PRIMING AND THE EFFECTS OF SENTENCE AND LEXICAL CONTEXTS ON NAMING TIME: EVIDENCE FOR AUTONOMOUS LEXICAL PROCESSING*

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Models of language processing which stress the autonomy of processing at each level predict that the semantic properties of an incomplete sentence context should have no influence on lexical processing, either facilitatory or inhibitory. An experiment similar to those reported by Fischler and Bloom (1979) and Stanovich and West (1979, 1981) was conducted using naming time as an index of lexical access time. No facilitatory effects of context were observed for either highly predictable or semantically appropriate (but unpredictable) completions, whereas strong inhibitory effects were obtained for inappropriate completions. When lexical decision time was the dependent measure, the same results were obtained, except that predictable completions now produced strong facilitation. In a further experiment the inhibitory effects of context on lexical decision times for inappropriate targets were maintained, even though unfocussed contexts were used, in which no clear expectancy for a particular completion was involved. These results were interpreted in terms of a two-factor theory which attributes the facilitation observed with the lexical decision task to post-access decision processes which are not involved in the naming task. The inhibitory effects were attributed to interference resulting from semantic integration. In contrast to the results for sentence contexts, lexical contexts of the doctor–nurse variety produced clear facilitation effects on naming time (but no inhibitory effects). It was also shown that relatively minor variations in the type of neutral context could completely alter the relative importance of facilitation and inhibition.

Introduction

There is a considerable body of evidence to support the argument that the recognition of a word in a sentence is fundamentally altered by its immediate linguistic environment (e.g. Miller and Isard, 1963; Tulving and Gold, 1963; Morton, 1964; Forster and Ryder, 1971; Schuberth and Eimas, 1977; Morton and Long, 1976; Marslen-Wilson and Tyler, 1975). Basically, these experiments show that in a

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sentence such as *John ate the food*, various measures of the speed with which the target word *food* is recognised show substantial facilitation compared with other target words, such as *foot*, which are not semantically appropriate to the sentence context.

The reality of this phenomenon is scarcely open to doubt. However, there appear to be a number of problems with the interpretation of this effect. In what follows, we will attempt to show that the most widely accepted interpretation raises more problems than it solves.

The standard interpretation derives from the early work of Miller, Heise and Lichten (1951), and also Miller and Isard (1963). Using an information theory approach, these authors argued that the grammatical and semantic context acted to constrain the number of possible alternatives. It was assumed that the reader or listener was able to exploit these constraints so that the task of choosing the correct lexical interpretation of the input was made more efficient. These ideas are reflected fairly directly in more recent theories. For example, word-detector models (e.g., Morton, 1970; Meyer and Schvaneveldt, 1976) make the assumption that feedback from higher levels of interpretive processing increases the level of activation in the detectors of all words which are semantically and grammatically appropriate to the context. The result of this increase in activation is that the detectors for appropriate words will fire more readily when their associated stimuli are presented. An essentially equivalent account can be offered within the framework of lexical search theories (e.g., Becker, 1979; Forster, 1976; Schuberth, Spoehr and Lane, 1981). In this type of theory, recognition involves an ordered search through a list of lexical entries until a match is found between a coded representation of the stimulus and the specification of the word contained in the entry. Speed of access to the entry depends on a number of factors, one of which is the size of the search set. In the absence of context, this search set is controlled solely by the stimulus properties of the target word. However, when a context is provided, the set of stimulus-specified entries may be further constrained so that only the entries of words appropriate to the context are included, thus reducing the time to locate the appropriate entry (e.g., Forster, 1976). Alternatively, it can be assumed that two sets of entries are independently defined. One set is controlled by the stimulus properties of the target word, and the other is controlled by the context. On the assumption that the second set is smaller than the first, location of the correct entry will be faster with context whether both sets are searched in parallel, or the context-controlled set is searched first.

These types of account will be referred to as priming explanations of the sentence context effect. In word-detector models, priming occurs when the detectors for appropriate words receive an increment in activation. In ordered-search models, priming occurs when the search path is modified so that contextually appropriate words are considered earlier than they would be in the absence of context. For present purposes the most important features of the priming models are that (a) the priming action occurs before the target word is presented, and (b) that a relatively large set of words is assumed to be facilitated.

In contrast to the priming models, there are a number of possible explanations that locate the context effect temporally posterior to presentation of the target word.
We shall refer to these as post-access explanations. For example, in one such explanation, the effect of context is to modify decision processes occurring after lexical access has been completed, and hence the context effect is relegated essentially to the status of a methodological artifact. A further possibility is that context does affect lexical access, but only after a candidate entry has been located. In the absence of context, the only method of checking that the correct entry has been located is to make a detailed comparison between the entry and the features extracted from the stimulus. However, when a context is present, the candidate entry can also be checked for compatibility with the context. If this compatibility falls below some critical value, the entry is rejected, and the search resumes. Obviously, this strategy will interfere with the recognition of contextually inappropriate words. It may also produce facilitation for appropriate words if the context-checking procedure is in some way superior to feature-checking (e.g., when stimulus definition is poor).

The priming theory of sentence context is analogous to the explanation of a different type of context effect, in which the context consists of a single lexical item semantically related to the target word (Meyer and Schvaneveldt, 1971; O'Neil, 1953). This phenomenon is thought to exhibit the same two properties mentioned above. That is, the priming action spreads across a number of related words, and occurs prior to the presentation of the target word. For example, as shown by Fischler (1977) and Bednall (1978), priming is not restricted to strong associates of the context word, but also extends to non-associates which are related in some way to the context. Thus, doctor facilitates not only nurse, but also words such as operation, scalpel and lawyer. This type of effect will be referred to here as a lexical context effect.

The priming explanation of the sentence context effect presents a number of interesting problems. Consider the case of the context John tricked Mary into eating the —. It is perhaps not too implausible to suggest that once the verb of the sentence has been established, the selection restrictions associated with the verb could be used to select out a class of words that could occur as object. In this case, the relevant class would be all words that refer to edible objects. However, more than just the verb must be involved, since the subject of the verb is also relevant. For example, grass would not be a plausible completion of the sentence with a human as the subject, but would be if the subject were a horse. Thus the priming mechanism would have to be designed so that the class of words activated was just the class of objects edible by the subject of the sentence.

It is not at all difficult to construct further examples of this type. For example, consider the context John ate the —. In this case it seems that the appropriate class would be all edible objects that it is plausible to imagine one human tricking another human into eating. Such examples serve to demonstrate two points. First, a sentence context effect could not be mediated by a purely passive process. Instead it would have to involve an active, complex inferential system that took into account far more than simple lexical properties such as selection restrictions. Second, the priming process could not exploit what might be called "natural" semantic classes. For example, the class of edible objects might be considered a natural class in the sense that all words referring to members
of this class would normally be specifically marked for this property (i.e., there may be a semantic feature "edible-inedible"). The detectors for these words might also be organised together, or interconnected in some way so that once the concept of "edible object" was activated, all detectors for members of this class could also be rapidly activated. Hence, there is a readily available mechanism to mediate priming effects if a natural class is involved. But the class of objects that one human could plausibly trick another into eating is surely not a natural class in the sense that the words referring to these objects are unlikely to be specifically marked for this property. It also seems most unlikely that the mental lexicon is structured so that all words belonging to this class could be automatically selected for priming.

Suppose it was possible to design an experiment which showed a sentence context effect across a class of words that could not be considered a natural class. How could such an effect occur? Obviously, there would have to be an inferential process which systematically enumerated the possible completions. For example, suppose the context was *The bird flew down onto the -*, and our experiment showed that words such as *branch, perch, ledge, lawn, verandah*, etc., were all facilitated, whereas words such as *mirror, moon, pencil*, etc., were not. Since there is no obvious semantic property common to the facilitated words (other than being plausible completions of the context sentence), it follows that each plausible completion would have to be independently discovered prior to the target word actually occurring. Only in this way could a priming effect be explained.

But this explanation raises a number of puzzling questions. Such an enumeration procedure would surely require considerable time to reach completion, but in order for it to serve any purpose at all, it must be completed on line before the target word is presented. Even more puzzling is the fact that this enumeration must in some sense be a more efficient procedure than relying solely on the stimulus properties of the target word. That is, it must be possible to enumerate say, a dozen possible completions in less time than it takes to locate the correct entry on the basis of the physical features of the target word.

It must be conceded that this objection to the priming interpretation of sentence context effects is by no means decisive. Since virtually nothing is known about relative speeds of operation of different kinds of mental processes, there is nothing compelling about this argument. However, it should be noted that the claim that sentence context effects are best interpreted as generalised priming effects now becomes a very strong claim indeed. It should also be noted that the same problems do not necessarily apply to the lexical context effects, since it is not difficult to imagine that these effects take advantage of pre-existing networks in some kind of semantic cross-referencing of lexical entries, as discussed in Forster (1976, 1979).

