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It has often been noted by empirical studies that our immediate recall of a sentence is somewhat accurate, or *verbatim*, but that the exact wording is forgotten soon and only semantic information is retained. Why is this the case? The usual answer to this question is that verbatim information is stored in short-term memory but is later forgotten after the meaning of the sentence is decoded and stored in long-term memory (e.g., Anderson & Paulson, 1977; Bransford & Franks, 1971; Sachs, 1967, 1974; see von Eckardt & Potter, 1985, for a review). One of the best known studies that tried to explore this forgetting process is Sachs (1967). In this study, she investigated the retention of syntactic and semantic information shortly after auditory comprehension of connected discourse. Ninety-six subjects listened to twenty-four paragraph-length passages, each of which contained a target sentence. The subjects then heard a recognition test sentence which was either identical to the target sentence or slightly changed. The subjects responded by deciding whether the test sentence was "identical" or "changed," and then rated their confidence in their judgment on a 5-point scale. Two independent variables were manipulated: (a) the relationship between the target sentence in the passage and the test sentence (identical, semantic change, passive/active change, and formal change), and (b) the amount of interpolated material (IM) between the target and test sentences (0, 80, and 160 interpolated syllables).

Figure 1 shows the percentage of correct judgments for each test type. The subjects recognized any change very accurately immediately after hearing the target sentence (IM-0). On the other hand, when the IM was increased (IMs-80 & 160), the subjects became less able to recognize identical sentences as well as passive/active and formal changes. Only semantic changes from the target sentences were easily detected after relatively longer intervals. She interpreted these results as follows:

> The results suggest that the original form of the sentence is stored only for the short time necessary for comprehension to occur. When a semantic interpretation has been made,

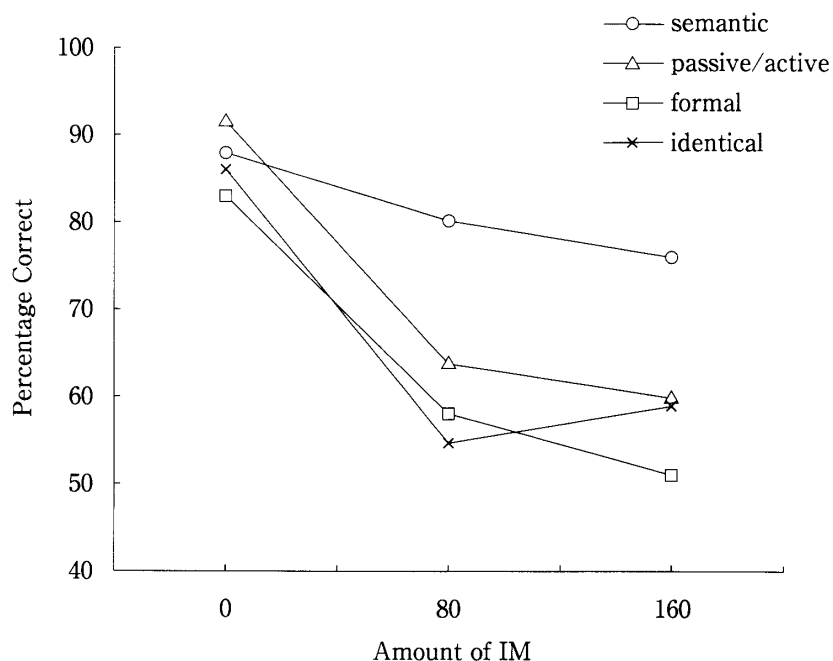the meaning is stored. (Sachs, 1967, p.437)

Figure 1. Percentage of judgments *identi*cal and *changed* that were correct for each test type (from Sachs, 1967, p.441)

An expanded replication of this study was conducted several years later by Sachs herself (Sachs, 1974). Major changes from the original study (Sachs, 1967) are listed below:

1. Visual presentation was added to the auditory presentation to broaden the generalizability of the earlier study.
2. Another test condition, i.e., lexical change, was added.
3. The intervals between original sentence and the test sentence were different (IMs-0, 80, & 160 in Sachs, 1967; IMs-0, 20, 40, & 80 in Sachs, 1974).

