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### Linguistic Context and the Priming of Semantic Information

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# LINGUISTIC CONTEXT AND THE PRIMING OF SEMANTIC INFORMATION

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Two experiments were carried out to demonstrate that linguistic context (in the form of a sentence) influences the interpretation of unambiguous words. Experiment I established that subjects read a sentence which primes a particular aspect of the meaning of one of the words it contains faster than they read a sentence which primes no particular aspect of the word's meaning. It also showed that subjects produce semantic characteristics of the word faster following the priming sentence than following the sentence that primes no particular semantic component. Experiment II corroborated these results using a task in which subjects read a sentence and then answered a question about the meaning of a word that occurred in it. Given a particular question, responses were faster when it followed a sentence that primed a characteristic relevant to the question than when it followed a sentence that primed no particular characteristic of the word. Responses were reliably slowest when the question followed a sentence that primed a characteristic that was not relevant to the question. Semantic priming is known to affect the identification of words and their disambiguation; the present study confirms that it also affects the specific interpretation of words.

## Introduction

The mental lexicon is implicated in at least two aspects of comprehension: the identification of a word, and the selection of the appropriate sense of an ambiguous word. The stream of speech sounds (or letters) has to be segmented and words recognized within it; words with more than one meaning must be disambiguated according to their context. The process of identifying a word has been shown to be susceptible to semantic factors: it is easier to decide that a string of letters is a word (the so-called "lexical decision" task) if it has been preceded by a semantically related word (Meyer and Schvaneveldt, 1971; Fischler, 1977). The same effect occurs when the task is to name the word (Meyer, Schvaneveldt, and Ruddy, 1975). This *semantic priming* can be created either by a single word or a sentence (Schubert and Eimas, 1977; Tweedy, Lapinsky and Schvaneveldt, 1977; Fischler and Bloom, 1979). It can also facilitate the recognition of a target phoneme in a sentence by making it easier to identify the word preceding the one bearing the target (Blank and Foss, 1978).

Although ambiguous words are seldom noticed as such—unless the sentence is

ambiguous as a whole—they do appear to take longer to process (Foss, 1970; Garrett, 1970; Foss and Jenkins, 1973; Cutler and Foss, 1974). On balance, the evidence suggests that all the different senses of an ambiguous word are accessed during comprehension (Conrad, 1974; Holmes, Arwas and Garrett, 1977; Cairns and Kamerman, 1975), though it has sometimes been claimed that linguistic context may prime a word in such a way that only the appropriate reading is accessed (Swinney and Hakes, 1976, but cf. Swinney, 1979). Certainly, one is normally consciously aware of only the relevant sense of the word. Indeed, Neely (1977) has suggested that semantic priming works in two distinct ways, depending on whether or not the priming material enters consciousness. When it does, then priming acts as a slow and capacity-limited mechanism, which can either facilitate or inhibit a subsequent response. When the priming material does not enter consciousness, however, it exerts an automatic and strategy-free effect, which can only facilitate responses. The distinction between the two sorts of priming is accordingly able to resolve some of the apparently conflicting results on both identification (see Swinney, Onifer, Prather and Hirshkowitz, 1979) and disambiguation (see Yates, 1978).

Semantic priming evidently has important effects on both the identification and disambiguation of words. It may also affect a third aspect of comprehension: the specific interpretation of unambiguous words. It seems unlikely that understanding a sentence calls for all that one knows about the meanings of the words in it. Different aspects of a word do indeed seem to become relevant as its context is varied (Johnson-Laird 1975; Hodgkin, 1977). Thus, the following two sentences bring to mind rather different aspects of apples:

He ate an apple (apples are consumable).

The apple ripened (apples are fruits).

Such differences presumably underlie the effects of “encoding specificity” demonstrated by Barclay, Bransford, Franks, McCarrell and Nitsch (1974). They showed that the way in which a noun is encoded may depend on the verb in the sentence. Hence, a recall cue such as “Something heavy” was more effective for the sentence, “The man lifted the piano,” than for the sentence, “The man tuned the piano”. Although the effectiveness of appropriate cues over inappropriate cues was well established in their experiments, whether they gave rise respectively to facilitation and inhibition remained unclear.

