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Semantic facilitation and lexical access during sentence processing: An investigation of individual differences

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An earlier experiment (Blank & Foss, 1978) showed that the time required to access the object noun of a sentence was shortened if the noun was preceded by a semantically related verb or adjective. When both the verb and the adjective were semantically related to the noun, the amount of facilitation of lexical access was additive. However, additivity appeared to break down for subjects who did poorly on the comprehension test administered in that experiment, suggesting that the activation function among related lexical items was different for good and poor comprehenders. Such a finding would have implications for theories of lexical facilitation, especially the two-factor theories such as the one proposed by Posner and Snyder (1975). The present experiment again measured access time for the object noun of a sentence when it was preceded by an unrelated or a related verb or adjective (four sentence types). Two groups of college subjects were tested, relatively good (N = 63) and relatively poor (N = 42) comprehenders. The difference in the time taken to retrieve the object noun was ascertained by measuring reaction time to respond to the initial phoneme of the next word in the sentence (phoneme monitoring technique). Reaction times were shorter when the noun was preceded by a semantically related word; the effects of two sources of related context (verb and adjective) appeared to be additive for *both* groups of subjects. These results were discussed within the context of two-factor theories of lexical activation and within the context of Morton's (1969) logogen model.

This paper is primarily concerned with the effects of semantic context on lexical access during sentence processing. An earlier study on this topic (Blank & Foss, 1978) apparently found that context effects varied between subjects in a systematic way; the present paper is also concerned with following up this observation.

Although we are focusing here upon the relation between context and lexical access during sentence processing, this relation has been studied much more often in experiments using lists of words. Thus, there are numerous studies in the literature reporting that the retrieval time for a word in a list decreases when it is preceded by a semantically related word. For example, Meyer and Schvaneveldt (1971) conducted an experiment in which word-nonword judgment times were measured. They found that it took less time to judge that "nurse" was a word when it was preceded by a related word such as "doctor" than when it was preceded by an unrelated word such as "butter."

Attempts to account for context effects in lists have generally been based either on search models of lexical access, in which a system of cross-references between related lexical entries provides a "shortcut" to semantically related words (e.g., Forster, 1976), or on some notion of lexical activation "spreading out" from already retrieved words to other, related ones (e.g., Morton, 1969). Recently, refinements of these basic models have been proposed; these refinements amount to two-factor theories of lexical processing (e.g., Posner & Snyder, 1975). One of the two factors is "automatic activation." In Posner and Snyder's view, the presentation of a word automatically facilitates access to other, associated words in the memory system. The facilitation is automatic in the sense that it occurs without intention, does not give rise to conscious awareness, and does not interfere with other ongoing mental activities. Automatic activation is a rapid process, having a rise time of less than 100 msec in some cases (e.g., Warren, 1977). Warren also presents some evidence suggesting that the decay time of the activation may be relatively rapid, although this is not so secure a fact (cf. Kirsner & Craik, 1971; Warren, 1972). Posner and Snyder (1975) have reviewed much of the evidence for the automaticity of the activation process.

The second factor in the two-factor theory is controlled attention, that is, processing that is under the control of an executive or a scheduling algorithm. Unlike the automatic activation factor, the executive has limited capacity, it has a reflection in consciousness, and it inhibits pathways that are not being activated. It also is thought to have a slower rise time than the automatic activation. Neely (1977) has reported data

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that are consistent with predictions derived from Posner and Snyder's (1975) two-factor theory.

Experiments manipulating semantic relatedness have contributed to the formulation of two-factor theories of lexical processing, and, as such, they have made a contribution to our understanding of attentional processes. However, to be of general interest to those concerned with language processing, the experiments and theory should also illuminate at least one of two other general issues. The first deals with the structural or organizational aspects of the mental lexicon. That is, we would like this body of research to provide us with information about the nature and organization of the semantic pathways themselves. Although Collins and Loftus (1975) note that automatic activation will lay bare some of the organizing principles of the mental lexicon, little progress on this front has been made so far. There is some evidence from Warren's (1977) study that the automatic activation of synonyms follows a different time course than that followed by words related in other ways (e.g., opposites). This suggests that synonyms have a special status in the mental lexicon and that the structure of the lexicon should reflect this difference. However, the evidence from Warren's study is not very strong, nor did the experiment investigate a particularly wide range of semantic relationships. Neely (1977) also noted that activation experiments could be used to discover which lexical units in semantic memory were connected by automatic links. He suggested that some relatively subtle properties of verbs of motion (e.g., velocity information) might not yield automatic activation of their related words. If this is true, it becomes an open question whether one should take the reaction time (RT) data obtained in the activation paradigm as the sole criterion of a strong semantic link. Finally, the work of Posner and Snyder (1975) suggests that the system of organization for emotional tone may be activated somewhat separately from other aspects of words. It is clear that much work needs to be done before we can determine what this line of research contributes to our understanding of the structure of the mental lexicon.

