Variance of the Number of Target Words Recalled : Experiment 3.

Source of Variance	Sum of Squares	df	F	p
Recall Interval (I)	0.747	1	0.255	---
List (L)	0.747	2	0.360	---
Interaction : I X L	4.456	2	0.760	---
Error(a)	35.185	12		
Number of Sentences(N)	12.926	2	4.962	$p < .05$
linear trend	12.675	1	9.732	$p < .01$
Interaction : N X I	5.197	2	1.995	---
: N X L	2.074	4	0.398	---
: N X I X L	0.987	4	0.189	---
Error(b)	31.259	24		
Types of Sentences (T)	10.259	2	5.978	$p < .01$
linear trend	8.898	1	10.370	$p < .01$
Interaction : T X I	0.457	2	0.266	---
: T X L	3.740	4	1.089	---
: T X I X L	4.061	4	1.183	---
Error(c)	20.592	24		
Interaction:N X T	6.259	4	1.927	---
linear trend	6.125	1	7.545	$p < .01$
Interaction:N X T X I	10.876	4	3.349	$p < .05$
:N X T X L	2.746	8	0.422	---
:N X T X I X L	9.382	8	1.445	---
Error(d)	38.963	48		

trend(F1,24)=10.370, p<.01). The amount of recall increased linearly as the encoding sentences had more coherence among themselves; recall was lowest(the mean number of recalled words was 4.889) with the lowest coherent UNRELATED sentences, slightly higher (the mean number of recalled words was 5.000) with the DEFINITION(intermediate coherence) sentences, and highest (the mean number of recalled words was 6.338) with STORY (highly coherent) sentences. The overall effect of the number of input sentences on amount recalled was significant (F(2,24)=4.962, p<.05); with the increase in the number of input sentences, recall of the target words increased in a linear fashion (F(1,24)=9.732, p<.01). Although the main interaction effect between the number of input sentences and the types of sentences was not significant, its linear trend was significant. (F(1,48)=7.54 , p<.01). As shown in Figure 3, the amount recalled in the STORY condition increased in a steep linear fashion with the increase in the number of input sentences, this increase was less steep in the DEFINITION sentences, and least steep in the UNRELATED sentences. The main effects of retention interval (F(1,12)=0.255, p>.10) and of lists(F(2,12)= 0.360, p>.10) were not significant; however, the retention interval , the number of input sentences, and the types of encoding sentences showed some interaction effect (F(4,48)=3.349, p<.05). Within the immediate recall

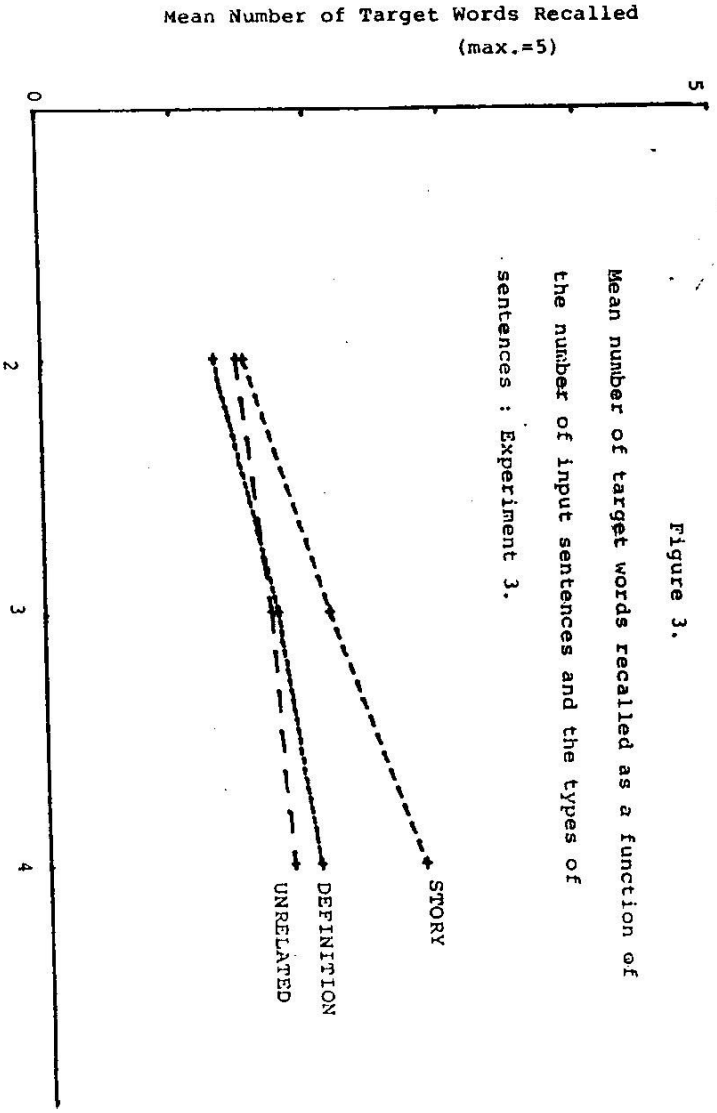

Figure 3.