The aim of the present experiments was to determine whether linguistic context can prime one aspect of an unambiguous word, rendering it more salient than other aspects of the word’s meaning. Since the ordinary process of comprehension provides no direct measure of saliency, we decided to test for such effects in the first experiment by asking subjects to produce associative responses to a word that had just occurred in a particular sentence.

## Experiment 1

### *Method*

On each trial, the subjects read a sentence followed by one word that had occurred in it. Their task was to produce those characteristics of the word that the sentence suggested to

them. We recorded both the time they took to read the sentence and the latency of the response to the word. There were 12 target words and each of them occurred in three different sentences: a sentence that was intended to prime one particular aspect of a word's meaning, a sentence that was intended to prime another independent aspect of the word's meaning, and a sentence that was intended not to prime any particular aspect of the word's meaning. The following examples illustrate the three conditions:

The goldsmith cut the glass with the diamond (diamonds are hard).

The mirror dispersed the light from the diamond (diamonds are brilliant).

The film showed the person with the diamond (primes no particular aspect of diamonds). Each priming sentence was intended to prime one, but not the other, aspect of the meaning of the word. Four target nouns occurred in the subject noun phrase of the sentence, four occurred in the object noun phrase, and four occurred in the adverbial noun phrase.

The subjects acted as their own controls and carried out the task for all 36 sentences presented in random order.

### Materials

There were 12 target nouns (six mass nouns and six count nouns) of approximately the same frequency of occurrence, and for each of them two priming sentences and one non-priming sentence was devised. All the sentences were in the active voice and of the sort illustrated above; they differed principally in whether the target noun was located in the subject, object, or adverbial noun phrase.

In order to establish the correctness of the experimenters' intuitions, and, if necessary, to enable the materials to be appropriately modified, an independent panel of ten judges was asked to rate all the sentences twice. On the first presentation of a priming sentence, the judges' task was to state what aspect of the meaning of the target word was suggested by the sentence, and then to rate on a four-point scale the strength to which the feature chosen by the experimenter was suggested by the sentence. On its second presentation, the judges rated the strength to which the sentence suggested the feature of the target noun that the other priming sentence was supposed to render salient. On the first presentation of a non-priming sentence, the judges stated what aspect of the meaning of the target noun it suggested and then rated the strength to which the sentence suggested the feature of the target noun that one of the priming sentences was intended to render salient; on its second presentation, the judges rated the strength to which the sentence suggested the feature of the target noun that the other priming sentence was intended to render salient. The ideal pattern of ratings was one where each priming sentence was considered to prime the appropriate feature maximally and to prime the inappropriate feature minimally, and the non-priming sentence was considered to prime both of these features minimally. This pattern occurred on 93% of occasions, and accordingly corroborated our intuitions about the materials to be used in the experiment.

### Procedure

The subjects' task was to read a sentence presented tachistoscopically and then, when they were ready, to press a button. This response (which unbeknownst to them was timed) caused one word that had occurred in the sentence to be presented 1 s later for a duration of 2 s. The subjects responded to the word as soon as possible by stating what characteristics of it had been suggested by the sentence. Their responses activated a voice-key that stopped a timer that had started on the presentation of the word. There was a 1-s warning tone prior to the beginning of each trial; there was a 9-s interval after the appearance of a target word and before the start of the next trial. The materials were presented in a two-field tachistoscope; the subjects' verbal responses were tape-recorded.

The subjects were instructed to read the sentences carefully, and to press the button with their dominant hand. They were told to produce as many characteristics of the word that they could in the time available, but their responses should be specifically suggested by the sentence. They were provided with an example of the sort of response that was required. Finally, they were instructed that *if no specific characteristic came to mind, then they should*

make no response at all rather than one that was not suggested by the sentence. There were 12 practice trials prior to the experiment proper.

