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Processing and memory of central versus peripheral information as a function of reading goals: evidence from eye-movements

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Abstract The present study examined the effect of reading goals on the processing and memory of central and peripheral textual information. Using eye-tracking methodology, we compared the effect of four common reading goals—entertainment, presentation, studying for a close-ended (multiple-choice) questions test, and studying for an open-ended questions test—on the specific reading time of central and peripheral information and the overall reading time of expository texts. Text memory was tested using multiple-choice questions. Results showed that readers devoted more time to central information than peripheral information during initial reading, regardless of reading goal, but that they adjusted their rereading to the reading goal, with total reading time being longer for central information under some (entertainment and presentation) but not all (open-ended and close-ended questions tests) reading goals. Moreover, readers devoted more time to reading the texts for a study purpose (test or presentation) than for an entertainment purpose, and devoted more time in reading the texts to answer open-ended questions than close-ended questions. Finally, we found that readers remembered more central information than peripheral information under all reading goals. These findings suggest that centrality affects readers' early processing of text whereas reading goals only affect subsequent processing. Interestingly, processing time during reading predicted memory for peripheral information but not for central information.

Keywords Reading goals · Centrality · Online processing · Reading time · Text memory · Eye tracking · Close-ended questions · Open-ended questions

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Introduction

Readers remember central ideas that are important to understanding the overall meaning of the text better than peripheral ideas that are less crucial to understanding the text (e.g., Britton, Meyer, Hodge, & Glynn, 1980; Brown & Smiley, 1977; Keenan & Brown, 1984; Kintsch, Kozminsky, Streby, McKoon, & Keenan, 1975; Miller & Keenan, 2009; Thorndyke, 1977). According to the selective attention hypothesis (Britton, Meyer, Simpson, Holdredge, & Curry, 1979; Goetz, Schallert, Reynolds, & Radin, 1983; Gomulicki, 1956; Meyer, 1975), central ideas are better remembered because readers allocate more attention during reading to process central ideas compared to peripheral ideas. Consistent with this hypothesis, Cirilo and Foss (1980), and Britton, Muth, and Glynn (1986) found that central information is read more slowly than peripheral information. However, in this study reading time was measured using a self-paced, sentence-by-sentence reading setting in which look backs and rereading of earlier sentences were not possible.

To examine the selective attention hypothesis in a more natural reading setting, Hyönä and Niemi (1990) employed an eye-tracking methodology. Participants were instructed to read the text in order to summarize its main ideas, while their eye movements were recorded by a frontal camera. Hyönä and Niemi (1990, Experiment 2) found a longer initial reading (i.e., first-pass) of central sentences compared to peripheral sentences and more rereading of (i.e., regressions to) central sentences appeared in the "Introduction" section of the text. They concluded that attention allocation during reading explains the centrality effect found with text memory after reading. However, Hyönä and Niemi did not test the centrality effect in memory, because their participants were explicitly instructed to report only on central information in their text summaries. Thus, the memory of central and peripheral information could not be compared directly and, consequently, the correspondence between the online (i.e., reading time) and offline (i.e., memory) centrality effects could not be tested. Moreover, a general component of this and related research is that readers are given a single, specific reading goal. As a result, it is impossible to determine whether reading goals differentially affect attention to and memory for central and peripheral information.

In the current study we investigated the effect of centrality on both online attention and offline memory using eye-tracking methodology and memory test. Furthermore, we examined these centrality effects under reading goals which did not explicitly call for a focus on central information, as the summarizing task in Hyönä and Niemi's (1990) study did. Some reading goals, such as studying for a multiple-choice question test, require the processing of peripheral information to a greater extent than other reading goals, such as reading for self-entertainment. Hence, we aim to investigate to what extent readers actively regulate their processing of textual information, and whether such regulation differentially affects central compared to peripheral information. Eye-movement measures allowed us to test whether readers regulate the processing of textual information during initial reading, during rereading of textual information, or during both stages of processing.

There is considerable evidence that readers adjust their reading strategies and engage in different cognitive processes as a consequence of their reading goals (e.g., Linderholm & van den Broek, 2002; Linderholm & Zhao, 2008; Lorch, Lorch, & Mogan, 1987; McConkie, Rayner, & Wilson, 1973; Narvaez, van den Broek, & Barron-Ruiz, 1999; van den Broek, Lorch, Linderholm, & Gustafson, 2001). Using a think-aloud procedure, Linderholm and van den Broek (2002), for example, showed that readers produce knowledge-based elaborations and connecting inferences, which are essential for text comprehension and memory, more frequently when they read for study than when they read for entertainment. The results of other studies, using learning-strategies questionnaires, have suggested that students adopt deep-level processing strategies (e.g., integrative thinking) when they study to write an essay and surface-level processing strategies (e.g., memorization) when they study to answer multiple-choice questions (MCQ) (e.g., Foos & Clark, 1983; Marton & Saljo, 1984; Scouller, 1998; Tang, 1992). However, to our knowledge, there has been no investigation of the effect of these reading goals on the online processing and memory of central and peripheral information.

