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4 Words and Contexts

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Students of reading disagree about many things. They disagree about the role of letters, about the role of phonological form, and even about the role of the printed word itself. But most are agreed that context is an important determinant of word recognition. In one form or another, "contextualism" is embraced by nearly every student of reading.

The forms of contextualism vary considerably. There is a kind of methodological contextualism like that espoused by Haber (1978), who, in a recent review of reading research, refused to consider any studies of the recognition of isolated words or letters on the grounds that they have nothing to do with reading. At another extreme, there is the kind of radical contextualism offered by theorists like Goodman (1976) and Smith (1971), who seem to hold that context is everything in reading, that the only role of the individual word is to confirm the expectations of the reader. But whatever the precise form of their obeisance, virtually all students of reading honor the role of context in word recognition.

There is certainly good reason for this respect. Context determines the referent of pronouns and other deictic terms. Context determines the form class of uninflected words (like *sleep* and *shovel*); it selects the appropriate reading for homographs (like *letter* and *table*). Context lowers the recognition threshold of appropriate words and raises that of inappropriate ones. Context can not only facilitate the correct recognition of a word, it can even produce a word's misrecognition, as Goodman (1970), Kolers (1970), and Weber (1970) have observed.

Context clearly has profound effects on word recognition, and these effects are recognized by nearly everyone who has theorized about reading. But despite this all but universal respect, we know very little about *how* context influences word recognition. In fact, we would argue that it is just because of this harmony that we know so little; disagreement is a powerful incentive to research, and if there is nothing to doubt, there is nothing to challenge.

It is in this context, then, that we want to offer some observations on the role of context in word recognition. We believe that the role of context in reading has been misunderstood, and we hope to promote our understanding of context by calling into question the received views on the matter.

CONTEXT AND CONTEXT

We would like to begin by observing that context is not just context. There are several, if not many, different kinds of context, ranging from the reader's physiological condition to the syntactic category of the immediately prior word. We have little to say about this enormous range of possibilities; it certainly seems reasonable that any or all of them might have some effect on the recognition of some words (cf. studies of food deprivation and the recognition of food-related words; Brozek, Franklin, Guetzkow, & Keys, 1946). But we do think it important to draw at least one basic distinction among the many forms of context: the distinction between global and local context.

By *global* context, we mean the text in which the target word is embedded—the book, chapter, or passage in which the reader finds the word. By *local* context, we mean the immediately surrounding phrase or sentence.

Both of these classes of context can be shown to affect the recognition of a word. For example, readers of a biology text seldom interpret the word *cell* to mean part of a jail. And you, the reader, are not likely to take *mean* to signify surly in the preceding sentence.

But the effects of global and local context must be very different in one important respect. The effect of global context must be semantic and not syntactic. That is, global context must facilitate the recognition of words in certain semantic categories, but, in doing so, it must ignore the syntactic categories of those words. A book on surgery, for example, will provide a global context that will presumably facilitate the recognition of words like *trephine, scalpel,* and *surgical,* but it must promote the recognition of these words without regard to their form class; it must be essentially indifferent to syntax. The effect of local context, in contrast, must have an important syntactic component. If a sentence begins, *After removing her tumor, the . . .* , words of two or three syntactic categories are permissible, but most are excluded. Thus, local context may also facilitate the recognition of words in a particular semantic category, but it must pay attention to their syntactic status as well.

Because of this difference, the effects of local and global context must have very different time courses. The effect of global context must be stable. It must hold across phrases and sentences—if not paragraphs and pages—to sustain semantically appropriate words. The effect of local context, on the other hand, must be transitory. If local context correctly predicts that the next word is an article, its prediction for the word after that must be different.

We are led, then, to seek distinct mechanisms to explain the effects of global context on the one hand, and local context on the other. Let us look first at global context.

GLOBAL CONTEXT

We have observed that the effect of global context must be semantic. Accordingly, we seek a mechanism by which a given context can facilitate words in a particular semantic category. We know of only two ideas that have been offered to account for such an effect. One is the idea of *spreading activation,* and the other has been called *location shifting.*

The idea of spreading activation is by far the more popular. It has provided the basis for a popular theory of semantic memory (Collins & Loftus, 1975); it has also been used to explain the effects of semantic relatedness in a variety of tasks, ranging from sentence verification to lexical decision (in which subjects decide if strings of letters are words or not).

The basic idea is that the mental representation of words and the concepts that underlie them are arranged in a kind of network, and the activation of a concept node in the network when a word is recognized spreads to other, semantically related concepts. Thus, if a reader has just seen the word *doctor,* activation will spread to concepts like nurse, facilitating the subsequent recognition of the word *nurse*.