Given these considerations, it seems worthwhile to consider whether there are alternative explanations of the sentence context effect that might avoid these problems. There appear to be at least three possibilities.

1. The sentence context effect may be produced by a post-access process, such as the context-checking procedure described earlier. That is, purely stimulus-based methods are used to locate candidate entries which are each checked for
compatibility with the context. The advantage of this proposal is that it completely eliminates the need to enumerate possible completions prior to the occurrence of the target word. This explanation implies that the context effect should be inhibitory for inappropriate completions, since the correct entry will initially be rejected when it is found to be incongruous.

(2) Sentence context may influence word recognition only when stimulus-based methods are inadequate, or unusually slow (Forster, 1976). In support of this contention is the fact that poor readers appear to show larger context effects than good readers (e.g. West and Stanovich, 1978). Further support is provided by the observation that degradation of the target word increases sentence context effects (Forster, 1976), although Schuberth et al. (1981) have recently reported that sentence context and degradation combine additively rather than interactively.

(3) The evidence in favor of a sentence context effect may be of a far more restricted nature than previously supposed. Fischler and Bloom (1979) have recently presented evidence which suggests that this might be the case. Following an earlier experiment by Schuberth and Eimas (1977), Fischler and Bloom had subjects make lexical decisions on the last word of a sentence. Three types of target words were used. The first type consisted of words that a different group of subjects had previously given as completions of the incomplete context sentence. These target words are here referred to as predictable completions. These words ranged from highly predictable (99% of subjects giving the same completion) to only moderately predictable (9%). The second type consisted of unlikely, but semantically appropriate completions (3% predictable). The third type consisted of semantically anomalous completions. In line with the predictions derived from a priming theory of sentence context effects, predictable completions produced faster lexical decisions than unlikely completions, which in turn were faster than anomalous completions. Thus, because appropriate but unlikely completions were faster than anomalous completions, the priming effect appeared to extend to a large set of words, many of them quite unpredictable from the context. However, further comparisons showed that this is a misleading interpretation. For the priming theory to be correct, context should also facilitate performance relative to a control condition in which no context is provided at all. However, neither the predictable nor the unlikely completions showed significantly faster responses when compared with a no-context control. The only significant effect was obtained for the anomalous condition, and this was an inhibitory effect, i.e., responses were faster without a context. Subsequent post hoc analysis of the predictable completions showed that the magnitude of the facilitation effect was influenced by predictability, but the only circumstance in which significant facilitation could be demonstrated was when the completion was 91% predictable.

Thus, Fischler and Bloom's evidence suggests that the difference in response times for appropriate and inappropriate completions is entirely the result of an inhibitory effect on the inappropriate words. True facilitation is only observed for highly predictable completions. Even this effect disappears when the rate of presentation of the context is increased (Fischler and Bloom, 1980).

Fischler and Bloom discuss their evidence in terms of the two-process theory of expectancy developed by Posner and Snyder (1975a,b), and successfully applied to
the lexical context effect by Neely (1976, 1977). This theory postulates two types of context effects. One is a purely automatic process that has the properties of a priming action: it spreads through a network, and primes detectors of a number of semantically related words; it acts rapidly, is not under conscious control, and has no effect on unprimed detectors. The second effect is non-automatic in the sense that it requires attentional capacity, is under conscious control, and develops slowly; its priming action is limited to a small set of detectors, but unlike the automatic effect, it inhibits the activity of non-primed detectors.

Applied to Fischler and Bloom's data, this theory suggests that the sentence context effect is limited to the non-automatic, strategic type of effect. Since it is slow-acting, the subject has time to enumerate only one possible completion, but the expectancy so formed has inhibitory effects on other words. This analysis is not entirely satisfactory, since as Fischler and Bloom point out, inhibitory effects are not obtained for unpredictable but appropriate completions. Nor was it the case that the inhibitory effects were under conscious control, since instructions to avoid forming expectancies were not successful in eliminating the inhibitory effects.

The pattern of results in a similar experiment reported by Schuberth and Eimas (1977) support the conclusions of Fischler and Bloom to some degree. They compared highly predictable completions and inappropriate completions to a no-context control, and found facilitation in the former case, but inhibition in the latter. No appropriate but unpredictable condition was included. However, the results of this experiment are difficult to interpret owing to the fact that subjects had to report both the context and the target word after making a lexical decision. Since this creates a heavier demand on processing capacity in the context condition than in the no-context condition, it is possible that decision times in the context condition were slower than they should have been.

On the other hand, the data reported by West and Stanovich (1978) do not support the conclusions of Fischler and Bloom. For adult subjects, they reported facilitation effects without an associated inhibitory effect for unexpected completions. This study employed a similar procedure, except that a naming response was required for the target word. Since naming times are faster for words than for pronounceable nonwords (Forster and Chambers, 1973; Frederiksen and Kroll, 1976), this measure should serve as an index of the time required for lexical access of the target word to be completed. In a subsequent study (Stanovich and West, 1979), the same results are reported for normally presented target words. However, when the target word was degraded, both facilitation of expected completions and inhibition of inappropriate completions was obtained. Similar results were reported when the presentation of a non-degraded target word was delayed by 750 ms. These results were taken to show that an automatic priming effect occurs under non-degraded conditions (hence no inhibitory effects), but when the target word is either delayed, or is degraded, there is sufficient time for a slower-acting conscious mechanism to take control.

Although the facilitation effects reported by Stanovich and West (1979) tended to be marginal, subsequent experiments using a naming response have produced far more secure facilitation effects (Stanovich and West, 1981). Once again, facilitation was obtained without a corresponding inhibitory effect for inappropriate
completions. However, the most significant aspect of these results was the fact that clear facilitation was obtained for so-called “difficult” completions, which were low frequency, unpredictable words, but which were nevertheless appropriate to the context (e.g., ledger as a completion of The accountant balanced the —). In fact facilitation for these words was greater than for predictable completions, and hence there is a clear-cut disconfirmation of Fischler and Bloom’s (1979) finding that appropriate but unpredictable completions show no facilitation effects at all.

The research to be reported in the present paper has the principal aim of resolving this issue: do unexpected but appropriate completions show a facilitation effect? If they do not, then the priming theory of sentence context effects is substantially weakened.

This issue is highly relevant to the general question of interaction between levels of language processing. On the one hand, there are models of the language processor which allow extensive interactions between the levels of lexical, syntactic and interpretive processing (e.g. Morton, 1970; Marslen-Wilson and Welsh, 1978; Johnson-Laird, 1977). These models allow for the possibility that any level of processing can be directly influenced by feedback from any higher level. Thus, syntactic processing can be influenced by factors concerned with the likely or expected meaning of the sentence, while lexical processing can be influenced by both syntactic and interpretive factors. Such theories would clearly lead one to expect a strong priming effect of a sentence context on lexical processing. In contrast to these theories, there are models of the language processor which stress the autonomy of processing at each level (e.g. Forster and Olbrei, 1973; Garrett, 1978). In the most extreme version of this model (Forster, 1979), each level of processing accepts input from only one source. The lexical processor accepts input only from a feature analysis level, and the syntactic processor accepts input only from the lexical level. Thus any one level is immune to either interference or guidance from any higher level. This theory clearly requires that sentence contexts should not influence lexical processing (either positively or negatively). However, effects due to lexical context (i.e. single word contexts) are entirely acceptable within this theory, since they can be described as within level effects rather than between level effects. That is, the lexical context effect is assumed to be mediated by structural properties entirely internal to the lexical processor itself, and no other level of processing need be involved (Forster, 1979). Viewed from this perspective, then, the possibility that lexical and sentence context effects might have different properties takes on considerable significance.

The experiments which follow examine both sentence and lexical context effects using both word naming and lexical decision tasks. The aim of these experiments is to establish whether a sentence context exerts either a facilitatory or an inhibitory effect on lexical access, and whether such effects necessarily support an interactive view of the language processor. The experiments also have the subsidiary aim of determining whether lexical and sentence context effects can be usefully distinguished.

**Experiment I**

In this experiment, the effect of a sentence context on recognition of predictable,
appropriate (but unpredictable) and inappropriate target words was assessed using both a word naming task and a lexical decision task. The advantage of the naming task is that it minimises the possible influence of decision effects unrelated to the process of lexical access. The lexical decision task is open to criticism in this regard. For example, it is possible that subjects are strongly influenced to respond “No” to any target word that is inappropriate to the context. This inclination apparently stems not from any failure to recognise the target word, but instead from a tendency to respond in terms of appropriateness. Such a strategy could well be responsible for both facilitatory and inhibitory effects of context.