The results of this experiment are shown in Figure 2. Sachs concluded that the results confirmed her earlier study (p. 98). However, two points attract our attention here, especially concerning the visual condition. First, the retention of passive/active changes was significant in the visual mode even after a certain number of interpolated syllables. Sachs offered two possible interpretations regarding this conflict: (a) a change in voice can be viewed as a change in focus or emphasis, which makes it easier to identify the change; and (b) the degree of spatial reorganization of a sentence can be an important variable in the visual mode (p. 99).
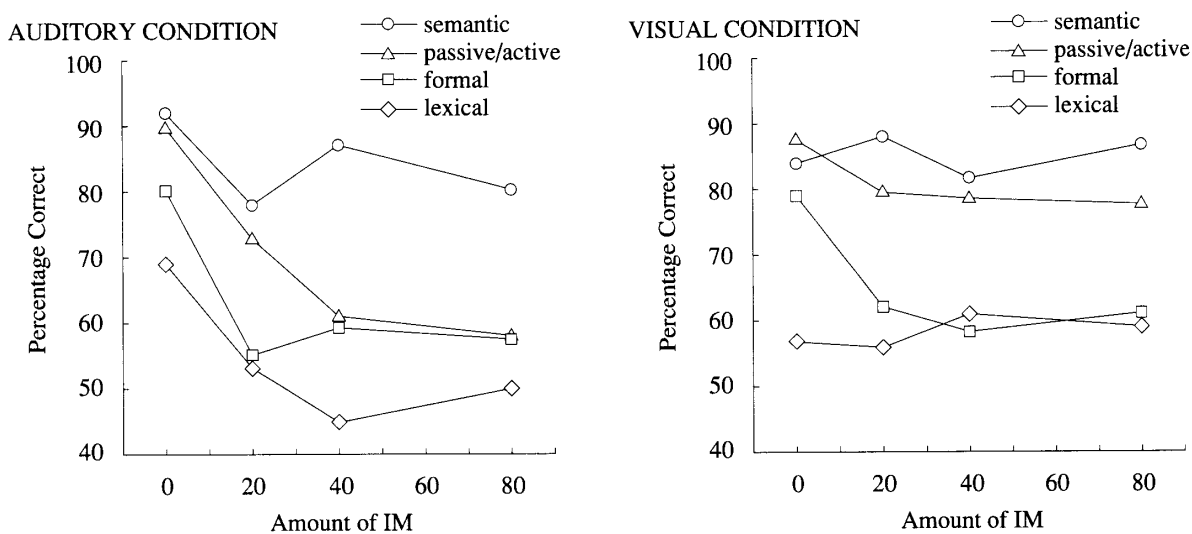
Figure 2. Accuracy in judging changes for each test type (from Sachs, 1974, p.97)[1]

Furthermore, Figure 2 shows us, though not statistically so, that the subjects were less able to recognize lexical changes even immediately after the target sentence (IM-0), especially in the visual mode. This seems to need an explanation, and I will discuss it below with reference to studies by Potter and others (Potter, 1993; Potter & Lombardi, 1990; von Eckardt & Potter, 1985).

Potter rejected the hypothesis by Sachs and many others who claim the dominance of verbatim information in short-term memory. In contrast, she proposed an alternative hypothesis that verbatim information is forgotten immediately after processing a sentence; higher accuracy of verbatim recall is due to the fact that the semantic representations of recently used lexical items are still active.

To test this claim, Potter and her colleagues conducted experiments on sentence processing and recall. In von Eckardt and Potter (1985), for example, twenty-four compound sentences were created as test sentences. The order of the two clauses in each sentence is interchangeable without a noticeable difference in meaning. Each sentence contains one target word, e.g., "The *carrot* was badly overcooked, and the stew had too much pepper in it." Forty subjects heard these test sentences, saw a probe which was either a drawing or a written word, and then judged if the probe was in the test sentences. Von Eckardt and Potter claim that if the hypothesis by Sachs and others is true, the response time would be shorter to written probes than drawings.

The result supported their claim: there was no significant difference in response time to written probes and pictures. They conclude that "immediate memory for a sentence is based primarily on a semantic representation, one that is stronger for the more recent of two

clauses" (p. 375). They obtained similar results with spoken probes and pictures.

These results and their claims may explain the relatively unclear results for lexical changes in Sachs (1974). Von Eckardt and Potter further claim that the results indicate that even short-term memory, as opposed to long-term memory, is semantically oriented rather than structurally oriented. However, what they proved can apply only to the lexical level of representation. In other words, they did not provide counter-evidence for short-term retention of formal information of a sentence, i.e., Sachs' subjects' high accuracy of formal changes and loss after a certain amount of intervening material. I will discuss this issue in more detail below by looking closely at these two studies.