We do not share others' enthusiasm for this idea. As we see it, an explanatory model should tell us the parts that underlie a phenomenon, how they fit together, and what they do. In short, it should specify a mechanism. The notion of spreading activation does not; it says only that the activation of a given word will spread and facilitate the recognition of related words. It might as well be called spreading facilitation, for it seems to us to provide only a circular explanation of the effect of semantic relatedness on recognition.

But the notion of spreading activation is taken seriously by many of our colleagues, and we might well ask whether such a thing could account for the effect of semantic context in reading.

A paradigm for the study of such effects has been offered by Meyer, Schvaneveldt, and Ruddy (1972). They asked subjects to decide whether strings of letters formed words and measured the latencies of their decisions. They found that the time it took to decide whether a given string of letters formed a word was reduced if that word was immediately preceded by a semantically related word. (Thus, subjects' decisions that *nurse* is a word were faster when that string followed *doctor* than when it followed an unrelated word like *carrot.*) This effect has been taken to be an exemplary instance of spreading activation, and we might well wonder whether the facilitation observed in this task underlies the effect of semantic context in ordinary reading.

The problem with this idea is that semantically related words rarely occur next to one another, at least so it seems to Forster (1979) and us. Thus, a demonstration that the occurrence of a related word immediately before a target word facilitates recognition of the latter is of questionable relevance to ordinary reading.

If the effect of global context is to be mediated by spreading activation from semantically related words, that activation must reach across—or persist through—a number of intervening words. On the face of it, spreading activation seems unlikely to do this. For one thing, Neely (1977) has recently provided evidence that the effect of semantic relatedness in the lexical decision task decays very rapidly unless it is sustained by a conscious strategy which could scarcely figure in ordinary reading. But Meyer et al. (1972) have shown that the effect of semantic relatedness persists over one intervening word. Moreover, Scarborough, Cortese, and Scarborough (1977) have shown that the effect of *repeating* an item in the lexical decision task is undiminished by as many as 32 intervening items. (That is, a subject's decision that *nurse* is a word is faster if *nurse* has previously occurred in the list, even if the earlier occurrence was 32 items back.) If we took word identity to be the very extreme of semantic relatedness in the lexical decision task, then we might expect to see a persistent effect of semantic relatedness. And if we were to see such a persistent effect, then we might be able to maintain the view that the effect of global context in normal reading is due to spreading activation. Accordingly, we conducted the following experiment.

Experiment 1

We asked each of 16 graduate students and faculty members to make lexical decisions about each of 300 letter strings. On each trial, a three- to six-letter string appeared on a cathode ray tube (CRT) controlled by a DEC PDP 8/I computer; the letters were all capitals, and the string subtended a maximum visual angle of 1.5 degrees. The subject indicated his or her decision by pressing the appropriate button, and the computer recorded each response time in milliseconds.

Half of the strings formed words; half formed pronounceable nonsense syllables. Eighty of the 150 words were considered target words; paired with each target word was a closely related priming word. Each of the target words was preceded by its priming word at one of seven lags: 0, 1, 2, 4, 8, 16, or 32 intervening items; for 10 of the items, the priming word was omitted from the list (yielding, in effect, an indefinitely long lag).

Words were rotated through conditions across subjects such that each subject saw 10 different words in each of the eight conditions, and each of the words

occurred equally often at each lag. Median response latency was computed for each condition for each subject, and means of those medians are presented in Fig. 4.1.

As one would expect, the occurrence of a related word just prior to the target (0-lag) facilitated the recognition of that target, reducing the time it takes sophisticated subjects to decide that it is a word by 20 msec. But the intervention of a single item virtually eliminated that facilitation, and beyond a one-word lag there is no evidence in our data that the prior occurrence of a semantically related word has any effect at all on lexical decision latency.

These results provide no encouragement for the view that spreading activation might explain the effect of semantic context on word recognition. We expect that an advocate of spreading activation might argue that our results are not relevant to ordinary reading, in that ordinary reading matter does not interpose lists of up to 32 randomly selected words and nonsense syllables between a pair of related words. We must agree, but we would add that ordinary reading matter almost never juxtaposes semantically related words either. Hence, if we discount the present results on this basis, we must also discount those many studies of semantic context in the lexical decision task, which like Meyer et al. (1972) have used adjacent pairs of semantically related words. In any event, we would argue that there is simply no evidence that spreading activation could account for the effect of semantic context on word recognition in ordinary reading.