According to one hypothesis readers have little control over the attention they direct to process central and peripheral ideas, at least during the initial processing of the information, because the processing time of textual ideas as a function of their centrality is affected by text-based factors that are not under the reader's control. Clark (1977), for example, suggested that central ideas more typically introduce new information (e.g., new theme or a subtopic, a new character, and/or a new initiating event) than elaborate on earlier information. Therefore, central ideas require more processing time to identify and establish the relevant connections to the global macrostructure of the text representation, whereas peripheral ideas are more easily and more quickly integrated locally within the text representation via connections to preceding adjacent ideas (Cirilo & Foss, 1980; Lorch & Lorch, 1986; Thorndyke, 1977).

A related view holds that central ideas have more conceptual connections with other textual ideas than peripheral ideas (e.g., Trabasso & Sperry, 1985; van den Broek, 1988). This view leads to a similar conclusion regarding the involvement of text-based factors in the processing time of central and peripheral ideas. The processing of central ideas is longer (and deeper) than the processing of peripheral ideas because more connections are established with central ideas than with peripheral ideas in the construction of text representation during reading. Thus, not only initial processing of central ideas will be longer due to the establishment of connections with earlier information, but also rereading of central ideas will be longer, due to more connections between new central ideas and earlier central ideas. In both versions of the first hypothesis, the primary influence on processing comes from centrality, whereas reading goals are expected to affect processing later and to a lesser extent.

According to an alternative hypothesis readers do regulate the time they devote to processing of central and peripheral ideas in accordance with their reading goals. In this view readers—consciously or subconsciously—estimate the centrality level of textual information during reading and adjust the time they devote to process that information. Bower (1976) and Mandler (1978), for example, have stated that central ideas are more salient in the story-grammar structure than peripheral ideas. They argued that central ideas fill the basic, essential slots of the story frame, and therefore readers deliberately choose to process them more thoroughly. Thus, in line with this reasoning, readers can choose to process peripheral information to the same extent or more thoroughly than central information as early as during initial reading under specific reading goals.

Indirect support for this hypothesis could come from research towards the effect of information relevance on processing. A series of studies conducted by Kaakinen and colleagues (e.g., Kaakinen & Hyönä, 2005, 2008; Kaakinen, Hyönä, & Keenan, 2002, 2003), which examined the effect of reading perspective on the online processing of texts, showed that readers can identify the information units in the text that are relevant to their reading perspective (e.g., descriptions of valuable items in reading a story from a perspective of a thief; Kaakinen & Hyönä, 2008) and devote more processing time to these relevant units as early as during the first-pass reading. These results were found with narratives as well as with expository texts (e.g., reading a text which describes different diseases from a perspective of a person who are interested in studying one of the diseases; Kaakinen et al., 2003). Yet, although information centrality and information relevancy are close constructs, they are not equivalent (e.g., McCrudden & Schraw, 2007; Schraw, Wade, & Kardash, 1993). Information relevancy is determined by the reading goal or task irrespective of the textual content. That is, the same idea within the same text could be functioning as either a relevant or an irrelevant idea based on the reading goal or task of the reader. Information centrality, on the other hand, is determined by the textual content and structure irrespective of the reading goal. Therefore, conclusions about the processing of central and peripheral information are not straightforward based on studies that examine the processing of relevant and irrelevant information. The present research provides a direct means for testing the hypothesis that readers can regulate the online processing of textual ideas as a function of their centrality.

Overview of the present study

In the present study we examined the effect of reading goals on the online processing and memory of central and peripheral information in expository texts. We compared the effect of four reading goals: (1) entertainment, (2) presentation, (3) studying for a test with open-ended questions (OQ), and (4) studying for a test with close-ended (multiple-choice) questions (CQ). Online processing was examined by an eye-tracking device, using the following measures: (1) the total reading time of an information unit, (2) the time spent reading an information unit for the first time (first-pass reading), (3) the time spent rereading an information unit (regression), (4) the average duration of fixations landed within an information unit, (5) the total number of fixations landed within an information unit, and (6) the average length of forward saccades. Text memory was examined using MCQ on central and peripheral information after reading was completed.