The second general issue upon which studies of semantic relatedness within word lists may bear is that of sentence processing. The question is, do the effects found in word lists transfer to situations in which sentences are being understood? It seems likely that they will, for there is little utility to the entire semantic activation process except insofar as it applies to the use of language. Thus, we are led to ask some more specific questions. For example, does the retrieval of a word during sentence processing lead to automatic activation that affects the speed of retrieving later, related words? If so, are the parameters of the process similar to those observed in the research using lists? As we will note below, there is some reason to suspect that the answer to the second question is *no*, even if the answer to the first is *yes*.

Somewhat surprisingly, there are only a few studies in the literature that have investigated the effects of semantic relatedness on lexical access in sentences. In one such study, Morton and Long (1976) manipulated the transitional probability of words within sentences and measured the retrieval difficulty of high-transitional (i.e., "expected") words vs. low-transitional words. In the context "The man sat reading a ______," the word "book" is more probable than the word "bill." Morton and Long presented their listeners with some sentences that contained the high-transitional probability word (e.g., book) and other sentences that contained the low-transitional probability word (e.g., bill). The task used was phoneme monitoring; subjects were asked to respond by pushing a button when they heard a word beginning with a specified target phoneme. The target was the initial segment of the high- or low-transitional probability word (in this example, /b/). Morton and Long found that RT to respond to the target phoneme was shorter when the target began the expected word. They argued that this reflected the more rapid access of that word. Thus, semantic relatedness appeared to speed lexical retrieval during sentence processing. It should be noted that, in the materials used by Morton and Long, it was not always possible to pinpoint the specific words in the context that were related to the target-bearing word of interest. Instead, the target-bearing word was related to the meaning of the prior sentence fragment and not necessarily to the meanings of particular words constituting that fragment.

The study conducted by Blank and Foss (1978) examined the effects of semantic relatedness on lexical retrieval when the semantically related words could be specified precisely. The relation of their study to those using word lists is straightforward. Blank and Foss presented their subjects with sentences like those shown in Table 1 and tried to assess the relative speed with which the object nouns of the sentences were retrieved.

Table 1
Examples of the Four Sentence Types and Mean Phoneme Monitoring Reaction Times (From Blank & Foss, 1978)

Source of Prior Context	Reaction Time in Milliseconds	Experimental Sentence
None	482	The drunk concealed his aching *eye* probably without realizing he was doing so.
Verb	460	The drunk *winked* his aching *eye* probably without realizing he was doing so.
Adjective	462	The drunk concealed his *bloodshot eye* probably without realizing he was doing so.
Verb and Adjective	438	The drunk *winked* his *bloodshot eye* probably without realizing he was doing so.

Note–The critical lexical items and the target phonemes are italicized.

Some sentences were relatively neutral in that there was no prior word in the sentence that was closely related to the object noun. In other sentences, either the verb or the adjective was related to the noun, or both were. Norms were gathered before the experiment to help insure that the verb and the adjective were equivalently related to the noun. The subjects were asked to monitor for a word-initial target phoneme that, in the experimental sentences, immediately followed the object noun (/p/ in the examples of Table 1). If the presence of a semantically related word speeds lexical access, then the time to respond to the target phoneme ought to be relatively short.[1]

Blank and Foss (1978) found that phoneme monitoring RTs were affected by the presence of words semantically related to the object noun. The average RTs in their data are also shown in Table 1. Two aspects of these data are notable. First, the adjective and the verb had equivalent facilitative effects. The effectiveness of the adjective suggests that the rise time for the activation phenomenon is as fast in sentences as it is in the list studies. The effectiveness of the verb suggests that the decay times are no more rapid in sentences than in lists (a reasonable finding; if anything, we might expect that decay times would be longer in sentences). The second notable aspect of these data is the additivity of the activation effects. Both the related verb and the related adjective yielded about 20-msec decreases in RT when they occurred alone; when together, they led to about a 40-msec decrease in RT. This additivity effect is probably not general; it almost surely has an upper limit and may be bound by other parameters as well. But it is notable because it is not necessary and because it somewhat constrains models of the activation process that we might wish to entertain first.