The naming task does not appear to be open to this criticism. Accessing the interpretation assigned to the complete sentence in no way assists the task of pronouncing the final word in the sentence. Since there are no complex decisions to be made (other than the obvious one of deciding which word to pronounce), it seems reasonable to suppose that the technique is free of many other possible kinds of decision-effects. Moreover, pronouncing a word in a sentence seems a far better approximation to a natural task than making a lexical decision about a word in a sentence. The disadvantage of the naming task is that it may be less sensitive to variations in lexical access time than the lexical decision task, since it seems likely that subjects occasionally determine the pronunciation of the target word by rule, rather than by look-up. When irregular words are involved, this strategy produces a mispronunciation, and the data from such a trial can be discarded. However, when regularly pronounced words are involved, no detectable error in pronunciation will occur, and hence there is no way to remove the random error introduced. These considerations suggest that the lexical decision task and the naming task fall at opposite ends of a continuum, with the former task being somewhat “oversensitive” to effects and the latter being somewhat insensitive. The most appropriate way to cope with this problem is to use both types of latencies as dependent variables.

The method of presentation to be used is based on the RSVP technique (Forster, 1970), in which the words of the sentence are successively displayed at a rate roughly comparable to speech. This technique has also been used by Fischler and Bloom (1980). To avoid any uncertainty about which word was the target word, a cue was inserted into the sentence immediately prior to the target word. This technique was used by Swift (1977) in a sentence context study examining the effects of predictability on word naming. This technique differs from that used in many other experiments, where the entire context is presented simultaneously. The purpose of using a serial display of the context was to achieve better control of the time available for contextual effects to occur.

The sentence contexts were chosen so that they all led to strong expectancies for a single completion, i.e., all were relatively predictable. In the predictable condition, this expected word was the target word. In the appropriate condition, an entirely plausible completion was chosen, but one which was not predictable. For example, with the context He thought he wasn’t earning enough —, the predictable completion was money, while the appropriate (but much less predictable) completion was respect. The important point to note is that both target words are entirely plausible completions of the context. That is, the concept of
someone earning respect is not markedly less plausible than the concept of someone earning money. Moreover, it seems reasonable to suppose that any generalised priming effect produced by the context should extend to both words, although perhaps not equally. This is not necessarily true of previous studies, where completions were chosen purely by predictability tests. By using unpredictable completions that are nevertheless highly plausible, we increase the chances of observing a priming effect in this condition.

The third target condition also differs from previous experiments. Instead of using anomalous completions, this experiment used completions that were merely implausible in context. For instance, in the example cited, grapes was chosen as an inappropriate completion. The aim here is to avoid any possibility of a confounding of contextual properties, since anomalous completions must violate selection restrictions, and these are sometimes thought of as syntactic properties. Thus it might have been argued that anomalous completions violated both semantic and syntactic constraints, and hence were not comparable to appropriate but unlikely completions. No such objection can be made in the case of implausible completions.

Perhaps the most important feature of any experiment dealing with context effects is the choice of a neutral context condition, since any conclusions about the relative strengths of facilitation and inhibition depend entirely on this choice. As Fischler and Bloom (1980) point out, the neutral context should match the sentence contexts for their alerting properties, and also for processing requirements, but without constraining the target word in any way. Rather than use a row of Xs or digits, which they claim do not control for processing demands, Fischler and Bloom (1979, 1980), use sentence contexts that are always semantically anomalous when combined with the target word. While there is evidence that consistently inappropriate contexts function as a suitable control, there is the very obvious danger that substantial overestimates of lexical access time may occur with this method. Stanovich and West (1979, 1981) use neutral sentence contexts such as It was the — or They said it was the —, and they argue that such a context is entirely neutral semantically (though not syntactically). However, it seems there may be some doubt about the neutrality, since sentences such as They said it was the dike or They said it was the tooth seem distinctly less plausible than sentences such as They said it was the champagne, or They said it was the eclipse.

In the series of experiments reported here, the neutral context is always a randomly chosen list of words matched for length with the sentence contexts. This context prevents the subject from integrating the target word semantically or syntactically with the preceding context. As argued elsewhere (Forster, 1979), this integration process may well interfere with the availability of lexical processor outputs to conscious decision-making systems, and hence will produce an overestimate of lexical access time. This is avoided if integration is impossible. On the other hand, the word-list neutral context actively engages the lexical processor in recognising a variety of word types immediately prior to the occurrence of the target word, and hence controls at least for lexical processing demands.

Finally, an attempt was made to eliminate from the sentence context any word that was strongly associated with the target word and which occurred just before it.
This is obviously necessary in order to avoid confounding sentence and lexical context effects. However, in order to produce contexts with highly predictable completions, it was necessary to allow some words which were related to the target word, e.g. saucepan-stove, rain-umbrella, earn-money, etc. This follows from the rather obvious fact that if none of the words in the context are related in any way to the target, then the target is not likely to be very predictable.

Method

Materials and design

The experiment was designed as two independent sub-experiments, one using naming time as an index of speed of access, the other using lexical decision. Different groups of subjects were employed in the two sub-experiments, but the same test items were used.

A total of 39 different sentence contexts were constructed, and three different completions were selected for each context. The first set of completions were designated as predictable completions. These were all completions given by at least 8 out of 15 subjects instructed to complete the context by giving the word that they thought was the best completion. The average predictability of these target words was 76%. The second set of completions were chosen to be unpredictable. These were all less than 14% predictable, the mean value being 4.5%. No target word was included that was rated less than 4 on a 7-point scale of plausibility by another panel of seven judges. The mean rating here was 5.5, where a score of 7 denotes highly plausible, and 1 denotes highly implausible. These completions are referred to as appropriate completions. Finally, the inappropriate completions were selected so that none of the same panel of judges considered the completion to be anomalous, but all agreed that it was implausible. Throughout, target words which were strong associates of words in the context were avoided as far as possible.

Each sub-experiment was designed with three groups of subjects, each group receiving a different combination of contexts and target words. All groups received the same set of 39 contexts, but the target words varied, so that for each group, 10 contexts had predictable completions, 10 had appropriate completions, and 10 had inappropriate completions. This was arranged so that across the three groups, it was possible to compare performance on any given context in the three conditions. For example, consider the context In the long grass the horses were quietly-... Group A received the target word GRAZING (predictable), group B received STANDING (appropriate), while group C received FLYING (inappropriate). In addition, group A received STANDING preceded by a random word list, while group B received FLYING and group C received GRAZING preceded by the same word list context. Thus no subject was ever presented with the same context or target word more than once.

For both the lexical decision and the naming time experiments, there were 78 items in which the target item was a word, 39 having a sentence context, 39 having a list context. For the lexical decision experiment (but not the naming experiment), an additional 78 items were added in which the target item was a pronounceable nonword formed by taking a real word and altering two of the letters (e.g. PENCH, MASKEY, GROOT). Half of these were preceded by sentence contexts, half by random word lists. Two important points should be noted. First, the sentence contexts for the nonwords were chosen so that approximately two thirds had an obvious completion, hence avoiding any possibility that this property of the context could be used by the subject to bias his decision. Second, the words which served as a basis for constructing the nonwords were never the expected completion of the sentence. This was not the case in Fischler and Bloom's (1979) experiment, and it could be argued that items such as Fiona spun the wool with a spinning wheem, where the expected completion wheel is very similar to the nonword target wheem might force the subject to carry out an elaborate check on the spelling of both words and nonwords, thereby minimising any possible facilitation effect.
Procedure

In this experiment and in all subsequent experiments, the materials were presented on a computer-controlled video display using upper-case \(7 \times 9\) dot matrix characters. Subjects initiated a trial by depressing a footswitch. A delay of 200 ms followed before the item commenced. Each word of the context was successively presented at a rate of 500 ms/word, with each word centred in the screen, and superimposed on the preceding word. Following the last word of the context, a 500-ms warning signal consisting of a row of equal signs (= = = = = =) was presented, which signalled that the next display would be the target. This was also presented for 500 ms. Subjects in the naming task were instructed to read the context silently, and then to vocalise the target word as quickly as possible, but were warned to wait until it actually occurred before responding. Subjects in the lexical decision task were instructed to press a "Yes" key with the preferred hand if the target was a word, otherwise to press a "No" key.

The items in the six different conditions were presented in a semi-random order, a different order being used for each subject. Following the subject's response, feedback concerning the latency was displayed on the screen.

Subjects

A total of 48 volunteer undergraduates served as subjects, and were paid for their participation. Equal numbers were used in each of the groups.

Results

In this experiment, as in subsequent experiments, the effects of outliers were curtailed by cutoffs established \(+2\) S.D. units from the mean of each subject. For the naming task, the data were discarded from trials on which the subject mispronounced the target word, or responded in less than 200 ms, or the response was not detected. For the lexical decision task, data from trials on which an incorrect response occurred were discarded.

