Text segmentation affects oculomotor reading behaviour and reading comprehension

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Abstract

Modern digital reading tools often segment texts into smaller units to improve attention and comprehension, but evidence on their effectiveness is mixed. This study examined how segmentation affects eye-movement patterns and comprehension. Participants read either full texts, paragraph-by-paragraph, or sentence-by-sentence, and answered comprehension questions after each text. Eye movements were recorded and analyzed using mixed-effects models. Comprehension was highest in the sentence condition, suggesting that segmentation supports local integration and reduces distractions. Full-text reading led to longer reading times, more regressions, and stronger global wrap-up effect, whereas sentence-level segmentation increased local processing but resulted in more efficient comprehension overall.

Keywords: reading, eye-tracking, text comprehension, text segmentation

Introduction

Modern digital reading applications incorporate text segmentation features that present content in smaller linguistic units, such as phrases or sentences. These tools are designed to enhance attention and improve comprehension; however, existing data on their effectiveness is controversial (Koornneef, 2024; Lemarié, Eyrolle, Cellier, 2008).

On the one hand, segmentation may facilitate more focused processing by limiting the amount of visual information perceived at one time. This can help the reader to focus on deeper semantic processing of the segment, reducing the likelihood of good-enough comprehension and thereby improving understanding of the text as a whole (Lemarié, Eyrolle, Cellier, 2008; Prinz-Weiss, König, 2023; Gerber-Moron, Szarkowska, Woll, 2018).

However, it may also disrupt discourse coherence by reducing the accessibility of context, increasing the cognitive load and making it difficult to interpret the text as a whole (Delgado et al., 2018; Mangen, Walgermo, Brønnick, 2013). Furthermore, segmentation may disrupt the integrity of the text, hindering the reader's ability to construct a mental model of it, which is crucial for comprehension (Kintsh, 1998).

This study aims to investigate the impact of text segmentation on oculomotor reading behaviour and text comprehension, which is important not only for educational and informational applications, but also for contributing to a deeper

understanding of meaning construction in reading. We compared three reading conditions: full text on the screen, paragraph-by-paragraph presentation, and sentence-by-sentence presentation.

Materials and methods

12 encyclopedic-style texts 120-170 words long from the Russian subcorpus of Multilingual Eye-movement Corpus (Siegelmann et al. 2022) were chosen as stimuli. The texts are available at the project's OSF page (https://osf.io/3527a/).

The participants were asked to read the texts in one of the three conditions (full text, paragraph-by-paragraph, sentence-by-sentence) and answer 8 comprehension questions after each text requiring "yes" or "no" answers. Questions included literal and inferential ones. The eye-movements of the readers were recorded using the EyeLink 1000+ desktop mount eye-tracker (1000 Hz). One text served as a training trial during which eye-movements were not recorded.

81 native speakers of Russian (54 female) aged 18–61 with normal or corrected-to-normal vision and no reported reading disorders volunteered to take part in the study. Each participant was randomly assigned to one of the experimental conditions. The experiment was carried out in accordance with the Declaration of Helsinki, all the participants provided informed consent.

Results

Comprehension rates were analyzed, as well as saccadic activity, regression rates and reading time. Mixed linear models were used for statistical analysis, in cases where linear models could not be used, non-parametric statistical tests (Mann-Whithey U-test and Kruskal-Wallis test) were applied.

The segmentation condition (full text, paragraphs or sentence-by-sentence) was included as a fixed factor, while the participants and texts were included as random factors. Modelling was performed using the *statsmodels* package for Python (Seabold & Perktold, 2010).

Table 1 presents the average values of eye movement activity parameters when reading text in the three considered formats, as well as the results of the pairwise format comparisons. The proportion of correct answers to questions about the texts was calculated for each participant, and a statistically significant difference was found between the groups ($p = 0.041$), with higher text comprehension accuracy in the sentence-by-sentence condition.

Table 1. Oculomotor parameters for reading text in different text segmentation formats[1].

Parameter	Sentence-by-sentence presentation	Paragraph-by-paragraph presentation	Full text presentation
Total reading time (s)	72,3 (SD = 22.7) **	68,4 (SD = 20.2) ***	84,1 (SD = 24.6)
Fixation duration on the final words of the fragment compared to the other words (ms)	326 (SD = 89) vs 201 (SD = 70) *, **	298 (SD = 85) vs 254 (SD = 74)	–
Fixation duration on the final words of the text (ms)	209 (SD = 75) **	284 (SD = 88) ***	398 (SD = 97)
Average number of saccades per word	0,32 (SD = 0.08) *, **	1,33 (SD = 0.39) ***	0,82 (SD = 0.19)
Average number of regression saccades within a sentence	2,55 (SD = 1.14) *, **	2,18 (SD = 1.09) ***	2,76 (SD = 1.23)

Discussion

Our findings demonstrate that text presentation format significantly impacts reading strategies, eye movement activity and reading comprehension.

The longest reading time and the highest number of regressions were recorded in the full-text condition, since readers actively return to previously read information when the full context is available, forming a coherent mental model. The classic wrap-up effect is most pronounced in the full-text condition: the final word is perceived as the final point of the global semantic structure and the mechanisms that integrate the content of what has been read into a single mental model of discourse are activated (Kintsch, 1988).

Eye-tracking data revealed format-dependent differences in cognitive load: in paragraph-by-paragraph presentation, the total number of saccades increased, which is characteristic of scanning-type reading; in sentence-by-sentence presentation, the number of regressions remained unchanged compared to other conditions but was redistributed within the accessible fragment. This can be considered a kind of compensation for the inability to return to the left context. Additionally, under sentence-by-sentence condition, a pronounced wrap-up effect was observed at the boundaries of sentences, with the duration of fixations on the final words of sentences increasing significantly. This indicates enhanced integration of information within a single sentence, rather than across the entire text. Therefore, our eye movement data indicate adaptive mechanisms of attention regulation in conditions of limited visual context.

Comprehension accuracy was highest in the sentence condition, suggesting that segmentation may enhance local integration and reduce distractions, thereby supporting more effective processing of textual information. This is consistent with the idea that fragmented presentation can facilitate the retention of information in working memory (Koornneef, 2024).

Overall, sentence-level segmentation increased local processing effort but supported better comprehension, possibly by facilitating incremental integration and reducing interference from upcoming content. Full-text formats encouraged globally coherent reading but at a cost of longer processing time and more regressive eye movements.

Notes

1. One asterisk indicates a significant difference (p-value < 0.01) between the sentence-by-sentence presentation and the paragraph-by-paragraph presentation; two asterisks indicate a significant difference between the sentence-by-sentence presentation and the full-text presentation; three asterisks indicate a significant difference between the paragraph-by-paragraph presentation and the full-text presentation.

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