We are inclined toward the location-shifting view. According to this idea, the reader's mental lexicon is organized, like Roget's original thesaurus (Roget, 1852), along semantic lines. Thus, each word is grouped with related words into semantic regions, which, like the pages in a small computer's memory, are

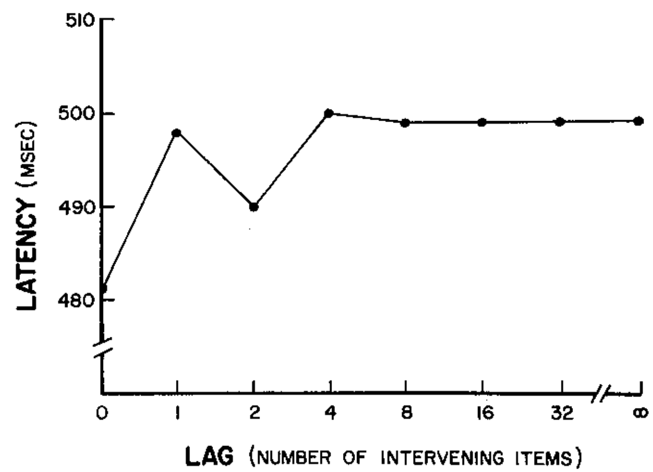

FIG. 4.1. Lexical decision latency as a function of number of intervening items (lag).

functionally distinct. So words closely related to a given word are nearby in the same region, whereas unrelated words are located in remote locations. As in the computer, we assume that words in the current region can be directly accessed, whereas words in other regions require either indirect addressing or a shift in location. Thus, related words can be easily accessed, but unrelated words cannot.

The location-shifting view was rejected by Meyer et al. (1972) on the basis of a single result: In a triple lexical decision task, the third lexical decision is facilitated if the first word is related to the third even if the second is not (e.g., *doctor-shovel-nurse*). Meyer et al. argued that, according to the location-shifting view, recognition of the unrelated second word (*shovel*) must require shifting location from the semantic region of the first (and third) word and so should eliminate any facilitation between these words. But facilitation was observed, so Meyer et al. decided against location shifting.

We believe their rejection of this hypothesis was premature. For one thing, all we need assume to defend the hypothesis against the Meyer result is that the reader can keep more than one page at a time in working memory. But more importantly, we doubt that the reader's location in semantic memory—the current page—is determined by single words. Rather, we suppose that it is determined by the substance of the text he or she is reading, and we suspect that it would seldom be changed by a single unrelated word.

We believe that location shifting holds more promise than spreading activation. But we have no evidence for the location-shifting view, and as yet, it is little more than a metaphor. We would conclude that if this is the best idea we have about how semantic context effects word recognition, we do not understand how global context works.

LOCAL CONTEXT

There is abundant evidence in the psycholinguistic and reading literatures to show that sentential context can dramatically facilitate word recognition. For example, Tulving and Gold (1963) demonstrated that the presence of a sentential context like *Far too many people today confuse communism with* in the preexposure field of a tachistoscope can reduce the duration threshold of an appropriate word like *socialism* by as much as a third. But there is little evidence as to why this should be so. In fact, precious few ideas have been offered to show how the sentence might have this effect.

Probably the most prevalent idea is that sentential context enables the reader to predict what is coming and that this prediction somehow facilitates the processing of the predicted material.

The idea that context increases predictability feels right. It is consistent with the observation that the readability of text is closely related to its predictability (Rubenstein & Aborn, 1958), and the reading process certainly seems to be

disrupted by the occurrence of an unexpected and inappropriate word. But that the idea feels good should not be sufficient for us to accept it. We should demand more of a theory than we do of a warm bath. As Gibson and Levin (1975) have pointed out, any theory which holds that the reader proceeds by forming hypotheses and testing them cannot be evaluated until we are told *what* is predicted. This is an important point, and it cannot be emphasized too strongly because in the absence of this specification an hypothesis theory runs a serious risk of being circular. One can always say that material facilitated was expected, material misread unexpected. If we are to entertain the idea seriously that word recognition is facilitated by the reader's expectations, guesses, hypotheses, or predictions, we must specify just what is expected, guessed, hypothesized, or predicted.

Unhappily, hypothesis theorists like Goodman (1976) and Smith (1971) are frustratingly vague on this score. We expect that they might deny that the reader formulates hypotheses about specific words. Instead, they would probably argue that the reader's expectations concern the gist—the substance—of the reading matter (not any particular words). This may well be, but if the first n words of a sentence are to influence the recognition of the $n + 1st$, then the reader's hypothesis must have some bearing on that word. Thus, we are led to ask what prediction the reader might make about the $n + 1st$ word, and what effect such a prediction might have.

At one extreme, sentential context might lead the reader to predict a specific word. This possibility has some appeal to us: The next word sometimes feels inevitable to the reader, and knowledge that a certain word is under fixation clearly enhances its recognition.

Thus, a hypothesis theory claiming that the reader hypothesizes specific words would seem to have real explanatory power. But the problem it faces is that specific word predictions are seldom correct.