Mean response times for the three types of context conditions and the associated neutral context controls are shown in Table I for both tasks. The results for each task were separately analysed in a \(3 \times 2 \times 3\) factorial design, the factors being Groups

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(subject groups in the analysis of subject means, item groups in the analysis of item means), Context (context-no context) and Target type (predictable-appropriate-inappropriate). Considering the naming times first, it can be seen that a sentence context produces only a very small facilitation effect of 4 ms relative to a word-list context when the target word is highly predictable from the context. When the
target is merely appropriate, the effect of the sentence context is to inhibit naming responses, but once again, only to a minor degree (8 ms). However, for inappropriate targets, the inhibitory effect is more substantial (18 ms). These differences were tested for significance in three individual comparisons using the error term appropriate for testing the interaction of the Context and Target main effects. The context effect for predictable targets proved not to be significant, \( \min F'(1,122) < 1 \) (both \( F_1 \) and \( F_2 < 1 \)), and the same was true for the inhibitory effect for appropriate targets, \( \min F'(1,121) = 1.74, P > 0.05 \) (neither \( F_1 \) nor \( F_2 \) significant). However, the inhibitory effect for inappropriate items was clearly a reliable effect, \( \min F'(1,121) = 8.83, P < 0.01 \).

In contrast, the lexical decision times show a strong facilitatory effect for predictable completions, \( \min F'(1,144) = 5.36, P < 0.05 \), and an equally strong inhibitory effect for inappropriate targets, \( \min F'(1,114) = 15.23, P < 0.001 \). The small inhibitory effect for appropriate completions was not significant, \( \min F'' < 1 \) (neither \( F_1 \) nor \( F_2 \) significant). The pattern of errors follows the pattern of reaction times, with more errors being obtained in the more difficult conditions; however, the interaction between Completion type and Context was not significant, \( \min F'(2,148) = 2.01, P > 0.05 \). Finally, the responses to nonwords were not affected by the type of context (633 ms with a sentence context, 639 ms with a list context), \( \min F'' < 1 \), nor were there any differences in error rates (11% in both conditions).

**Discussion**

The results for the naming task do not support the findings of West and Stanovich (1978) or Stanovich and West (1979, 1981), who reported a predominantly facilitatory context effect. Instead, it appears that the substantial difference between naming times for predictable and inappropriate targets (38 ms) is almost entirely attributable to an inhibitory effect of the sentence context on the inappropriate targets.

On the other hand, the lexical decision results show a combination of facilitation and inhibition. These results also parallel those of Fischler and Bloom (1979), and also Schuberth and Eimas (1977) who found facilitation for highly predictable targets and inhibition for inappropriate targets.

The most important aspect of the results from the point of view of the priming theory of sentence context effects is that in neither task is there any facilitation of appropriate but unexpected targets. If anything, there is a slight tendency towards inhibition, although neither of these effects approach significance. Hence it appears that there is little evidence for a generalised priming effect.

The only respect in which the results from the two tasks disagree (apart from variations in magnitude) is in the results for predictable targets, where lexical decision responses show clear facilitation, but naming responses do not. It seems unlikely that this could be attributed to a failure of the naming task to be sufficiently sensitive to variations in access time, since the naming task produced a highly significant inhibitory effect for inappropriate completions. Thus it would have to be argued that the naming task was insensitive to facilitatory effects, but sensitive to inhibitory effects, which would scarcely make sense given the claim that context
effects on naming time are predominantly facilitatory (Stanovich and West, 1981). Nor would it make sense on purely theoretical grounds, since the reason for this insensitivity would have to be the fact that subjects can eventually determine the pronunciation by rule. But this would have the effect of minimising long latencies, and hence the sensitivity to inhibitory effects is far more likely to be the one to suffer.

The absence of any facilitation for predictable targets in the naming task raises questions about the correct interpretation of the strong facilitation observed for these items in the lexical decision task. If one takes the view that the naming task and the lexical decision task at least share one common element, namely, sensitivity to access time (Forster and Chambers, 1973), then the implication is that the lexical decision effect must be due to some post-access decision process which is not involved in the naming task. The most likely candidate appears to be the process of deciding whether to respond with the left or right hand, and it is possible that the expectancy generated by the context could be used to simplify this process. For example, subjects might adopt the following two-stage decision-rule: (1) if the target matches the expected word, respond with the preferred hand (i.e., a "Yes" response) immediately. (2) If there is a mismatch, then check whether an entry has been located which matches the target, and respond with the preferred hand if such an entry exists. This decision-rule will produce faster lexical decisions for expected targets, but might possibly slow down responses to all unexpected targets due to the time required to complete the first stage (assuming that stage 1 is omitted when no expectancy is generated by the context, as in the word-list context condition).

It might be argued that this decision-rule is nothing more than a minor restate-ment of the priming theory of sentence context. That is, candidate entries are suggested by the context and compared with the actual target to confirm or reject the hypothesis. However, the important point to note is that the expectancy generated by the context is said to affect decision-making only, not lexical access time. In other words, a conscious expectation that a particular word is about to occur does not alter access time when that word subsequently occurs, but it may alter the speed with which decisions can be made about that word. The reason for making this claim is, of course, the fact that no facilitation occurred in the naming task.

Much of the preceding discussion depends crucially on the suitability of a random word-list as a neutral context. If this were challenged, then quite different options present themselves. For example, suppose it were argued that a random word-list produced too fast an estimate of context-free access time, say, by as much as 20 ms. This would bring the naming time results into line with those reported by Stanovich and West (1979, 1981), and it could then be concluded that naming time produces predominantly facilitatory effects, whereas lexical decision produces both facilitation and inhibition.

There are two reasons for doubting whether this is the way to try to resolve matters. First, in the cases in which semantically anomalous contexts have been compared with random word-list contexts (e.g. Miller and Isard, 1963; Forster and Ryder, 1971), it has been found that word-lists produce poorer recognition per-
formance than anomalous contexts. Hence it seems more likely that a word-list context would produce too slow an estimate of context-free access time. Correction for such an error would simply increase the inhibitory effects observed in the present experiment. Second, there are grounds for arguing that it makes no sense to criticise a potential neutral context on the grounds that it produces underestimates of context-free access time, unless it can be shown that the context contains cues to the nature of the target word. In other words, when faced with two or more potential candidates for a neutral context that are otherwise equally suitable, it would make sense to always choose the fastest of the alternatives.

Finally, it may help to consider the evidence from the nonword condition of the lexical decision experiment. In their lexical decision study, Schuberth and Eimas (1977) reported that a sentence context had a marked facilitatory effect on nonwords as well as words. This was true whether the neutral context was a blank stimulus field, or a list of digits. Since this result is very difficult to interpret theoretically, it might be suggested that it be taken as an a priori indicator of the suitability of the neutral context. Thus, in the Schuberth and Eimas (1977) study, the nonword facilitation effect would simply mean that the neutral context produced over-estimates of the context-free access time. Applied to the current experiment, this nonword test suggests that the random word-list was a suitable control, since there was a difference of only 6 ms in decision times for the sentence and word list contexts.

The conclusions to be drawn from this experiment therefore seem to be as follows: (1) When a random word-list is used as a neutral context, neither the naming task nor the lexical decision task shows any sign of a generalised priming effect across the entire set of appropriate completions. (2) Facilitation is obtained only for lexical decisions on highly predictable targets. The failure to obtain the same effect with the naming task suggests that this is artificial. (3) The only clear effects of a sentence context are therefore the inhibitory effects for inappropriate targets observed with both tasks.

These conclusions raise a number of questions. What is the point of a context effect that is purely inhibitory? Do the results depend on the fact that in all conditions, the context would have produced strong expectancies for a particular completion? Could facilitation for appropriate completions be observed in the absence of strong expectancies? These questions will be addressed in the third experiment. However, before we consider these questions, we turn to a quite different issue: do the above conclusions also apply to the lexical context effect?

**Experiment II**

It will be recalled that the autonomous model of language processing discussed earlier (Forster, 1979) distinguishes sharply between the putative contextual effects of sentences and single lexical items. The former kind of effect involves an...
interaction between levels, which, according to the model, cannot occur. The latter effect, however, can be seen as a purely within-level effect mediated by structural connections within the lexical processor itself, and hence the existence of a lexical context effect does not violate the assumption of autonomy. Thus the autonomy model is committed to the impossibility of genuine sentence context effects, but can readily accept the possibility of lexical context effects.

The findings reported in the previous experiment appear to support the autonomy model in as much as they suggest that there is no facilitatory effect for sentence contexts (although the inhibitory effects still remain to be explained). This support would be enhanced if it could also be shown that genuine facilitatory effects could be obtained with lexical contexts, under much the same conditions as used in Experiment I.

Accordingly, this experiment studies the effect of lexical context on naming time using serial presentation similar to that in Experiment I. Three types of context are used. In the first condition, the context word and the target word are highly associated, and these pairs are termed Predictable. In the second condition, the same context word is used, but the target word is only weakly associated with the context word. These pairs are referred to as Related. In the third condition, the same context word is paired with an unrelated word. These pairs are Unrelated pairs. Thus, the Predictable, Related and Unrelated conditions of this experiment can be seen as analogous to the Predictable, Appropriate and Inappropriate conditions of Experiment I. However, problems arise in selecting a directly comparable neutral context. In Experiment I, this consisted of an unstructured sequence of words unrelated in any way to the target, which was designed to prevent the formation of any expectancy concerning the target. In some ways, the Unrelated condition of the present experiment is comparable to this condition (the absence of any relation to the target), but it differs in that an expectancy about the target word could still be formed. Hence it was decided to include the traditional neutral context of a row of Xs used by Neely (1976, 1977).