The data in Table 1 seem highly compatible with Morton's (1969) logogen model. According to this model, the internal entities corresponding to word concepts (the logogens) have the equivalent of a counter associated with them. This counter is incremented when appropriate sensory information is received or when semantically related words have been activated. (Posner and Snyder's, 1975, common pathways model is equivalent to this view.) In particular, the internal counter will be incremented for each semantically related word, although the size of the increment is not necessarily the same for each one. Within Morton's model there is a threshold value above which the count must rise before the logogen is activated. We might suspect that there is a further decision rule about logogen activation that applies when processing external (sensory) signals. This rule may state that some appropriate phonetic or orthographic information must be present when receiving information from an external source before the logogen exceeds threshold. The following observation provides informal evidence for this requirement. When spoken, phrases like "bread and button" seem to result in a momentary "garden path" experience in the listener, a violation of expectations since "butter" seems to be activated. Phrases like "bread and needle" do not seem to produce such experiences. Thus, prior context may lead to a level of activation of an internal unit that rises to, but stays below, the threshold value.

To be somewhat more explicit, let A_T = the threshold level of activation required for a logogen to become activated. Let A_t = total level of activation due to prior context for that same logogen at some point in time. Further, let a_w be the amount of activation received by the logogen of interest due to the presence of word W; let a_x be the amount of activation to that logogen due to the presence of word X, and so on. We will require that $A_t < A_T$ in all that follows. The evidence from the Blank and Foss (1978) experiment supports the conclusion that $A_t = \text{SUM}(a_w, a_x)$. Of course, this is only a crude first approximation, since it does not take into account the rise and decay times of the activation. Other functions are possible and have been proposed: for example, $A_t = \text{TEMP}(a_w, a_x)$, where TEMP refers to the source of context that is temporally closer (and prior) to the logogen whose A_t we are calculating. This is the "location shift" model discussed by Meyer and Schvaneveldt (1971; see also Meyer, 1973), among others. Another model would have $A_t = \text{MAX}(a_w, a_x)$. This is a model in which the logogen keeps track of the sources of the input and only responds to one of them, the one with the larger input to it. Such a model might be helpful when considering the problems of ambiguity, where it is sometimes the case that words related to two interpretations of an ambiguous item might occur earlier in the sentence and yet only one interpretation (logogen) is activated.

The present study investigated further the issue of semantic context effects during sentence processing. In particular, it was an attempt to deal with an anomaly observed in the Blank and Foss (1978) data, one that appeared to require that two functions of the above sort be hypothesized in order to describe the performance of two groups of subjects. We have already presented in Table 1 the data from one group of Blank and Foss' subjects. These are the data from the "good" subjects in the experiment. Good subjects were determined by their scores on a comprehension test that was given after all of the sentences had been heard. The comprehension test used was a recognition test; subjects were given a list of sentences and were asked to indicate which ones had occurred during the earlier part of the experiment and which had not. Some of the nonoccurring sentences were similar in meaning to the actually occurring sentences. Those subjects who scored above chance on this test were considered the good subjects; there were 44 of them.

The data from the 17 "poor" subjects, those that did not score above chance on the recognition comprehension test, were not reported by Blank and Foss (1978), but they are presented in Table 2. As can be seen, both when the verb was related to the object

Table 2
Mean Phoneme Monitoring Reaction Times (in Milliseconds) Data from 17 "Poor" Subjects

Verb Context	Adjective Context	
	Unrelated	Related
Unrelated	529	467
Related	479	463

noun and when the adjective was related to it, the RTs decreased–and by approximately the same amount. However, the two effects were not additive as they were for the "good" subjects. Two sources of relevant context led to no more facilitation than did one.

How can we account for the failure of additivity for the poor comprehenders? One simple and straightforward explanation is that their data are unreliable. With only 17 subjects, not balanced across material sets, it is quite possible that a sampling error occurred. However, the data are so striking that they encourage speculation (and further work). Thus, from a more theoretical perspective, we might hypothesize that these subjects set their thresholds, A_T, to relatively low values (a possibility that exists within the logogen framework). This would permit either of the related words by themselves to make A_t, the momentary activation level, so close to A_T that the additional amount of activation from the other related words could have no added effect on A_t. (Recall that according to our speculations semantically related words can increase A_t only so far, such that $A_t < A_T$.) However, this possibility seems to be ruled out by the data. If A_T were set low, then we would expect that the overall RTs for these subjects (the poor comprehenders) would be relatively fast compared with the good comprehenders. In fact, they were slower.