Mean number of target words recalled as a function of the number of input sentences and the types of sentences : Experiment 3.

test, the amount recalled was a linearly increasing function of the number of input sentences for all types of encoding sentences. With the delayed recall test, the number of input sentences had a significant effect only in the STORY condition; in the DEFINITION condition and in the UNRELATED sentence condition the amount recalled was a negatively accelerated function of the number of input sentences. No other interaction effects were significant.

DISCUSSION

The significant linear trend in the interaction between the types of encoding sentences and the number of input sentences shows that the positive effect of the number of input sentences on recall is relatively small when there is not a clear coherence (integratedness) among the encoding sentences, whereas the number of input sentences has a strong effect on recall when there is a clear thematic coherence among the encoding sentences. This effect is particularly marked if recall is delayed somewhat(90 seconds), as opposed to immediate(10 seconds). These results suggest that recall is a function of the degree of integratedness or coherence among encodings as well as of the amount of activated information or number of encodings. It also suggests that simply increasing the number of input

sentences or increasing the amount of activated information would not produce a clear effect beyond a certain point, unless the encoding sentences could be integrated into coherent units. This probably explains why an increase in the number of input sentences from 3 to 4 in the Varied sentence condition of Experiment 2 failed to produce a strong effect on recall.

All these findings substantiate our assumption that we need integrative elaboration as well as spreading elaboration to ensure a better memory performance. Why, then, and how, does integrative processing produce better recall performance? The present experiment does not produce a definite explanation of why integrative elaboration in terms of thematic coherence produces better retrieval performance. Nevertheless, the results of this experiment suggest some possible explanations. One of the possible sources of the positive effect of thematic coherence could be attributed to the fact that the presence of thematic coherence makes it easier for the subjects to comprehend the input materials by allowing the subjects to utilize the same interpretation scheme repeatedly (Rumelhart,1977). This gives to subjects the advantage of concentrating their encoding time and efforts not so much on processing the literal meaning of the sentence as on activating additional

(mostly inferential) information. This would lead to a more elaborate trace or more full and detailed descriptions of the target encoding. On the other hand, the main source of the thematic coherence effect could be found in the fact that thematic or any other type of coherential processing coherence employs concepts of higher levels of abstraction. When the subjects are constructing a thematic coherence among the encoding sentences, they are building up some kind of semantic and pragmatic relation between the neighbouring sentences, and fitting them into the global structure of a theme. In other words, constructing a thematic coherence involves activating various levels of inferential information; these vary from the low level information of individual word concepts up to the higher level information of abstract relational concepts. This extra inferential information of lower and higher abstraction levels would add fuller and more specified descriptions (Norman & Bobrow,1979) to the target encodings. These fuller and more specified descriptions would in turn -- as in the case of spreading elaboration as discussed at the end of Experiment 2---make the target encodings more distinct. This availability of various levels of information and the distinctiveness brought by it would make the target encodings more discriminable and reconstructable at the time of recall. This could have produced the positive effect of

thematic coherence. This interpretation fits into Norman & Bobrow's 'levels of descriptions' view of memory, and Jacoby and Craik's(1979) view on elaboration and distinctiveness. Still, the present interpretation is very loosely conceived and speculative to a considerable degree; it needs further refinement and experimentation.

There is one drawback in applying the above interpretation to the results of this experiment and in citing the results of this experiment as solid evidence for the effect of coherence or integrative elaboration. It concerns the issue of an index of the degrees of thematic coherence. In this experiment we have used the STORY sentences, DEFINITION sentences, and UNRELATED sentences as 3 different levels of thematic coherence (or 3 levels of 'same themeness'). This distinction of 3 levels of thematic coherence was based more on the experimenter's intuitive conception of coherence than on any sound logical or experimental foundation. We might consider the STORY sentences and UNRELATED sentences as two extremes on the dimension of 'same-themeness' or thematic coherence, but it is not easy to say unambiguously that the defining descriptions of DEFINITION sentences occupy an intermediate position on the dimension of 'same-themeness' or 'thematic coherence.' This uncertainty concerning where DEFINITION sentences fit in the dimension of thematic coherence is