Method

Design and materials

The design was parallel to that of Experiment I. A total of 39 single word contexts were chosen, and for each three different targets were selected. Predictable targets were always the most frequent response to the context word in various word association norms (Postman and Keppel, 1970), e.g., BITTER–SWEET. Related targets were chosen from the middle ranges of the ranked set of associates, e.g., BITTER–ALMONDS. Unrelated targets did not occur as associates, and were judged to be unrelated to the context word, e.g., BITTER–CARDS. The average predictability (percentage number of subjects giving the word as an associate) of the predictable targets was 48.5%, and for Related targets, it was 0.9%. As in Experiment I, three groups of subjects were used, with contexts and targets assigned to groups so that no subject saw any context or target word more than once, but across the three groups, it was possible to compare the effect of the same context word on the three types of targets, as well as obtaining estimates of naming time on each target word in the non-context condition.

Procedure

The presentation conditions were modelled on those used in Experiment I. On each trial, three stimuli were serially presented at a 500-ms rate. These stimuli were the context
word, the warning signal (as in Experiment I), and the target word. For the no-context control condition, the context word was replaced by a row of Xs (this is not a minor point; in pilot experiments, the context word was simply omitted, so that only two stimuli, the warning signal and the target item were presented. However, this produced unusually long naming latencies in many cases since subjects had adopted a strategy of responding to the third stimulus in each sequence, and were therefore still waiting for the final stimulus to occur). As in Experiment I, subjects were told merely to pronounce the word which followed the warning signal.

Subjects

A total of 30 paid undergraduate volunteers served as subjects, with equal numbers in each of the three groups.

Results and discussion

Mean naming times are shown in Table II. Both the Predictable and the Related (unpredictable) pairs showed similar facilitatory effects, while the Unrelated context showed no effect at all. Individual comparisons showed that the context effect obtained for the Predictable condition was significant, \( \text{min } F'(1,147)=12.28, P<0.001 \), as was the effect in the Related condition, \( \text{min } F'(1,156)=9.17, P<0.01 \), while the Unrelated condition showed no difference between the context and control conditions, \( \text{min } F'<1 \).

<table>
<thead>
<tr>
<th></th>
<th>Predictable</th>
<th>Related</th>
<th>Unrelated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>No context</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>d</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

The most important aspect of these results is the successful demonstration of a lexical context effect on naming times under conditions comparable to Experiment I. The second notable aspect of the results is that the magnitude of the semantic priming effect is independent of the strength of association between the context prime and the target word, confirming the findings of Fischler (1977). This suggests that the role of attentional factors is minimal in this type of experiment, since the predictable associates would be much easier to anticipate than the unpredictable associates. This conclusion is strengthened by the absence of any inhibitory effects of an unrelated context word (assuming that inhibitory effects are diagnostic indicators of a strategic effect). It should be emphasised that the prime word in the Unrelated condition was the same as in the other two conditions, hence there is no reason to believe that expectancies should have been any weaker in this condition. It should also be noted that the stimulus onset asynchrony used was 1000 ms, which is well within the range required to produce inhibitory effects in a lexical decision experiment (Neely, 1976, 1977). This suggests that the inhibitory effects in a lexical context experiment are task-dependent, since they occur for the
lexical decision task, but not for a naming task. The most obvious explanation of this fact is that the locus of the inhibitory effect is in the decision phase of the task, not in the lexical access phase. That is, access of the target word is not affected by the fact that the target item is unexpected, whereas the decision that it must be a word is affected. This argument depends, of course, on the assumption that the role of decision processes is minimised in a naming experiment.

If these arguments are correct, then the fact that a sentence context produces inhibitory effects on naming time when the target word is inappropriate (as shown in Experiment I) takes on new significance. These effects are not presumably a result of any strategic anticipational process. We return to this point in the next experiment.

Experiment III

At this point, it is perhaps useful to summarise how the results of the preceding experiments can be interpreted within the framework of an autonomous theory of language processing. On the assumption that any genuine effect of context on the speed of lexical access should be reflected equally in both a naming task and a lexical decision task, it is inferred that a purely lexical context is capable of facilitating lexical access without an inhibitory cost (Experiment II), whereas a sentence context is not (Experiment I). The only facilitatory effect of a sentence context is restricted to highly predictable targets in a lexical decision task. Since this effect is not obtained for a naming task, it is tentatively concluded that this effect occurs at the decision stage rather than at the stage of access. These results are in accord with the assumption of autonomous levels, since a lexical effect is a within-level effect, while a sentence effect would have to be a between-levels effect (Forster, 1979).

However, strong inhibitory effects of a sentence context are found for both types of tasks, and hence cannot readily be attributed to decision processes. Since these effects violate the autonomy principle just as much as facilitatory effects, it is necessary to offer some explanation of them. We will consider four possible explanations; the first and second assume that genuine priming effects occur, and therefore are incompatible with an autonomous theory of lexical processing. The third and fourth explanations attempt to explain the effects without recourse to a priming mechanism.

Pure inhibition

As Fischler and Bloom (1979) point out, the inhibitory effect appears to be a cost without a benefit. One way of making sense of this proposal is to suggest that the function of context is not so much to facilitate the correct analysis of the target word as to inhibit incorrect analyses. That is, rather than priming the detectors of likely words, the context inhibits the detectors of all unlikely words. This effect is shown in Table III as a negative influence on inappropriate targets only. If we assume in addition a decision effect for predictable targets in a lexical decision task [Table III, effect r(b)], the obtained pattern of facilitation and inhibition can be explained. For a naming task, this latter effect is not required.
Opposed effects theory

The essential problem for the Posner–Snyder theory is to explain why appropriate targets show neither facilitation nor inhibition. In this version of the theory, this is explained by equal and opposing effects. The facilitation effect [Table III, effect 2(a)] is a genuine priming effect for all plausible completions, which is completely balanced for appropriate targets by an inhibitory effect resulting from the unexpected nature of the completion. This theory can explain all results, except for the absence of facilitation in a naming task.

Integration theory

This theory is based on the assumption that the results of analysis at any particular level of processing are not necessarily immediately available to conscious awareness (cf. Foss and Swinney, 1973; Forster, 1979). In general, it is assumed that results of analysis at higher levels are communicated more rapidly than, and take precedence over lower-level results. Thus, when a word occurs in isolation, or in the context of a random list of words, the results of lexical analysis are made available to awareness more or less immediately. However, when a word occurs in the context of a sentence, it is automatically integrated with that context, and the output of this integration takes precedence over, and actually inhibits transmission from the lexical processor to awareness. In the case of semantically plausible sentences, this process of integration can be completed quickly enough so that there is effectively no interference (or so little that it is a marginal effect, as indicated in Table I). However, with an inappropriate target, interpreting the complete sentence is a much slower process, and hence the communication channel between the lexical processor and awareness is temporarily blocked. Other variants of this theory could be suggested, but the essential idea remains the same: the inhibitory effect is caused by the difficulty of integrating the target word into the context, not by any effect of context on recognition of the target word. With the addition of a decision effect for predictable targets, this theory can also reproduce the lexical decision results.

Error-checking

As mentioned earlier, it is possible that the only role of context is to provide information about the accuracy of the access mechanism. When a candidate entry has been selected on the basis of the physical properties of the target word, it is checked for compatibility with the context. If the compatibility falls below some criterion value, the entry is rejected and the search continues for another candidate. If no candidate reaches the criterion, then one of the original candidates must be reinstated. Obviously this will lead to inhibitory effects for inappropriate targets, since the entries for these target words are likely to have been falsely rejected [Table III, effect 4(a)]. Since time must be spent checking candidates for semantic compatibility, there ought to be an additional inhibitory effect for all types of completions, except perhaps predictable completions, where much of the computation could have been carried out prior to occurrence of the target [Table III, effect 4(b)]. This effect leads to the possibility that small inhibitory effects might
be obtained for appropriate targets (as suggested by the results of Experiment I). Finally, as in the previous theory, a special decision effect must be postulated to handle the facilitation for predictable targets in a lexical decision experiment. Balanced against the inhibitory effects (but not shown in Table III) is a possible savings due to the fact that it may be more efficient to use semantic context as a check than having to make detailed comparisons of physical features.