We might also suspect that the rise time for activation would be slower for poor comprehenders than for good comprehenders, and that this could help account for the lack of additivity. The data immediately refute this conjecture, however, since the poor comprehenders showed a facilitative effect for the related adjective when it was the only semantically related word in the sentence.

Descriptively, we can say that the activation functions for the two groups appeared to be different. The good comprehenders had $A_t = \text{SUM}(a_w, a_x)$, while the poor comprehenders appeared to have $A_t = \text{MAX}(a_w, a_x)$. Perhaps it is necessary for the processing system to activate all of the interconnections among the related items before the SUM function is operative, and for some reason the poor comprehenders tended not to undergo such thorough activation. If the difference in functions between the good and poor comprehenders is chronic, it is important to conclusively demonstrate it and then to investigate why the difference exists.

We believed, then, that the difference between the two types of subjects was highly interesting and of great potential importance. Identifying a processing difference between good and poor comprehenders raises the possibility of being able to analyze it and perhaps even of doing something about it. The present experiment follows up the earlier work. It is a replication and extension of the Blank and Foss (1978) study, conducted with the two populations of subjects ("good" and "poor" comprehenders) in mind at the start. Specifically, subjects were presented the same four kinds of sentences as are shown in Table 1. They were asked to comprehend the sentences and to monitor for a word-initial target phoneme. As in the previous study, the target always occurred immediately after the object noun in the experimental sentences. But, unlike the previous study, we decided beforehand to test sufficient numbers of subjects so that we would obtain roughly comparable sample sizes of both good and poor comprehenders for each material set. We were interested in whether the performance of the good and poor comprehenders would differ, with only the former showing the additivity phenomenon. The present study also extended the earlier one by employing two tests of comprehension. The first was the recognition comprehension test that was used in the Blank and Foss experiment. The second was a standardized test of listening comprehension, the Sequential Tests of Educational Progress (STEP test, devised by the Educational Testing Service). The latter test used totally independent materials, that is, materials that were not drawn from the experimental sentences, and it presumably measured a much "deeper" level of comprehension than did the recognition test. Use of the STEP test along with the recognition test permitted us to examine the relationship between the two, and it also permitted us to examine the relationship between the RT data and the standardized test.

METHOD

Design and Materials

The 32 basic experimental sentences constructed by Blank and Foss (1978) were used in this study. Each sentence had four versions: The verb was either semantically related or unrelated to the following noun, and, crossed with this variable, the adjective preceding that noun was either semantically related or unrelated to it. This defines four conditions. In order that each basic sentence be able to occur in each condition across the experiment, four material sets were constructed. Each material set contained all 32 basic sentences; 25% of the sentences in each material set came from each of the four conditions. Across the material sets, each basic sentence occurred in all four conditions. There were two basic groups of subjects, good and poor comprehenders, determined by the scores on the recognition comprehension test. The experiment was a 2 (verb type: related/unrelated) by 2 (adjective type: related/unrelated) by 2 (comprehension group: good/poor) by 4 (material sets) factorial, with the first two variables within subjects and the last two between subjects.

The verb-adjective-noun triplets used in the experimental sentences were selected on the basis of relatedness ratings obtained for the adjective-noun and verb-noun pairs. The ratings were made by 127 undergraduate psychology students who did not participate in the main experiment. These ratings were collected in order to insure that the degree of relatedness between the verb and the noun was identical to that between the adjective and the noun. Details of the rating technique can be found in Blank and Foss (1978).

Experimental sentences were constructed so that the word following the noun began with the target phoneme (e.g., the target is /p/ in the sentences shown in Table 1). The six stop consonants were used as targets with the following frequencies of occurrence among the experimental sentences: /b/, 9; /p/, 5; /d/, 8; /t/, 2; /g/, 4; /k/, 4. The beginning structure of each experimental sentence was always *NP V det adj N*. . . .

The frequency of the related and unrelated words for both the adjectives and verbs were matched according to Kučera and Francis (1967) estimates. In addition, whenever possible, they were matched for syllable length and initial phoneme. The experimental sentences are given in Appendix A of the Blank and Foss (1978) paper.