further reflected by the fact that the superiority of DEFINITION sentences over UNRELATED sentences in recall amount was statistically insignificant. It seems that the 3 different lists of thematic coherence reflect a presence or absence of thematic coherence rather than 3 different levels or degrees of thematic coherence or integratedness of encodings. This implies that three different degrees of thematic coherence reflected in the 'STORY', 'DEFINITION', and 'UNRELATED' sentences could reflect the presence or absence of a certain thematic (coherential) integrative processing; it should not, on the other hand, be considered as a good index of the degrees or levels of further integrative processing after a certain coherence has been established. We should try to find other possible variables that do indeed reflect the different degrees of integrative processing beyond the presence or absence of thematic coherence.

Some possible variables are suggested by Halliday & Hassan's work(1976) on cohesion. In their book on cohesion of texts, they present several sources and types of cohesion in text such as lexical cohesion, coreferential cohesion, and conjunctive cohesion. They argue that these types of sentence connections determine the cohesiveness or integratedness of information in a text. In the following

experiments, the possibility that these variables reflect the degrees of further integrative elaboration is investigated.

CHAPTER VIII

EXPERIMENT 4

Experiment 4 was conducted to investigate whether, once a certain degree of thematic coherence has been established, increasing the degree of connectiveness among the encoding sentences through repetition of some words would have any effect on the recall of target words.

The importance of repetition of words or arguments within a text in comprehending and remembering the text has been emphasized by several researchers. Manelis & Yekovich(1976) have suggested that "mere repetition of the arguments would increase the number of connections among the propositions, making the text more coherent and easier to process (p. 302)." Kintsch & van Dijk(1978) also state that "referential coherence corresponds to argument overlap among propositions... Referential coherence is probably the most important single criterion for the coherence of text base(p.6)." Thus we could assume that the number of argument overlaps, or the number of coreferential 'ties'(Halliday & Hassan,1976) could be a factor that determines the cohesiveness and connectiveness of the encodings once a certain degree of thematic coherence

has been established.

Most of the recent studies on this issue of coreference have been concentrated on the recall of propositions as a function of the number of argument overlaps(Manelis & Yekovich,1976), or on the recall of target words as a function of the number of times those target words were repeated across sentences (Kintsch et.al.,1975); they have not investigated the recall of some target words as a function of the repetition of non-target words, nor have they tried to incorporate referential coherence into the framework of depth of processing or elaborative processing. These two points were investigated in this experiment by varying the number of times certain non-target words were repeated across the encoding sentences.

Method

Subjects. The subjects were 15 Queen's University students taking an Introductory Psychology course.

Materials. From the story list of Experiment 3, 40 target words and their sentences were chosen as the materials of this experiment. Each set of 4 sentences of each target word were slightly modified so that the number of repeated items (coreferent ties) across 4 sentences is either 0, 1, 2, or 3. In the 0-coreferent tie condition, no

content words other than the target word recurred across 4 sentences (see Appendix II for an example); in the 1-coreferent tie condition, only one content word (other than the target word) recurred across 4 sentences; in the 2-coreferent condition, either a word recurred twice or two content words recurred once each across 4 sentences; and in the 3-coreferent condition, there were 3 recurrences of one or two words across 4 sentences(see Appendix I).

Procedure. The general procedures were the same as those in Experiment 3, except that only the story sentences were presented and all 4 sentences were presented in sequence. The presentation rate was 5 seconds per sentence. After the subjects had read 160 sentences (4 sentences x 40 target word stories), they were given a 5 minute free recall test of the target words.

Design. The experimental design was a within-subjects design. The number of repetitions of coreferent words was the only factor, with 4 levels;namely, 0, 1, 2, or or 3 coreferent ties.

Table 4.

An Analysis of Variance of the Number of Target Words Recalled as a Function of the Number of Coreferent ties : Experiment 4.