**Table III**

**Alternative theoretical analyses of the components of the sentence effect**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Predictable</th>
<th>Type of completion</th>
<th>Inappropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pure inhibition theory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Inhibitory</td>
<td>o</td>
<td>o</td>
<td>-</td>
</tr>
<tr>
<td>(b) Decision*</td>
<td>+</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2. Opposed effects theory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Automatic priming</td>
<td>+</td>
<td>+</td>
<td>o</td>
</tr>
<tr>
<td>(b) Expectancy</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. Integration theory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Integration</td>
<td>o</td>
<td>o</td>
<td>-</td>
</tr>
<tr>
<td>(b) Decision*</td>
<td>+</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>4. Error checking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) False rejection</td>
<td>o</td>
<td>o</td>
<td>-</td>
</tr>
<tr>
<td>(b) Checking time</td>
<td>o</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(c) Decision*</td>
<td>+</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

*The decision effect is relevant only in a lexical decision experiment*

There are obviously both positive and negative features to each theory. The Pure Inhibition theory suffers from the computational cost of enumerating all unlikely completions so that their detector thresholds can be raised. The Opposed Effects theory must deny or explain away the absence of facilitation in a naming task, and also faces the embarrassment of postulating cancelling effects, as does the Error Checking model. Finally, the Integration theory is forced into the somewhat ad hoc position of assuming that predictable and appropriate targets can be integrated quickly enough to avoid any substantial interference effects.

In attempting to distinguish between these theories, it may be instructive to ask the following question. To what extent do the results depend on using contexts which generate strong expectancies? Suppose that instead we use unfocussed sentences, in which the range of acceptable completions is so wide that it would be absurd to suggest that they could ever be enumerated rapidly enough, e.g. *As he got older, John found that he liked — .* What predictions do each of the theories make for appropriate completions of these types of contexts?

The Pure Inhibition theory might explain the inhibitory effect for focussed sentences in the following way: the detector thresholds for all words are first automatically raised; the set of plausible completions is then enumerated, and the detector thresholds for each of these words is then lowered to its original position.
But for unfocussed sentences this theory becomes more improbable. Since there would be insufficient time to correct the detector thresholds of all possible completions, there would now be a high probability of encountering inhibition for both appropriate and inappropriate targets.

For the Opposed Effects theory, using unfocussed sentences would eliminate or minimise the expectancy effect. This should enable a facilitatory effect to emerge for appropriate targets. In addition, the inhibitory effect for inappropriate targets should disappear.

However, for the Integration theory, nothing should be changed if unfocussed sentences are used. The decision effect is irrelevant, since this depends on using focussed sentences. The integration effect remains unchanged, since inappropriate targets will still take longer to integrate, regardless of whether the sentence is focussed or unfocussed. Similar conclusions apply in the case of the Error Checking model. False rejections of inappropriate targets will still occur for unfocussed sentences, and the checking procedure will still require extra time.

To summarise: using unfocussed sentences with a lexical decision task eliminates effects 1(b), 2(b), 3(b) and 4(b) in Table III. All other effects are unchanged except for 1(a) in the case of appropriate targets, which converts to an inhibitory effect. Thus Pure Inhibition predicts inhibition for both appropriate and inappropriate completions of unfocussed sentences. Opposed Effects now predicts facilitation for appropriate targets, but no effect for inappropriate targets. Integration theory predicts no effect for appropriate targets, but inhibition for inappropriate targets, while the Error Checking model predicts inhibitory effects for both.

The evidence currently available tends to suggest that the Integration theory makes the correct predictions. Fischler and Bloom (1979, table 4) reported that as the predictability of the target word increased, there was no corresponding increase in the tendency towards inhibitory effects for either unlikely (appropriate) or anomalous completions suggesting that the inhibitory effects have little to do with expectancies. However, the low end of the predictability scale here consisted of items ranging from 19% to 7% predictability, and it could not be safely concluded that these items did not generate strong expectancies. In fact, even for the 19% sentences, quite strong expectancies may have been generated, but these may have differed across subjects, thereby producing a low predictability score.

Hence it is desirable to subject the predictions to a more direct test, using sentences which are deliberately constructed to minimise the possibility of strong expectations for a particular target word.

In this experiment, the contexts were chosen so that there were as few constraints as possible on the completion, while still making it possible to select inappropriate completions. Thus very broad contexts were avoided, e.g. *John heard of a —*, or *In this world there are too many —*. Typical examples of the contexts used were: *They were all busy looking for —*, *Every Saturday they gather to —*, *They did their best to salvage the —*. Performance on appropriate and inappropriate completions to these sentences was examined using the lexical decision task in order to maintain comparability with previous experiments in the literature. Also, in order to keep the ratio of predictable to unpredictable items comparable with Experiments I and II, a set of highly predictable contexts was also included.
Method

Materials and design

Thirty contexts were chosen from a larger set of low constraint contexts such that no more than three out of a panel of 16 judges agreed on the best completion. Appropriate and inappropriate completions were then selected for these 30 relatively unfocussed contexts. The average predictability for the appropriate completions was 11.8%; these were all judged to be relatively plausible, and the inappropriate items were judged to be implausible, without being anomalous. Two sets of items were prepared. In each set half the contexts were combined with appropriate completions, half with inappropriate completions, so that across the two sets each context occurred once with each type of completion (these items are listed in the appendix). To keep the proportions of predictable, appropriate and inappropriate items the same as in earlier experiments, a different set of 15 contexts with predictable completions (average predictability 91.9%) was added to each set. Finally, a set of 45 control items were added, where the context consisted of a random list of five, six or seven words. In each set, the targets for these items were the words used in the other set as completions of the sentence contexts. Thus the design of this experiment differed from the previous experiments in that the contexts used for the predictable condition were not the same as those used in the appropriate and inappropriate conditions. For the nonword trials, a further set of 90 items were included with orthographically legal nonwords as targets, half having a sentence context, half having a random word list as context.

Procedure

This was the same as for the lexical decision task in Experiment I.

Subjects

A total of 50 paid undergraduate volunteers served as subjects. These were divided into two equal subgroups, one group receiving the first set of items, the other receiving the second set.

Results and discussion

The mean lexical decision times are reported in Table IV. As in Experiment I, a significant facilitation of 42 ms was observed in the Predictable (focussed) condition, \( \min F'(1,163)=22.08, P<0.001 \). The most important results, however, concern the unfocussed contexts. Here we find essentially the same pattern as in Experiment I with focussed contexts. Appropriate targets do not show any

<table>
<thead>
<tr>
<th></th>
<th>Predictable (Focussed)</th>
<th>Appropriate (Unfocussed)</th>
<th>Inappropriate (Unfocussed)</th>
<th>Nonwords</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L E</td>
<td>L E</td>
<td>L E</td>
<td>L E</td>
</tr>
<tr>
<td>Sentence context</td>
<td>481 3.6</td>
<td>531 7.7</td>
<td>571 13.2</td>
<td>594 6.0</td>
</tr>
<tr>
<td>List context</td>
<td>523 6.3</td>
<td>534 10.0</td>
<td>549 10.0</td>
<td>599 12.8</td>
</tr>
<tr>
<td>d</td>
<td>42 3</td>
<td>-22</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

significant context effect, \( \min F'<1 \), while inappropriate targets show a significant inhibitory effect of 22 ms, \( \min F'(1,153)=5.27, P<0.05 \). The only respects in
which these results differ from those of Experiment I are the failure to confirm the weak inhibitory effect for appropriate targets, and a reduction of the size of the inhibitory effect for inappropriate targets from 65 to 22 ms. There were no significant differences in the error rates for words, and these generally followed the pattern observed for lexical decision times. For the nonwords, there was no significant effect of context on decision times, \( \min F' < 1 \), although there were significantly more errors made in the list context condition, \( \min F'(1,126) = 10.20, P < 0.01 \).

These results confirm the expectations derived from the Integration theory. Using unfocussed contexts does not eliminate the inhibitory effect for Inappropriate completions, nor does it alter the null result for Appropriate completions. The maintenance of the inhibitory effect appears to be especially damaging to any theory which treats this effect as a consequence of strong expectations for a specific completion. If this effect is instead due to interference from the integrative process, then this may well explain why Fischler and Bloom (1979) found that inhibition was maintained when subjects were instructed to avoid forming expectancies. If integration is not a voluntary process, but is automatically triggered whenever a syntactically well-formed sequence of words is presented, then inhibitory effects will always be generated whenever an inappropriate completion is presented. It should be pointed out, however, that the 22-ms inhibitory effect observed here is substantially less than the 65-ms effect observed for the lexical decision task in Experiment I. Thus it is possible that at least part of the inhibitory effect observed with focussed sentences is due to expectancies.

The results also lend support to the Error Checking model, although there was no trace of the expected inhibitory effect for appropriate completions. This is probably not critical for this theory, since the cost of carrying out the check may be offset by a reduction in the amount of time spent checking physical features. However, it must be conceded that this amounts to postulating opposing and cancelling effects, and hence the failure of context to exert any effect on appropriate targets is not really explained adequately.

Once again, it should be pointed out how much the above conclusions depend on the choice of an appropriate neutral context. As in Experiment I, it seems that the best evidence in support of the random word list is the absence of any context effect on decision times for nonwords (although there was an error difference in the present experiment). However, this is hardly a definitive test, and depends critically on a particular theoretical view for its validity. It is therefore disturbing that consistent facilitatory effects have been reported for naming time (Stanovich and West, 1979, 1981). The next two experiments address this issue.