Twenty-eight filler sentences were constructed. Eight of these did not contain the target phoneme, and the remainder varied the target position. The filler sentences were identical for each of the four material sets. The 60 sentences were randomized, with each basic sentence occurring in the same position for all material sets.

A male speaker recorded each of the four material sets on one channel of a tape. A pulse, inaudible to subjects, was placed on the second channel of the tape at the beginning of each target phoneme. The pulse started a timer that stopped when subjects pressed a button.

Subjects

The subjects were 105 undergraduate psychology students at the University of Texas at Austin who participated in the experiment in partial fulfillment of a course requirement. Performance on the recognition comprehension test (see below) determined whether a subject was "good" or "poor." Enough subjects were tested so that a minimum of 10 good and 10 poor subjects heard each of the four sets of materials. The number of good and poor subjects, respectively, in each of the four sets were: 14, 11; 14, 10; 23, 10; and 12, 11.

Procedure

Subjects were tested in groups of one to six, with the experimenter and subjects occupying adjoining rooms. Each subject was seated in a booth out of direct sight of the others.

Instructions describing the subjects' task were recorded at the beginning of each experimental tape. The instructions and the test sentences were presented binaurally over headphones. Subjects were told to lightly rest the index finger of the preferred hand on the button in front of them. They were instructed to listen for a word-initial sound (e.g., "/bə/ as in Bob") and to press the button as quickly as possible when they heard it. A trial consisted of the word "ready," specification of the target phoneme, and the presentation of a sentence. Subjects were given three practice sentences, one of which did not contain the target phoneme. After the experimenter answered questions clarifying any uncertainties regarding the instructions, the experimental and filler sentences were presented.

Subjects were forewarned in the instructions that a comprehension test would be administered after they had heard all the sentences. This instruction emphasized the importance of paying close attention to the sentences. Immediately following presentation of the test sentences, subjects were given a printed comprehension test. This test was a recognition test consisting of 24 sentences, half of which the subjects had heard during the experiment and half of which they had not heard. All of the sentences on the comprehension test that had been presented during the experiment were fillers. Since these were identical for each of the four experimental tapes, a single test was administered to all the subjects. Subjects were asked to indicate by a check mark those sentences that they had heard during the experiment. They were told that "about half" of the test sentences were old. Of the sentences that subjects had not heard, half were derived from actual filler sentences in one of two ways. Either many of the words were identical to those that occurred in the originally presented filler sentence, or the derived filler sentence was structurally similar to the original sentence. The following is an example of an actual filler sentence that subjects heard during the experiment and a sentence derived from it that occurred on the comprehension test: *The sniper assassinated the young President with a rifle* (filler). *The President was assassinated while he was campaigning* (test). The remaining sentences were not related to any of those presented during the experiment.

The standardized test of listening comprehension, the STEP test, Form 1B, was presented some days subsequent to the experiment proper. It was administered on a group basis to those subjects who had participated in the experiment during a given week. The STEP test consists of 12 short selections to be read aloud. These selections were presented via tape to the subjects so that each presentation would be constant. Each selection from the test is followed by a group of questions or incomplete statements pertaining to the selection (also presented aurally), and the subject is to select the best answer from a set of four possibilities. The tape consisted of alternative selections from the STEP test, six in all, in order to fit the test's administration into a 1-h format. Apart from this, the standard test procedure was employed. Debriefing of the subjects followed this phase of the experiment.

RESULTS

The 105 subjects were first divided according to performance on the recognition comprehension test. Sixty-three subjects scored significantly above chance on this test, and 42 did not. The mean RT for each subject was computed for each of the four experimental conditions. RTs longer than 1,500 msec were replaced by the subject's mean RT, as were any RTs that were above 2 standard deviations from the subject's mean. The resulting means of means are shown in Table 3.