Before discussing the differences between the two studies above, it will be of some use to describe the process of sentence decoding. If a sentence is spoken, the first step is to hear a stream of sound. The sound stream is then decoded into a chain of words. (These processes are not relevant to the visual, or written, mode.) These words are analyzed into phrases, and finally, a sentence. The meaning of the whole sentence is finally understood and then stored in the long-term memory.

If this process is true, it can be hypothesized that lexical information can be converted into semantic information before understanding the whole meaning of a sentence, since we recognize each word before we analyze the syntactic structure of that sentence.
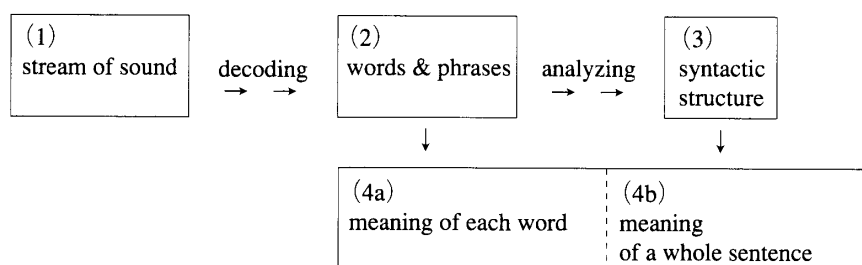

Figure 3. A proposed sentence processing model

It will be helpful to make use of this figure to differentiate claims by Sachs from those by Potter. Both can be regarded as the same in that they basically dichotomize form and meaning of a sentence. What is different is that von Eckardt and Potter explored two variables, i.e., the lexicon and the meaning of words (2 & 4a in Fig. 3), while Sachs looked into the lexicon, structure, and meaning. A conflict arose between these two studies because of the confusion of the term "meaning." By referring to Figure 3, it is clear that von Eckardt and Potter (1985) only considered the meaning of individual words (4a), while Sachs mingled together both meaning of words and that of a whole sentence (4a & 4b). The recognition of

the meaning of individual words (4a) and the meaning of a sentence (4b) may or may not be interrelated, but it should be noted that the meaning of lexicon may be decoded before the meaning of the whole sentence is understood. This will be more obvious in the visual mode since word boundaries are already indicated as spaces in written text.

These hypothesized processes match the inconsistencies in the reviewed studies well. For example, the relatively lower accuracy of recognition of lexical changes in the visual mode shown in Sachs (1974) can be explained clearly: meanings of words are decoded earlier than the meaning of the whole sentence. Therefore, the information of each word can be turned into more abstract semantic information before the meaning of a whole sentence is decoded.

The purpose of this study is to reexamine the recognition memory for sentence processing considering the above discussion. This will be achieved by conducting a partial replication of Sachs (1974).

METHOD

Subjects

The subjects were twelve native speakers of American English. All of them were graduate students in linguistics or applied linguistics at the time of the experiment.

Materials

The same passages and test sentences as Sachs (1967; 1974) were used in this study[2]. Out of 24 paragraph-length passages from the original study, fifteen were selected. Three of them were used as warm-up passages, and the other 12 were used for data collection. Each passage contains a set of related sentences. Each set consists of (a) the base sentence, (b) semantically changed sentence, (c) formally changed sentence, and (d) lexically changed sentence. Passive/active change was not used in this study because this change may bring unexpected variables, as discussed before. A sample set of related sentences is shown below:

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BASE:      THE FOUNDING FATHERS CONSIDERED OWNING SLAVES TO BE IMMORAL.
SEMANTIC:  THE FOUNDING FATHERS CONSIDERED OWNING SLAVES TO BE MORAL.
FORMAL:    THE FOUNDING FATHERS CONSIDERED OWNING SLAVES IMMORAL.
LEXICAL:   THE FOUNDING FATHERS THOUGHT OWNING SLAVES TO BE IMMORAL.
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Two aspects of the passage and test sentence were varied systematically as independent

variables: (a) the amount of interpolated material between the original and test sentence, and (b) the relationship between original and test sentence.

Amount of Interpolated Material. Three amounts of interpolated material (IM) were tested in Sachs (1967), i.e., zero syllables, 80 syllables, and 160 syllables. In Sachs (1974), there were four (0, 20, 40, and 80 syllables). This study set the following three amounts of IM: 0, 20, and 40 syllables. This is due to the fact that no dramatic changes were found after IM-40 in Sachs (1974).

At one of these levels of IM, the passage is interrupted with ellipsis marks and the subjects turn the page to see the test sentence. They are asked whether the test sentence is identical to the original sentence, or it has been changed.

