

On Visual and Contextual Factors in Reading: A Reply to Rayner and Slowiaczek

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Rayner and Slowiaczek seem to have a different conception of the issues our experiments address than we do. Our basic concern was to understand how expectations influence the benefit to be derived from a preview of a target word in parafoveal vision. They, on the other hand, focus on whether subjects are sensitive to aspects of the preview, regardless of whether there is a benefit. As we stated in our article, we agree that our data demonstrate that subjects are sensitive to the information contained in the preview, both when they have expectations about the set of possible target words and when they do not. But this fact does not change our main point, which is that *the extent to which the preview produces a benefit depends on the subject's expectations.*

We view reading as a process in which the reader constructs an interpretation of the text at several different levels of processing, using whatever clues are available. These clues include visual information derived from the text and contextual information obtained from words previously read. This view does not, of course, originate with us, and there are a large number of studies in the literature examining the interaction of sensory and contextual information in reading and listening to speech (Foss & Blank, 1980; Marslen-Wilson & Welsh, 1978; Morton, 1969; Neisser, 1967; Rumelhart, 1977; Tulving & Gold, 1963; and many others). The experiments reported in our article (McClelland & O'Regan, 1981) support this viewpoint, not only by demonstrating main effects of both expectations and preview visual information on the time it takes to name a target word, but by showing clearly an interaction of the effects of these two sources of information on the extent of the benefit that can be derived from the preview.

Rayner and Slowiaczek (1981) have a very different view of the reading process than we do. They focus on reading as a "word identification activity where visual features are used to identify letters and recognize words" (p. 650). Though they acknowledge that context may play some role in reading, it is apparent that they are primarily concerned with the "bottom-up" aspects of reading, viewing these as somehow independent of the role of context. From their view of reading, it is understandable that their main concern in studies of parafoveal information processing in reading is to determine "whether or not the visual information [contained in a parafoveal display] can be perceived" (p. 648). At first glance this seems like a reasonable starting place for any model of reading. The authors appear to mean by the word *perceived* something like "registered by the sensory mechanisms so as to be available for use by higher processes." If that is what they mean, we would have to point out that there is more to reading, even as they define it, than sensory registration. Of course it is important to know what can be registered. But sensory registration is not reading or even word recognition. We would like to suggest that we may not be able to understand what the effect of the registered information will be on the representations that are formed at higher

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levels without considering the role of expectations. Most experiments, including our own, do not show exactly where in the processing system expectations and sensory information begin to work together, but our study and many others clearly show that both sorts of influences jointly determine performance in a very wide variety of information-processing tasks.

With this prologue, we turn to the specific complaints Rayner and Slowiaczek raise about our interpretations of our findings. First we consider what seems to be their central complaint: that we have picked an inappropriate baseline, and that if we had picked another we would have reached different conclusions. Then we consider the other issues they raise.

What Is the Right Baseline?

Rayner and Slowiaczek (1981) object to our use of the X preview (consisting of a row of x's) as a baseline for assessing the effects of other preview conditions. They contend that the X preview condition may be suspect because subjects may be able to recognize the row of x's and ignore it. For this reason they prefer our D preview condition, since in this case the preview cannot be recognized as a special neutral stimulus and ignored. This objection might be justified if we had been interested in finding out what information subjects were sensitive to in parafoveal vision. But we were interested in a different question, namely, how well such information can be put to beneficial use in uttering the target word. To understand this point better, consider what the different aspects of the data of Experiment 1 show.

Increasing naming times are found as we go from the same-word preview to the same-shape-and-end-letter, the same-end-letter (not the same shape), and completely different previews. This means that some information in the previews was extracted and affected naming time for the target word. These data show that subjects were sensitive to the differences among the parafoveal previews in both expectation conditions of the experiment. Thus, we agree with Rayner and

Slowiaczek (1981) on this point. Important issues remain, though. The data from these four conditions are compatible with radically different interpretations about the costs and benefits of the use of preview information. One possibility is that preview information can facilitate but not disrupt target-naming performance. At the other extreme it is possible that preview information can only disrupt and cannot facilitate target naming. It is obviously important to know where between these two extremes the truth lies. We might try presenting no preview at all, but this would probably not really do, since naming time may also be shortened by a warning effect that may be produced by any preview at all. Some kind of neutral preview must be found to assess the costs and benefits of the information extracted from parafoveal vision. This neutral preview must be as good a warning signal as the other previews, but it should be possible for subjects to ignore its content.

