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On Priming by a Sentence Context

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SUMMARY

The results of 11 experiments on the effect of sentence context on word recognition converge on a general model of context effects during reading. Previous investigations of sentence context effects on word-naming time have uncovered a pattern of facilitation dominance. Another recurrent finding has been that words that are more difficult to recognize in isolation display larger context effects than easier words. The experiments reported here show these effects to be robust and serve to eliminate several alternative explanations. Two experiments demonstrated the appropriateness of the neutral condition used to assess facilitation and inhibition. Another experiment showed that the effects were not dependent on the particular experimental procedure that was used. It was shown in three separate experiments that manipulations that were designed to affect subject strategies did not change the pattern of results. The context effects obtained in sentence context situations do not seem as amenable to strategy manipulations as are the effects obtained in single-word priming experiments, probably due to the continuous comprehension demands of the sentence context situation that are not present in single-word priming experiments. Three experiments are reported where an interaction between stimulus quality and context condition is obtained. The interaction replicated across two different forms of stimulus degradation, but only one form increased inhibition effects as well as facilitation effects. It was concluded that previous inconsistencies in sentence context experiments regarding the presence of a Context × Stimulus Quality interaction were due to the small size of the stimulus quality main effect in some experiments. Other inconsistencies between previous sentence context experiments in the magnitude of the inhibition effects observed were resolved in the last three experiments by showing that a sentence context produces more inhibition in the lexical decision task than in the naming task. It was found that the same stimuli that had produced inhibition dominance in the lexical decision experiments of Fischler and Bloom (1979, 1980) displayed facilitation dominance in a naming task. Experiment 11 directly demonstrated that the two tasks produce different amounts of inhibition when the same stimuli are used. Sentence integration processes that occur after lexical access appear to be responsible for some of the inhibition observed in lexical decision tasks. It was concluded that research from a variety of paradigms is converging on a model where lexical access during reading is characterized as an automatic subroutine that is not guided by conscious contextual expectancies but can be facilitated by an automatic process of spreading activation in semantic memory. However, because lexical access occurs so rapidly, message-level comprehension processes can detect a semantic anomaly even within a single eye fixation. Finally, lexical access during reading is characterized by compensatory interactions of two types. First, slowed word recognition will automatically result in greater contextual facilitation because logogen threshold changes due to spreading activation will have a larger effect when the rate of stimulus processing is decreased. Disruptions in the data-driven word recognition subroutine may also induce the executive processor to expend attentional resources at the lexical level, perhaps in the form of contextual expectancies. However, the latter form of compensatory interaction may have negative effects on message-level comprehension processes, due to a redirection of cognitive resources.

Theories of the reading process must deal with an issue that reappears in many areas of cognitive psychology, that of determining how stimulus information and prior knowledge combine to result in a percept, memory representation, or response. This problem has been at the forefront of much of the recent research on the effect of context on ongoing word recognition during reading. Despite an increasing amount of research activity, the literature on the nature of the interaction between various stimulus factors and contextual information in the sentence context situation still contains several empirical and theoretical ambiguities. The purpose of this article is to address some of these ambiguities.

In a 1977 article, Schuberth and Eimas introduced a method of studying sentence context effects on visual word recognition that involved having subjects make a lexical decision about a letter string that had been preceded by an incomplete sentence. Compared with a neutral condition, subjects responded faster to a word preceded by a congruous context (an effect hereafter called *contextual facilitation*) and slower to a word preceded by a context that made the word incongruous (an effect hereafter called *contextual inhibition*). West and Stanovich (1978) used a similar paradigm but instead had the subject name the terminal word. Subsequent studies using the latter paradigm (Stanovich & West, 1979, 1981; Stanovich, West, & Feeman, 1981; West & Stanovich, 1982) have yielded results that put several constraints on models of sentence context effects on word recognition. This article focuses on three of the most robust and constraining of these data patterns (see Stanovich & West, 1979, 1981; West & Stanovich, 1978, 1982, for details): (a) Contextual effects are larger for words that are more difficult to recognize in isolation. This effect occurs even when the more difficult words are *less* predictable from the preceding sentence context than are the easier words. (b) Contextual effects are larger when the target word is degraded by contrast reduction. (c) In general, when the target word is not degraded, and particularly when the word is easy to recognize in isolation, performance tends to be facilitation dominant (that is, facilitation effects are more pronounced than inhibition effects). A typical set of results is displayed in Table 1.

Using these basic trends as a data base and building on the theoretical ideas of Posner and Synder (1975a, 1975b) and Neely (1976, 1977), we have argued that recognition during normal ongoing reading is not guided by conscious expectancies but instead can be facilitated by an inhibitionless spreading activation mechanism. However, alternative theoretical explanations for each of the findings do exist. Furthermore, other experiments in the published literature that have used somewhat different methodologies have sometimes not produced results consistent with those listed above. The experiments reported here represent an attempt to resolve at least partially the theoretical and empirical inconsistencies in the literature.

The first studies we report are focused on methodological issues that are related to the stability and generality of the data patterns observed. These methodological issues are of particular relevance to the paradigms used to study sentence context effects on word recognition. That is, before engaging in further

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Table 1
Mean Reaction Times (in msec) and Mean Percentage of Errors

Word type	Congruous M	Congruous % E	Neutral M	Neutral % E	Incongruous M	Incongruous % E	Facilitation	Inhibition	Overall context effect
Easy	746	.0	785	2.6	774	2.6	39	−11	28
Difficult	891	2.6	986	4.7	997	6.3	95	11	106

Note. % E = percentage of errors. (Adapted from "The Effect of Sentence Context on Ongoing Word Recognition: Tests of Two-Process Theory" by K. E. Stanovich and R. F. West, *Journal of Experimental Psychology: Human Perception and Performance*, 1981, *7*, 658–672. Copyright 1981 by American Psychological Association. Reprinted by permission.)

theoretical speculations and empirical extensions, we thought it desirable to make sure that the basic data patterns were on firm footing. It is unfortunately true that many research areas in cognitive psychology have been plagued by findings that either do not replicate or are changed by relatively minor experimental variations. Given some previous conflicts in the literature on context effects on word recognition, we thought it particularly important to address these methodological considerations.

Methodological Issues

In sentence context experiments of the type cited above, it is very difficult to control one particular methodological feature, the amount of time elapsing between the subject's reading of the context and the presentation of the target word. Our procedure differs from that of Schuberth and Eimas (1977) and from that of Fischler & Bloom (1979) in this respect. They presented the context for a fixed interval during which the subject read the sentence silently. In our experiments, subjects read the contexts out loud, and the experimenter presented the target immediately after the subject's articulation of the last context word. It should be clear that both procedures introduce variability into the context-processing/target-processing interval. In our procedure the inherent variability in the experimenter's presentation times is the cause of the variance. It is important to note that the fixed presentation procedure does not remove this variability, it merely transfers it from the experimenter to the contexts, which differ in the amount of time required to read them. The point is not that either procedure is preferable but that it is probably important to ascertain whether results replicate across the two procedures. Thus, in Experiment 1 we assessed the effect of congruous, neutral, and incongruous contexts on word naming time using a fixed interval procedure.

Experiment 1

Method

Subjects. The subjects were 24 undergraduate students recruited through an introductory psychology subject pool.

Stimuli and apparatus. A total of 192 sentences were constructed so that their last two words were the words *the* and a noun that was predictable from the preceding context (e.g., *the skier was buried in the snow*). The 192 sentences were composed of 96 pairs. The 2 sentences that made up a pair were identical except for their terminal words (e.g., *the skier was buried in the snow* and *the skier was buried in the avalanche*). Thus there were 96 sentence contexts; each one had two target words. One of the target words in a pair was a relatively easy word (e.g., *snow*), and the other was a relatively difficult word (e.g., *avalanche*). The mean number of letters in the easy words was 5.0 (SD = 1.3), and the mean number of letters in the difficult words was 7.4 (SD = 2.1). According to the Kucera and Francis (1967) count, the mean frequency of the easy words was 124.3, and the mean frequency of the difficult words was 7.1.

A pilot study in which the sentence contexts were presented to 25 college students as a cloze task produced data indicating that the difficult words were less predictable. Across all contexts the easy target word was predicted 43% of the time on the subject's first guess, whereas the difficult target word was predicted only 11% of the time on the subject's first guess. An effort was made to assess the strength of the relationship between the target words and the critical content words of the context. For each sentence, each target word was paired with the noun that was the subject of the sentence and the main verb of the sentence. The resulting four pairs were randomly assigned to one of four lists. Each list was shown to a separate group of 30 subjects. Thus, no subject saw a target word more than once. Subjects made a judgment as to how related the word pair was on a scale from 1 to 5, where 5 indicated a high degree of relationship. Across all contexts the mean relatedness rating, when the target was paired with the sentence subject, was 3.32 for the easy words and 3.37 for the difficult words, a difference that did not approach statistical significance. When the target was paired with the main verb, the mean relatedness rating was 2.68 for the easy words and 2.79 for the difficult words, a difference that also did not approach significance. Thus, although the easy words were more predictable, the easy- and difficult-word sets were equally related to words in the context. The 96 contexts were organized into 48 pairs (e.g., *the skier was buried in the* was paired with *the bodyguard drove the*). Incongruous sentences were formed by combining target words from one member of the pair with the context of the other. The neutral context condition was the incomplete sentence *they said it was the*. The complete set of stimuli is presented in Appendix A of the Stanovich and West (1981) article.

The stimuli were presented on a BMC CRT monitor with a refresh cycle of 16.7 msec under the control of an Apple II microcomputer. A Mountain Hardware Clock, telegraph keys, and a Lafayette Instruments voice key were all interfaced with the computer to enable the collection of naming times. All letters were uppercase and were presented at a viewing distance of approximately 64 cm. Five-letter words subtended a horizontal visual angle of approximately 1.88°, and the space between words, approximately .45°. When the target word was presented, it was in the position it would have occupied had the complete sentence been presented. A button press by the experimenter initiated the onset of the context. The context was presented for 2,500 msec (an estimate, based on four subjects, of the amount of time needed to read the contexts out loud; corresponding reading rate = 120 wpm) before the target word appeared.

Procedure. Subjects were individually tested in a session that lasted approximately 30 min. They were told to look at the screen and to read silently the sentence contexts that appeared. Subjects were instructed to name the target word as rapidly as possible when it appeared. Each subject received a random ordering of 12 practice trials consisting of 2 trials given under each of the six conditions formed by the factorial combination of context (congruous, incongruous, neutral) and word difficulty (easy, difficult). Following the practice trials, each subject received a random ordering of 72 experimental trials, consisting of 12 trials given under each of the above six conditions. The assignment of target words from the total population was counterbalanced across subjects so that each word was presented equally often under each of the three context conditions. No subject saw the same target word or sentence context more than once in the course of the experiment, and no subject saw more than one member of an easy–difficult word pair. When sentence contexts were used in incongruous context trials, the deleted terminal words from the original sentences were never seen by the subject.

Results and Discussion

Trials on which some type of experimental malfunction occurred (e.g., the vocal response was too soft for the relay setting) were dropped from the data analysis. Trials on which the subject articulated the wrong word or had a response time that was either longer than 2,000 msec or longer than 2.5 standard deviations above the mean for that condition were scored as subject errors and also dropped from the analysis. The mean reaction times and the mean percentage of subject errors for all of the experimental conditions are displayed in Table 2. Also contained in Table 2 are the magnitudes of the overall context effect (the difference between the congruous and incongruous conditions), the facilitation effect (the difference between the congruous and neutral context conditions), and the inhibition effect (the difference between the neutral and incongruous conditions). All of analyses that follow are based on the subject's mean reaction time in each condition.

An analysis of variance (ANOVA) on the reaction times indicated that the effects of word difficulty, $F(1, 23) = 73.5$, and context condition, $F(2, 46) = 19.7$, were significant at the .001 level. The Word Difficulty × Context Condition interaction was statistically

Table 2
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 1

Word type	Congruous *M*	Congruous % E	Neutral *M*	Neutral % E	Incongruous *M*	Incongruous % E	Facilitation	Inhibition	Overall context effect
Easy	592	2.1	617	2.1	628	1.0	25	11	38
Difficult	702	4.2	783	5.6	794	4.9	81	11	92

Note. % E = percentage of errors.

significant, $F(2, 46) = 4.78$, $p < .025$, indicating that the previous finding, that difficult words displayed larger context effects, was replicated. Planned comparisons indicated that the only component of the overall context effect that was separately significant at the .05 level was the 81-msec facilitation effect for the difficult words ($p < .001$). Within each condition of word difficulty, the error rates were relatively stable across context condition. To the extent that the error rates in the neutral and incongruous conditions are different, the difference is in the direction opposite to an inhibition effect (thus, attenuating the nonsignificant 11-msec effects that were observed). Error rates were higher for more difficult words. This pattern of error rates will be recapitulated in virtually all of the studies to be presented in this article. That is, the error rates are either low and fairly constant across context condition or are correlated with context condition in ways that serve to reinforce the conclusions drawn. Thus, the error rates in subsequent experiments are not discussed extensively but are mentioned only when they serve to qualify the conclusions drawn from the reaction times.

The results of Experiment 1 are easily summarized. The basic data patterns previously observed with the experimenter-initiation procedure were replicated with a fixed-interval procedure. Difficult words displayed larger context effects, and both word sets displayed facilitation dominance. The magnitudes of the effects were similar to those obtained with the experimenter-initiation procedure (see Stanovich & West, 1981, and several experiments reported below).