Relationship Between the Original and Test Sentences. The test sentence was either identical to the original, or changed from it. Three types of changes were employed in this study. In semantic change, the meaning of the base sentence was altered by changing the subject and object in the sentence, by negation, etc. Formal change was carried out by changing structure, such as dative alternation, without changing its meaning. To create lexical changes, synonyms of lexical items in the original sentences were prepared and substituted. For more detail, refer to Sachs (1967, pp. 438-439) and/or Sachs (1974, pp. 95-96). This study followed the descriptions in these two studies.

Design and Hypotheses

There were twelve possible conditions (4 types of related sentences x 3 different IMs). After three trial passages, each subject read twelve passages, each of which contained one of the twelve conditions. Twelve subjects times twelve conditions completed a factorial design of 144 (12 x 12).

Three hypotheses were made concerning each type of change (semantic, formal, and lexical).

Hypothesis 1 (semantic change). Correct detection of semantic changes will be better than chance under all three different amounts of IMs. This hypothesis is consistent with Sachs (1967; 1974), which has already been discussed in the previous section.

Hypothesis 2 (formal change). The subjects will recognize formal changes at a better-

than-chance level at IM-0. The rate of correct detection, however, will decrease as the amount of IM increases. This hypothesis implies that verbatim information of a sentence is stored for a very short time necessary to decode the meaning of the sentence. After the meaning is understood and turned into semantic representation, the verbatim information will be forgotten.

Hypothesis 3 (lexical change). The subjects will not detect lexical changes better than chance throughout the three different amounts of IMs. This hypothesis is derived from the assumption that the decoding of words precedes the processing of a whole sentence. In other words, lexical information will be turned into semantic information even before the subjects finish reading the whole sentence, and therefore those changes in the test sentences cannot be easily recognized even right after the target sentence is read.

Procedures

One to four subjects were tested at a time in a 20-minute session. The subjects read three warm-up and 12 experimental passages. During the warm-up, the subjects were encouraged to ask the tester any question regarding the procedure. The materials were stapled, one passage per page, and as soon as the subjects came to the end of the passage they turned the page and read the test sentence. Responses were "identical" or "changed." The subjects were told not to reread the passage, and were encouraged to read at a normal speed rather than memorize it. Here is the instruction printed on the first page of the test form:

The purpose of this experiment is to find out how well people can remember what they have just read.

In this experiment you will read a series of short passages — some folk tales, history, biography, and so on — but each passage will be interrupted. When you reach the interrupted part of the passage, please turn the page. You will find a sentence from somewhere in the passage. Sometimes it will be repeated with exactly the same words as you read in the original. But sometimes it will be changed in some small way.

If the words are just as they were in the original sentence in the passage, mark *identical*. If there is any change at all, you will mark *changed*.

RESULTS

Table 1 and Figure 5 show the results for each type of change at the three levels of

interpolated material. Chi-square tests revealed that the subjects recognized semantic changes better than chance at IM-0 (χ^2 (1)=5.334, p<.05), and at IM-20 (χ^2 (1)=12.000, p<.001). Also, a slight tendency was found toward correct detection at IM-40 (χ^2 (1)=3.000, p<.10). These results are consistent with Hypothesis 1.

Table 1. Number of correct judgments for each test type

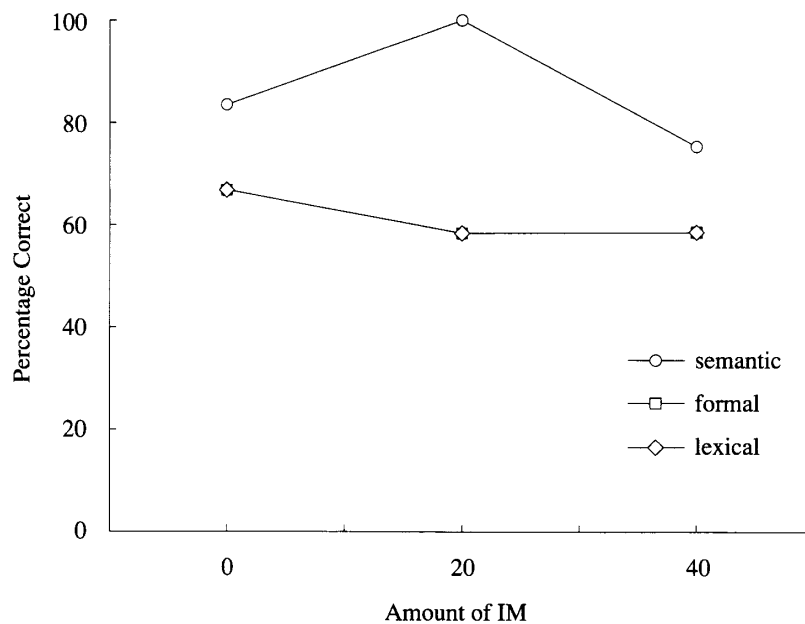|	Amount of Interpolated Material		
	0	20	40
Semantic change	10 *	12 ***	9 +
Formal change	8 ns	7 ns	7 ns
Lexical change	8 ns	7 ns	7 ns