Obviously the different preview is not appropriate for assessing costs and benefits, since in this condition, all but the middle letter of the target word are replaced with letters that are visually quite different from the replaced letters in the target. The asterisk condition appears to be considerably superior, in that it provides no information about what word the target will be. It is also extremely unlikely to mislead the subject about the possible identity of the target word—no subject would mistake it for one of the possible five-letter target words used in the experiment. Thus, from the point of view of assessing costs and benefits, this appeared at first to be a good baseline condition. However, the AST condition seemed possibly less than perfect as a warning stimulus because of the small size of the single asterisk used compared to our other previews, which contained the same number of letters as the actual target word. For these reasons, and others reviewed in our article, we felt that the X preview might be superior. Although our argument is not airtight, the internal checks we were able to make in the data were consistent with the view that in fact subjects were able to ignore the row of x's, just as Rayner and Slowiaczek (1981)

suggest, and for our purposes this was exactly what we wanted.

In any case, it does not matter to our basic point whether the X condition provides an exact zero point for assessing the benefits derived from the potentially informative previews or not. What matters is that there is an interaction of expectation condition and type of preview condition. Potentially informative (end-letter, shape-end-letter, and word) previews produce relatively faster reaction times compared to uninformative previews (X, asterisk) when the subjects have expectations about what the target word might possibly be than when they have no such expectations. This pattern is clearly visible in the results of both Experiment 1 and Experiment 2. From these results we find it difficult to escape the conclusion that informative previews produce more benefit when the subject has appropriate expectations.¹

Rayner and Slowiaczek (1981) complain in their discussion of the baseline issue that "in the Rayner et al. (1978) studies, the different potential control conditions yielded a relatively consistent interpretation of the results. Such consistency of interpretation as a result of different control conditions is not apparent in the McClelland and O'Regan study" (p. 649). Alas, life is often more complex than some of us would like it to be! The complaint is not that we did not run more than one potential control condition—since we did—but that the different conditions did not all lead to exactly the same conclusions. We have two responses to this point. First, although different baselines lead to different conclusions, the conclusions relate to different issues, and there is no contradiction. Second, had we only run the constrained set expectation condition, which is comparable to the situation in the Rayner, McConkie, and Ehrlich (1978) study, we would have achieved the same consistency of interpretation as they did. They found, as we did when our subjects knew something about what to expect, that all previews similar to the target word produced a benefit compared to a number of different "potential baselines." Our data demonstrate that this picture changes dramatically when the subjects

have no idea what to expect. The problem seems not to be that we have run too few conditions, but too many.

What Is the Right Interpretation?

We now turn to the objection Rayner and Slowiaczek (1981) raised first, which questions the logic of our "suggest[ion] that partial visual information can only be used when the reader has some expectation of what to look for" (p. 646). We agree that it would be illogical to conclude from our results that partial information can only be used when the reader has some expectation of what to look for, since the evidence clearly shows differences among the preview conditions in both expectation conditions. Earlier versions of our article contained wording that may have encouraged this view of what we were trying to say, and Rayner and Slowiaczek (1981) deserve credit for forcing us to make ourselves clearer. Our focus all along has been on the conditions under which subjects derive benefit from a preview, not merely the conditions under which they are sensitive to preview information and are influenced by it regardless of whether it helps or hurts. This point should now be clear.

If the principal effect of expectations is not to alter sensitivity to parafoveal visual information, just what might the effect of expectations be? In considering our interaction, Rayner and Slowiaczek (1981) assert that "the most plausible interpretation

¹ If any doubt remains that knowledge of the set of possible target stimuli plays a dramatic role in determining how much benefit a perceiver may gain from a brief preview in parafoveal vision, a recent experiment by Paap and Newsome (personal communication) should put these doubts to rest. These authors used lexical decision latency instead of pronunciation latency as the dependent measure. When subjects saw each of the 80 target words only once, Paap and Newsome found no difference between reaction times to a same-word preview and a row of x's. However, when two subjects who were quite familiar with the stimuli were tested repeatedly using the same materials, the same-word preview had an advantage of 265 msec. These data clearly show that the extent of the benefit that can be derived from a preview of a word in parafoveal vision depends on a prepared mind.

... is that the reader employs a conscious guessing strategy in trying to use preview information" (p. 646). While the particular model we offer to account for the data does not rely on such strategy differences, we have no particular reason to exclude this possibility. Indeed it seems likely that differences in the availability of reliable expectations should influence some strategic aspects of reading performance, and it would be useful to learn more about exactly what these influences might be.

We now consider a more specific, and potentially quite serious, problem that Rayner and Slowiaczek (1981) raise with our experiments, particularly Experiment 1. This is the possibility that the difference in results between the two expectation conditions of Experiment 1 is due to the fact that we used only eight different target words in the constrained set condition, and no two of these words could begin with the same letter. In principle, then, it would have been possible for the subjects to tell which of the possible targets had been shown from the first letter alone. If this aspect of the design was responsible for our interaction, our findings would certainly not be of general interest.