Experiment 2

Although the finding of larger overall context effects for difficult words is not dependent on the neutral condition, the correct partitioning of context effects into facilitation and inhibition is obviously dependent on the choice of an appropriate neutral condition. We have used the neutral condition *they said it was the* because it was not predictive of any of the target words, nor did it contain words related to any of the targets. One way to assess empirically the adequacy of a neutral condition is to see whether several different conditions that should all be neutral actually yield the same pattern of results. Such a direct comparison of three different neutral conditions is attempted in Experiment 2 (another such comparison is contained in Experiment 9), although it should be noted that across several different studies (Stanovich & West, 1979, 1981; West & Stanovich, 1982) the basic findings of facilitation dominance and greater contextual effects for difficult words have already been replicated using three different neutral conditions (*the, the the the, they said it was the*).

Table 3
Examples of Stimuli

Condition	Context	Target
Congruous	the banker locked the	*hidden* safe
Congruous	the train pulled into the	*tiny* depot
Neutral	they said it was the	*hidden* safe
Neutral	they said it was the	*tiny* depot
Incongruous	the train pulled into the	*hidden* safe
Incongruous	the banker locked the	*tiny* depot

In Experiment 2 we attempted an additional empirical attack on the question of the adequacy of the neutral condition by using the following simple logic. If two sentence context conditions that did not yield a context effect were constructed, one could then embed within them neutral conditions that, if they are appropriate controls, should yield times equivalent to the other two. This we accomplished in Experiment 2 where we used as targets, not the terminal noun of the sentence, but instead a word that modified the noun. The modifier was chosen so as not to be predictable from its congruous context. Neither was it related to the words in the context. Examples of the materials are given in Table 3. It should be clear that with such words, repairing the targets with incongruous sentences should have little effect on modifier naming, because there is no predictability or semantic relatedness to be disrupted. Within these conditions we embedded the neutral conditions *they said it was the*, *the next word will be* (a neutral condition recently used by McClelland & O'Regan, 1981), and *they were thinking about the* (chosen to have the same characteristics of nonassociation with target words and lack of predictiveness).

Method

Subjects. The subjects were 24 undergraduate students recruited through an introductory psychology subject pool.

Stimuli and apparatus. The 96 sentence contexts and corresponding pairs of easy and difficult terminal nouns used in Experiment 1 (see Appendix A of Stanovich & West, 1981) were used as stimuli. A word (either a noun or an adjective) that modified the terminal noun was inserted into each completed sentence (e.g., *The whale was injured by the ship/harpoon* became *The whale was injured by the first ship/harpoon*). Thus, the last three words of each sentence were the word *the*, a word that modified the sentence's last word, and a noun that was congruous with the sentence's preceding words.

The words that modified the terminal nouns were selected to be neutral with respect to the context (i.e., they were not predictable from or highly associated with the sequence of words in the prior context). Thus, the modifier *first* was considered to be neutral with respect to the sentence context *The whale was injured by the.* Only 48 neutral modifiers were used, so that each modifier occurred with two different sentence contexts. Repetitions of a modifier during an experimental session were always separated by at least 30 trials.

The sentences were organized into pairs (e.g., *The whale was injured by the first ship/harpoon* was paired with *The skier lived in the simple house/chalet*). The last two words (the modifier and the noun) of each sentence were then deleted. The resulting incomplete sentences were used as sentence contexts, and the deleted two words were used as modifier plus word (MW) targets. A sentence context and an MW target were considered to be congruous when they had been derived from the same original sentence. A sentence context and an MW target were considered to be incongruous when they had been derived from opposite members of the original sentence pair (e.g., *The skier lived in the* was considered incongruous with the MW target *first ship/harpoon*). Across all MW targets, the mean number of letters in the modifiers was 5.6. Three different neutral sentence context conditions were created by presenting either *They said it was the*, *The next word will be*, or *They were thinking about the* before an MW target. The apparatus used was described in Experiment 1.

In this experiment we used the experimenter target-initiation procedure that had been used in previous studies (e.g., Stanovich & West, 1979, 1981). Prior to the collection of the data, the experimenter was given extensive practice in synchronizing the pushing of the control button with the articulation *the* (the context word that always immediately preceded the target modifier). Of course, some time invariably elapsed between the subject's articulation and the experimenter's button press. However, the experimenter tried to minimize this time by attempting, on all trials, to synchronize his button press with the articulation of *the* such that the button was activated as soon as possible after the end of the articulation of *the.* The experimenter was instructed to develop a criterion so stringent that it occasionally resulted in their pressing the button during the articulation of *the*, thus aborting the trial. There were only a few experimenter-aborted trials, but those that did occur were distributed approximately equally across all experimental conditions, indicating that the criterion was consistently applied.

Procedure. Subjects were individually tested in a session that lasted approximately 30 min. Subjects were told to look at the screen and to read aloud the sentence contexts that appeared. In addition, they were instructed to name the targets as rapidly as possible when they appeared. Although a target consisted of both a modifier and a terminal noun, the subjects were told to name only the modifier. In addition, the subjects were instructed that only the vocal response to the modifier was timed, so they were free to read the contexts at a comfortable pace.

Each subject received a random ordering of 12 practice trials consisting of 2 trials given under each of the six conditions formed by the factorial combination of context (congruous, incongruous, neutral) and target type (a modifier followed by either an easy or difficult target). Following the practice trials, each subject received a random ordering of 72 experimental trials consisting of 12 trials given under each of the above six conditions. The 24 trials presented under the neutral condition were divided equally between the three different neutral sentence contexts. The assignment of targets from the total population was counterbalanced across subjects so that each MW target was read equally often under each type of context condition. No subject saw the same MW target or sentence context more than once in the course of the experiment. When sentence contexts were used in incongruous context trials, the deleted terminal words (the modifier plus noun pair) from the original sentences were never seen by the subject.

Results and Discussion

Across all conditions, the mean reaction time to the modifier when the terminal noun was an easy word was virtually identical to the mean time when the terminal noun was a difficult word, so this variable will not be considered further (although this finding could be viewed as further supporting evidence that the characteristics of words in the right parafovea do not affect current processing; see Stanovich & West, 1983). The mean reaction times and mean percentage of subject errors in Experiment 2 are displayed in Table 4. A one-way ANOVA on the reaction times indicated that the effect of context condition was not significant, $F(4, 92) = 1.39$.

The results of this experiment provide strong support for the argument that a neutral condition used in several previous experiments (Stanovich & West, 1983; West & Stanovich, 1982; Experiment 1 and the rest of the experiments in this article) is an appropriate one to use in partitioning context effects into facilitation and inhibition. As expected, the materials and design of this study resulted in similar times for the congruous and incongruous conditions. The time for *they said it was the* was the same as that displayed in the two context conditions. Thus, the neutral *they said it was the* produced times indistinguishable from those displayed in a sentence context situation that did not produce a context effect, a finding that suggests that the processing requirements of our neutral condition do not systematically bias reaction times in either direction. Additional converging evidence on this point is provided by the fact that the three neutral conditions did not differ significantly from each other. Even a planned comparison between the mean times in the *the next word will be* (which, when compared with the two other context conditions, appears to underestimate neutral response times) and *they said it was the* neutral contexts did not reach statistical significance ($.05 < p < .10$). In the absence of any contraindicative evidence, we feel reasonably safe in using the context *they said it was the* as a neutral condition (see also Experiment 9 below).

Table 4
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 2

	Context condition					
	Congruous		Neutral		Incongruous	
Neutral condition	*M*	% E	*M*	% E	*M*	% E
they said it was the	484	.9	485	.0	485	.5
the next word will be			471	.5		
they were thinking about the			485	.0		

Note. % E = percentage of errors.

Strategy Manipulations

We have previously argued (West & Stanovich, 1982) that sentence context effects in ongoing word recognition are caused by an automatic spreading activation process rather than by strategies that involve the conscious prediction of upcoming words. The facilitation dominant pattern, as well as other aspects of the results that are discussed below, strongly suggests the operation of a spreading activation mechanism. If we are correct in this conjecture, then results from the sentence context paradigm should not be greatly changed by manipulations designed to affect subject strategies. In the next series of experiments we attempted three such manipulations.

Experiment 3

Perhaps the most striking finding to come out of the work on sentence context effects on naming latency is the fact that less predictable words can display larger contextual effects, provided that they are more difficult to recognize in isolation than the more predictable words. An additional finding was that both easy and difficult words displayed a pattern of facilitation dominance. These findings present difficulties for many current models of context effects on word recognition and are particularly troublesome for any model that accounts for contextual effects by positing a process whereby subjects consciously predict a particular target word. For example, the results cannot be accommodated by Becker's (1980) verification model, a model that has had considerable success in accounting for the results of single-word priming experiments, although it has not generally been applied to the sentence context situation (the exception is the work of Schuberth, Spoehr, & Lane, 1981). The verification model posits two strategies, the prediction strategy and the expectancy strategy, that result in facilitation dominance and inhibition dominance, respectively. According to Becker (1980),

> the important distinction to be made here is that between situations that allow rather specific predictions of related target words and situations that allow only general expectations to be formed. The basis for this distinction comes largely from the types of materials that produce the two patterns of results. On the one hand, stimulus materials that allow subjects to fairly well predict the related target produce facilitation dominance. On the other hand, materials that preclude prediction, but seem to allow a general expectation yield interference dominance. (p. 507)

Thus the verification model can perhaps account for the facilitation dominance shown by the easy words by assuming that their cloze predictability of 43% is "fairly well predictable." However, the model clearly seems to predict that the difficult words, due to their low predictability (11%), should display inhibition dominance, a pattern that is contradicted by the data.

There is, however, a crucial caveat to this apparent contradiction of the verification model. Easy- and difficult-word trials were mixed in our previous studies (Experiment 1; Stanovich & West, 1981; West & Stanovich, 1982; but see Stanovich et al., 1981). Thus, due to randomization, the subjects were precluded from adopting different strategies for the two word sets. It could be argued that subjects could well have adopted one particular strategy and maintained it throughout the entire experiment. Perhaps the presence of the more predictable easy words induced the subjects to adopt the prediction strategy, and this strategy was maintained despite the presence of less predictable difficult words (whose occurrence the subject could not have predicted, due to randomization), which by themselves would have induced the inhibition-causing expectancy strategy. In short, the alternative explanation of the facilitation dominance of the difficult words given by the verification model is that the contextual pattern was not due to any particular properties of the difficult words themselves but instead was due to the fact that they were embedded in a series of more predictable easy words that induced a strategy that was used during all trials. Becker (1980, Experiment 5) produced results from a single-word priming paradigm indicating that list mixing could possibly have such an effect. He found that category primes, which when blocked result in inhibition dominance, produced facilitation dominance when mixed with highly predictable associates and antonym primes (although the results are somewhat ambiguous due to the presence of a good deal of inhibition in the error rates).

It is quite easy to test whether it is possible for the verification model to account for the facilitation dominant pattern of the difficult words. This is done by blocking rather than mixing the easy- and difficult-word trials. If the account given by the verification model is correct, then the difficult words should produce inhibition dominance when they are blocked, particularly when the difficult block is the first that the subject completes (there could well be strategy carry-over effects when a difficult block follows a block of predictable easy words; see Becker, 1980). In Experiment 3 subjects named easy and difficult words preceded by congruous, incongruous, and neutral sentence contexts. Experimental conditions are similar to those of the Stanovich and West (1981) study, except that word difficulty was blocked in Experiment 3.

Method

This experiment was actually run twice. After completion of the first experiment (which will be called Experiment 3A), an exact replication was run using subjects from another university and a slightly different apparatus (this experiment will be called Experiment 3B). There were 32 subjects in each experiment.

The stimuli used in Experiments 3A and 3B were the same as those used in Experiment 1. The stimuli in Experiment 3A were typed on 10.2 × 12.7 cm cards in lowercase Letter Gothic font with an IBM Selectric II typewriter. One set of cards contained the sentence contexts, and another contained the target words. Approximately 70% of the contexts required two lines. In these cases the final letter in the last word of the top line was always two spaces directly above the final letter of the sentence context. The stimuli were presented via a Scientific Prototype tachistoscope at a viewing distance of approximately 76 cm. Five-letter words subtended a horizontal visual angle of approximately .72°. The contexts and the target words were presented in separate fields of the tachistoscope and were aligned so that if both were presented simultaneously, the stimuli looked like a complete sentence. Target-word onset was controlled by a button pushed by the experimenter that immediately caused the target to be displayed and simultaneously started a millisecond clock. When the subject responded verbally to the target, a voice-activated relay stopped the clock. In Experiment 3B the stimuli were typed on 6 × 90 in. (15.2 × 22.9 cm) cards in lowercase Letter Gothic font with an IBM Selectric II typewriter. The stimuli were presented via an Iconix tachistoscope at a viewing distance of 88.9 cm. No sentence required two lines. Five-letter words subtended a horizontal visual angle of approximately .62°. Both experiments used the experimenter-initiation procedure described in Experiment 2.

Following 12 practice trials, each subject completed two blocks of 36 experimental trials. One block contained only easy target words, and the other block contained only difficult target words. One half of the subjects received the easy block first, and one half of the subjects received the difficult block first. The assignment of words from the total population was counterbalanced across subjects so that each word was read equally often under each of the three context conditions. No subject saw the same target word or sentence context more than once in the course of the experiment, and no subject saw more than one member of an easy–difficult word pair. When sentence contexts were used in incongruous context trials, the deleted terminal words from the original sentences were never seen by the subject.