The reader may not realize just how difficult it is to predict the exact word in running text. To demonstrate this point, we asked a colleague to guess—one at a time—the first 100 words of each of 10 ordinary reading selections. Before we began each selection, we gave our subject its author, title, and subject matter. He then began to guess. After each guess, we read the correct word, and then repeated (at our subject's request) the entire text up to and including that word. Thus, he had available, at every point, the entire preceding context to assist him. His results are presented in Table 4.1.

As the table shows, our intelligent, well-educated reader, given unlimited time to select a word, predicted only about one word in four, with the exception of one book which appeared to be highly redundant for him. We would submit that this must be near the upper bound of predictability, and the accuracy that could be achieved in real time by the average reader must be far, far less. Still we can ask whether performance like this would, in fact, enhance word recognition if it were achieved. It seems fair to assume that the reader's correct predictions

TABLE 4.1
Proportion of Correct Guesses of the First 100 Words of 10 Books by Subject DJF, Ph.D.

Author	*Title*	*Proportion*
Cash, W. J.	*The mind of the south*	.20
Fischer, B.	*Bobby Fischer teaches chess*	.21
Foss, D. J., & Hakes, D. T.	*Psycholinguistics*	.74
Gardner, J.	*October light*	.21
Gould, S. J.	*Ever since Darwin*	.39
Guevara, C.	*The diary of Che Guevara*	.23
Malinowski, B.	*Magic, science, and religion*	.20
Stillman, I. M., & Baker, S. S.	*The doctor's quick weight loss diet*	.32
Wooden, J.	*They call me coach*	.25

would facilitate the recognition of the predicted words. But what about the false predictions, which outnumber the true by at least three to one? To answer this question, we ran a simple experiment.

Experiment 2

We asked 12 of our friends (faculty and graduate students) to recognize and name aloud each of 75 words as quickly as possible without making mistakes. The words were presented one at a time on a CRT, and prior to each word, we gave the subject a vocal warning signal. On one third of the trials the warning signal was the word that would subsequently appear; on one third it was another, unrelated word; and on one third it was the word *ready*. Presentation of the target word started a timer, the onset of the subject's response triggered a voice-key that stopped the timer, and our computer recorded each latency.

Mean naming latencies for the three types of trials are presented in Table 4.2. As the table reveals, a correct prediction did facilitate the recognition and naming of the word by about 30 msec. But a false prediction had the opposite effect, retarding recognition by about 12 msec. If these estimates are anywhere near the true values, it is clear that the net effect of prediction at the level of the single word cannot be to facilitate word recognition: The cumulative effect of the more

TABLE 4.2
Mean Naming Latency as a Function of Type of Forewarning

Type	*Latency (msec)*
Ready signal	442
Target word	413
Unrelated word	454

frequent false predictions would be to swamp the advantage of the occasional correct one. Thus, we are led to conclude that readers cannot be picking their way through text, anticipating it word by word. We must look for another idea.

The hypothesis that the reader expects or anticipates particular words is the limiting case of a more general hypothesis that local context facilitates word recognition by reducing the number of alternatives. It is generally accepted that the time it takes to make a choice is well approximated by a linear function on the logarithm of the number of alternatives. In other words, every time you double the number of alternatives, you increase choice reaction time by a constant amount. By the same token, decreasing the number of alternatives has the opposite effect, so that if context reduces the number of available alternatives, this might be expected to reduce the time it takes to recognize the target word.

At first glance, this is an appealing hypothesis because of its parsimony. As Garner (1972) puts it in discussing Tulving and Gold's results: "... it is likely that the context improves recognition accuracy by a mechanism which is not at all unique to the use of words as stimuli. Most likely, the context provides a smaller message set for the observer, and thus improves accuracy of recognition [p. 278]." In one or another version, this view has been widely accepted by students of reading, prominently including Smith and Holmes (1971). But closer inspection raises a disturbing question.

Although choice reaction time is known to vary linearly with the logarithm of the number of alternatives over a wide range of stimuli and responses, the slope of that function varies inversely with stimulus–response compatibility and with practice (Fitts & Posner, 1967). In naming Arabic numerals, for example, Mowbray (1960) found no effect of number of alternatives whatsoever. Given that word recognition involves highly practiced, highly compatible stimulus–response pairs, there is a serious question as to whether reducing the number of alternative words could be expected to have any effect at all on their speed of recognition.