**Experiments IV and V**

Stanovich and West (1979, 1981) have reported a number of experiments in which targets congruous with a sentence context show clear facilitation effects with a naming task, while incongruous (inappropriate) targets show neither facilitation nor inhibition. Further, they also report (Stanovich and West, 1981) that "difficult" congruent targets (unpredictable low frequency completions of the
context) show greater facilitation than "easy" congruent targets (highly predictable completions). Since these results are diametrically opposed to the findings reported here, it seems advisable to ask whether these differences are due to variations in experimental technique, or to differences in the type of neutral context employed, or perhaps to some other factor altogether.

Stanovich and West required their subjects to vocalise the context. The experimenter was trained to trigger the target presentation coincident with vocalisation of the final word of the context. In some cases, the neutral context consisted of the single word the, in others it consisted of the sequence the the the. In terms of the likely "tuning up" effects of the context on the speech production apparatus, it seems quite possible that neither of these neutral contexts are strictly comparable to a sentence (however inappropriate it might be semantically), since vocalisation is far more likely to be fluent in a syntactically well-formed sequence. In other experiments, they avoid this problem by using a neutral context such as "It was the — ”, which at least forms a sentence with the target word, although as argued earlier, this is not necessarily a totally neutral context. However, if a sentence context automatically produces an inhibitory effect on lexical outputs (as argued in the previous experiment), this neutral context would itself be inhibitory, and hence it would be impossible to detect inhibitory effects.

The best way to resolve this issue is to repeat the naming experiment using the presentation and measurement techniques described in Experiment I, but using the items and neutral context used by Stanovich and West (1981). If this experiment produces a predominantly inhibitory pattern of effects, then the presentation and measurement techniques are implicated. If a predominantly facilitatory pattern emerges, then the neutral context is implicated. In this case, repetition of the experiment using the random word list neutral context used in Experiment I should produce an inhibitory pattern. The next two experiments were designed in this way.

Materials and design

For both Experiments IV and V, a total of 96 contexts were taken from Stanovich and West (1981). For each context there was an "easy" target which was generally a high frequency, highly predictable completion of the context, and a "difficult" target, which was a low frequency, unpredictable completion (e.g., for the context The politician appealed to the — , the easy target was people, while the difficult target was constituency). Fourteen of these target words had to be modified to make them more suitable for the cultural background of the subjects used in these experiments (e.g. such words as homecoming, alumni, coed and sorority). The total set of 172 items was divided into eight subsets, such that each set contained 36 easy targets and 36 difficult targets. Within each set, 12 targets were preceded by a congruous context, 12 were preceded by an incongruous context, and 12 were preceded by a neutral context. In Experiment IV, the neutral context was "It was the — ”, and in Experiment V it was a random sequence of three, four or five content words.

The eight sets of items were chosen so that each target word appeared in all three context conditions, but no subject saw the same target word or the same context more than once. Incongruous items were produced by replacing the target word of a congruous item by one of the congruous targets from another set. In no case did a set include a target word and its congruous context which occurred in different items.

Procedure

Naming times were obtained for the target words under exactly the same conditions as in
Experiment I. The only difference between Experiments IV and V was the composition of the neutral context items.

Subjects
A total of 48 volunteer undergraduates served as subjects, half in each experiment. Subjects were paid for their participation in the experiment.

Results and discussion
The mean naming times for easy and difficult targets are shown in Table V. Considering first the results for Experiment IV, in which the neutral context of

<table>
<thead>
<tr>
<th>Target</th>
<th>Experiment IV Congrous</th>
<th>Incongruous</th>
<th>Neutral (It was the —)</th>
<th>Experiment V Congrous</th>
<th>Incongruous</th>
<th>Neutral (Word-list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>498</td>
<td>517</td>
<td>517</td>
<td>497</td>
<td>520</td>
<td>507</td>
</tr>
<tr>
<td>Difficult</td>
<td>570</td>
<td>591</td>
<td>587</td>
<td>581</td>
<td>599</td>
<td>588</td>
</tr>
<tr>
<td>d</td>
<td>72</td>
<td>74</td>
<td>70</td>
<td>84</td>
<td>79</td>
<td>81</td>
</tr>
</tbody>
</table>

Stanovich and West (1981) was used, it can be seen that a predominantly facilitatory effect of context was obtained. The main effect of context was significant, \( \text{min } F' (2, 352) = 7.19, P < 0.01 \), with a facilitatory effect of 18 ms for congruous targets, and an inhibitory effect of only 2 ms for incongruous targets. Individual comparisons with the neutral context showed a significant effect for the congruous targets, \( \text{min } F'(1, 50) = 8.40, P < 0.01 \), and a non-significant effect for incongruous targets, \( \text{min } F'(<1 \text{ (} F_1 \text{ and } F_2 < 1 \text{).} \) Easy targets were named faster than difficult targets, \( \text{min } F''(1, 68) = 60.76, P < 0.001 \), but there was no interaction between the difficulty effect and the context effect, \( \text{min } F'(<1 \text{ (} F_1 \text{ and } F_2 < 1 \text{).} \)

A different pattern of results emerges for Experiment V, in which a random word list was used as a neutral context. Congruous targets showed a facilitatory effect of 8 ms, while incongruous targets showed an inhibitory effect of 13 ms. Individual comparisons showed that the facilitatory effect for congruous targets was not significant, \( \text{min } F'(1, 39) = 2.04, P > 0.05 \text{ (} F_1 = 3.24, F_2 = 5.50 \text{), while the inhibitory effect for incongruous targets was significant, } \text{min } F'(1, 91) = 4.68, P < 0.05. \) As in Experiment IV, easy targets were named faster than difficult targets, \( \text{min } F'(1, 39) = 53.56, P < 0.001, \) and there was once again no interaction between this factor and the context effect, \( \text{min } F'(<1 \text{ (} F_1 \text{ and } F_2 < 1 \text{).} \)

The results of these two experiments first of all establish that there is no empirical disagreement between the results reported in this paper and those of Stanovich and West (1979, 1981). A predominantly facilitatory pattern of context effects can be obtained if a neutral context such as \( \text{It was the —} \) is used. However, if a random word list is used, a mixed pattern results, in which the only
secure result is an inhibitory effect. In other words, the question of facilitation v. inhibition probably can be settled only by producing decisive arguments in favour of one type of neutral context over another.

The second result of interest is the failure to obtain any interaction between the difficulty of the target and the context effect. As Table V shows, the magnitude of the difficulty effect is remarkably constant across the three context types in both experiments, although subjects in Experiment V tended to show a larger overall effect. Stanovich and West (1981) reported a quite different result, with difficult targets producing larger context effects than easy targets. As they point out, the difficult targets were not only less predictable than the easy targets, they were also of much lower frequency. Hence it is of interest to note that Schuberth et al. (1981) have recently reported no interaction between frequency and context, and it might be argued that the present results are in fact a confirmation of their findings.

One possible explanation of this result is that the interaction reported by Stanovich and West was due to occasional trials with unusually long latencies. Since latencies were trimmed in the present experiments by imposing cutoffs, it is possible that an interactive effect was accidentally eliminated. However, this proved not to be the case. Renanalysis of the results without imposing any cutoffs produced only trivial alterations of the means.

**General discussion**

The research reported here raises serious doubts about the existence of a priming effect based on the semantic properties of a sentence context. At a purely theoretical level, arguments have been proposed which show that the priming action would have to be based on the independent enumeration of each of the possible completions of the sentence. No other alternative seems possible, since the plausible completions for most sentences are unlikely to be functionally interconnected. This argument implies that, at best, the priming action would be limited to one or two highly predictable completions. However, results using the naming task suggest that even this conclusion is too strong, since there was no significant facilitation effect even for highly predictable completions.

Adherents of the view that there is a genuine priming effect from a sentence context must cope with the fact that even when a lexical decision task is used, there is no generalised priming effect for the set of appropriate but unexpected completions. It appears that the only way to cope with this fact is to argue that the control conditions are somehow inappropriate, i.e., that they produce underestimates of the true latencies in the absence of context. Such an argument will be difficult to justify, since any errors in the selection of a control condition would be more likely to produce overestimates. That is, if a range of otherwise equally suitable control conditions produced different estimates of baseline performance, then it seems one would be justified in selecting the fastest estimate as the most suitable. However, there are other criteria that could be proposed. For example, in a lexical decision experiment it could be suggested that a suitable neutral context should produce no effect for nonwords, as was the case for the random word list in
the present experiments. Since a nonword effect is extremely difficult to interpret in terms of contextual processes, it could be argued that it is diagnostic of an inappropriate measurement of the baseline.