Results and Discussion

The mean reaction times and mean percentage of subject errors for Experiment 3A are displayed in Table 5. An ANOVA on the mean reaction times indicated that the effects of word difficulty, $F(1, 30) = 228.2$, and context condition, $F(2, 60) = 42.9$, were both significant at the .001 level. The Word Difficulty × Context Condition interaction was statistically significant, $F(2, 60) = 8.0$, $p < .005$, indicating that the previous finding that difficult words displayed larger context effects was replicated. There was no significant effect of block order ($F < 1$). The order factor did not interact with word difficulty, $F(1, 30) = 1.98$, $p > .10$, or context condition, $F(2, 60) = 2.89$, $.05 < p < .10$. The three-way interaction was not significant ($F < 1$). Planned comparisons indicated that in Block 1, the easy words displayed a significant 23-msec inhibition effect ($p < .05$), but the 17-msec facilitation effect did not reach statistical significance. In Block 1 the difficult words displayed facilitation ($p < .001$) but no inhibition. In Block 2 the easy words displayed facilitation ($p < .001$) but no inhibition. In the case of the difficult words, both the 47-msec facilitation effect and the 38-msec inhibition effect were statistically significant ($p < .001$ and .005, respectively).

The pattern of results from this experiment utilizing sentence contexts was unlike that of Becker's (1980) low-predictability single-word prime experiment. The difficult words did not shift to an inhibition dominant pattern when they were presented together and were in the first block that the subject completed. These relatively unpredictable words maintained a pattern of facilitation dominance even when they were blocked and not preceded by practice on congruous sentence frames that were always followed by the more predictable easy words. The order factor did not interact with context condition, and the three-way interaction was not significant. The basic finding that difficult words displayed larger overall context effects was found with both orders of presentation.

Although the predictions of the verification model were not confirmed, there was a slight trend in the results indicating that when an easy block was presented first, the facilitation and inhibition effects were of roughly equal magnitudes for both the easy words and the difficult words on Block 2. When the difficult block was presented first, there was facilitation dominance for both sets of words. However, there was no hard evidence for the reliability of this trend. The Order × Context Condition interaction did approach statistical significance ($.05 < p < .10$). Furthermore, there is evidence in the error rates that the apparent inhibition in the reaction times of the difficult words in Block 2 may have resulted from a speed–accuracy trade-off. The error rate in the neutral condition for these words was unusually high, 3.7% higher than the rate in the incongruous condition. Thus, the error rate difference goes in the direction opposite to the inhibition effect in the reaction times, indicating that a portion of the latter may be spurious. Despite the lack of strong evidence for a shift in contextual patterns based on block order, the theoretical importance of such an effect seemed to war-

Table 5
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 3A

Word type	Context condition: Congruous *M*	Congruous % E	Neutral *M*	Neutral % E	Incongruous *M*	Incongruous % E	Facilitation	Inhibition	Overall context effect
Block 1									
Easy	495	2.1	512	3.1	535	3.6	17	23	40
Difficult	605	5.2	692	3.6	703	2.6	87	11	98
Block 2									
Easy	472	1.6	516	2.1	513	2.6	44	−3	41
Difficult	608	2.6	655	9.4	693	5.7	47	38	85

Note. % E = percentage of errors.

Table 6
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 3B

Word type	Congruous M	Congruous % E	Neutral M	Neutral % E	Incongruous M	Incongruous % E	Facilitation	Inhibition	Overall context effect
Block 1									
Easy	694	.5	726	3.6	742	1.6	32	16	48
Difficult	795	1.0	868	1.6	884	2.1	73	16	89
Block 2									
Easy	584	1.6	613	3.1	627	2.1	29	14	43
Difficult	735	2.1	797	3.6	855	2.6	62	58	120

Note. % E = percentage of errors.

rant at least a follow-up of the suggestive trend displayed in Experiment 3A. Thus, Experiment 3B was run as a replication of Experiment 3A. The only difference between the two experiments was that a different apparatus was used.

The mean reaction times and the mean percentage of subject errors for Experiment 3B are displayed in Table 6. Also contained in Table 6 are the magnitudes of the facilitation, inhibition, and overall context effects. An ANOVA on the mean reaction times indicated that the effects of word difficulty, $F(1, 30) = 41.7$, and context condition, $F(1, 30) = 21.7$, were significant at the .001 level. The Word Difficulty × Context Condition interaction was significant, $F(2, 60) = 6.16$, $p < .005$, replicating the by now well-established result that more difficult words displayed larger context effects than easy words. There was no main effect of block order ($F < 1$), but block order did interact with word difficulty, $F(1, 30) = 11.47$, $p < .005$. The relative slowness of the difficult words was greater when they were in the first block. The crucial Block Order × Context Condition interaction was not significant ($F < 1$). The three-way interaction was also not significant ($F < 1$), indicating that the interaction between word difficulty and context condition was not modified by block order.

Planned comparisons indicated that in Block 1, the easy words displayed a 32-msec facilitation effect that did not quite attain statistical significance ($p < .10$). The inhibition effect did not approach significance. The difficult words displayed a 73-msec facilitation effect ($p < .001$), but did not show a significant inhibition effect. In Block 2 the facilitation effect for the easy words approached but did not attain significance. In Block 2 the difficult words displayed a statistically significant 62-msec facilitation effect ($p < .001$) and a 58-msec inhibition effect ($p < .005$).

Experiment 3B replicated the basic data patterns of Experiment 3A. Again, the predictions of the verification model were not confirmed. Difficult words did not produce a pattern of inhibition dominance when they were blocked and presented first. The Order × Context Condition interaction did not approach significance in Experiment 3B ($F < 1$). The tendency for difficult words to display larger context effects was not modified by block order (three-way interaction, $F < 1$). Unlike Experiment 3A, the easy words did not show a tendency to produce a mixed pattern of facilitation and inhibition when they were in Block 1. The difficult words did display such a tendency when they were in Block 2, although the trend is again attenuated by an error rate difference between neutral and incongruous conditions that is in the direction opposite to the inhibition apparent in the reaction times.

The results of Experiments 3A and 3B appear to justify the following conclusions. The data patterns involving easy and difficult words observed by Stanovich and West (1981; West & Stanovich, 1982) apparently were not the result of mixing easy- and difficult-word trials. When word type was blocked, the difficult words continued to display a larger context condition effect, regardless of which block came first. The critical condition, difficult words in Block 1, produced unequivocal results. Difficult words maintained a pattern of facilitation dominance. It is unclear how strongly we should interpret the trend toward more equal facilitation and inhibition for difficult words in Block 2. At least one thing is clear, however. Whatever the magnitude of such a change, it is not in the direction expected on the basis of Becker's (1980) data. The verification model, developed almost entirely within the context of single-word priming experiments, does not appear to be able to account for the pattern of results obtained from these experiments using a full sentence context.

Experiment 4

The failure to alter the data pattern by the blocking of words according to predictability in Experiments 3A and 3B (a manipulation that, at least according to the verification model, should have led to strategy shifts) is actually consistent with some other research indicating that the results in sentence context paradigms are strategy invariant. Forster (1979) discussed a study by O'Connor in which a sentence plausibility effect was shown not to depend on whether plausible sentences were blocked or mixed with implausible sentences. Using a lexical decision task, Fischler and Bloom (1979, Experiment 5) found that instructing the subjects to avoid generating expectancies from the context and to treat the reading of the sentence and the lexical decision as two separate tasks resulted in a pattern of results nearly identical to that obtained when such instructions were not given. Stanovich and West (1981, Experiment 1) examined another manipulation that was expected to affect subject strategies, that of varying the probability of a congruous trial. They found that increasing the proportion of congruous trials from 33% to 66% did not alter the pattern of facilitation dominance in their data.

In Experiment 4, the probability manipulation is again used but in the context of a more powerful test. The probability study of Stanovich and West (1981, Experiment 1) used the materials from the West and Stanovich (1978) experiments. Because those sentences were designed to be read by fourth-grade children and were very predictable, it could be argued that they were not ideal materials to use in a study where a probability manipulation was used in order to induce a strategy shift. In Experiment 4 the materials used in Experiments 1 and 3 (which were designed for adults) were used. Only the difficult target words were used in order to maximize the chances of observing a change in contextual pattern across conditions. Additionally, the Stanovich and West (1981) study contained no directly comparable "control" group. Rather, the results under the 66% condition were simply contrasted with previous results using a similar paradigm and 33% congruous targets. In Experiment 4 a directly comparable control group is used.

Method

The subjects were 32 undergraduate students recruited through an introductory psychology subject pool. The stimuli and apparatus were the same as in Experiment 1 except that only the difficult targets were used. The experimenter initiation procedure, described in Experiment 2, was used. Sixteen subjects were assigned to the 66% congruous condition where, subsequent to 6 practice trials, they completed 72 randomly ordered experimental trials, consisting of 48 congruous context trials, 12 neutral trials, and 12 incongruous context trials. The assignment of context conditions was counterbalanced across subjects so that each word appeared eight times with a congruous context, two times with a neutral context, and two times with an incongruous context. For the 16 subjects in the 33% congruous condition, each word appeared equally often under congruous, neutral, and incongruous context conditions. The neutral context was *they said it was the.* No subject saw the same target word or sentence context more than once in the course of the experiment.

Results and Discussion

The mean reaction times and mean percentage of subject errors for all experimental conditions are displayed in Table 7. An ANOVA conducted on the mean reaction times indicated that the effect of context condition was significant, $F(2, 60) = 16.7, p < .001$, but the effect of subject group failed to attain significance, $F(1, 30) = 2.72, p > .10$. More important, the interaction between subject group and context condition was not significant ($F < 1$). Planned comparisons indicated that the 43-msec facilitation effect shown by the

Table 7
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 4

Subject group	Congruous *M*	Congruous % E	Neutral *M*	Neutral % E	Incongruous *M*	Incongruous % E	Facilitation	Inhibition	Overall context effect
66% congruous	602	2.5	645	4.7	676	4.7	43	31	74
33% congruous	566	4.9	596	5.5	620	9.9	30	24	54

Note. % E = percentage of errors.

66% congruous group was statistically significant ($p < .01$). The 31-msec inhibition effect of that group and the 30-msec facilitation effect shown by the 33% congruous group did not quite attain statistical significance ($.05 < p < .10$, in both cases). The pattern of context effects for both groups was not completely facilitation dominant, due to the fact that only difficult words (which tend to show more inhibition) were used.

The results of this experiment can easily be summarized. The pattern of contextual effects was not altered by increasing the proportion of congruent trials. The Context × Subject Group interaction did not approach significance. Even the mild tendency for the 66% congruous group to show a larger overall context effect is balanced by the fact that the 33% congruous group displayed a larger effect in the error rates. To the extent that there is inhibition in the error rates in the 33% condition, note that it is not occurring in the condition that one would have expected if a higher congruous probability leads to greater use of a conscious prediction strategy.

Experiment 5

The results of Experiment 4 again confirmed the finding that a variable that would be expected to influence subject strategies did not alter the pattern of contextual effects. The results do not appear to result from a particular subject strategy, or at least not one that is readily manipulated. Nevertheless, in Experiment 5 we made another attempt to empirically solidify this conclusion.

It could be argued that the experimental procedure used in the previous studies was not one that would encourage strategic or "deep" processing of the context. Specifically, although the subject was required to read the context, he or she was not required to recall it or integrate it with the target word. Thus, the procedure may not encourage the subject to use the conscious semantic strategies that result in inhibition. In Experiment 5 one half of the subjects made a congruity judgment after naming the target word. It was expected that having to make a judgment as to the meaningfulness of the sentence would force the subjects to process the context more deeply. The pattern of contextual effects on word recognition displayed by these subjects was compared with that of a control group who were not required to make a congruity judgment.

Method

The subjects were 32 undergraduate students recruited through an introductory psychology subject pool. The stimuli and apparatus were the same as in Experiment 3B, except that only the difficult target words were used. The neutral condition was *they said it was the.* Subsequent to the practice trials a control group of 16 subjects completed the 72 experimental trails as in the previous experiments. The other 16 subjects made a congruity judgment immediately after naming the target word. They were simply asked to indicate whether or not the sentence was congruous or "made sense." Thus, a "yes" answer was appropriate for the congruous and neutral trials, and a "no" answer was appropriate for the incongruous trials. All other aspects of the procedure were as in Experiment 3.

Results and Discussion

Subjects were extremely accurate in their congruity judgments, making an average of less than one error per subject during the course of the experiment. The mean reaction times and mean percentage of subject errors for all of the experimental conditions are displayed in Table 8. An ANOVA on the mean

Table 8
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 5

Subject group	Context condition								
	Congruous		Neutral		Incongruous				Overall context effect
	M	% E	*M*	% E	*M*	% E	Facilitation	Inhibition	
Congruity judgment	768	3.7	862	3.1	893	4.2	94	31	125
No congruity judgment	658	2.1	739	3.7	758	4.7	81	19	100

Note. % E = percentage of errors.

reaction times indicated that the effect of subject group was statistically significant, $F(1, 30) = 4.42$, $p < .05$. Subjects who made the congruity judgments responded more slowly, possibly due to the increased processing requirement in this condition. The effect of context condition was statistically significant, $F(2, 60) = 28.1$, $p < .001$. The critical Subject Group × Context Condition interaction did not approach significance ($F < 1$). Planned comparisons indicated that both groups displayed significant facilitation effects of 94 and 81 msec, respectively ($p < .001$, in both cases). The control group did not display a significant inhibition effect ($p > .10$), whereas the 31-msec inhibition effect shown by the congruity judgment group approached significance ($.05 < p < .10$). In short, both groups displayed a pattern of facilitation dominance. The somewhat larger context effect (although not significant) shown by the congruity judgment group is partially balanced by an error rate difference in the other direction and may also be due to the slower overall times for the group. We have consistently found, as have other investigators (Perfetti & Roth, 1981), that subjects who are slower at recognizing words in isolation display larger context effects.

