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Sensitivity to lateral information on a perceptual word identification task in french third and fifth graders

Rachid Khelifi, Laurent Sparrow, Séverine Casalis *

Université Lille, Nord de France, Laboratoire URECA, Domaine universitaire du Pont de Bois, BP 149, 59653 Villeneuve d'Ascq Cedex, France

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ABSTRACT

This study aimed at examining sensitivity to lateral linguistic and nonlinguistic information in third and fifth grade readers. A word identification task with a threshold was used, and targets were displayed foveally with or without distractors. Sensitivity to lateral information was inferred from the deterioration of the rate of correct word identification when displayed with distractors. Results show that the two reader groups were sensitive to both right and left lateral information. The area of sensitivity to this information was more extended for the identification of easy words than difficult words. Examination of the detrimental effect of distractors suggests that in both third and fifth graders, the impact of lateral information on foveal processing is the result of a general distraction effect, but also of linguistic processing whose nature remains to be clarified.

1. Introduction

During reading, visual information is extracted not only from the fixated word, but also from the immediately following word. This suggests that more than one word can be processed on a single fixation. Although expert readers' extraction of parafoveal information is well documented (for an in-depth review, see Rayner, 1998), less is known about children's sensitivity to lateral information. The aim of the present study is to examine this question through a reading task with isolated words.

Given the limited amount of existing research on children's sensitivity to lateral information, we review some of the main findings collected with expert readers, most of which have been obtained using eye movement paradigms. We then turn to the question of development.

In reading, eyes move across a text in a series of rapid movements called saccades, each one followed by a fixation during which information is acquired. These movements are needed because our vision is increasingly limited with distance from the center of the visual field. The visual field consists of three different areas: foveal, parafoveal and perifoveal areas. The foveal area extends about 2° out from the center of the eye, and provides much greater visual acuity than the parafoveal area, which extends out to 5° on either side of fixation. Beyond the parafoveal area extends the perifoveal area, with very poor acuity. Thus, eye movements enable us to successively bring new areas of text into foveal vision to subject them to more detailed analysis.

Although foveal vision is essential for reading, the importance of parafoveal vision is suggested by two pieces of evidence. First, reading speed is reduced when parafoveal information is suppressed (McConkie & Rayner, 1975; Rayner, Inhoff, Morrison, Slowiaczek, & Bertera, 1981). Second, when foveal information is removed, it is still possible to read using the parafoveal area (Rayner & Bertera, 1979). Thus, parafoveal information contributes to the optimal functioning of reading processes.

1.1. Perceptual span in reading

The total amount of information that a reader can extract during a single fixation is an important question for studies on eye movements and reading. Among the various methods used to evaluate the size of the effective visual field – also called the perceptual span – the *moving window* technique developed by McConkie and Rayner (1975) is the most effective. This technique consists in presenting a text to a reader with only a part of it around the fixation point – a window of a predefined size – being visible at any given time. Outside of this window, the letters of the text are replaced by other letters. Whenever the reader moves his eyes, a new area of text is made available, whereas the portion of the text that was previously visible is replaced by a different string of letters. Letter changes take place during saccades. Readers usually can't detect them because of the saccadic suppression that reduces sensitivity to visual input during eye movements (Matin, 1974). The total amount of information exposed at each fixation is thus precisely

* Corresponding author.
E-mail address: severine.casalis@univ-lille3.fr (S. Casalis).

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manipulated by the experimenter. The basic assumption of this manipulation is that reading should be disrupted when the window is smaller than the perceptual span. Using this technique, many studies have shown that the total amount of information extracted during each fixation is limited (Häikiö, Bertram, Hyönä, & Niemi, 2009; McConkie & Rayner, 1975; Pollatsek, Rayner, & Balota, 1986; Rayner, 1986; Underwood & McConkie, 1985). In skilled readers of alphabetical writing systems (like English or French) reading normal-sized type, the perceptual span is asymmetric to the right and extends from 3 to 4 character spaces to the left of fixation to about 14–15 character spaces to the right of fixation. In general, this area includes the word displayed at the fixation point and one or two words immediately to its right (Rayner & Pollatsek, 1987). This means that during one fixation, readers are able to acquire information that appears in the foveal area as well as some information located in the parafoveal area.