We are aware of four attempts to resolve this issue experimentally. Unfortunately, though, these four experiments have produced conflicting results. For example, in an experiment reported by Frick (1953), subjects named words that were presented individually on a screen. Each experimental word was preceded by a list of from 4 to 1024 words, one of which was the subsequently presented target word. Frick reported that naming latency increased linearly with number of alternatives. But, unfortunately, the details of this study were not reported, so we cannot be sure just how the experiment was conducted or how large the effect was. A similar study reported by Pollack (1963) collected data from five subjects over a period of 4 months and also found that naming time increased with number of alternatives, at a rate of about 13 msec per log unit. But here again, evaluation of the experiment is difficult because Pollack tells us that he was reporting data left behind by his predecessors and admits knowing very little about the procedures of the experiment. Thus, even though these experiments seem to support the idea that reducing the number of alternatives facilitates word recognition, we must evaluate their findings with some caution.

The other two experiments reached somewhat different conclusions. Pierce and Karlin (1957) asked subjects to read aloud lists of 256 words drawn from vocabularies ranging from 2 to 256 words. As expected, they found that reading time for the list increased monotonically with vocabulary size, but the function was markedly negatively accelerated; although there was a dramatic effect as vocabulary increased from two to four items, there was little effect beyond that. Approaching from the other direction, what this means is that reducing the number of alternative words had virtually no effect until the reader was constrained to fewer than four. These data offer little support for the idea that the facilitative effect of context on word recognition is mediated by a reduction in the number of alternatives, for, as Shannon (1951) has shown, the average uncertainty of a word in English text is about eight bits. Inasmuch as 2^8 equals 256, what this means is that, on the average, sentential context reduces the number of alternatives to 256 words. The Pierce and Karlin results clearly indicate that such a reduction would have absolutely no effect on speed of recognition.

In the most recent experiment to be reported, Theios and Muise (1977) obtained pronunciation latency data for single words drawn from vocabularies ranging in size from 2 to 24. Their results showed little or no effect of vocabulary size on pronunciation latency, again supporting the conclusion that number of alternatives has no effect on reading time.

We cannot easily account for the divergence of findings in these four experiments, largely because some of them were not reported in enough detail to allow for meaningful comparisons. So we attempted to obtain our own evidence by conducting still another experiment that manipulated the number of alternatives and measured their effect on the latency of recognizing individual words.

Experiment 3

We once again prevailed on our friends to name single words, presented one at a time on a CRT, and measured the naming latency for each word. Prior to each word, a subject was handed a three-by-five card on which were typed all (and only) the words that might be presented on that trial. The card contained from 1 to 32 alternatives, which subjects were asked to read aloud; when finished, they pressed a button to present the target word and named it as quickly as possibly.

The results for five highly practiced subjects are shown in Fig. 4.2. There was a large increase in naming latency from one alternative to two, reflecting the difference between simple and choice reaction time, but for all larger numbers of alternatives, there were no significant differences, according to a Newman-Keuls test. A linear-trend analysis over all numbers of alternatives greater than one failed to show evidence of a linear relationship between the log (base 2) of

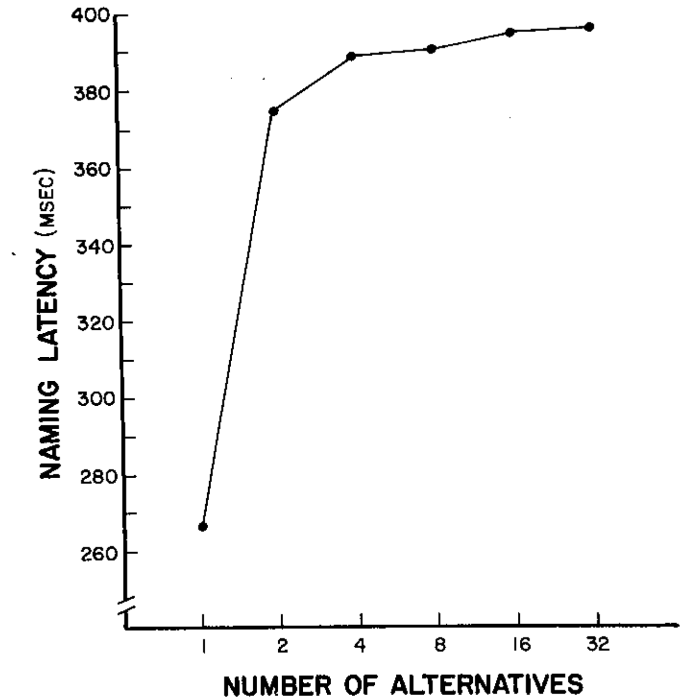

FIG. 4.2. Naming latency as a function of number of alternatives.

the number of alternatives and naming latency $F(1,4) = 3.67$, $p > .10$. Inasmuch as even a minimal sentential context appears to reduce naming latency, it is tempting to conclude that the effect of syntactic context cannot be mediated by a reduction in the number of alternatives.