Using this paradigm, we examined (a) to what extent readers control their selective reading time of central versus peripheral information, (b) to what extent readers control their reading time of the whole text (across centrality), (c) the correspondence between reading time and text memory, and (d) the time course of the effects of reading goal and information centrality (if present). The total reading time measure was employed to address the first three issues, whereas the measures of first-pass and rereading time were employed to address the fourth issue (Kaakinen et al., 2002). The average fixation duration and the total number of fixations measures were employed to explore whether variations in total reading time originate in variations in the durations of fixations or their frequencies (Hyönä & Niemi, 1990; Kaakinen et al., 2003; Rayner, 1998, 2009; Rayner, Chace, Slattery, & Ashby, 2006). Finally, the average fixation duration and the length of forward saccades were used to compare the ease in which central and peripheral information are conceptually integrated within the text representation. Longer fixations and shorter saccades are typically interpreted as an indication for more effortful integration (Hyönä & Niemi, 1990; Rayner & Sereno, 1994; Vauras, Hyönä, & Niemi, 1992).

In line with the online and offline effects found for reading goals (e.g., Linderholm & van den Broek, 2002) and reading perspectives (e.g., Kaakinen et al., 2003), we hypothesized that the reading goals in the present study will affect the selective reading time of central versus peripheral information and the reading time of the whole text, and that the adjustments in text processing would have corresponding effects on the readers' memory. More specifically, we expected to find a longer reading time for central information, at least during the first-pass reading phase. Several studies that used the sentence-by-sentence exposure paradigm have found longer reading time for central information compared to peripheral information in the first (and only) encounter with the information units (e.g., Cirilo & Foss, 1980). However, when rereading of earlier information is possible (as in normal reading and in our paradigm), one would expect readers to employ a more equal balance between reading time for central and peripheral information, especially under more demanding reading goals such as studying for a test.

With regard to the reading time of the whole texts, we expected to find the shortest reading time in reading for entertainment, because readers are usually less committed and less engaged in deep-level processing when they read for entertainment than when they read for study (e.g., Linderholm & van den Broek, 2002). We also expected to find a longer reading time for the OQ test condition than for the CQ test condition, because learning for an OQ test elicits deeper-level processing than learning for a CQ test (e.g., Foos & Clark, 1983; McConkie et al., 1973). It was more difficult to predict the relative time of reading for presentation, because this type of reading goal has hardly been investigated. We included this goal because it is a commonly used academic task on students' reading.

With regard to memory of textual information, we expected to find a correspondence between the pattern of (total) reading time and the pattern of performance in the final MCQ test, in line with the selective attention hypothesis (e.g., Britton et al., 1979). Specifically, we expected to find the worst performance (across question type—central or peripheral) in the entertainment condition, and better performance under the OQ test than the CQ test condition. Finally, we expected to observe better performance in the MCQs that tap central information than in the MCQs that tap peripheral information, especially under reading goals in which central information was read for a longer (total) time.

Method

Participants

Sixty-four students (61 female) from Leiden University, the Netherlands, participated in this study. They were paid approximately 8 Euros for a single 80-min session. The age of the participants ranged from 17 to 24 (M = 19.1, SD = 1.4). All participants were native Dutch speakers who according to self-report did not suffer from any diagnosed learning deficit. Participants had good or corrected-to-good eyesight.

Apparatus

Eye movements were recorded using the EyeLink 1000 desktop mounted eye-tracker of SR Research (see http://sr-research.com/pdf/techspec.pdf). Sampling frequency was 1000 Hz and spatial accuracy was approximately 0.4°. Only the right eye was tracked. The participant's head was kept immobile with the use of a chin and head rest. The stimuli were presented on a 19-in. wide screen monitor at a distance of 65 cm from the participant.

Materials

Ten expository texts were used in the present study, adapted and translate into Dutch from free access examples of reading comprehension tests on the web (e.g., http://www.usingenglish.com/comprehension). The texts were grouped into two blocks of five texts each, with each block of texts assigned to one reading goal. One block of texts included the following topics: the Chinese Wall, the invention of the airplane, the Trojan War, Albert Einstein, and the hardest language. The length of the texts in this block ranged from 347 to 471 words (M = 398, SD = 54). The other block of texts included the following topics: Anastasia the daughter of Czar Nicholas II, Reality TV, the volcano Vesuvius, Marie Curie, and cheating and plagiarism. The length of the texts in this block ranged from 314 to 458 words (M = 391, SD = 57). Each text was presented on a single screen using a 16 point Ariel font and double spacing between the text lines.