Source of Variance	Sum of Squares	df	F	p
Number of Coreferent Ties	39.25	3	8.14	$p < .01$
Error(a)	67.50	42		
linear	10.83	1	6.42	$p < .05$
error(a1)	23.62	14		
quadratic	22.82	1	17.33	$p < .01$
error(a2)	18.43	14		
cubic	5.60	1	3.08	$p > .05$
error(a3)	25.45	14		

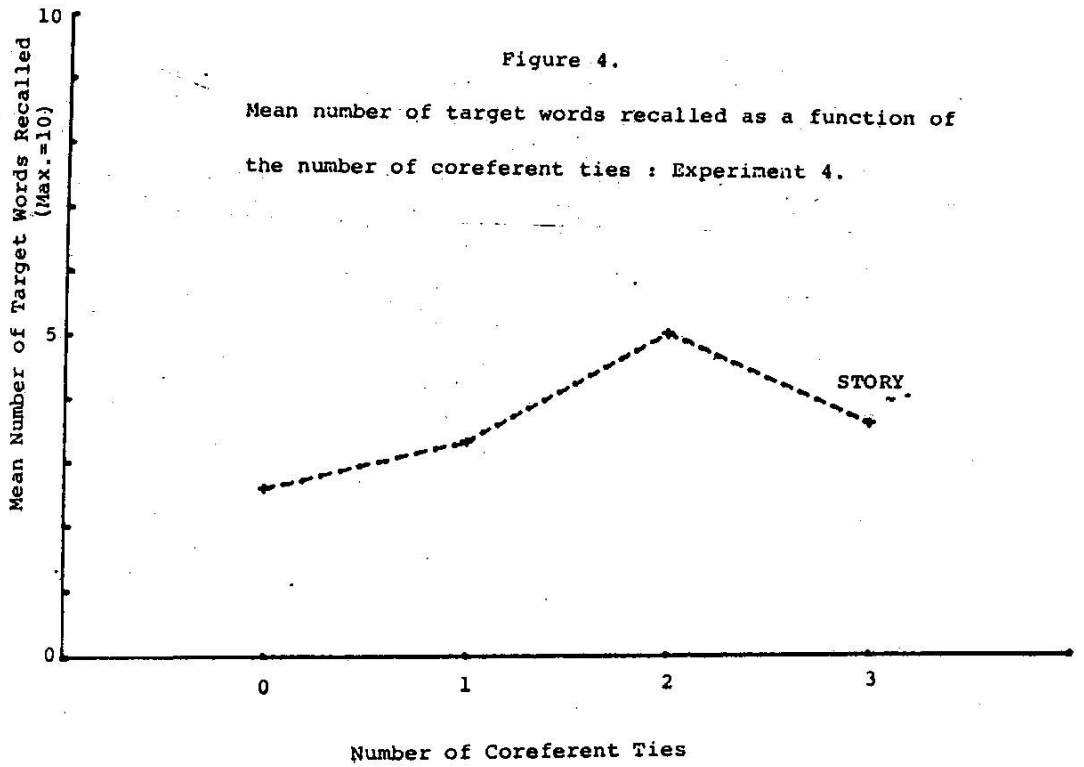

Figure 4.

Mean number of target words recalled as a function of the number of coreferent ties : Experiment 4.

Results

The mean number of recalled target words as a function of the number of coreferent ties is shown in Figure 4. An analysis of variance of these data is presented in Table 4. The analysis shows that the number of coreferent ties has a significant effect on the amount of recall of target words ($F(3,42)=8.14$, $p<.01$). A trend analysis of this effect indicates that this effect is mainly quadratic ($F(1,14)=17.33$, $p<.01$) and to some degree linear ($F(1,42)=6.42$, $p<.05$). As Figure 4 shows, the amount of recall increased linearly as the number of coreferent ties increase from 0 to 2, yet this linearity did not hold beyond the 2-coreferent tie condition. The significant quadratic trend ($F(1,14)=17.33$, $p<.01$) showed that with the 3 tie condition, recall amount decreased sharply from the level of 2-tie condition. A Newman-Keul's Q test showed this difference between the 3-coreferent condition and the 2-coreferent condition was significant ($Q(1,59)=4.281$, $p<.05$).

Discussion

In general the results showed that the amount of recall of target words is an increasing function of the number of coreferent ties across 4 encoding sentences. From the 0- coreferent condition to the 2-coreferent condition, the amount of recall increased steadily for each additional coreferent tie. Beyond the 2-coreferent condition, however, an additional tie did not increase the amount recalled. On the contrary, it decreased in the 3-coreferent condition. This result is quite contradictory to our assumption of a positive linear function between the number of coreferent ties and the amount of recall.