For the present, we dare not draw this conclusion because our study has two shortcomings. First, as we did not include conditions beyond 32 alternatives, we cannot be sure that the full effect of reduction in the number of alternatives might not be enough to account for the contextual effect. Second, the set of alternatives from which our words were drawn were totally arbitrary, quite unlike the sets that context might provide. Until these weaknesses are remedied, we cannot be positive that the effect of context could not be mediated by a reduction in the number of alternatives. But neither our results nor those of the other two well-documented experiments reported earlier provide any support for the almost universally accepted assumption that it is. Hence, we do think it is fair to conclude that there is little evidence that the reader's expectations, guesses, hypotheses, or predictions mediate the influence of sentential context on word recognition.

FORM AND CONTEXT

In the end, global and local, semantic and syntactic context converge on the word under fixation. At that point, contextual information must combine with the visual information arising from the printed page to determine the recognition of a word. The question of how these two sources of information combine is crucial to theories of reading.

There are only two answers to this question. One is that context and visual form provide independent sources of information in determining the word; the other is that they interact in some way.

The latter view is certainly the more popular. Most theorists (e.g., Gibson & Levin, 1975; Goodman, 1976; Smith 1971), if we interpret them correctly, hold that context and form interact, such that context influences the extraction of visual information from the word. But the issue cannot be decided by election; it must be settled in the laboratory.

Some 15 years ago, Tulving, Mandler, and Baumal (1964) apparently settled this matter in favor of interaction. Their argument went as follows: Suppose one knew the probability of recognizing a word given only a certain amount of information about its form (and nothing about its context); call this f. Suppose one also knew the probability of recognizing the same word given only a certain amount of context (and nothing about its form); call this c. Finally, suppose one knew the probability of recognizing the word given *both* form and context; call this p. If form and context are independent, then these probabilities must combine according to:

$$p = f + c - fc$$

If they do not, form and context cannot be independent, and they must be interacting.

Tulving et al. (1964) proceeded to measure the probability with which subjects recognized tachistoscopically presented words given various amounts of context and form. The target words were the final words of nine-word sentences. Context was varied by presenting 0, 2, 4, or all 8 of the preceding words of the sentence in the preexposure field. Form information was varied by exposing the target words for eight different durations, ranging from 0 to 140 msec in 20-msec steps.

Estimates of f at each of the eight exposure durations were obtained from the 0 context conditions, and estimates of c at each of the four levels of context were obtained under the 0 exposure duration condition. The remaining seven levels of form combined with three degrees of context then yielded 21 separate opportunities to test the independence hypothesis. In every instance, the probability of recognition given both form and context exceeded that predicted by the independence hypothesis. Tulving et al. naturally rejected that hypothesis and concluded that context and form must interact in word recognition.

The logic of the argument made by Tulving et al. (1964) seems irrefutable. If the estimates of f and c are valid, and if these are independent, then they must combine according to Equation 4.1. Observed performance clearly exceeded predicted values, so apparently we are forced to conclude that the two information sources are not independent.

There is, however, a weak link in the chain of argument. The argument clearly depends on the validity of the estimates of f and c. If these estimates are too low, then we must underestimate performance when form and context are combined, not because form and context interact, but simply because we have underestimated their independent contribution. It occurred to us that Tulving et al. might have done this by allowing each subject only one response on each trial. A brief tachistoscopic exposure, or a few words of context, seldom narrows the list of possible alternatives to one word. If subjects under these conditions are limited to a single response, they may be forced to choose among several possibilities, which the form, or context, suggests. If subjects choose anything but the target word, the probability of either form or context having brought the target word to mind will be underestimated.

An analogy may make this point clearer. Suppose 100 subjects were asked to name a floor covering and assume that 50 of them said *rug*. Now suppose another 100 subjects were given the form *r——g* and asked to complete the word, and again assume that 50 said *rug*. We take the first proportion to estimate c and the second to estimate f. We assume these probabilities to be independent, and we predict that the probability of saying *rug* given both clues will be .50 + .50 − (.5)(.5) = .75. But we observe that the performance of a third group given both clues is very close to perfect. We cannot conclude from this finding, however, that contextual and visual information interacted because the apparent interaction is nothing but a failure to estimate the amount of information provided by the two clues accurately. For example, given *r——g*, although only half the subjects gave *rug* as their first response, even those who thought *rag* or *rig* most likely also thought of *rug*.

In this example, it is clear that what we should do to estimate f or c accurately is allow our subjects to give more than one response and set f and c equal to the proportion who include *rug* among their responses in each case.

In similar fashion, we reasoned that Tulving et al. may have underestimated the amount of information their subjects extracted from tachistoscopically presented words by limiting them to a single response and that a better estimate would be obtained by permitting the subject to make multiple responses. So we decided to replicate the experiment and do just this.