1.2. Different regions in perceptual span

Depending on the nature of the information to be extracted, the perceptual span can be divided into three different areas: the letter identity span, from which information about the exact identity of letters can be obtained; the letter feature span, from which information about the letter shape is acquired; and the word length span, from which information about word length is extracted (Häikiö et al., 2009; Rayner, 1998). Different uses of the moving window technique are required to evaluate the size of these different spans. Evaluating the size of the word length span requires removing all information outside the predefined window by deleting spaces between words, and obscuring both letter identity and global letter shape. Assessing the size of the letter feature span requires removing letter identity information outside the predefined window and altering global letter shape. Finally, letter identity span can be evaluated by altering only the identity of the letter outside the predefined window, preserving global shape and word length. With such manipulations, the word length span has been found to extend to 14–15 character spaces to the right of the fixation point, the letter feature span at the very most to 11–12 character spaces, and letter identity span to not more than 7–8 character spaces.

1.3. The flexibility of the perceptual span

Perceptual span size has been found to vary according to many factors. For example, it extends no more than 6 character spaces to the right of fixation in Japanese (Ikeda & Saida, 1978) and 3 character spaces to the right of fixation in Chinese (Inhoff & Liu, 1998). Japanese and Chinese are more densely packed languages than English. As underlined by Rayner, "it takes more characters per sentence in English than in Japanese and Chinese" (1997, p 323). Thus, the number of character spaces that can be extracted in a single fixation depends on the features of the writing system.

The asymmetry of the perceptual span seems to be partially determined by the reading direction of the language. Pollatsek, Bolozky, Well, and Rayner (1981) reported that the perceptual span of native Israelis showed an asymmetry to the right when they read English and an asymmetry to the left when they read Hebrew—a language that, in contrast to English, is spelled from right to left.

The amount of parafoveal information acquired has also been shown to be less when foveal processing is more difficult. For example, Henderson and Ferreira (1990) showed that when the fixated word is difficult to process (infrequent or syntactically ambiguous), less information is extracted to its right. This was revealed by the fact that readers were less affected when there were changes in the adjacent word (to be fixated). By contrast, when the fixated word was easy to process, reading was disturbed by change in the adjacent word. A similar pattern has been observed in developing readers. Rayner (1986) showed that the size of the perceptual span of fourth-grade children depends on the difficulty of the text they read: it was much smaller when they were given a college level text in comparison with a reading level-appropriate text. Häikiö, Hyönä, and Bertram (2010) focused on the acquisition of parafoveal information in the case of compound words. They found that more information was extracted from the second constituent of a compound word when the first constituent was a high-frequency word than a low-frequency one.

1.4. The development of perceptual span size in beginning readers

The research of Rayner (1986) was the first to take a developmental perspective on the study of perceptual span in reading. Rayner has shown that beginning readers have a smaller perceptual span than skilled readers, extending about 11 character spaces to the right of fixation, less than the 14 and the 14–15 character spaces to the right of fixation observed respectively in sixth-grade children and in adult readers. Increasing proficiency in reading allows the learner to process more information on a single fixation. Moreover, it appears that after 1 year of reading instruction, beginning readers already present a perceptual span with a rightward asymmetry.

While the study of Rayner (1986) focused on word length span and letter feature span, an experiment performed by Häikiö et al. (2009) examined letter identity span in child readers. Using the moving window technique, these authors replaced letters outside a predefined window with visually similar letters, leaving the original letter shapes visible. Thus, any decrease in reading speed could be attributed only to the deletion of letter identity information with no possible confounding effect from altered letter shape information. The results showed that letter identity span increases throughout the elementary school years. Second and fourth graders had letter identity spans of 5 and 7 character spaces to the right of fixation respectively, while sixth graders, like adults, had a letter identity span of 9 character spaces to the right of fixation. Thus, sixth graders and adults can identify more letters in a single fixation than second and fourth graders.

1.5. Why use isolated word identification to assess the effect of lateral information?

All of the abovementioned studies use eye movement tracking to study the role of lateral information in text reading. While this situation places the reader in a natural context, it also engages several other forms of processing, such as syntactic parsing, inference making, text integration, and also implies an influence of contextual information on word identification. The influence of context is particularly relevant in children given that they have been proven to be more sensitive to context than adults (West & Stanovich, 1978). Thus, confounds in word processing based on contextual influence have a greater effect in children. Therefore, it is important to examine the extent to which the effects mentioned above can be observed in isolated word processing, without the intervention of these high-level processes. This is particularly important in the study of children's reading given the lack of material from this area—both theoretical models and empirical data—that illuminates the processes involved in reading, and more specifically for our research, the identification of isolated words. Another reason for using an isolated word reading task is that eye movements are normally not required in such a situation. Therefore, attentional factors can be assessed without influence from basic oculomotor constraints.