#### Subjects

Twelve undergraduates (seven women and five men) at the University of Sussex were tested individually. They had not previously participated in an experiment of this sort. They were paid 70p for taking part in the experiment, which lasted about half an hour.

### Results and discussion

TABLE I

*The meaning reading times of the sentences (ms) in Experiment I, the mean latencies of response to the target words (ms), and the mean number of trials on which no response was made to a target word*

	Responses following a priming sentence	Responses following a non-priming sentence
Reading times	2914	3304
Response latencies	2353	3454
Response failures	0.66	2.33

Table 1 presents the mean reading times for the sentences, the mean latencies of response to the words, and the mean number of trials on which subjects failed to respond to a word. The subjects read the priming sentences significantly faster than the non-priming sentences ( $t_{11}=3.53$ ,  $P<0.005$ ); they responded significantly faster to a primed target word than to a non-primed target word ( $t_{11}=5.073$ ,  $P<0.0005$ ); they responded to primed words reliably more often than they responded to non-primed words ( $t_{11}=2.08$ ,  $P<0.01$ ). The responses to primed target words were also more uniform than those to non-primed target words. We assessed the difference using a simple measure, the number (max=12) reached by the most frequent response to each word. The mean for the primed condition was 8.83 and the mean for the non-primed condition was 3.00, and the difference between the two conditions was reliable (Mann-Whitney  $U$  test,  $z=4.14$ ,  $P<0.001$ ). There were no effects of the syntactic position or of the syntactic category (mass v. count) of the target nouns.

The results confirmed the hypothesis that linguistic context can affect what components of the meaning of an unambiguous word are rendered salient. There were more occasions following non-priming sentences than following priming sentences when subjects were unable to state any relevant characteristic of the noun, and the subjects read priming sentences faster than non-priming sentences and responded to their target words faster, too. However, the somewhat unusual nature of the task necessitates caution in drawing conclusions. In order to extend the empirical findings, we carried out a further experiment in which the task was closer to ordinary comprehension. Since the linguistic context was a sentence that would be consciously processed, we were also able to examine Neely's (1977) hypothesis that conscious priming can exert both facilitatory and inhibitory effects.

## Experiment II

### *Method*

The subjects' task was to read a sentence and then to answer a question about the meaning of a word that had occurred in it. There were three conditions.

1. The sentence primed the characteristic of the word that the question was about.
2. The sentence primed some other characteristic of the word.
3. The sentence primed no particular characteristic of the word.

We predicted the following trend: answers to the questions preceded by a relevant priming sentence would be relatively fast, answers to the questions preceded by a non-priming sentence would be of an intermediate speed, and answers to the questions preceded by an irrelevant priming sentence would be relatively slow.

The subjects acted as their own controls and received 12 trials in each of the three conditions, making up a total of 36 test trials. For each subject, a given target noun was always followed by the same question; it was the preceding sentence that differed; it primed a feature relevant to the question, or a feature irrelevant to the question, or no particular feature. In order to counterbalance the materials, however, two questions were made up about each target noun, and the materials were assigned to the subjects so that for every subject who received one question about a given target, there was another subject who received the other question. These materials were based on those of Experiment I, and one question was primed by one of the priming sentences and the other question was primed by the other priming sentences. Four target nouns occurred in the subjects of sentences, four in their objects, and four in adverbial phrases.

Each subject also received 12 "filler" trials, which were included to provide the requisite number of questions to which the answer was "No", and to reduce the chances of the subjects being able to guess either which noun the question would be about or what the question would be.