Then why did an increase in the number of coreferent ties fail to produce an increase in the amount recalled in the 3-coreferent tie condition? It might be argued that our assumption was wrong. Yet the clear presence of a monotically increasing function between the 0-coreferent condition and the 2-coreferent condition suggests an alternative possibility: that our assumption is correct but some uncontrolled variables could have caused the low level of recall in the 3- tie condition. One of the possible causes could be related to the imaginability of each story, but in constructing the stories, we tried to keep the general image evokability of each story fairly constant. As the sentences in the Appendix II show, there is no clear

difference in imaginability of each story across different coreferent condition. Another possible source of the low performance could be the number of non-coreferent (not-repeated) items in each story. In constructing the materials, we kept the total number of words in each story fairly constant while we systematically varied the number of coreferent items. This method of construction naturally led to an inequality in the number of non-repeated items across different coreferent conditions. This could have caused the low performance in the 3-coreferent condition, since this condition has the smallest number of non-coreferent items.

This possibility will be investigated in the next experiment.

CHAPTER IX

EXPERIMENT 5

Experiment 5 was conducted to investigate whether the low recall under the 3-coreferent condition was due to the inequality of the number of non-repeated(non-coreferent) items in the 3-tie condition as compared with the other tie conditions. In constructing the materials of Experiment 4, the mean number of words per story was kept constant, while the number of coreferent words was varied; therefore, the mean number of different words across 4 sentences of each story was greater for the 0-, 1-, and 2- coreferent conditions than for the 3-coreferent condition where more than 3 words were the repeated (coreferent) words. In that experiment the mean number of non-repeated words was 9.6, 9.3, 9.0, and 8.0 for the 0-, 1-, 2-, and 3- coreferent conditions respectively. We could argue that this imbalance in the number of different arguments (non-repeated words) in the 3-coreferent condition, as compared with the other conditions, might have caused the low recall in the 3-coreferent condition of Experiment 4. Experiment 5 investigated this possibility.

Method

Subjects. Twelve Introductory Psychology students at Queen's University served as the subjects.

Materials. The sentence materials of Experiment 4 were slightly lengthened so that the mean numbers of non-repeated (non-coreferent) words were balanced for 4 different coreferent tie conditions. The mean number of non-repeated content words was 9.9 , 9.5, 9.5, and 9.85 for the 0-, 1-, 2-, and 3-coreferent conditions respectively.

Procedure. The procedure was identical to that of Experiment 4.

Design and Analysis. The analysis of the correctly recalled target words was done by collapsing the data of this experiment and the data of Experiment 4. The data of the 3 subjects who served first in that experiment were excluded from the present analysis, thus equalizing the number of subjects in the two experiments. Thus, the design was a 4X2 factorial design: the number of coreferent ties was a within-subjects factor with 4 levels (0, 1, 2, and 3 coreferent ties); and the number of non-repeated words across different coreferent conditions was a

between-subjects factor with 2 levels (equalized (Experiment 5) vs. unequalized (Experiment 4)).

Results

Figure 5 shows the mean number of recalled target words for the equalized and unequalized conditions. An analysis of variance of the data is given in Table 5. The analysis indicates that the variable of the number of non-coreferent (non-repeated) items had no effect on recall ($F(1,22)=2.80$, $p>.05$). The number of non-repeated items did not raise the amount recalled in the 3-coreferent condition. The effect of the number of coreferent ties, on the other hand, showed ---as it did in Experiment 4---a significant quadratic function ($F(1,66)=26.49$, $p<.001$). After a steady linear increase in the amount recalled as the number of coreferent ties increased across conditions, there was a sharp drop in the 3 coreferent condition. However, this drop signifies not necessarily a continuous function, but the addition of some new factor peculiar to that condition. What this factor might be is discussed below. An additional analysis showed that there was no significant effect of whether the repetition of words across sentences was of one single word, or two or three different words ($F(1,9)=2.94$, $p>.05$).