We too were seriously concerned about this possibility after completing Experiment 1. At that point, we knew that when subjects had no expectations, little in the way of a preview benefit effect was obtained. Further, the only studies that produced reliable preview benefit effects assessed against suitably neutral baselines had used small sets of target words (eight in our case, and 30 in the case of Rayner et al., 1978). Thus, it seemed quite possible that preview benefit effects could only be obtained under quite unnatural expectation conditions. It was partly to address this concern that we decided to carry out Experiment 2, in which the expectations were generated by real English sentences, and the target word was different on each trial. Since we obtained a substantial preview benefit effect in Experiment 2, our concerns were allayed. We decided not to make an issue of the point in our article, choosing to focus instead on the more positive aspects of our findings.

Why Use Parafoveal Previews?

On page 648 of their article, Rayner and Slowiaczek (1981) say that if our study was done to assess costs and benefits, there was no particular reason to use parafoveal previews; foveal previews would have been just as good, since our study was not concerned with determining sensitivity of parafoveal information.

It is certainly true that we were not interested in sensitivity to parafoveal information per se. But we were interested in the benefit subjects were able to derive from parafoveal information in a reading task. It seems best to use parafoveal previews rather than foveal ones to do this. It is not clear how we could simulate the kind of information loss that occurs in parafoveal vision if we used foveal presentations. Rayner and Slowiaczek also say on the same page that "parafoveal presentation is only interesting as a test of whether or not the visual information can be perceived." This is not true. Parafoveal presentation is also interesting as a test of whether parafoveal information can facilitate reading.

Relevance to Reading and Integrating Information

We agree with Rayner and Slowiaczek (1981) in general when they say that what happens in our experiments may not be the same as what happens in normal reading. Our task clearly differs from normal reading in many important ways, some of which we mentioned in our article. However, we must comment on the issue of whether our experiments actually address the integration of information over successive fixations. Rayner and Slowiaczek surmise that our subjects could read our previews perfectly and thus did not, in fact, integrate information.

This is not the case. We have tested 11 subjects in a repetition of Experiment 2 in which the target word was not presented on half of the trials, so that the subjects were forced to try to identify the target from whatever contextual and/or preview information they were given. It was clear that subjects adopted a very different strategy in this version of the experiment than they had

Table 1
Probability Correct Identification of Target Words Not Actually Shown as a Function of Preview and Context Conditions

Preview	Context		
	Neutral	Low constraint	High constraint
Word	.47	.63	.88
Shape and end letter	.08	.28	.65
X	—	.11	.37

Note. Trials with the neutral context and the X preview condition were not run, since neither source provides any constraint, and subjects would be forced to guess wildly, with little hope of success.

used in Experiment 2 or any other experiments we have run in which the target word was actually presented after the preview for direct viewing. In this version of the experiment, the subjects seemed to make a conscious effort to get the most they possibly could out of the context and the preview. Thus, it seems likely that the results of this study overestimate the reliance that subjects in our Experiment 2 were placing on both the context and the preview. The percent correct word identification responses for the conditions of the experiment in which no target was shown are presented in Table 1. (When the target display was presented, responses were more than 98% correct in all conditions.) With a neutral context sentence, subjects were only able to identify the target word correctly from the same word preview 47% of the time. With expectations, of course, this figure goes up. We imagine that subjects would be able to identify the target word correctly most of the time in the constrained set condition of Experiment 1 as well, though we never actually looked at this issue. Subjects in the Rayner et al. (1978) experiments were also able to identify target words correctly nearly all of the time when the preview was presented at about the same distance from the fovea as in our experiments. Presumably this is because their subjects were quite familiar with the stimuli.

While these results suggest that subjects cannot identify our stimulus words infallibly

without the aid of context, they do suggest that parafoveal information is good enough to permit word identification when there is context a reasonably high percentage of the time. However, even with context, word identification on the basis of the preview is not always reliable, particularly in weak contexts. Since our subjects almost never make mistakes when the target word is actually shown (responses were 98% correct or better in all conditions of Experiment 2 and on those trials of the present experiment in which the target is shown), it is clear that the responses are not being based solely on the preview information in any condition that includes the presentation of the target in the fovea.

A Final Word on the Nature of the Reading Process

Finally, we would like to agree with Rayner and Slowiaczek's (1981) point that reading should not be thought of as a process "in which the reader uses a minimal amount of visual information and mainly guesses the meaning of upcoming words on the basis of context" (p. 650). This is certainly not our view. However, we cannot agree with their view that reading is primarily a word identification activity in which visual information is used to identify letters and words. At least, this is not all there is to reading, or even to word identification. As we have said, it seems likely to us that reading should be thought of as a process in which the reader relies on both visual and contextual information to help identify the words on the printed page. Our results support the view that both contextual and stimulus factors are important by demonstrating that the presence of useful information in a parafoveal preview can increase the benefit that can be derived from context, just as the presence of contextual cues can increase the benefit that can be derived from the preview. More research is clearly necessary to demonstrate these effects in more naturalistic reading contexts.

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