Experiments 3, 4, and 5 produced no evidence indicating that manipulations designed to affect subject strategies alter the pattern or magnitude of the context effects observed in the sentence context situation. Neither blocking the stimuli, increasing the proportion of congruous trials, nor forcing the subject to make a congruity judgment changed the pattern of the context effects. The magnitude of the overall context effect was also reasonably stable across these different manipulations. These results contrast with those of several single-word priming experiments that have shown significant effects of these variables (Becker, 1980; Tweedy & Lapinski, 1981; Tweedy, Lapinski, & Schvaneveldt, 1977) but are consistent with other sentence context experiments (Fischler & Bloom, 1979; O'Connor, cited in Forster, 1979). Perhaps the ongoing processing and comprehension that naturally occurs during the reading of sentences obviates the use of specialized strategies, whereas in single-word priming studies, the unfilled interval between prime recognition and target onset invites the use of conscious strategies not normally engaged in during sentence processing because of continuous comprehension requirements. The relative invariance of the facilitation dominant pattern suggests that it is automatic spreading activation and not conscious strategies that is the cause of the context effects in the sentence context situation. We will return to these conjectures in the General Discussion section. In the next set of experiments we seek converging evidence for these conclusions by attacking another theoretically important issue in the literature on context effects, whether contextual manipulations and the quality of the visual stimulus interact in the sentence context situation.

Sentence Context and Stimulus Quality

Many models of contextual effects make predictions about the magnitude of the interaction between a context effect and visual quality (see, for example, Becker & Killion, 1977; Meyer, Schvaneveldt, & Ruddy, 1975; Schuberth et al., 1981; Stanovich & Pachella, 1977; Stanovich & West, 1979). The results of studies using the single-word priming paradigm have consistently displayed an interaction between context and visual quality. Across a variety of experimental conditions, the context effect produced by single-word priming has increased when word recognition was slowed by several different types of stimulus degradation (Becker & Killion, 1977; Massaro, Jones, Lipscomb, & Scholz, 1978; Meyer et al., 1975; Sanford, Garrod, & Boyle, 1977; Sperber, McCauley, Ragain, & Weil, 1979). The interaction has been found in both lexical decision and naming tasks.

The data from experiments using a full sentence context has not been as consistent as that from single-word priming experiments. Although context and visual quality have been found to display a large interaction in several experiments, some investigators have failed to detect a statistically significant interaction. Stanovich and West (1979, Experiment 1) found an interaction between sentence context and stimulus degradation in a naming task where degradation was induced by contrast reduction. A similar data pattern was displayed in a second experiment, but it did not reach statistical significance. Forster (1976) used a naming task and degraded the target stimuli by reducing their duration and following them with a mask. He also found a Sentence Context × Simulus Degradation interaction. Perfetti and Roth (1981), using a naming task, tested fourth-grade children and found an interaction between sentence context and amount of degradation, where the degradation was produced by removing portions of the target word. Their results are not consistent with those of Schwantes (1981) who, using a lexical decision task and testing third-grade children, did not find an interaction. However, Schwantes (1981) did find that adults displayed a statistically significant Sentence Context × Stimulus Degradation interaction.

Alford (Note 1) found no interaction between context and stimulus intensity in a naming task, but the observation of such an interaction may have been precluded in his experiment due to the fact that the main effect of intensity was extremely small (less than 25 msec). Similarly, the interpretation of the results of a study by Schuberth et al. (1981) is problematic. Unlike most previous studies, their manipulation of degradation was done between, rather than within, subjects. A lack of strong statistical support for the presence of an interaction led them to argue for the additivity of the two variables. However, both the reaction times and error rates displayed a pattern consistent with previous work that has shown an interaction between these variables. The context effect in the reaction times increased from 44 msec in the normal condition to 59 msec in the degraded condition, and the context effect in the error percentages increased from 2.3% in the normal condition to 3.4% in the degraded condition. This, combined with the fact that the 108-msec degradation effect in the Schuberth et al. (1981) study is considerably smaller than that induced in other experiments where an interaction has been observed (e.g., over 300 msec by Perfetti & Roth, 1981, and approximately 200 msec by Stanovich & West, 1979), suggests the possibility that an underlying interaction was not detected in the Schuberth et al. (1981) experiment. Finally, Mitchell and Green (Note 2, Experiment 2) reported a nonsignificant interaction between context and degradation. However, it is difficult to integrate their work with previous research because the paradigm used differed markedly from others in this literature. Their procedure of having subjects advance themselves through a text by successively pressing a button to expose new three-word phrases results in fairly long latencies (1,300 to 2,100 msec) and heavily involves comprehension processes that take place subsequent to lexical access.

Clearly, the data on the interaction between context and visual quality that has been derived from sentence context tasks is considerably more inconsistent than that generated by single-word priming tasks. This situation is particularly unfortunate because the existence of a Context × Stimulus Degradation interaction is relevant to theoretical arguments regarding the relationship of the single-word priming situation to the context effects obtained in a full sentence situation. Failure to find the interaction in the latter case would suggest a marked discontinuity in the types of mechanisms that are mediating contextual effects in the two paradigms. In contrast, if a Context × Degradation interaction does occur in the full sentence paradigm, it would suggest that, at least at some level, the two tasks are tapping similar contextual mechanisms. In Experiment 6, we attempt to establish whether a Sentence Context × Stimulus Degradation interaction occurs in the paradigm used in our previous experiments. Although the focus of this study was on the overall context effect, facilitation and inhibition were also assessed.

Experiment 6

Method

The subjects were 32 undergraduate students recruited through an introductory psychology subject pool. The stimuli, apparatus, and all aspects of the procedure were as in Experiment 3B, except that easy and difficult words were mixed, and the 72 trials were split into two blocks. Subjects completed one block under the stimulus conditions of Experiment 3B and the other block under conditions where the target word was degraded by inserting in its field a neutral density filter that reduced the intensity of the stimulus by .4 log units. The sentence context was not degraded. One half of subjects completed the normal block first, and one half of the subjects completed the degraded block first.

Results

The mean reaction times and mean percentage of subject errors for all of the experimental conditions are displayed in Table 9. An ANOVA on the reaction times indicated that the effects of stimulus quality, $F(1, 30) = 58.5$, word difficulty, $F(1, 30) = 168.1$, and context condition, $F(2, 60) = 52.9$, were all significant at the .001 level. As in previous studies, context condition interacted with word difficulty, $F(2, 60) = 8.63$, $p < .001$. Difficult words displayed larger context effects. The effect of block order was not significant, $F(1, 30) = 2.83$, $.05 < p < .10$; however, order did interact with stimulus quality, $F(1, 30) = 15.70$, $p < .001$. The effect of stimulus quality was larger when the degraded block came first. The Stimulus Quality × Context Condition interaction was significant, $F(2, 60) = 4.30$, $p < .025$, as was the three-way interaction between order, stimulus quality, and context condition, $F(2, 60) = 6.08$, $p < .005$. The interaction between degradation and context condition was larger when the degraded block came first. In fact, this is somewhat of an understatement of the data. As can be seen from Table 9, in Block 2 the degradation effect on the neutral condition was only 37 msec, and there was vir-

Table 9
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 6

	Context condition								
	Congruous		Neutral		Incongruous				
Word type	*M*	% E	*M*	% E	*M*	% E	Facilitation	Inhibition	Overall context effect
Block 1									
Normal									
Easy	569	.0	616	.0	615	3.1	47	−1	46
Difficult	676	1.0	773	.0	783	1.0	97	10	107
Degraded									
Easy	680	2.1	759	4.2	808	4.2	79	49	128
Difficult	828	1.0	997	3.1	1092	2.1	169	95	264
Block 2									
Normal									
Easy	594	.0	637	.0	646	.0	43	9	52
Difficult	708	.0	747	4.2	821	2.1	35	74	109
Degraded									
Easy	621	2.1	643	1.0	663	2.1	22	20	42
Difficult	753	1.0	815	2.1	859	2.1	62	44	106

Note. % E = percentage of errors.

tually no difference in the magnitude of the overall context effect under normal and degraded conditions. In contrast, in Block 1 the 183-msec degradation effect resulted in much larger context effects in the degraded conditions. A separate ANOVA on the data from Block 1 indicated that the crucial interactions between context condition and stimulus quality, $F(2, 60) = 7.01$, and context condition and word difficulty, $F(2, 60) = 6.32$, were both significant at the .005 level.

Planned comparisons indicated that in Block 1 the facilitation effects in every condition were significant at the .05 level or below. The inhibition effects in the degraded condition were significant at the .025 and .001 levels for the easy and difficult words, respectively. In Block 2 only the easy words in the normal condition and the difficult words in the degraded condition displayed significant facilitation effects ($p < .05$ and .01, respectively). The 74-msec inhibition effect for the difficult words in the normal condition was statistically significant ($p < .001$), as was the inhibition effect for these words in the degraded condition ($p < .05$). No other effects were significant.

Discussion

Experiment 6 replicated our previous finding of an interaction between context and word difficulty, more difficult words displaying larger context effects. The focus of this study was, however, the Context × Stimulus Quality interaction, and here again the results were unambiguous. Experiment 6 presented data that clearly indicated an interaction between degradation and context condition. The data are consistent with previous experiments that have observed an interaction when degradation effects of a similar magnitude were induced (e.g., Perfetti & Roth, 1981; Stanovich & West, 1979). The results also mesh with those from single-word priming experiments, thus suggesting that at some level the tasks may be tapping similar mechanisms. The data of Experiment 6 also suggest that previous failures to observe an interaction in the sentence context situation (e.g., Schuberth et al., 1981; Alford, Note 1) were due to an insufficiently strong manipulation of degradation and/or experimental insensitivity. The results from Block 2 are especially supportive of this conclusion. There, degradation caused only a 37-msec increase in response time, and the magnitude of the overall context effect did not increase under degraded conditions.

In Block 1 degradation caused increases in both facilitation and inhibition. The presence of contextual inhibition has been interpreted (e.g., Neely, 1977; Stanovich & West, 1979) as indicating the operation of an attentional mechanism involving conscious expectancies. Our previous interpretation of why inhibition increases when the target is degraded (Stanovich & West, 1979) was that the decrease in word recognition speed allowed time for the slower conscious expectancy process to operate. An alternative explanation is that the mere presence of degradation induces the subject to use an expectancy strategy that is not employed under normal conditions. Unfortunately, the data from Block 2, which might have helped to select between these alternative explanations, was somewhat ambiguous. The fact that the overall context effect did not increase under degraded conditions would appear to support the time-locked explanation, since the magnitude of the degradation effect was so small (37 msec). It would appear to be not the mere presence of degradation that is important, but the actual slowing of word recognition that is caused by degradation. However, two findings are contrary to this conclusion. First, the degraded condition did not show facilitation dominance but instead a mixed pattern of facilitation and inhibition. Second, the difficult words showed a significant inhibition effect under normal conditions. The latter effect may be due to some type of strategy carry-over from the previous block of degraded trials. Such a strategy carry-over was built into the design of the next study, where normal and degraded trials were mixed rather than blocked.

Experiment 7

Experiment 7 was an attempt to examine the generality of the interaction between sentence context and stimulus quality displayed in Experiment 6. A different type of stimulus degradation was used. Instead of reducing the contrast of the stimulus display, asterisks were inserted between the letters of the target word. Another methodological change involved randomly mixing degraded and normal trials. Thus, in Experiment 7 subjects could not predict whether the target word would be degraded on a given trial. Patterns of contextual effects induced by the presence of degraded words should thus carry over to the normal stimuli. Any inhibition-causing strategy that is triggered by degraded words should cause inhibition in the normal condition.

Method

The subjects were 32 undergraduate students recruited through an introductory psychology subject pool. The stimuli and experimental procedure were the same as those used in Experiment 6, but the experiment was run on the apparatus used in Experiment 1. Degradation was produced by inserting an asterisk between each letter of the target word. The asterisk took up a normal character space. Subsequent to the practice trials, subjects completed 72 experimental trials in which the three context conditions appeared with equal probability; one half of the trials were degraded, and one half normal. Degraded and normal trials were randomly mixed throughout the sequence. Across subjects, each word appeared equally often in the six conditions defined by the factorial combination of the context condition and stimulus quality variables.

Results and Discussion

The mean reaction times and mean percentage of subject errors for all of the experimental conditions are displayed in Table 10. An ANOVA on the reaction times indicated that the effect of stimulus quality, $F(1, 31) = 307.7$, word difficulty, $F(1, 31) = 219.0$, and context condition, $F(2, 62) = 46.8$, were all significant at the .001 level. Again, the interaction between context condition and word difficulty was replicated, $F(2, 62) = 5.40$, $p < .01$. Word difficulty and stimulus quality displayed a significant interaction, $F(1, 31) = 8.30$, $p < .01$. The word difficulty effect was larger in the degraded condition. As in Experiment 6, the crucial interaction between context condition and stimulus quality was statistically significant, $F(2, 62) = 19.72$, $p < .001$. Larger context effects were obtained under degraded conditions. Planned comparisons indicated that all of the facilitation effects were significant at the .01 level or below, except the 31-msec effect in the easy–normal condition. None of the inhibition effects were statistically significant.