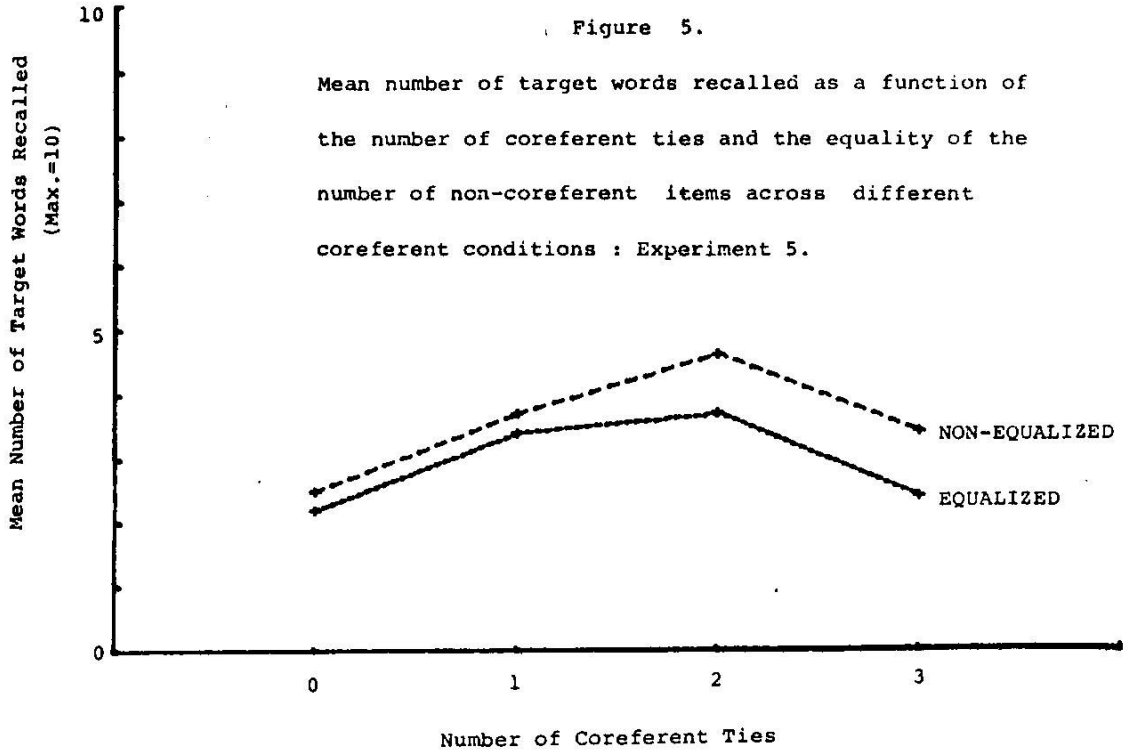

Figure 5.

Mean number of target words recalled as a function of the number of coreferent ties and the equality of the number of non-coreferent items across different coreferent conditions : Experiment 5.

Table 5.

An Analysis of Variance of the Number of Recalled Target Words as a Function of the Number of Coreferent Ties and the Numerical Equality of the Non-Coreferent Items : Experiment 5.

Source of Variance	Sum of Squares	df	F	p
Number of Coreferent Ties (R)	44.11	3	10.74	$p < .001$
linear	7.25	1	5.30	$p < .05$
quadratic	36.26	1	26.49	$p < .001$
cubic	0.60	1	0.44	---
Error(a)	90.35	66		
Numerical Equality of the Non-Coreferent Items (N)	5.51	1	2.80	---
Error(b)	43.23	22		
Interaction : R X N	4.28	3	1.04	---
linear	2.00	1	1.46	---
quadratic	0.01	1	0.01	---
cubic	2.27	1 1.	1.66	---

Discussion

From the above results we can infer that the number of non-repeated items has no clear effect on recall, and that the low performance under the 3-coreferent condition in Experiment 4 can not be attributed to the smaller number of non-coreferent items involved in that experiment. It implies, in fact, that when the total number of words is relatively fixed, and once a certain number of coreferent ties have been established across sentences, then a small difference in the number of non-coreferent items has no sizable differential effect on recall.

This conclusion leaves us with two alternative variables as the possible sources of the low performance in the 3-coreferent condition: the mean number of propositions by which each story is represented, and the types of conjunctions across the encoding sentences. To investigate the possibility that the low recall in the 3-coreferent condition might have been caused by a difference in the mean number of propositions per target story for the 3-coreferent condition as compared with other coreferent conditions, all the story sentences in the stimulus list of this experiment were analyzed and the mean number of explicit propositions

inherent in the text base structure was counted. The counting followed Kintsch's(1974) method of propositional analysis of text. The result showed that there was no clear difference in the number of propositions across the 4 different coreferent conditions; the mean number of explicit propositions was 7.9, 6.9, 8.1, and 8.9 for the 0-, 1-, 2-, and 3-coreferent conditions respectively. When the effect of the number of coreferent items was partialled out, the correlation between the number of target words recalled and the number of mean propositions was insignificant (r=-0.0163, $t(37)$= -0.093, p>.10). Therefore, the number of propositions in the text base of each set of 4 story-sentences could not be considered to be the major variable that brought about the difference between the 2- and 3- coreferent conditions in Experiments 4 and 5. Nevertheless, it is still possible that because of some other kinds of text structural variable, subjects somehow remembered the stories in the 3-coreferent condition in fewer propositions than the stories in the conditions involving fewer ties (especially in the 2-coreferent condition). This possibility is investigated in Experiment 6.