Experiment 4

After substituting new sentences for a few of the Canadianisms used by Tulving et al., we used a projection tachistoscope to present words to 20 friends. Each stimulus word was presented for 20, 40, 60, or 80 msec and was both preceded and followed by a pattern mask. Prior to the presentation of each item, the subjects read zero, four, or eight words of context. After each word was presented, subjects were asked to write down as many guesses as they liked. On the average, our subjects wrote down less than three. We then obtained our estimates of f by counting the proportion of subjects who included the correct word among their responses.

We did not try to obtain estimates of c in the same manner because we feared that even allowing multiple responses could not result in a valid estimate. The problem is that partial contexts, especially when they are not sentence initial, provide so little constraint that large numbers of words are congruous with such contexts. Thus, the number of guesses a subject might give in the absence of form would be limited only by the subject's endurance and enthusiasm for the task. An ambitious subject might maximize performance (i.e., c) by listing every word in the language; to stop a subject anywhere short of that would be arbitrary. For this reason, we felt that we could not obtain a valid estimate of c directly, so we decided instead to finesse the problem.

We observed that the independence formula can be rewritten as:

$$p = c + (1 - c)f$$

In this form, it is clear that the assumption of independence predicts that the probability of a correct response given both form and context should be a linear function of the probability given form alone, with intercept c and slope $(1 - c)$. Thus, if we were to combine a given level of context with various amounts of form and plotted the obtained results against those obtained with form alone, they should lie on a straight line whose slope is equal to one minus its intercept.

Our results are presented in Fig. 4.3, along with straight lines fitted by least squares. The data fall very close to those straight lines, which is to say that the probability of word recognition given both form and context conforms very closely to the values one would obtain if the contributions of form and context were totally independent.

We take these results to show that, at least in the tachistoscopic situation, context and form do not interact. This conclusion directly contradicts that recently drawn by Meyer, Schvaneveldt, and Ruddy (1975) and Becker and Killion (1977) from results they obtained in the lexical decision task.

Both groups of investigators found that the prior occurrence of a semantically related word facilitated the recognition of a target word more as the visual quality of the target was reduced (by degradation in one case, by reduction in brightness in the other). Thus, the effect of context varied inversely with the effect of form, and form and context were not independent in this task.

As noted earlier, we do not think that adjacent related words in the lexical decision task are representative of context in ordinary reading. Given this reservation, we were led to wonder how sentential context would combine with form to determine word-recognition latency. So we conducted a final experiment.

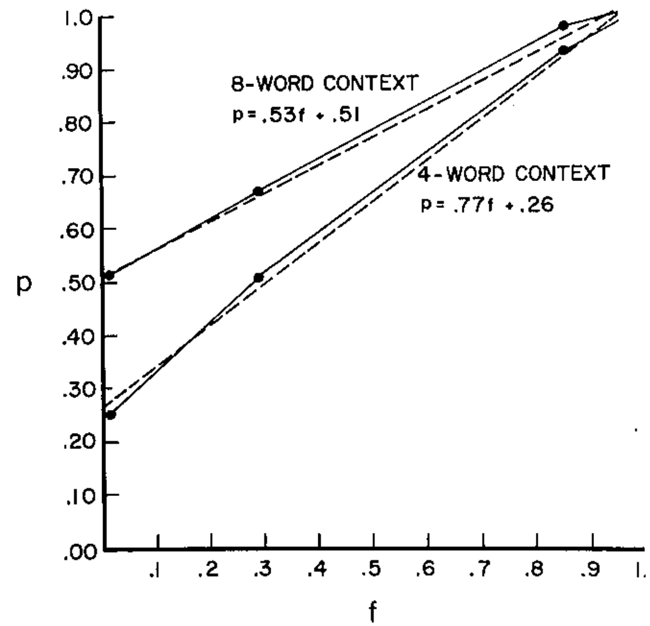

FIG. 4.3. Probability of correct recognition given both form and context as a function of probability correct given form aloen (f).

Experiment 5

We asked 16 faculty members and graduate students to name words varying in both intensity and context. Each subject named 100 words—half in isolation, half preceded by four words of sentence-related context, at each of two levels of intensity. The latencies of their responses were recorded, and their means are presented in Fig. 4.4.

Words presented at high intensity were recognized 23 msec faster than low-intensity words ($min\ F = 31.97$, $p < .001$). The effect of context was also significant, with words preceded by sentence context being recognized 19 msec faster than words preceded by neutral context ($min\ F = 22.07$, $p < .001$). But the interaction of context and intensity effects is not significant ($min\ F = 1.27$, $p < .10$).

These results are not consistent with those obtained by Becker and Killion: Both context and brightness have significant effects on naming latency, but the contextual effect is not greater on the lesser form; if anything the effect goes in the opposite direction.