Although the basic interaction between stimulus quality and context condition was replicated in Experiment 7, the nature of the interaction was quite different from that displayed in Experiment 6. Experiment 7 displayed a pattern of pure facilitation dominance in the degraded conditions. This finding is somewhat damaging to the time-locked explanation of the presence of degradation-induced inhibition advanced by Stanovich and West (1979) because the 195-msec degradation effect was within the range of previous experiments where inhibition was observed. The critical methodological feature that was responsible for the facilitation dominance displayed in this experiment is investigated in Experiment 8.

Table 10
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 7

	Context condition								
	Congruous		Neutral		Incongruous				
Word type	*M*	% E	*M*	% E	*M*	% E	Facilitation	Inhibition	Overall context effect
Normal									
Easy	624	.0	655	.0	647	.5	31	−8	23
Difficult	708	.0	776	.5	771	.5	68	−5	63
Degraded									
Easy	729	.5	835	.0	809	1.0	106	−26	80
Difficult	841	2.1	987	2.1	1,002	1.0	146	15	161

Note. % E = percentage of errors.

Experiment 8

The failure to find significant inhibition effects in the degraded conditions of Experiment 7 (although the overall Context × Degradation interaction was significant), as in Experiment 6, raises the question of what methodological difference between the two experiments was the cause of the difference in data patterns. It is possible that either the mixing of the trial types or the different method of degradation was the reason for the difference. In Experiment 8 the same method of degradation was used, but the stimulus quality variable was blocked, as in Experiment 6.

Method

The subjects were 32 undergraduate students recruited through an introductory psychology subject pool. All aspects of the stimuli, apparatus, and procedure were as in Experiment 7 except that the 72 experimental trials were divided into two blocks of 36 trials. One half of the subjects received the degraded block first, followed by the normal block, and the other half of the subjects received the reverse ordering.

Results

The mean reaction times and mean percentage of subject errors for all of the experimental conditions are displayed in Table 11. An ANOVA on the reaction times indicated that the effects of stimulus quality, $F(1, 30) = 187.3$, word difficulty, $F(1, 30) = 102.6$, and context condition, $F(2, 60) = 36.9$, were all significant at the .001 level. The Context Condition × Word Difficulty interaction was again replicated, $F(2, 60) = 3.61$, $p < .05$. The effect of block order was not significant ($F < 1$), but order did interact with stimulus quality in the same manner as in Experiment 6, $F(1, 30) = 21.5$, $p < .001$. As in Experiments 6 and 7, the crucial Stimulus Quality × Context Condition interaction was significant, $F(2, 60) = 7.71$, $p < .005$. Unlike Experiment 6, the interpretation of this interaction is not qualified by a three-way interaction between stimulus quality, context, and order, $F(2, 60) = 2.53$, $.05 < p < .10$. The context effect was larger in the degraded conditions in both blocks of trials. A separate ANOVA on the data from Block 1 indicated that the interaction between context condition and stimulus quality was significant for this block of trials, $F(2, 60) = 3.52$, $p < .05$.

Planned comparisons on the data of Block 1 indicated that all of the facilitation effects were significant at the .001 level except the 39-msec facilitation effect in the easy–normal condition (which approached significance, $.05 < p < .10$). None of the inhibition effects were significant. In Block 2 the 28-msec

Table 11
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 8

Word type	Congruous *M*	Congruous % E	Neutral *M*	Neutral % E	Incongruous *M*	Incongruous % E	Facilitation	Inhibition	Overall context effect
Block 1									
Normal									
Easy	477	.0	516	.0	504	1.0	39	−12	27
Difficult	582	2.1	685	2.1	666	4.2	103	−19	84
Degraded									
Easy	608	1.0	726	.0	692	3.1	118	−34	84
Difficult	764	3.1	889	8.3	921	11.5	125	32	157
Block 2									
Normal									
Easy	469	.0	497	.0	493	.0	28	−4	24
Difficult	561	2.1	622	6.2	616	2.1	61	−6	55
Degraded									
Easy	562	.0	629	3.1	632	4.2	67	3	70
Difficult	688	4.2	778	9.4	803	5.2	90	25	115

Note. % E = percentage of errors.

facilitation effect in the easy–normal condition was not significant. The 61-, 67-, and 90-msec facilitation effects were all significant ($p < .01$, 01, and .001, respectively). None of the inhibition effects were significant.

Discussion

The results of these three experiments on the effects of stimulus degradation converge on several conclusions. First, the general finding that the sentence context variable interacts with stimulus quality was strongly bolstered by these experiments. It is probable that previous failures to observe the interaction in the sentence context paradigm were due to the fact that the degradation main effect was not large enough. This conjecture is supported by the results from Block 2 of Experiment 6 and probably accounts for the results of Alford (Note 1) and Schuberth et al. (1981). The finding of a Stimulus Quality × Context interaction in this paradigm brings the results from the sentence context situation into line with those from single-word priming experiments. At least in a general sense, the processes mediating context effects in the two situations must have some similarity.

When one turns from the basic interaction to a consideration of the contextual mechanisms that must be operative, the results are a little more problematic. When the target word was degraded via contrast reduction, contextual facilitation and inhibition both increased. However, when the target word was degraded by inserting irrelevant characters between letters, only contextual facilitation increased, and the general pattern of facilitation dominance was maintained. The latter finding presents difficulties for our previous explanation (Stanovich & West, 1979) of Degradation × Context interactions in terms of a time-locked attentional processor that produces inhibition as word recognition time is slowed. Experiments 7 and 8 demonstrated that slowing word recognition does not necessarily produce inhibition.

The results of Experiment 8 demonstrated that the increase in inhibition in Experiment 6 was not due to a strategy caused by the blocking of stimulus conditions. Instead, the different patterns of context effects appear to be related to the type of stimulus degradation that was used. Because this relationship deserves further exploration, complicated theoretical speculation about it may be premature. We offer only a hypothesis that, admittedly, goes only a small way beyond data description. Perhaps subjects only use a conscious expectancy strategy when they are in doubt as to whether purely data-driven mechanisms will be sufficient to specify the stimulus. Contrast reduction, in slowing the initial stages of encoding, may signal executive processing systems that extra resources are necessary. The asterisk manipulation may slow later stages of feature comparison, visual scanning, and decision, and although disrupting performance, may never leave the system in doubt as to whether the stimulus will be resolved. Thus, it may not trigger conscious expectation strategies. These contrasting effects would not be without precedent. Different methods of stimulus degradation have produced disparate patterns of results in several experimental paradigms in cognitive psychology (Johnston & McClelland, 1973; Miller, 1979; Pachella & Fisher, 1969; Turvey, 1973).

Lexical Decision and Naming Task Differences in Sentence Context Effects

In our experiments the dominant data pattern under normal stimulus conditions has clearly been one of facilitation dominance. Although other investigators have observed facilitation dominance in sentence context experiments (Perfetti & Roth, 1981), inhibition dominance (Fischler & Bloom, 1979, 1980; Mitchell & Green, Note 2) and equivalent amounts of facilitation and inhibition (Schuberth & Eimas, 1977; Schwantes, Boesl, & Ritz, 1980) have also occurred in other experiments. We have previously argued (West & Stanovich, 1982) that the reason for the discrepant patterns of facilitation and inhibition was due to task differences in the various experiments. Specifically, facilitation dominance tended to occur in experiments using naming tasks, whereas studies using a lexical decision task tended to show considerably more inhibition or, in many cases, extreme inhibition dominance. In the West and Stanovich (1982) article it was demonstrated that inhibition would occur with the same stimuli and experimental situation that had produced complete facilitation dominance in the Stanovich and West (1979, 1981) experiments, as long as a lexical decision response was required. It was argued that the lexical decision task produced inhibition because it was more affected by postlexical message-level processes that detect incongruity.

Although the West and Stanovich (1982) experiments were successful in showing that the lexical decision task could induce inhibition in materials that had previously shown no inhibitory effects, there are still some discrepancies between experimental results when one proceeds to a more detailed examination of the magnitudes of the effects produced, particularly when the results of Fischler and Bloom (1979, 1980) are considered. The West and Stanovich (1982) experiments produced more facilitation and less inhibition than the experiments of Fischler and Bloom (1979, 1980). The former finding is not problematic, given one crucial difference in the stimulus sentences that were used in the two sets of experiments. Fischer and Bloom (1979, 1980) avoided relationships between context words and target words when constructing their materials, whereas those used in the West and Stanovich (1982) experiments contained many target words that were associated with or related to context words. If, as we have previously argued, spreading activation in semantic memory is the mechanism responsible for facilitation effects, then the greater facilitation shown in the West and Stanovich (1982) experiments is entirely expected.

Although the difference in the magnitudes of the facilitation effects is readily explainable, the difference in inhibition effects is more problematic. If inhibition is caused by postlexical message-level processes that are signaling incongruity, and thus incorrectly biasing a binary decision process toward a "no" response, then we would expect this mechanism to be equally disruptive in the West and Stanovich (1982) experiments and in the Fischler and Bloom (1979, 1980) experiments. Across a variety of different conditions, West and Stanovich (1982) observed inhibition effects in the range of 30–50 msec (inhibition was also evident in the error rates, but this was equally true in the Fischler & Bloom experiments). Using two different neutral conditions that were used in a between-subjects design (one group saw only a string of Xs and the other only anomalous words), Fischler and Bloom (1979) observed inhibition effects of over 100 msec. In another experiment where the context was presented via a rapid serial visual presentation technique, Fischler and Bloom (1980) observed inhibition effects averaging over 70 msec. In both studies, the magnitude of the inhibition effect was not changed considerably when assessed against a condition where the target word was congruous with the context but not usually generated as a completion of the sentence. Recent experiments reported by Fischler (Note 3) indicate that the procedure of comparing neutral and context conditions between subjects in the Fischler and Bloom (1979, 1980) experiments may have been partially responsible for the larger inhibition effects that were observed. In experiments where the neutral condition was assessed within subjects, Fischler (Note 3) found the inhibition effects to fall in the range of 40–70 msec, considerably below those observed in the earlier experiments. Perhaps when neutral trials are blocked together, subjects can adopt specialized strategies that facilitate processing the target, strategies that are not applied when the neutral trials also occur with regular context trials.

The inhibition effects observed by Fischler (Note 3) at least begin to fall in the range observed by West and Stanovich (1982). Nevertheless, it is still useful to investigate whether there may be another factor, in addition to the lexical decision response requirement, contributing to the inhibition in the Fischler (Note 3) experiments. In Experiment 9 we investigated whether differences in the stimulus materials could be the cause of the additional inhibition. Experiment 9 was run with a subset of the materials used by Fischler and Bloom (1979, 1980), but the procedure was the experimenter-initiation naming methodology used in our earlier experiments. This experiment also served as an additional test for our explanation of the mechanism responsible for the inhibition observed in lexical decision experiments. In several previous experiments (Fischler & Bloom, 1979, 1980; Fischler, Note 3) these stimuli have produced inhibition effects in the range of 50–110 msec. Because the task in Experiment 9 was naming, we expected the inhibition effects to be considerably less. Finally, in Experiment 9 we used the three neutral context conditions that were tested in Experiment 2 in order to take advantage of the opportunity to compare these neutral contexts when embedded within an entirely different set of sentences.

Experiment 9

Method

Subjects. The subjects were 96 undergraduate students recruited through an introductory psychology subject pool.

Stimuli and apparatus. A subset of 95 sentence contexts was formed by selecting every sentence context that ended in either the article *the* or *a* (in order to provide a set more comparable to our previous contexts, which always ended in the article *the*) from the appendixes of completion norms listed in Bloom and Fischler (1980). The total number of sentences in the subset was raised to 96 with the inclusion of an additional sentence context ending in *a* that was formed by dropping a terminal adjective. Seventy of the selected 96 sentence contexts ended in *the*, and 26 ended in *a*. Two congruous target words based on completion norms were selected for each sentence context. One of the target words was the primary response (i.e., the most probable first guess when the sentence was presented with the final word missing), and the other target word was a nonprimary response with relative low probability (e.g., the words *bone* and *shoe*, respectively, for the sentence context *The puppy chewed on the*). Thus, the nonprimary words were congruous with the sentence, but relatively unpredictable or unlikely completions. The primary and nonprimary targets will be termed the predictable and unpredictable congruous words, respectively. The mean cloze probabilities of the predictable and unpredictable target words were .61 and .07. The mean number of letters in the predictable words was 4.7 ($SD = 1.0$), and the mean number of letters in the unpredictable words was 5.5 ($SD = 1.8$). According to the Kucera and Francis (1967) count, the mean frequency of the predictable words was 156.7, and the mean frequency of the unpredictable words was 85.9. Congruous context conditions were formed by presenting target words with their corresponding sentence contexts. The 96 sentence contexts were randomly organized into 48 pairs with the constraint that terminal articles matched (e.g., *The puppy chewed on the* was paired with *He smiled and sat down at the*). Incongruous context conditions were formed by presenting targets with the opposite members of the sentence context pairs (e.g., *He smiled and sat down at the* was considered incongruous when paired with either *bone* or *shoe*). The incomplete sentences *They said it was the*, *The next word will be*, and *They were thinking about the* were used as neutral conditions. The apparatus described in Experiment 1 was used in this study. The experimenter-initiation procedure and naming task described in Experiment 2 were used.