CHAPTER X

EXPERIMENT 6

Experiment 6 was conducted to investigate whether subjects somehow retained the stories of the 3-coreferent condition in a smaller number of propositions than was the case for the other coreferent conditions. In spite of the absence of any significant correlation between the number of explicit propositions in the text base and the number of recalled target words, it is still possible that due to some uncontrolled text structural variables subjects somehow retained the stories of the 3-coreferent condition in a relatively small number of propositions, and that this could have caused the low recall of the 3-coreferent condition in Experiments 4 and 5. This possibility is investigated in the present Experiment by giving a cued recall test of the stories, and by analyzing the recalled story protocols in terms of the number of verb propositions produced. The reason why the number of verb propositions were chosen instead of all types of propositions ('propositions' in Kintsch's (1974) term) were as follows; first, in constructing the materials the number of other types of propositions (propositions with noun predicates ---e.g., "strange sound"---, propositions with adjective

predicates---e.g., "highly strange"---,or locative-temporal propositions---e.g., "in the house", "in the morning") were not exactly controlled across different stories while the number of verb propositions---e.g., "bubbles fly"--- was kept relatively constant. Second, a pilot analysis done on the recall protocols of some subjects showed that a large number of 'omission', 'overgeneralization', and 'pseudo - discriminations' (Frederiksen,1975) were present with non-verb types of propostitions.

Method

Subjects. The subjects were 10 Queens' University students in the Introductory Psychology class. They were tested individually.

Materials. The materials of Experiment 5 were used again.

Procedure. The procedure was identical to that of Experiment 5, except that the recall test was a cued recall of story sentences in stead of the free recall of target words. Subjects were given 40 target words as the recall cues on response sheets, randomly ordered, and they were asked to recall the story sentences for each target word.

They were instructed that they could recall and write down the story sentences in their own words, paraphrased, if they were unable to remember the exact wordings. Their recall protocols were analyzed in terms of the number of verb propositions employed in recalling each story.

Design. The experimental design was a within-subjects design with one within-subjects factor. The factor was the number of coreferent ties:there were 4 levels (0, 1, 2, and 3 coreferent ties).

Results

The mean number of verb-propositions per recalled target story as a function of the number of coreferent ties is shown in Figure 6. An analysis of variance of the data revealed (Table 6) that the mean number of recalled verb propositions per story is---despite the appearance of the graph---a linearly increasing function of the number of coreferent ties upto the 2-coreferent tie condition; in the 3-coreferent tie condition, however, the mean number of recalled verb propositions decreased as compared with that associated with the coreferent condition.

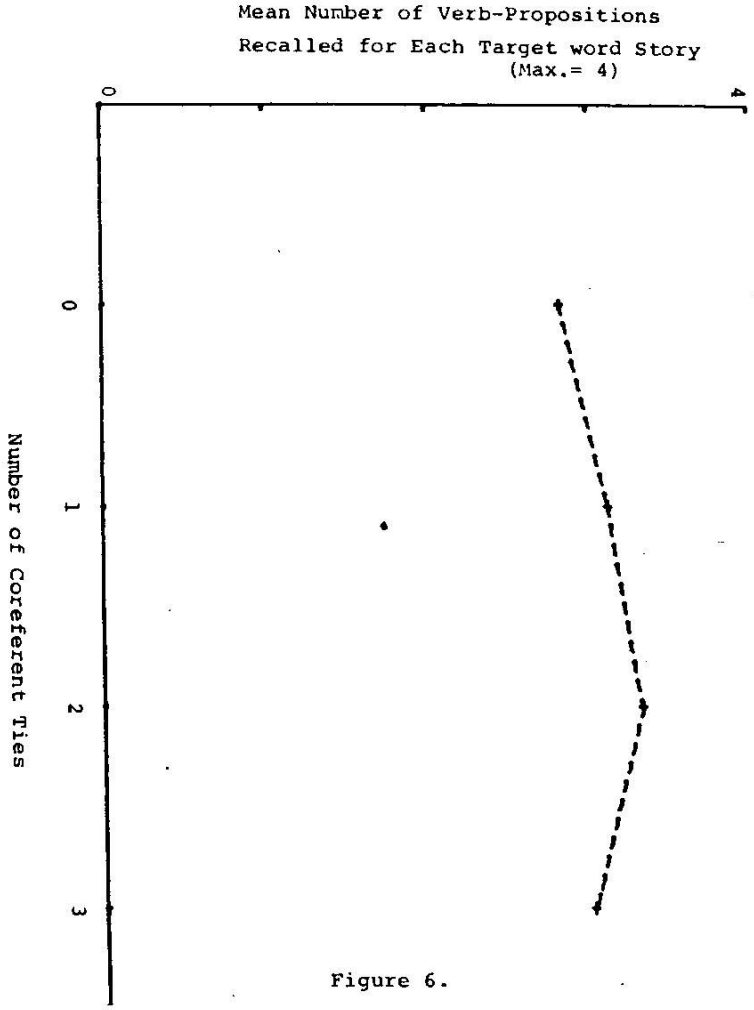

Figure 6.