+p<.10 *p<.05 ***p<.001

Figure 4. Percentage of correct judgments for each test type

With regard to the lexical change, no statistically significant tendencies were found. Thus Hypothesis 3 was supported. I restate it here: The subjects will not detect lexical changes better than chance throughout the three different amounts of IMs.

However, the results for the formal change were not consistent with Hypothesis 2, which predicted verbatim information to be stored first and then later forgotten. This needs further discussion.

DISCUSSION

In this section I will discuss the results of formal change, which conflicts with my

assumption. In the first place, it is important to note that the small number of subjects, twelve, makes it difficult to show any clear tendency. Setting this aside, the results can be interpreted in two different ways.

No verbatim information is stored even right after recognition. The result of this study is in a sense consistent with the claim by Potter and others (Potter, 1993; Potter & Lombardi, 1990; von Eckardt & Potter, 1985). Although they only found evidence for this claim at a lexical level, with no support for the formal, or syntactic level of representation, Potter and Lombardi (1990) conclude that:

> ... immediate recall of a sentence is not based on a surface representation in the usual sense, but — like longer-term recall — is based on a representation of the meaning of the sentence... (p. 634)

The similar pattern of formal changes to lexical changes in the present study can be regarded as evidence for their claim, thus as counter-evidence for Sachs, at the formal level of representation too. However, this is not likely the case because the opposite results were found more than once in Sachs (1967; 1974), which used the same passages and test sentences.

Verbatim information was forgotten before the subjects turned the page. At IM-0, ideally, the subjects are to encounter the test sentence with no interval. However, even though I did not measure, it took a few seconds to perhaps five seconds, for them to actually turn the page. It is probable that the verbatim information was once stored in the short-term memory and then already forgotten during this short period of time. The verbatim representation may have existed indeed, but was not detected in this experiment. To solve this problem, computer programs, such as PsyScope, will be helpful.

CONCLUSION

This study has shown that semantic information and verbatim information of a sentence are stored in different ways. Whereas semantic representation is kept in longer-term memory, the exact lexical and syntactic information is forgotten soon after the recognition of the meaning is completed. Further study with a larger number of subjects and a more precise design will make the process clear in more detail.

ACKNOWLEDGMENTS

NOTES

1. The data, originally presented as a table in Sachs (1974), was shown in figures for the ease of comparison. (p. 3)
2. The passages were obtained from Sachs (1966). It should be noted that out of three different types of test sentences, lexical changes were created by the researcher because they were not available (p. 7).

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APPENDIX

A Sample Passage and Related Test Sentences

Passage:

When Heinrich Schliemann was a little boy his father told him the story of Troy. He liked that story better than anything he had ever heard, and made up his mind that as soon as he could, he would travel to Greece and find Troy. As a matter of fact, when he grew up he did manage to gather a fortune in a short time and equipped an expedition to the northwest corner of Asia Minor. There was a mound that according to tradition had been the home of Prianus, the King of Troy. Schliemann, whose enthusiasm was somewhat greater than his knowledge, wasted no time in preliminary explorations, but began at once to dig. Then something curious happened. Instead of finding polished tools and crude pottery, he found statuettes and jewelry. He had dug with such haste and zeal that his trench went straight through the heart of the city for which he was looking and carried him to ruins of another buried town which was at least a thousand years older than the Troy of which Homer had written. He suggested that the coast of the Aegean had been inhabited by another race of men, fully ten centuries before the Great Trojan War. The wild Greek tribes had invaded this country and the two had intermingled. This proved to be the case. In the late seventies of the last century, Schliemann visited the ruins of Mycenae, ruins which were so old that Roman guide-books marveled at their antiquity.

Test Sentences:

Base.	Instead of finding polished tools and crude pottery, he found statuettes and jewelry.
Semantic change.	Instead of finding statuettes and jewelry, he found polished tools and crude pottery.
Formal change.	He found statuettes and jewelry instead of polished tools and crude pottery.
Lexical change.	Instead of finding polished tools and rough pottery, he found statuettes and jewelry.