These results surely suggest that the effect of sentential context (i.e., the kind of context normally encountered in reading) is independent of the effect of form. In the terms of information processing, they suggest that context influences a separate (and presumably later) stage than that in which form is processed. These

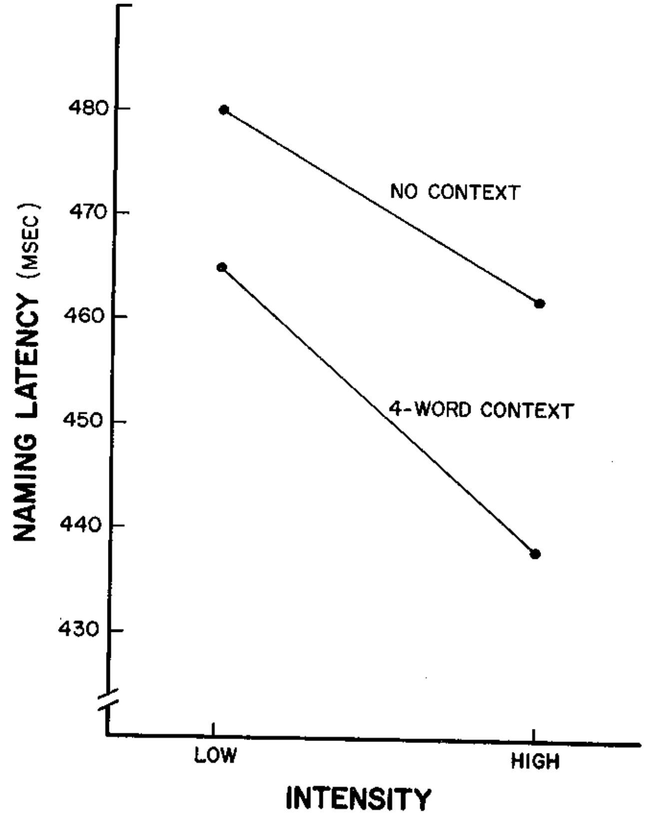

FIG. 4.4. Naming latency as a function of target-word intensity.

results are even consistent with the extreme view that context has nothing to do with word recognition until visual processing of the word is complete. One could interpret this to mean that we must seek a theory of reading that could get the reader from print to meaning without benefit of hypotheses, expectations, or even psycholinguistic guessing.

SUMMARY

First, we have observed that the effects of local and global context on word recognition must depend on different mechanisms because local context must involve a syntactic component lacking in global context. Inasmuch as the former changes every moment, the effect of local context must be transitory. But the effect of global context must be stable.

Second, the effect of global context cannot be mediated by the spreading activation between semantically related words commonly assumed to operate in

the lexical decision task, for that is not stable. It does not persist across intervening items, and semantically related words rarely occur in adjacent positions.

Third, the effect of local context cannot be mediated by the reader's expectations, guesses, hypotheses, or predictions because, if they are precise enough to help, they are wrong too often to do so.

Fourth, however the effects of normal syntactic and semantic context are mediated, they do not seem to interact with the effects of form; form and context are processed independently.

We began with the observation that students of reading have disagreed about virtually everything except context. We hope we have shown that there is also room to disagree about context.

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5 Processing Words in Context

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How do skilled readers identify words? Research directed at answering this question has been carried out for nearly 100 years by investigators in both education and experimental psychology (Cattel, 1885; Huey, 1908). Although the process of recognizing a single word would seem to be relatively simple in comparison to the complex linguistic and memory processes necessary to comprehend written discourse, an understanding of how word recognition takes place has remained relatively elusive. One reason why it has been difficult to build appropriate models of word recognition is that the process combines the operation of some mechanisms usually designated as strictly perceptual with those generally considered to be linguistic.

A brief review of the factors that seem to affect the word-recognition process will highlight the diversity of mechanisms responsible for its operation. At a strictly visual level, it is clear that factors affecting the visual quality of a word to be recognized will influence the speed and/or accuracy with which this is done. Such factors include the intensity of the stimulus material (e.g., Becker, 1976), the presence or absence of visual noice (e.g., Meyer, Schvaneveldt, & Ruddy, 1975), and the duration of the presentation (e.g., Tulving & Gold, 1963). Such variables presumably affect the usefulness of the visual information extracted from the stimulus. Also affecting word recognition at the visual level are featural characteristics such as type font (e.g., McClelland, 1977) and word and letter shape (e.g., Bouma, 1971). That letters within strings influence each other is shown by the fact that statistical redundancies between letter positions facilitate word recognition (e.g., Thompson & Massaro, 1973). However, there are a host of linguistic phenomena that appear to influence word recognition at least as much as the preceding visual factors. These include pronounciability (Gibson,