Mean number of verb-propositions recalled for each target word story as a function of the number of coreferent ties : Experiment 6.

Table 6.

An Analysis of Variance of the Number of Verb - Propositions in Each Story Recalled in Experiment 6.

Source of Variance	Sum of Squares	df	F	p
Number of Coreferent Ties	1.40	3	3.58	$p < .05$
Error(a)	3.51	27		
linear	0.31	1	2.25	---
error(a1)	1.24	9		
quadratic	1.02	1	9.78	$p < .05$
error(a2)	0.94	9		
cubic	0.06	1	0.43	---
error(a3)	1.34	9		

Discussion

The above results have shown that stories with a greater number of coreferential ties were recalled by means of a larger number of verb propositions for conditions involving 2 or fewer coreferent ties; stories with 3-coreferent ties, on the other hand, were recalled in fewer verb propositions than were the stories with 2-coreferent ties. We can easily attribute the source of the linearly increasing trend upto 2-coreferent condition to the different number of coreferent ties. The availability of more coreferent items in the stories somehow led the subjects to retain the stories by means of a greater number of propositions, which in turn could have led to a higher recall of target words embedded in the stories with more coreferent ties in Experiments 4 and 5. For the possible sources of the low recall in the 3-coreferent condition, we have already shown in previous experiments that we can attribute the low performance neither to the number of coreferent ties, nor to the mean number of non-coreferent items, nor to the mean number of explicit propositions in the text base. The findings of this experiment suggest that the low recall of the target words of the 3-coreferent condition in previous experiments could possibly be due to the fact that the stories of the 3 coreferent condition were somehow retained or made retrievable, in fewer verb

propositions than were the stories of the 2-coreferent condition. This interpretation, however, has not pointed out the real source of the low performance; it leaves us with the question of why the 3-coreferent stories were stored or retrieved in fewer verb propostitions in spite of the facts that they had more coreferent ties and that the mean number of propositions in the text base was not smaller than that of the 2-coreferent stories. We might find an answer to this question in the analysis of the stories in terms of the types of conjunctions across the 4 sentences of each story. A cursory examination of the stimulus sentences of the 2-coreferent condition and of the 3-coreferent condition showed that the connections across the 4 sentences of the 2-coreferent stories were often 'cause-effect' or 'cause-consequence' types of connections, whereas the connections in the 3-coreferent stories were often 'additive' or simple 'and-then' types of connections. When the recall protocols of each subject were analyzed in terms of omitted sentences, it was found that sentences that were connected to other sentences by 'non-causal' or 'additive' types of conjunctions were omitted more often than were sentences connected to others by causal conjunctions. A precise analysis of the types of sentence connections of each story, using Halliday and Hassan's(1976) classification scheme of 'types of conjunctions', revealed

that there was a clear difference in 'types of sentence connections' between the 2-coreferent story sentences and the 3-coreferent stories. In the 2-coreferent story sentences, 26.7 % of connections were of ADDITIVE connections (sentences that can be connected by additive conjunctions; such as 'and', 'or', 'and then', 'furthermore', etc.), while 73.3 % of connections were CAUSAL connections (sentences that can be connected by causal conjuntions ;such as 'so', 'because', for', ' as a result', 'in consequence', etc.) or ADVERSATIVE connections (sentences that can be connected by adversative conjunctions; such as 'yet', 'though', 'but', 'however', 'instead', 'nevertheless', etc.). In the 3-coreferent story sentences, on the other hand, ADDITIVE connections formed 46.7 % of the total connections, while CAUSATIVE connections consisted only 53.3 %. The result of this analysis suggests that we could possibly narrow down the source of the low recall performance in the 3-coreferent condition to the relative lack of CAUSAL-ADVERSATIVE connections in the 3-coreferent stories. This possibility is tested in the next two experiments; the effect of CAUSAL connections will be investigated in Experiment 7, and the effect of ADVERSATIVE connections will be investigated in Experiment 8.