Procedure. Following 12 practice trials, each subject completed a random ordering of 72 experimental trials. The predictable and unpredictable targets functioned like the easy and difficult words in previous studies, each set appearing on one half of the trials. There were equal numbers of congruous, incongruous, and neutral trials. The neutral trials were evenly divided across each of the three different neutral contexts. The assignment of words from the total population was counterbalanced across subjects so that each word was presented equally often under each of the three context conditions, and, within the neutral condition, each word was presented with each of the three neutral contexts equally often. No subject saw the same target word or sentence context more than once in the course of the experiment, and no subject saw more than one member of a predictable–unpredictable pair. When sentence contexts were used in incongruous context trials, the deleted terminal words from the original sentences were never seen by the subject.

Results

The mean reaction times and mean percentage of subject errors for all of the experimental conditions are displayed in Table 12. An ANOVA on the reaction times indicated that the effect of target type was significant, $F(1, 95) = 69.5$, $p < .001$. The predictable targets had faster response times, due to their higher frequency and shorter length. The effect of context condition was significant, $F(4, 380) = 25.3$, $p < .001$, but the interaction between context condition and target type was not, $F(4, 380) = 1.97$, $.05 < p < .10$.

Although reaction times in the three neutral conditions did not differ greatly from each other in absolute magnitude (the maximum difference between neutral contexts was 26 and 17 msec in the predictable and unpredictable conditions, respectively), an ANOVA on the neutral conditions alone revealed that they did differ significantly from each other, $F(2, 190) = 9.07$, $p < .01$. These differences were the same across target type (interaction, $F < 1$). In a number of ways, however, the results of the neutral conditions are consistent and serve to reinforce previous results obtained from this paradigm. Regardless of the neutral condition used, calculations of facilitation and inhibition on these data consistently indicate a pattern of facilitation dominance. Planned comparisons indicated that each of the derived facilitation

Table 12
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 9

Word type	Context condition								
	Congruous		Neutral		Incongruous				Overall context effect
	M	% E	*M*	% E	*M*	% E	Facilitation	Inhibition	
Predictable									
They said it was the	451	.8	476	.5	490	2.1	25	14	39
The next word will be			490	2.1			39	0	
They were thinking about the			502	1.0			51	−12	
M of neutrals			489				38	1	
Unpredictable									
They said it was the	491	1.2	505	.8	510	2.3	14	5	19
The next word will be			509	1.3			18	1	
They were thinking about the			522	.5			31	−12	
M of neutrals			512				21	−2	

Note. % E = percentage of errors.

effects for the predictable words was significant at the .001 level. In the unpredictable condition the 14-, 18-, and 31-msec facilitation effects were significant at the .05, .01, and .001 levels, respectively. The only inhibition effect to attain significance was the 14-msec effect for predictable words calculated against the *they said it was the* neutral context.

Discussion

Several general conclusions are supported by the results of Experiment 9. The size of the context effects in this experiment was smaller than those observed in our previous experiments, a finding probably resulting from the attempt to avoid associations and semantic relationships in the Bloom and Fischler (1980) stimulus set. The predictable words displayed a somewhat larger context effect than the unpredictable words. However, the Context × Target Type interaction was not significant ($.05 < p < .10$), and this trend was not apparent in subsequent studies (see Experiments 10 and 11). The failure of the predictable words to show a marked contextual advantage over unpredictable words argues against a conscious prediction process as the cause of the context effects in the sentence context situation (as does the lack of inhibition).

The failure to observe substantial inhibition effects in Experiment 9 supports our previous explanation (West & Stanovich, 1982) of the reason other sentence context experiments have produced mixed or inhibition dominant patterns. These same stimuli have shown massive inhibition effects when a lexical decision task was used (Fischler & Bloom, 1979, 1980; Fischler, Note 3). It is apparently the task characteristics, and not differences in the stimuli, that are the cause of the discrepancy between the results of Stanovich and West (1979, 1981) and Fischler and Bloom (1979, 1980).

Finally, the results of Experiment 9 serve to reinforce our confidence in the neutral context *they said it was the* that we have used in the previous experiments. Although the differences in the three neutral contexts were somewhat larger in Experiment 9 than in Experiment 2, the absolute magnitude of the differences was still small. More important, however, is the fact that of the three conditions, *they said it was the* produced the fastest times. Our consistently obtained pattern of facilitation dominance naturally causes concern as to whether our neutral condition is, for some reason, unusually slow, thus artifactually eliminating inhibition effects. Experiment 9 demonstrates that, at least when embedded within the Bloom and Fischler (1980) stimuli, our previous condition is the fastest of three plausible neutral conditions. This finding, combined with the results of Experiment 2, increases our confidence in the appropriateness of this neutral condition.

Experiment 10

Although the results of Experiment 9 revealed that the materials of Bloom and Fischler (1980) fail to show substantial inhibition when used in a naming task, the subset of contexts that were chosen was unrepresentative because to ensure comparability with the previous results of Stanovich and West (1981; and several previous experiments reported here), all of the contexts ended with articles. Of course, this factor may be an important determinant of the results obtained. Fortunately, the appendixes provided by Bloom and Fischler (1980) contain many examples of sentences that do not end in articles. In Experiment 10, we included the factor of whether the context sentence ended in an article or a nonarticle in the experimental design. This factor was varied orthogonally with target predictability and context condition.

Method

The subjects were 16 undergraduate students recruited through an introductory psychology subject pool. The 96 contexts and 192 target words used in Experiment 9 comprised one half of the stimuli. Because the contexts in the Bloom and Fischler (1980) appendixes are ordered according to the probability of the primary response, a matched set of 96 contexts was chosen by picking the 96 contexts that ended in nonarticles and were adjacent to the contexts that ended in articles. The mean cloze probabilities of the primary (predictable) and nonprimary (unpredictable) words in the nonarticle set were .61 and .07 respectively, closely matched to the probabilities in the article set. The mean number of letters in the predictable words was 4.8 (SD = 1.6) and the mean number of letters in the unpredictable set was 5.6 (SD = 1.8). Mean Kucera and Francis (1967) frequencies were 208.8 and 124.1, respectively.

Following 12 practice trials, each subject completed two blocks of 72 experimental trials. Equal numbers of article and nonarticle contexts were randomly intermixed within each block. The counterbalancing of the predictable and unpredictable words across context conditions was as in Experiment 9. The neutral context was *they said it was the.* All other aspects of the procedure were the same as in Experiment 9.

Results

The mean reaction times and mean percentage of subject errors for all of the experimental conditions are displayed in Table 13. An ANOVA on the reaction times was conducted with context congruity (congruous, neutral, incongruous), context type (article, nonarticle), and target type (predictable, unpredictable) as three orthogonal factors. The effects of context congruity, $F(2, 30) = 28.7$, $p < .001$, context type, $F(1, 15) = 22.9$, $p < .001$, and target type, $F(1, 15) = 15.3$, $p < .005$, were all statistically significant. As in Experiment 9, predictable words had faster response times. The target words drawn from the article sentences were responded to faster

Table 13
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 10

Word type	Congruous *M*	Congruous % E	Neutral *M*	Neutral % E	Incongruous *M*	Incongruous % E	Facilitation	Inhibition	Overall context effect
Article contexts									
Predictable	467	.0	506	.0	502	.5	39	−4	35
Unpredictable	501	1.0	522	2.6	531	.5	21	9	30
Nonarticle contexts									
Predictable	470	.0	534	2.1	529	.5	64	−5	59
Unpredictable	491	.0	537	2.1	552	2.1	46	15	61

Note. % E = percentage of errors.

than the words drawn from the nonarticle sentence. Although the effect was statistically significant, it was small in magnitude (approximately 15 msec). Because the two sets of words were reasonably close on frequency and length characteristics, we have no ready explanation of this effect. Context congruity did not interact with target type, $F(2, 30) = 1.09$. The contextual effects for predictable and unpredictable words were very similar. Context congruity did interact with context type, $F(2, 30) = 5.99$, $p < .01$. Context effects were larger for sentences ending in nonarticles. The three-way interaction was not significant. Planned comparisons indicated that the 39-, 64-, and 46-msec facilitation effects were significant at the .025, .001, and .01 levels, respectively. None of the inhibition effects were statistically significant.

Discussion

Two of the important findings from Experiment 9 were shown to generalize to sentence contexts that did not end in articles. The pattern of facilitation dominance was maintained across a wider variety of sentence types taken from the Bloom and Fischler (1980) norms. The context ending in an article is not the reason for the lack of inhibition. The other major result to replicate across context type was the finding that predictable and unpredictable target words displayed similar context effects, indicating again that predictability was not the variable mediating the effects that were observed. An unexpected finding was that nonarticle context types produced larger context effects. Again, predictability could not be the cause of the difference, because the context types were matched on this variable. Two possible reasons for this difference suggest themselves. Perhaps the word preceding the target in some nonarticle sentences is an associate or bears a semantic relationship to the target. Instances of such relationships do exist in the Bloom and Fischler (1980) sentences (e.g., sinking–ship, back–porch, lunch–hour, spare–tire, toy–doll, warm–milk). Such temporally close semantic associates are not present in the article sentences that end in the neutral *the* or *a*. Or perhaps the words in other parts of the nonarticle contexts were more strongly related to the target words. This is a possibility, because the Bloom and Fischler (1980) sentences were not normed for relatedness. Another possible reason for the larger context effects shown by the nonarticle sentences may be that in the congruous condition of such sentences the speech–motor articulation transition between the final context word and the target word is more compatible than that for the article sentences. This conjecture is indirectly tested in the lexical decision conditions of the next experiment.

Experiment 11

The results of Experiments 9 and 10 provide indirect evidence for the argument we had previously advanced (West & Stanovich, 1982) for why large inhibition effects have been observed in the lexical decision experiments of Fischler and Bloom (1979, 1980). We used as a general framework the model of language processing put forth by Forster (1979), where the lexical, syntactic, and message-level processers are arranged in a serial cascadelike (McClelland, 1979) structure, with each processor simultaneously sending information to a decision-making general problem solver that determines the appropriate response based on the task requirements. The relatively incompatible and unfamiliar binary response to linguistic materials required by the lexical decision task may allow information from the message level to become implicated in the response choice made by the decision maker.[1] The information sent to the decision maker when the message level detects an incongruity may be of the type that biases the decision maker toward a "no" response. Overcoming this bias may lengthen response time in the incongruous condition. The naming task, involving a more direct and compatible connection between lexicon and response, may be less likely to be influenced by such postlexical message-level processes (see de Groot, Thomassen, & Hudson, 1982; Tanenhaus, Flanigan, & Seidenberg, 1980, for related arguments). This explanation is strongly sup-

[1] See Parkin (1982, p. 48) for additional recent evidence that substantial postlexical processing takes place in the lexical decision task.

ported by the results of Experiments 9 and 10, which demonstrated that subsets of the stimuli that showed large inhibition effects in the Fischler and Bloom (1979, 1980) experiments do not display inhibition in a naming task. In Experiment 11, we sought more direct evidence for our hypothesis by examining the pattern of contextual effects shown by the stimuli of Experiment 10 in both a naming and a lexical decision task. The article- versus non-article-ending context variable was retained in Experiment 11 in order to assess whether these two context types act similarly in the lexical decision task.

Method

The subjects were 32 undergraduate students recruited through an introductory psychology subject pool. The stimuli and apparatus were the same as in Experiment 10. Each subject completed two blocks of trials. One half of the subjects completed the naming block first, followed by the lexical decision block. The other half of the subjects received the reverse ordering. The naming block consisted of 72 trials. The lexical decision block consisted of 108 trials, 72 word target trials, and 36 nonword target trials (24 preceded by nonneutral contexts and 12 preceded by the neutral context). The nonwords were all pronounceable (e.g., blonk, nuster, depper). Each block was preceded by 12 practice trials on the particular task to be used in that block. In the lexical decision task the subjects indicated their response by pressing one of two telegraph keys. Subjects made word responses with the right hand and nonword responses with the left hand. All other aspects of the procedure and counterbalancing were as in Experiment 10.

Results

The mean reaction times and mean percentage of subject errors for all of the experimental conditions are displayed in Table 14. An ANOVA was conducted on the response times. The main effects of task order and the Task Order × Context Congruity interaction were not significant (both Fs < 1). In light of these results, and the fact that task order did not enter into any other significant interactions involving context congruity, the data in Table 14 is collapsed across the former variable, and it will not be considered further. The main effects of task type, $F(1, 30) = 7.09$, $p < .025$, context type, $F(1, 30) = 16.7$, $p < .001$, and target type, $F(1, 30) = 66.5$, $p < .001$, were all significant. Responses were faster in the naming task, in article contexts, and for predictable words. The effect of context congruity was significant at the .001 level, $F(2, 60) = 55.6$. As in Experiments 9 and 10, context congruity did not interact with target type, $F(2, 60) = 1.75$. Unlike Experiment 10, context congruity did not interact with context type, $F(2, 60) = 1.64$. Context effects were not significantly larger in the nonarticle conditions, although there

Table 14
Mean Reaction Times (in msec) and Mean Percentage of Errors for Experiment 11

Word type	Congruous *M*	Congruous % E	Neutral *M*	Neutral % E	Incongruous *M*	Incongruous % E	Facilitation	Inhibition	Overall context effect
Article contexts									
Naming task									
Predictable	478	1.1	509	2.1	514	1.1	31	5	36
Unpredictable	513	1.1	534	2.1	542	1.1	21	8	29
Lexical decision task									
Predictable	487	3.2	544	2.6	550	4.7	57	6	63
Unpredictable	555	6.3	566	6.8	600	6.3	11	34	45
Nonarticle contexts									
Naming task									
Predictable	477	.0	537	3.1	531	2.1	60	−6	54
Unpredictable	509	1.6	553	1.6	565	3.7	44	12	56
Lexical decision task									
Predictable	511	1.0	539	3.7	582	4.2	28	43	71
Unpredictable	560	3.1	580	7.3	625	6.3	20	45	65

Note. % E = percentage of errors.

was a slight trend in that direction. The conjecture that the significant interaction in Experiment 10 might have been due to differing articulation transitions was not supported in Experiment 11. That hypothesis predicts a three-way interaction between context congruity, context type, and task type (since the lexical decision task does not require articulation). However, this interaction was not significant, $F(2, 60) = 1.19$. It is perhaps more likely that the significant interaction in Experiment 10 and the small nonsignificant trend in Experiment 11 resulted from associations between sentence final words and target words in the nonarticle contexts (or perhaps from stronger semantic relationships between the target and other context words).