### *Materials and procedure*

The test sentences were those of the previous experiment, combined with questions of the form: "Is a diamond hard?", "Is a diamond brilliant?" devised by inserting an adjective denoting a primed characteristic into a single Yes/No question frame. Each target noun also occurred in three other "filler" sentences (in different syntactic positions) which all the subjects received: one was followed by a question about the target noun to which the answer was "No", and the other two were followed by questions about another noun in the sentence, with one question requiring the answer "Yes" and the other question requiring the answer "No". Each subject accordingly received 72 sentences containing target nouns. There were 72 other trials made up from a further 12 nouns (six mass nouns and six count nouns), each of which occurred in six different sentences. Three of these sentences were followed by the same question that required the answer "No", and the remaining three were followed, respectively, by a question about the noun that required the answer "Yes", and by two questions about another noun in the sentence, with one question requiring the answer "Yes" and the other question requiring the answer "No". There was accordingly a total of 144 trials for each subject, half of which required a positive answer and half of which required a negative answer.

The subjects' task was to read a sentence presented tachistoscopically and then to read and to answer a question about one word that had occurred in it. They responded "Yes" by pressing a button with their dominant hand. They were told that the experimenter was interested in both the accuracy and the speed with which they responded, and hence, they should work as quickly and as carefully as possible. They were instructed to read the sentences with care since there would be more questions about them at the end of the experiment.

A warning tone of 0.5 s preceded each sentence. The sentence was presented for 5 s and, after a 1-s delay, the question appeared for 2 s. The onset of the question started a digital

timer, which stopped when a subject pressed one of the buttons. There was a 5-s delay between the trials to allow the experimenter to record the response and its latency. After 12 practice trials, the 144 trials of the experiment followed in random order (with the constraint that there were no adjacent trials involving the same target noun). The experimental session was divided into four phases with a few minutes interval between them in order to allow the experimenter to change the materials. In each phase, every target noun appeared twice, and the numbers of "Yes" and "No" questions were the same.

### *Subjects*

Twenty-four undergraduates (9 women and 15 men) at the University of Sussex were individually tested. They had not previously taken part in any experiment of this sort. They were paid 80p for taking part in the experiment, which lasted about 45 min. The data from four subjects were discarded either because they made more than 15% of errors or because their latencies were greater than 2 s; four further subjects were tested to replace them.

### *Results*

TABLE II

*The mean latencies to respond to the questions (ms) in Experiment II, and the mean numbers of erroneous answers*

	Responses following a relevant priming sentence	Responses following a non-priming sentence	Responses following an irrelevant priming sentence
Response latencies	1016	1089	1142
Errors (max. = 12)	0.54	0.88	1.33

The mean latencies for answering the questions correctly, and the mean numbers of errors, are presented in Table II. There was a highly significant effect of the nature of the sentence on the latency to respond to the question (min  $F'$  2,89 = 6.26,  $P < 0.005$ ). The results confirmed the predicted trend: responses following a priming sentence were faster than responses following a non-priming sentence, which in turn were faster than responses following an irrelevant priming sentence [ $F(1,46) = 6.49$ ,  $P < 0.025$ ]. There were no reliable effects of the syntactic position of the target noun in the sentence, or of the category of target noun (mass v. count).

The mean error rate in answering all the questions was 7.6%. An analysis of variance, treating subjects as a random factor, established that the only significant effect on errors was the nature of the sentence [ $F(2,46) = 8.42$ ,  $P < 0.001$ ]; this effect was corroborated by an analysis in which the materials were treated as a random factor [ $F(2,42) = 4.85$ ,  $P < 0.025$ ]; but the min  $F'$  test failed to reach significance [min  $F'(2,80) = 3.07$ ,  $P < 0.1$ ].