An unequal-N analysis of variance was carried out on the data. No overall difference due to subject type (good vs. poor) was found ($F < 1$). Also, the subject-type variable did not interact with either the verb type (related vs. unrelated) or the adjective type (related vs. unrelated) (both $Fs < 1.2$). Importantly, the three-way interaction among these variables was also far from significant ($F < 1$). Overall, however, the verb-type variable was significant both by subjects and by items [$F_1(1,97) = 19.21$, $p < .001$; $F_2(1,31) = 6.80$, $p < .04$; min $F'(1,57) = 5.02$, $p < .05$]. Likewise, the adjective-type variable was also significant [$F_1(1,97) = 14.36$,

Table 3
Mean Phoneme Monitoring Reaction Times (in Milliseconds) for "Good" and "Poor" Subjects on the Recognition Test

Subject Type	Verb Context	Adjective Context: Unrelated	Adjective Context: Related
Good	Unrelated	506	485
	Related	488	476
Poor	Unrelated	497	482
	Related	477	457

$p < .001$; $F_2(1,31) = 5.68$, $p < .03$; min $F'(1,60) = 4.07$, $p < .05$].

The pattern of results was similar when data from the "good" subjects alone were analyzed and when the data from the "poor" subjects alone were tested. For the good subjects, both the verb and the adjective variables were significant when tested by subjects and were nearly so when tested by items [verb effect: $F_1(1,59) = 5.76$, $p = .02$; $F_2(1,31) = 3.19$, $p = .08$; adjective effect: $F_1(1,59) = 9.59$, $p < .005$; $F_2(1,31) = 3.33$, $p = .08$]. For the poor subjects, both the verb and the adjective variables were significant when tested by subjects and when tested by items [verb effect: $F_1(1,38) = 16.16$, $p < .001$; $F_2(1,31) = 8.73$, $p < .01$; adjective effect: $F_1(1,38) = 5.26$, $p < .03$; $F_2(1,31) = 4.11$, $p = .05$].

The subjects' performance on the recognition comprehension test did not correlate significantly with their performance on the STEP test. Since this was so, it could be that "good" and "poor" comprehenders on the STEP test might differ in their patterns of RTs. Accordingly, the subjects were divided into three groups of approximately equal size: good, average, and poor comprehenders on the STEP test. The RT data from the first and last of these groups were computed. Mean RTs from these two groups are shown in Table 4.

An overall analysis of variance (by subjects) yielded no effect due to subject type ($F < 1$), nor did this variable enter into any significant interactions. In particular, the three-way interaction among subject type, verb type, and adjective type was not significant [$F(1,54) = 1.70$, $p = .20$]. However, both the verb-type and adjective-type variables were highly significant overall [$F(1,54) > 13$, $p < .001$, in both cases].

The "good" and the "poor" comprehenders on the STEP test showed similar patterns of results when their data were analyzed separately. Analyses of variance (by subjects) on the data from these groups yielded significant effects due to the verb-type and adjective-type variables for both of them ($p < .02$, in all cases) and no interactions of verb type with adjective type.

DISCUSSION

The present experiment replicated the main findings of Blank and Foss (1978). The prior occurrence of words semantically related to the object noun of a sentence led to decreases in response times to target phonemes that occurred immediately after that noun. This finding is consistent with the hypothesis that access or activation of words is speeded by the prior occurrence in the sentence of semantically related words. These results are compatible with Morton's (1969) logogen model, given our addition that $A_t < A_T$. This study also confirmed the earlier finding that the facilitation effect has a very fast rise time. The presence of the related adjective, which occurred immediately prior to the object noun, led to significant decreases in RT relative to the control condition, in which an unrelated adjective preceded the object noun.

The present experiment did not replicate the difference in response patterns Blank and Foss (1978) observed between "good" and "poor" comprehenders. In this experiment the data from both groups of subjects were, to varying degrees, consistent with the additivity effect shown by the "good" subjects in the earlier study. Thus, the function $A_t = \text{SUM}(a_w, a_x)$ summarizes, to a first approximation, the performance of both groups. If anything, the "poor" subjects in this experiment behaved somewhat more in accordance with additivity than did the "good" subjects, although the relevant three-way interactions were far from significant. The "poor" subjects did not behave according to $A_t = \text{MAX}(a_w, a_x)$, as they appeared to have done in the Blank and Foss experiment. The earlier results were apparently due to lack of counterbalancing across materials, small sample size, and so on.

It is worth reiterating that the additivity effect, although general in that the data from both groups of subjects are consistent with additivity, is almost certainly parameter bound. Additivity would not continue as A_t approached A_T.