The crucial interaction between context congruity and task type just missed statistical significance, $F(2, 60) = 3.05$, $p = .0549$. This marginal interaction was in the predicted direction, and its interpretation is not modified by any higher level interactions. The lexical decision task displayed larger inhibition effects than did the naming task. In fact, replicating the results of Experiments 9 and 10, planned comparisons indicated that none of the inhibition effects in the various conditions involving the naming task were significant. In contrast, three of the four conditions involving the lexical decision task displayed significant inhibition effects at the .025 level or below. Collapsed across all of the conditions, the mean inhibition effect in the lexical decision task was 32 msec, compared with 5 msec in the naming task.

All of the facilitation effects over 28 msec were significant at the .05 level. Collapsed across task order, the mean nonword lexical decision times when the nonword was preceded by a sentence context was 644 msec. The mean nonword lexical decision time when preceded by the neutral context was 675 msec. The mean error rates in these two conditions were 13.1% and 11.2%, respectively.

Discussion

The results from the naming task replicated the data of Experiment 10. Neither type of sentence context displayed any significant inhibition. Again, predictable and unpredictable target words displayed similar context effects. The lexical decision task displayed a different pattern, exhibiting roughly equal amounts of facilitation and inhibition when collapsed across conditions. Although the lexical decision task displayed facilitation to the same extent as the did naming task (indicating that the increase in inhibition was not due solely to a shift in the neutral condition; see West & Stanovich, 1982), only the former displayed significant inhibition effects. Naming tasks show a pattern of facilitation without inhibition that changes to mixed pattern when a lexical decision task is used. Because this result has now been observed in three different experiments using two completely different sets of stimuli (see West & Stanovich, 1982), it seems safe to conclude that the use of the lexical decision task was at least a partial cause of the inhibition observed in previous sentence context experiments. Of course, other design features could also play a part in causing inhibition, for example, unusually long target onset delays that encourage prediction strategies not used in normal reading (see Mitchell & Green, 1978). Although the inhibition effects in Experiment 11 are still not quite as large as those observed by Fischler (Note 3) in his latest experiments using a within-subjects neutral condition, there remain other procedural differences that could account for the small residual discrepancy. Finally, rather than viewing the task difference demonstrated here as a problem, we see it as a promising first step in developing a taxonomy of on-line reading tasks based on their differential sensitivity to operations at various levels in the language-processing hierarchy (see Swinney, 1981). We would reiterate Morton's (1981) point that

> the apparent chaos in the data on word recognition will only be resolved when we treat separately such tasks as lexical decision, word monitoring, reading time, semantic classification and t-scope recognition. To regard them all as equivalent with respect to the study of *word recognition* is a recipe for disaster. Our models should point plausibly to the differences between the tasks in addition to the similarities. (p. 229)

A Brief Summary

The final discussion of how the results of the experiments presented in this article can be integrated with previous empirical and theoretical work on sentence context effects is facilitated if the major data patterns revealed by the 11 experiments are summarized.

The finding reported by Stanovich and West (1981) that more difficult words displayed larger context effects than easier words, even though the difficult words were less predictable, was found to be extremely robust, obtaining across a variety of experimental manipulations. Experiment 1 demonstrated that the result obtains when a fixed-interval context presentation procedure was used. The interaction between word difficulty and context condition was also found when the word difficulty variable was blocked (Experiment 3) and when the target words were visually degraded (Experiments 6, 7, and 8). The interaction has also been obtained with a completely different set of stimulus sentences (Stanovich et al., 1981) and with the lexical decision task (West & Stanovich, 1982).

The pattern of facilitation dominance observed by Stanovich and West (1979, 1981) was also found to be robust, as long as the target words were not visually degraded. Because this finding is dependent on the appropriateness of the neutral condition, an attempt was made to validate the neutral context used in the studies reported in this article. Experiment 2 demonstrated that neutral context yielded the expected time when embedded within two sentence context conditions that were designed so as not to display a context effect. In that experiment, the times in the *they said it was the* condition did not differ from those produced by two other potential neutral conditions. Experiment 9 did reveal a small, but significant difference between the times in the neutral conditions. However, *they said it was the* produced the fastest times of the three. The major concern, of course, is whether this neutral condition produces times that are artificially slow, thus decreasing inhibition effects. The results of Experiment 9 are reassuring on these grounds. In summary, the results of Experiments 2 and 9, taken together, give us no reason to believe that *they said it was the* artifically inflates response times. It should also be noted that if the results of Experiment 9 are considered in conjunction with those of Stanovich and West (1979, 1981; West & Stanovich, 1978), the finding that word naming times in a sentence context task are characterized by facilitation dominance has now been replicated across five different neutral conditions and three different sets of sentences.

Several results indicated that the pattern of contextual effects in the naming task is not altered by manipulations that should affect subject strategies. Blocking the stimuli according to word difficulty (Experiment 3) did not change the basic pattern of results. Manipulations of context type probability (Experiment 4) and depth of processing (Experiment 5) did not interact with context condition.

Experiments 6, 7, and 8 produced strong evidence indicating that stimulus quality and context interact in the sentence context situation as they do in the single-word priming paradigm. However, the nature of the degradation manipulation appeared to affect differentially the components of the total context effect. Reducing stimulus contrast increased both contextual facilitation and inhibition. Inserting characters between letters of the target only increased the magnitude of the facilitation effect. It appears that slowing word recognition speed does not necessarily result in increased inhibition.

Finally, our previous explanation (West & Stanovich, 1982) for why inhibition has been observed in other sentence context experiments received support in Experiments 9, 10, and 11. Experiments 9 and 10 demonstrated that the same stimuli that have shown significant inhibition effects in lexical decision experiments fail to display inhibition in a naming task. Experiment 11 solidified conclusions based on these results by directly showing differential inhibition for these stimuli across the two tasks, a finding that has been replicated with a different set of stimuli (West & Stanovich, 1982).

General Discussion

The properties of the contextual effects obtained in the sentence context situation have been clarified considerably by the experiments reported here. Several empirical ambiguities have been resolved, and, in the process, several specific theoretical models of sentence context effects have been falsified. For example, several aspects of the results are not consistent with predictions derived from the verification model (Becker, 1980), and the results of Experiments 7 and 8 falsify our previous explanation of sentence context effects in terms of a time-locked, two-process theory of expectancy (Stanovich & West, 1979, 1981). However, we feel that it is still useful to maintain the distinction between context effects that operate via spreading activation in semantic memory and those that are due to conscious predictions arising from expectancy processes that are attentional, strategic, and capacity depleting. It will be argued that this distinction helps to illuminate the fact that the results reported here and much other recent work from related paradigms are indeed converging on a set of general conclusions regarding the relationship of word recognition and contextual processes in fluent reading, conclusions that also may have implications for theories of the development of reading fluency.

Several aspects of the results suggest that an automatic spreading activation process is heavily implicated in the contextual effects that are observed in the sentence context situation and that the effects obtained may be a manifestation of the more general semantic priming effect. The finding of facilitation dominance and larger contextual effects for difficult words were maintained in the face of several manipulations that should have affected subject strategies, had such strategies been cause of the contextual effects. A manipulation of the probability that the target words would be congruous has not interacted with context condition in three separate experiments (Experiment 1 of Stanovich & West, 1981; Experiment 4 of the present article; and an unpublished replication). Fischler (Note 3) also has reported that probability manipulations do not change the context effects in his paradigm. Forcing deeper processing by requiring a congruity judgment (Experiment 5), likewise, did not change the results. Converging evidence regarding this manipulation comes from an experiment by Fischler and Bloom (1979, Experiment 5) where they attempted to decrease the depth of processing by instructing subjects to avoid generating expectancies from the context and to treat the reading of the sentence and the lexical decision as two separate tasks. Performance under these instructions was identical to that observed in the standard situation. Experiment 3 demonstrated that blocking the stimuli, a manipulation that has altered facilitation and inhibition in a single-word priming experiment (Becker, 1980), did not result in significant changes in the contextual effects. O'Connor (cited in Forster, 1979) also failed to find a significant blocking effect in a sentence context experiment.

The evidence on the effect of "strategy" variables on context effects appears to be reasonably convergent. Such variables seem to have significant effects in single-word priming experiments (Becker, 1980; Tweedy & Lapinski, 1981; Tweedy et al., 1977) but have negligible or nonexistent effects in sentence context experiments (Experiments 3, 4, and 5; Fischler & Bloom, 1979; O'Connor, cited in Forster, 1979; Stanovich & West, 1981; Fischler, Note 3). It is likely that the ongoing comprehension and semantic integration demands of reading a sentence partially obviate the effectiveness of specific strategies (Forster's, 1979, 1981, arguments regarding the primacy of integrative "message level" processes in sentence processing are relevant here). Such comprehension and integrative processes are not operative in the single-word priming situation, leaving processing capacity available for the utilization of specialized strategies (see Ratcliff & McKoon, 1981, for a related argument; Banks, Oka, & Shugarman, 1981, for an analogous example of how tasks that more closely mimic the continuous processing requirements of reading can lead to different results than more discrete tasks). Additionally, in such experiments, a delay is often introduced before the onset of the target. Mitchell and Green (1978) have pointed to the potential problems of generalizing the results of priming experiments that utilize delays that are unrepresentative of the actual reading situation. Again such a procedure facilitates the utilization of strategies that may not have time to operate under the time constraints of actual reading. Finally, all of the single-word priming experiments cited above have used the lexical decision task. For reasons outlined by West and

Stanovich (1982) and in the introduction to Experiment 11, that task may be more likely to detect the effects of strategies that influence processes occurring *after* lexical access than is the naming task. In summary, we would caution that excessive reliance on single-word priming experiments when generalizing to the reading process (e.g., Becker, 1980) may lead to an overestimation of the extent to which conscious strategies affect lexical access. Evidence presented in the experiments reported here converges with the results of other studies in indicating that strategy manipulations may be much less effective in the sentence context situation.

In addition to the relative nonmalleability of the contextual effects, there are other aspects of the results that are suggestive of an automatic activation process. The observation of facilitation without inhibition has previously been interpreted as indicating the operation of a cost-free spreading activation process (Neely, 1977; Posner & Snyder, 1975a, 1975b; Stanovich & West, 1979). The basic finding that difficult words show larger contextual effects (primarily of a facilitative nature) than easy words is also indirect evidence for the operation of an automatic spreading activation process. Since the easy words were more predictable from the contexts, one would expect that if a conscious prediction process were the cause of the contextual effects, easy words should show greater facilitation, because the conscious prediction will more often match the target word on easy-word trials. However, the actual outcome, replicated several times in the experiments reported above, is just the opposite. Difficult words displayed more facilitation.

It is probably relevant that although the difficult words were less predictable, they were not less strongly related to the content words in the sentence contexts (see the Methods section of Experiment 1). This means that when in a congruous context, difficult words are less likely to benefit from conscious predictions but are just as likely to benefit from activation that spreads from associated or semantically related words in the context. If the process responsible for the contextual effects was one of automatic spreading activation in a semantic network, rather than conscious prediction, then difficult words should stand to benefit from congruity just as much as easy words (the reason difficult words actually show greater facilitation is discussed below).

A consistent result obtained in Experiments 9, 10, and 11, that predictable words did not show larger contextual effects than unpredictable words that are completions of the same sentences, also argues against conscious prediction as the mechanism responsible for the effects observed and indirectly supports an explanation in terms of spreading activation. In fact, the cloze probability of the unpreditable words is so low that if subjects were generating conscious expectancies one might easily expect inhibition for these words in the congruous condition—a result that never obtains. Although Fischler and Bloom (1979) obtained less facilitation for these words than we do, probably due to the presence of some borderline incongruities created by these words that have negative effects on a post-access process in the lexical decision task (see West & Stanovich, 1982), they never obtained inhibition. Note that the equivalence of the context effects for predictable and unpredictable words should not be viewed as a failure to replicate the Word Difficulty × Context interaction observed with the Stanovich and West (1981) word set. Bloom and Fischler (1980) reported no norms regarding the semantic relationships between target words and context words. Even if the predictable and unpredictable words were matched on this variable, the recognition time difference between the two sets (approximately 18 msec, averaged across the naming conditions of Experiments 9, 10, and 11) is markedly less than the easy–difficult word difference (always over 100 msec) and probably not large enough for an interaction to be detected.