### **General discussion**

Some sentences bring to mind one aspect of a word's meaning rather than another; other sentences bring to mind no particular aspect of a word's meaning. This distinction between priming and non-priming sentences is apparent when an individual is asked explicitly what a sentence suggests about a word, as we found

in the study designed to check our intuitions about the materials for Experiment I. The experiment itself showed that subjects can produce relevant characteristics of a target word faster and more often after a priming sentence than after a non-priming sentence. What was unexpected, however, was the striking difference in reading times: the subjects read the priming sentences nearly 400 ms faster than the non-priming sentences (which were of equal length). In fact, as a referee has pointed out, the opposite result might have been expected on the grounds that a sentence that primes a particular aspect of a word's meaning might require a greater amount of processing than one that only necessitates accessing the general sense of the term. The result might be considered to be an artefact of the experimental task: the subjects attempt to find some element of the target noun's meaning that is suggested by the rest of the sentence, and their task is correspondingly easier in the case of a priming sentence. There are two difficulties with this explanation. First, the subjects initially had no way of anticipating which of the three nouns in the sentence is the target. Second, the predicted differences in the responses to the subsequently presented target nouns were strongly confirmed: the subjects took considerably longer to respond to an unprimed noun than to a primed noun. The differences would surely have been minimised if the subjects were carrying out the experimental task during the time it took them to read the sentence. It might be argued, however, that the context of a priming sentence leads the subjects to expect the target word and in this way facilitates its recognition within the sentence. But this conjecture is hardly consistent with either the size of the difference or the absence of any effect of the surface position of the target noun within the priming sentence. Perhaps the best way to account for the difference in reading times is in terms of a general view of comprehension as the construction of a "mental model" based on linguistic clues (see Johnson-Laird, 1980). The more clues that an utterance provides for the construction of a specific and determinate model, the easier the model should be to construct. The advantage of a priming sentence is precisely that it makes easier the task of selecting the relevant aspect of the meaning of a word to be employed in constructing the model.

In Experiment II, the subjects' task was to answer an explicit question such as, "Is a diamond brilliant?", and there was a reliable trend in their latencies: responses were faster following a relevant priming sentence than following a non-priming sentence, which in turn led to faster responses than a sentence priming an irrelevant aspect of the word's meaning. These results establish two major points. First, they show that context exerts an almost immediate effect on the interpretation of a word, since the subjects had to read a sentence and at once answer a question about the meaning of one of its words. The earlier work of Barclay *et al.* (1974) established rather less reliably an encoding effect of context in a study of cued recall. Second, the results establish that context can exert an inhibitory effect. When the sentence primes an irrelevant aspect of meaning, it takes longer to answer the question about the word's meaning. This finding corroborates both the model of semantic priming proposed by Neely (1977) and our hypothesis that the interpretation of a sentence is based on only certain components of the meanings of the words it contains.

The following picture of the role of the lexicon in comprehension now emerges.



First, as a repository of phonemic and graphemic information, it is used in the process of identifying words within the stream of discourse, though identification is also aided by semantic factors, too. Second, the information that it contains about the meanings of words appears to be organised in a way that permits access to the general sense of a word without the need to retrieve a complete and detailed specification of that sense. One can grasp that the intended sense of the word, *bridge*, for example, concerns the structure rather than the card-game, without having to bring to mind the complete semantic analysis. Third, the information about a specific sense that is retrieved depends in part on the context of the word. Comprehension may often require a very specific *instantiation* of a term to occur. A noun such as *container* may be taken to refer to a basket in one context and to a bottle in another context (Anderson and Ortony, 1975); a verb such as *cook* may be taken to refer to frying in one context and to boiling in another context (Garnham, 1979). Understanding in these cases consists in building a mental model of the entities referred to on the basis of the relevant aspects of the meanings of words.

In conclusion, it appears that only some aspects of the meaning of a word are retrieved from the lexicon during the process of comprehension, and that the selection is determined by the linguistic context in which the word occurs. Alternatively, all the semantic information about a word is initially retrieved, and then a selection is made from it on the basis of context. It may prove to be impossible to obtain conclusive evidence to decide between these two alternatives: a task making use of normal comprehension will not reveal what is initially retrieved from the lexicon, and a task reflecting immediate retrieval will not involve normal comprehension. Nevertheless, we can be reasonably sure that semantic priming influences all three of the major processes of comprehension that depend on the mental lexicon. It was known to affect the identification of words and their disambiguation. The present study confirms that it affects their specific interpretation.

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