It is also worth noting that the explanation offered here for the decrease in phoneme monitoring RTs when the verb and adjective are related to the noun is not the only possible one. Another plausible account of this observation would state that the monitoring times are sensitive to the difficulty that listeners have in integrating words into higher level structures such as phrases. It is reasonable to assume that such integration occurs more rapidly when the lexical items within the phrase are semantically related to each other than when they are not. Along with Blank and Foss (1978), we opt for the explanation in terms of lexical access, since it appears to be the more parsimonious position. Recall that in list experiments related words led to faster RTs in the lexical decision task. In those experiments the problem of integrating the words into higher level units does not arise. Thus, by adopting the hypothesis that related words speed lexical access, we can account both for the findings in list experiments and for those in sentence experiments.

The lack of correlation between the recognition comprehension test and the STEP test indicates that our labeling of the two groups may have been questionable. At the least, it suggests that the two types of tests

Table 4
Mean Phoneme Monitoring Reaction Times (in Milliseconds) for "Good" and "Poor" Subjects on the STEP Test

Subject Type	Verb Context	Adjective Context	
		Unrelated	Related
Good	Unrelated	489	460
	Related	458	444
Poor	Unrelated	487	476
	Related	476	452

measure quite different aspects of comprehension. This is not surprising given the nature of the two tests. The STEP test seems to examine a much "deeper" level of comprehension than the recognition test. It often requires that the listener make inferences based upon both the material presented in the short passage and the listener's knowledge of the word. The recognition test requires no inference-making capabilities. In contrast to the STEP test, it deals with isolated sentences rather than with short texts.

In this experiment we observed no difference in the RT patterns between the good and the poor comprehenders as defined by either test. Why was this the case? (We are aware that the lack of an experimental effect traditionally does not cry out for an explanation, but two points are relevant. First, the experiment was probably sensitive enough to pick up differences of any sizable magnitude. Some differences of 20 msec were found to be significant here. Second, the groups do differ on the comprehension test. Why is that not reflected in their "on-line" sentence processing?) Earlier, we noted that many theorists have proposed two-factor theories of attention in which automatic and controlled processing are distinguished. Perhaps this distinction can help us to understand the lack of difference in response patterns between the two groups of subjects. The prior occurrence of a semantically related word in a sentence or a list may facilitate access of the word of interest in an entirely passive way. That is, in these circumstances, the subject's attentional control or strategies may have little or nothing to do with performance. Activation of related words is automatic (Neely, 1977). Since we are dealing with processes that are automatic, and since there is little reason to suppose that the two groups differ in how well their passive attentional systems operate, it is understandable that they do not differ in experiments such as the present one. If we want to find differences in processing between the two groups, we may have to look elsewhere. Two-factor theories of attention suggest that we should look at nonpassive components of comprehension, those that are at least in part under control of the active attentional systems.

Consider the following experimental paradigm. Subjects are presented with short stories in which an early word such as "doctor" suggests a medical setting. No other words in the early part of the passage are inherently medical words. After a few seconds, the passive activation of "nurse," and so on, should decay. But good comprehenders may continue to activate such words, via their controlled attentional systems, until the topic passes from the medical setting. Thus, they should rapidly retrieve "nurse" even if the word occurs many words downstream from "doctor." Subjects who do not continue to activate words that are related to the topic of conversation will not have the retrieval of "nurse" facilitated. Here, then, is one possible place to look for processing differences, even at the level of lexical access, between good and poor comprehenders. Other high-level processing differences can no doubt also be examined. Thus, two-factor theories of attention may help us to sort out some aspects of sentence processing that might otherwise be confused.

Before dismissing totally the role of the passive activation system in accounting for individual differences in comprehension, we should note that the range of comprehension abilities tapped in this experiment was narrow. Perhaps even the passive activation system will differ for listeners who are very poor comprehenders.

To summarize, the results of the present experiment suggest that both good and poor comprehenders are equally sensitive to the passive activation of words (or logogens) that are related to the words retrieved earlier in a sentence. Over some range, these activation effects appear to be additive for both groups. We have suggested that the similarity between the groups occurs because semantically related words are rapidly and passively activated for all listeners. Differences between the groups will probably not occur in the passive activation component of the processing systems, but rather, in those components that may be subject to attentional control. Thus, differences between good and poor comprehenders due to context effects may only be observed when the contexts are at some distance from the word of interest.

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NOTE

1. Careful readers may have noted that the target phoneme occurred *on* the word of interest in the Morton and Long (1975) experiment, while it occurred *after* the object noun of interest in the Blank and Foss (1978) study. This difference can be critical in phoneme monitoring experiments (Foss, Harwood, & Blank, in press), but it is not critical for the present line of argument.

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