Previous work does suggest that spreading activation is a viable mechanism for facilitation in situations approximating the parameters of the sentence context paradigm. In various priming experiments spreading activation effects have been shown to persist despite intervening words between the prime and target (Blank, 1980; Blank & Foss, 1978; Brown & Block, 1980; Davelaar & Coltheart, 1975; Loftus, 1973; Loftus & Loftus, 1974; Schvaneveldt & Meyer, 1973), and purely in terms of time, the effects seem to persist long enough to be operative in the sentence context situation (Blank & Foss, 1978; Warren, 1972). Although it is true that sentences rarely contain words that are highly associated, facilitation due to spreading activation seems to be very pervasive (Collins & Loftus, 1975) and occurs even for nonassociated words as long as they are semantically related (Fischler, 1977). Note also that we do not wish to argue that spreading activation in sentences comes only from individual words considered singly. It is possible that spreading activation also results from semantic states induced by combinations of words.

The Word Difficulty × Context interaction is actually only an instance of a more general trend running through the results of the experiments reported here and previous experiments using the same paradigm (Stanovich & West, 1979, 1981; Stanovich et al., 1981; West & Stanovich, 1978, 1982). Simply put, factors that increase the difficulty of word recognition increase the magnitudes of contextual effects. Word difficulty, operationally defined in terms of word frequency and length, has repeatedly interacted with context condition. Although previous experiments had yielded contradicting results, Experiments 6, 7, and 8 produced clear evidence that degradation interacted with context condition, when the degradation effect that is induced is as large as that produced by the word difficulty variable. Finally, it has been demonstrated that reading fluency, a subject variable, mimics the effects of the experimental variables of difficulty and degradation. Readers who are slow at recognizing words in isolation, either due to developmental immaturity or to a lack of fluency, have displayed larger contextual effects in several different experiments (Biemiller, 1977–1978; Perfetti, Goldman, & Hogaboam, 1979; Perfetti & Roth, 1981; Schvanevelt, Ackerman, & Semlear, 1977; Schwantes, 1981; Schwantes et al., 1980; Stanovich, 1980; Stanovich et al., 1981; West & Stanovich, 1978).

The relationship between the size of the contextual effect and variables affecting the speed of word recognition (e.g., word difficulty, degradation, and reading fluency) suggests that word recognition performance is characterized by compensatory processing (see Stanovich, 1980). Word recognition performance during reading has been characterized by models that are interactive (i.e., models in which word recognition results from the simultaneous operation of contextual processes and stimulus analysis mechanisms; see Rumelhart, 1977). Such models invite the additional assumption that given a deficit in a particular processing operation, other processes will become implicated in performance to a greater extent, regardless of their level in the processing system. Thus, deficits in the feature extraction and/or encoding of a stimulus word will allow higher level contextual processes to determine performance to a greater extent. For example, Seymour (1976) and Sanford et al. (1977) have shown that due to the structure of the processing system, compensatory processing is an implication of Morton's (1969) logogen model. When the rate of feature extraction is slowed (by contrast reduction, for example, or by the larger number of letters subject to lateral masking in the case of difficult words), factors that affect the evidence requirements of logogens (e.g., contextual information) will have a greater affect on performance (see Figure 5 of Sanford et al., 1977). The three trends discussed in the previous paragraph appear to result from this type of interactive-compensatory processing (see Dell & Newman, 1980, for a similar conceptualization in the area of speech perception).

A General Framework

A general framework for conceptualizing the results of several of the experiments that were reported here is provided by adding the distinction between automatic and attentional effects to the general idea of compensatory processing. For example, as word recognition becomes more difficult, any contextual information that is input into the target-word logogen due to spreading activation will have a greater effect due to a slowed rate of featural processing (see Sanford et al., 1977). This compensatory increase in contextual influence as word recognition slows is automatic because the spreading activation process is not under subject control and does not deplete cognitive capacity. However, other types of compensatory processing may be capacity depleting. For example, conscious prediction of upcoming words in text is a strategy that subjects may use, but such a strategy would draw capacity away from other processing activities.

We have previously argued (Stanovich & West, 1979, 1981) that under normal stimulus conditions, adults recognize words so fast that the conscious expectancy mechanism is short-circuited, only the fast-acting spreading activation mechanism becomes implicated in their performance, and contextual facilitation without inhibition results. This is what we called the time-locked, two-process explanation because the reason that conscious attention did not become implicated in performance in certain experimental conditions was not due to a strategic decision on the subject's part but instead was due to the time constraints of the situation. Conditions where the recognition of the target word was not delayed resulted in facilitation without inhibition, because the conscious attention mechanism did not have time to generate an expectancy. Slowed word recognition allowed time for the attentional expectancy process to become implicated in performance. Only part of this explanation received support from the experiments reported here. Several findings that were discussed previously are consistent with the hypothesis that an automatic spreading activation process is the cause of the facilitation dominance in the results, as well as the greater facilitation shown by less predictable difficult words. However, the results of Experiments 7 and 8 call into question our explanation of how the conscious attention mechanism becomes operative. Specifically, it does not seem to operate in the purely time-locked manner that we had originally proposed. It may be that the development of conscious expectancies is not inevitable given time, but is more a function of the results of the executive monitoring of ongoing subprocesses (see Posner & Rogers, 1978, pp. 165–166). However, this caveat in no way destroys the *general* usefulness of the automatic/attentional distinction.

The general model of reading emerging from these studies is similar to the interactive-compensatory framework advanced by Stanovich (1980; see also Perfetti & Roth, 1981) but lacks the time-locked assumption invoked by Stanovich and West (1979, 1981). Adult readers normally do not use attentional capacity to predict upcoming words (Gough, 1981; Mitchell & Green, 1978) but focus conscious attention on comprehending and integrating the text. Under normal conditions, when word recognition proceeds efficiently, due to fast bottom-up processing and activation in the semantic network that has spread from previously recognized words, the executive processor is not signaled that any attentional resources are needed for lexical access to occur. However, the slowdown in lexical access caused by difficult or degraded words may, in some cases, trigger the conscious processor into providing additional information via contextual expectancies. This situation would obtain more frequently for less fluent readers who are less adept at recognizing words primarily on the basis of visual information. However, one result of using attentional capacity at the level of word recognition is that less capacity is left over to allocate to comprehension. This accounts for why even poor comprehenders often show very large contextual effects on word recognition (Stanovich, 1980). This view of reading (see Gough, 1981; Mitchell & Green, 1978; Perfetti & Roth, 1981, for similar conceptualizations) is antithetical to several popular models of reading (e.g., Goodman, 1967; Smith, 1978) that link the facility of the fluent reader to increased accuracy of lexical level predictions.

The general view of word processing during reading that we are led to bears many similarities to an explanation of the processing of lexical ambiguities put forth by Seidenberg, Tanenhaus, Leiman, and Bienkowski (1982; see also Cairns, Cowart, & Jablon, 1981; Oden & Spira, in press; Onifer & Swinney, 1981; Tanenhaus, Leiman, & Seidenberg, 1979). They

> found no evidence that subjects could use their knowledge of language or knowledge of the world to restrict access to one reading. The only contextual effect was due to lexical priming, an automatic, non-directed, intralexical process that is a consequence of the organization of semantic memory. (p. 523)

In addition, our model converges with recent trends in the study of early visual processing during reading (Brady, 1981); is generally congruent with the theoretical frameworks of Forster (1979, 1981), Fischler (Note 3), and Mitchell and Green (1978, Note 2); and meshes nicely with the conclusions drawn from recent studies of the effect of context on eye movements during reading (Ehrlich & Rayner, 1981; McConkie & Zola, 1981). Indeed, a step back from the minor methodological quibbles in this research area reveals a remarkable degree of convergence.

Forster's (1981) recent article revealed some empirical differences between our results and his (probably due to some methodological differences) but no real theoretical disagreement. He agreed that inhibition in the lexical decision task results from postlexical message-level processes and in his Experiment 1 replicated the finding that larger inhibition effects are found in a lexical decision task than in a naming task. Forster did not deny the possibility of lexical priming effects in sentences but argued that the terminal word of a sentence can be predictable without being related to any words in the sentence. Indeed, this is true and probably accounts for why there is no facilitation effect in the naming condition of his Experiment 1, because his sentences were constructed so as to avoid semantic relationships and associates. We agree that the actual magnitude of the priming effects to be expected from a more representative set of language materials is an open empirical question and also agree that the actual magnitudes of the effects will undoubtedly be smaller than those obtained in the typical laboratory experiments reported in the literature, because in the latter case the materials are often chosen to be unusually high in semantic relationships and predictability (see Stanovich & West, 1983; Gough, Note 4, on just this point). However these issues are resolved, it is important to note that differing speculations about the ecological representativeness of materials do not represent *theoretical* disagreements. Indeed, failure to distinguish these two types of controversies often makes our research literature seem more inconsistent than it really is.

The main empirical inconsistency between our results and Forster's (1981) is his failure to observe a Word Difficulty × Context interaction. There are several marked differences in methodology that may be relevant, for example, Forster's use of the rapid serial visual presentation procedure in which each word writes over the previous one and the introduction of a 500-msec neutral stimulus between the last context word and the target word. Also, no error rates are presented with Forster's reaction times, so perhaps a partial resolution resides there. He did report that a reanalysis including the outlier times still did not reveal an interaction, although neither the number of outliers nor the number of mispronunciations (included in our error rate measure) are reported. A related point concerns the overall magnitude of the reaction times. Averaged across over 15 conditions embedded within our experiments that have contained the easy–difficult comparison, we have found that the average difference between the easy and difficult word times is approximately 147 msec. Difficult-word reaction times in the neutral condition have only dipped below 600 msec once, and they are often over 700 msec. In contrast, Forster (1981) obtained a difficult-word reaction time of 587 msec and only a 70-msec difference between easy and difficult words (less than one half of what we usually obtain). This increases the importance of checking whether a larger context effect is not concealed in the error rates of a difficult condition that is speeded at the cost of increased errors.

One current model of lexical processing that appears to be at odds with the conceptualization outlined here is the verification model (Becker, 1980). Because that model involves a comparison of the visual stimulus with a stored candidate word that has been constructed on the basis of previous contextual information, it has a top-down emphasis not present in our framework. Further, the verification model posits two semantic strategies that are adopted based on the distribution and strength of the predictive relationships in the materials used. Becker (1980) summarizes the relationship as follows:

> On the one hand stimulus materials that allow subjects to fairly well predict the related target produce facilitation dominance. On the other hand, materials that preclude prediction but seem to allow a general expectation yield interference dominance. (p. 507)

As previously discussed, this model was developed entirely within the context of single-word priming experiments (and the lexical decision task), in which the processing requirements differ considerably from the situation of sentence processing,[2] particularly regarding the opportunities for strategy manipulations.

Several empirical results obtained here are inconsistent with the predictions derived from the verification model and serve to raise doubts about the generalizability of the model to the reading and sentence context situations. Experiment 3 demonstrated that when blocked and presented first, the difficult words did produce facilitation dominance. Yet these were just the type of stimulus materials that should have induced inhibition dominance, according to the verification model. The contexts spanned a wide range of predictability, but the overall predictability of the primary response was well below 50%. When coupled with the difficult target words, the predictability of the contexts is very low. A second set of problematic results is contained in Experiment 6. Based on an analysis of the verification model parameters by Neely (Note 5), it appears that the difficult-word set (or poorer readers, if the reading skill variable mimics word difficulty) cannot simultaneously produce more facilitation *and* inhibition. However, this is exactly what does happen in Block 1 of Experiment 6 (and occasionally in some experiments under normal stimulus conditions where the difficult words show small inhibition effects). The finding also obtains in a study with children (Stanovich et al., 1981), in which an additional troublesome result is found. Easy and difficult words display different patterns of contextual effects, despite the fact that differential strategy use is precluded due to stimulus randomization. Finally, the results of Experiments 9, 10, and 11 are problematic for the verification model.[3] Presumably, that model would have accounted for the inhibition dominance of the Fischler and Bloom (1979) results by positing the operation of the inhibition-causing expectancy strategy. However, the present results indicate that it was the task characteristics, not the strategic set, that was responsible for the inhibition obtained. Like other models where contextual strategies directly modify the process of lexical access, the verification model is falsified by the data presented here.

A final point of clarification regarding the theoretical position we have outlined is in order. We have argued that conscious strategies of contextual prediction do not normally *guide* lexical access. This, however, does not mean that such processes cannot have early occurring and potent effects on other levels of word processing. There is now mounting evidence (Ehrlich & Rayner, 1981; Frazier & Rayner, 1982; Irwin, Bock, & Stanovich, 1982; Mitchell & Green, 1978) for what Just and Carpenter (1980) called the immediacy assumption, the idea that individual words undergo as much analysis as possible by word encoding, lexical access, case role assignment, and discourse integration mechanisms as soon as they are encountered in text. Several different experiments have yielded estimates of lexical access time in the range of 150 to 250 msec (Gough & Cosky, 1977; Loftus & Loftus, 1974; Rohrman & Gough, 1967, Sabol & DeRosa, 1976). Consistent with these estimates, Kutas and Hillyard (1980) found that cortical potentials indicating semantic anomaly begin as early as 250 msec after target word onset. Thus even if conscious expectancies do not facilitate lexical access, such processes could have message-level effects even within a single eye fixation during reading, a conclusion supported by the results obtained from the lexical decision task.

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[2] The recent extension of the model reported by Eisenberg and Becker (1982) concerned sentence *verification* rather than sentence context effect on word *recognition*.

[3] See Antos (1979) and Besner and Swan (1982) for additional contradictory data.

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