The major impact of the reinterpretation of sentence context effects offered here is on formulations of the relationship between the lexical level of processing and higher interpretive levels. The results reported here argue that in reading at least, the lexical processor does not derive any benefit from inputs from higher levels, either syntactic or semantic. However, it is important to note that they do not necessarily rule out beneficial effects of context in other situations. For example, in the recognition of fluent speech, where the stimulus is highly degraded relative to words spoken in isolation (due to imprecise articulation, coarticulation effects, etc.), clear effects of context can be obtained, as shown in various monitoring studies (e.g. Marslen-Wilson and Tyler, 1975; Marslen-Wilson and Welsh, 1975; Morton and Long, 1976). However, these effects need not necessarily be priming effects, in the sense that context exerts its effect prior to the presentation of the target, as suggested by the work of Leventhal (1973), who reported stronger effects of a post-target context than a pre-target context in speech recognition. Such effects might instead reveal the operation of a post-access disambiguation procedure, in which one of several possible analyses provided by the lexical processor is selected on the grounds of compatibility with the overall context. The error-checking process discussed earlier is a variant of this proposal. It should be noted that from the standpoint of ordered-search models of lexical access, the results of Schuberth et al. (1981) could be taken as strong evidence for a post-access mechanism. They reported that the effect of frequency on lexical decision time was constant across a wide range of predictability. If the frequency effect is interpreted as an index of the duration of the search for the correct entry, then this result implies that context has no effect on the search process. Hence one must appeal to post-access mechanisms to explain the context effect.

Admittedly, there are some situations in which this does not seem to be particularly likely. For example, Marslen-Wilson (1976) points out that shadowing of speech inputs often involves such short latencies that the pronunciation of the target word begins before presentation of the target word has been completed. Essentially, subjects are identifying the target word on the basis of just its first syllable. Unfortunately, the interpretation of this result requires a precise distinction between perception of the target word, and guessing. In the visual domain, it has long been appreciated that a sentence context will enhance recognition of tachistoscopically presented words (e.g. Tulving and Gold, 1963), but it has also been accepted that this may be due to sophisticated guessing, i.e., guessing what the target word must have been on the basis of fragmentary cues, plus knowledge of context. How sophisticated guessing occurs is an open question. It might occur as a result of a pre-stimulus priming action, so that the correct detector fires even though only fragmentary information from the stimulus is available. If it does, then this would count as a clear violation of the autonomy principle, and would support an interactive view. But if this were really the case, then a similar effect should also be observed when the stimulus is intact, and speed of recognition rather
than accuracy is the dependent variable. Of course, as we have seen, there is little evidence to support this claim.

Further support for the autonomy position has been provided recently by Swinney (1979), and Tanenhaus, Leiman and Seidenberg (1979). These experiments have shown that both entries of an ambiguous word are accessed even when only one of the entries is appropriate to the preceding sentence context. This suggests that the apparent selective function of context occurs after access, not before. It is particularly interesting to note that this conclusion does not appear to be warranted when a lexical context is used rather than a sentence context (Schvaneveldt, Meyer and Becker, 1976). This is added evidence that the action of a lexical context is fundamentally different from that of a sentence context. Schuberth et al. (1981) have also drawn attention to possible differences between lexical and sentential context effects, pointing out that lexical contexts modify the frequency effect obtained for the target word, whereas sentence contexts do not. However, they do not propose that different mechanisms are involved; they assume a priming action in both types of context, but that the set of entries primed is far larger for a sentence context than for a lexical context, and is generated more slowly. What is being proposed in this paper is more radical, in that the reality of the sentential priming effect is denied altogether, and such effects as are obtained with a sentence context are interpreted as post-access effects.

It might be argued that this distinction between types of context cannot be sustained, since contexts that are appropriate to a target word are also likely to contain words which are lexically related to the target. There are two points to be considered here. First, it need not always be the case that lexical and sentence context effects are confounded. For example, it is possible to have even a highly predictable target without there being any word in the context related to the target. Examples drawn from the items used in Experiment I1 are as follows: It is a good idea to clean your teeth every day; During the heavy storm, water came in through the window; When not in use, the vacuum-cleaner is kept in the cupboard. Second, even in cases where the context does contain a related word, there is apparently no detectable effect, since otherwise the appropriate but unexpected targets would have shown a facilitation effect.

By way of conclusion, it may be useful to summarise the argument proposed here as follows:

(1) The strongest evidence against the view that the lexical processor is autonomous would be a generalised priming effect of a sentence context across a wide range of possible completions (since the effects for highly predictable completions are open to alternative explanations).

(2) With random word lists as a neutral context, no such effect occurred in either a naming task or a lexical decision task (i.e. there was no context effect for unexpected appropriate completions).

(3) While Stanovich and West (1981) do obtain evidence for a priming effect (i.e. the effect for difficult congruous items), this depends on using their particular type of neutral context.

(4) Lexical priming effects do not appear to be limited in the same way, since they occur both for the naming task and a lexical decision task, and across a range of
neutral contexts (e.g. in Experiment II, priming occurs whether the neutral context is taken to be a row of Xs or an unrelated word).

(5) It is hypothesised that in fact there is no pre-access priming effect of a sentence context, while there may be such an effect for a lexical context. This lexical effect, however, does not compromise the assumption of an autonomous lexical processor.

**Appendix**

*Materials for Experiment I*

Below are listed the 39 contexts with Predictable, Appropriate and Inappropriate completions listed in that order.

In the long grass the horses were quietly grazing/standing/flying.
It is a good idea to clean your teeth every day/morning/month.
Many seagulls huddled together on the beach/rocks/custard.
Mandy received lots of lovely cards on her birthday/engagement/conviction.
On the wall were several framed pictures/prints/dinners.
During the heavy storm water came in through the window/cracks/ears.
Budget changes invariably mean taxation increases/adjustments/bargains.
Would you like sugar in your tea/cocoa/shoes?
Frosts in Brazil have caused coffee prices to rise/alter/listen.
They could see snow on the distant hills/plain/idea.
Scuba divers enjoy exploring the ocean/seabed/stomach.
If you want to do a good job you should use sharp tools/pins/paper.
Use a spanner to tighten the nut/wheel/butter.
The marble slab was polished thoroughly before being used/laid/eaten.
Helen had to wear glasses for reading/driving/growing.
Some gum-trees can unexpectedly drop their leaves/branches/heads.
Allen drove to Sydney using his own car/sedan/grain.
Hurry up and put your clothes on/down/last.
Kevin was putting vegetable seedlings into the garden/hothouse/clock.
The builder and the architects discussed the plans/problems/dolphins.
The very sick child was given several blood transfusions/types/containers.
Philip carelessly splashed paint on his trousers/books/tail.
During their trip they bought many interesting souvenirs/objects/sermons.
There was several pieces of cake left on the plate/shelf/native.
Wendy chased a ball in front of a car/tram/face.
Stir the contents before starting to cook/paint/smell.
Please put the torn newspaper into the bin/bag/vase.
When not in use the vacuum-cleaner is kept in the cupboard/laundry/garden.
Once at the beach the children raced for the water/pier/snow.
Not everyone in Grade One can read/add/perch.
The incinerator was crammed full of rubbish/leaves/cattle.
Dianne accidentally cut her finger on the glass/blade/jelly.
A capital letter should be used to begin each sentence/paragraph/journey.
Stuart quickly tore a page from his book/diary/dinner.
The child scored very well in the test/event/harbour.
Alice hummed away quietly while she worked/drove/melted.
The little girl was lying beneath the swing with a broken leg/back/pencil.
The anxious mothers smoked many cigarettes while they waited/argued/slept.
From the kitchen came the delightful smell of freshly ground coffee/herbs/rice.
**Materials for Experiment III**

Below are listed the Appropriate and Inappropriate versions of the Unfocussed sentences.

Before leaving, Donna made a cake/foal.
They were all busy looking for clues/sounds.
The couple decided to grow maize/holes.
Sue handed Carol the towel/building.
Sandra quickly opened the letter/smoke.
Billy took photographs of trees/decisions.
Every Saturday they gather to sing/panic.
You should not waste your money on gambling/toenails.
He asked the doctor to look at his ear/hammer.
All his life Charles had wanted to learn judo/sleeping.
He was the only one to wear a hat to the opera/bathroom.
Father sent Pam to the shops to buy some tissues/echoes.
They did their best to salvage the project/grandfather.
Through the window they could see two sentries/germs.
What did Colin say about your new wife/oasis?
Jimmy happily bought two parrots/roads.
At least once a week they ate oysters/pencils.
Most Australian children like picnics/baskets.
Keith enjoyed eating plums/noise.
Judy enjoyed reading about horses/crumbs.
Steven cut through the bandage/milk.
Peter asked his uncle for a lift/planet.
Janet wrote requesting a leaflet/sultana.
The nervous child chewed at her nails/nose.
He spent a lot of time inspecting machinery/shavings.
Celia made a lot of money from selling her pottery/lungs.
Elizabeth realised she had run out of time/surface.
Rod does not like to work in the rain/oven.
Nothing is more important than health/skating.
Tim was very fond of green velvet/whiskers.

**References**


PRIMING FROM SENTENCE AND LEXICAL CONTEXTS


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