Centrality

Each text was parsed into information units. Each unit included a main predicate, its arguments (including time and place), and the adjectives and/or adverbs of these arguments (see "Appendix 1"). Three trained judges evaluated the centrality level of each information unit on a scale of 1 (least central) to 5 (most central). Centrality was defined by a joint estimation of the following two criteria: (a) the extent to which an information unit is important for the overall understanding of the text; (b) the extent to which comprehension would be impaired should the information unit be missing (e.g., Albrecht & O'Brien, 1991; Miller & Keenan, 2009; van den Broek, 1988). Judges discussed their scores following the evaluation of the first and the second texts, reached agreements over points of conflict points, and then evaluated the rest of the eight texts independently. For these eight texts, the centrality score of each information unit was defined as the average of the three judges' scores (Cronbach's $\alpha = 0.8$; see "Appendix 1").

To determine possible effects of information centrality, we included in our analyses 65 information units that received the highest centrality score ($M = 4.7$, $SD = 0.3$) and 62 information units that received the lowest centrality score ($M = 1.6$, $SD = 0.4$).

Memory

The MCQs in the final test addressed one central and one peripheral information unit from each text. These questions were presented in a random order in two separate tests, addressing the texts belonging to the two blocks. The same questions were designed in both open-ended and multiple-choice (with four choices) question format (see "Appendix 1"). Participants who were assigned to the OQ test condition answered the questions in their open-ended format. All participants under all reading goals conditions answered the twenty questions (ten on central information and ten on peripheral information) in their multiple-choice format. Only the answers to the MCQs were analyzed, because these answers allowed us to compare the memory performance of participants under all reading goals conditions.

Procedure

Participants were tested individually. Each participant was assigned randomly to a pair of reading goals conditions: either to the entertainment and presentation conditions or to the OQ and CQ tests conditions (i.e., there were no other combinations of reading goals). The order of the reading goals conditions and the matching of the reading goals with text blocks were counterbalanced across participants.

Reading goals were introduced by designated instructions that preceded the reading of each block of texts (see "Appendix 2"). Following the reading goals instructions, a calibration of the eye-tracker was conducted by means of a 13-point calibration grid that covered the entire computer screen. Then the participants read a block of five texts successively at their own pace from the computer screen while their eye movements were recorded by the desktop camera. When participants completed the reading of the five texts, they performed the task on which they were instructed in accordance with their reading goal. Following the reading for entertainment, the participants were asked to rank the texts according to their enjoyment of them, and to specify the three most interesting facts that they found in these texts. Following the reading for presentation, the participants were asked to present (i.e., retell) one of the texts in front of the experimenter, while the experimenter could ask questions during and/or at the end of the presentation. Following the reading for the OQ test, the participants were asked to answer ten open-ended questions in writing. Following the reading for CQ test, the participants were asked to choose the correct answer for ten MCQ. Importantly, at the end of the two reading goals blocks, all participants received an unexpected test with MCQ about all ten texts.[1] First they received questions that addressed the most recent five texts they had read, and then they received questions that addressed the earlier five texts they had read.

Results

Reading times

The three types of reading time data were analyzed separately: (1) total reading time—the sum of durations of all fixations landed within an information unit, (2) first pass reading time—the sum of durations of all fixations landed within an information unit before any subsequent unit was fixated on, and (3) rereading time—the sum of durations of all fixations landed within an information unit that had already been read once before. For the first-pass reading time measurement we excluded from the analysis all cases in which subsequent information units were read before the target information unit (22 % of the trials). The three reading time measurements were divided by the number of characters in that unit in order to control for length differences between information units (e.g., Frazier & Rayner, 1982; Rayner, Garrod, & Perfetti, 1992). Thus, the unit of measurement of the reading time dependent variables is milliseconds per character.[2]

For each measurement we computed the mean reading time per character for each participant in each of the eight experimental conditions (4 reading goals $\times 2$ levels of information centrality). Reading times which were more than two standard deviations above or below the mean of the experimental condition were excluded from the analyses (7.3 % of cases). To analyze the data, we conducted two separate 2-way factor analyses of variance (ANOVAs) with reading goals (ANOVA1: entertainment–presentation; ANOVA2: OQ test–CQ test) and information centrality

[1] Those participants who were assigned to the CQ test condition in the first block of texts received the two tests of multiple-choice questions separately, one following the first block of texts and a second following the second block of texts.

[2] Trueswell, Tanenhaus, & Garnsey (1994) criticized the use of reading time per character as a measurement for adjusting length in eye-movements data (see also Rayner, 1998). They demonstrated that the relationship between reading time per character and information unit length is non-linear and characterized by an inverse relationship (i.e., reading time/character is longer for smaller information units) at smaller lengths that reaches asymptote as the length gets larger. We have chosen to use this measurement of reading time per character because of the relatively large lengths of target units in the present study (60 characters on average compared to 12 characters in Trueswell et al.). At large lengths, the correlation between reading time/character and length approaches zero ($r = -0.07$ in this study) as would be expected in case that reading time/character removes most of the length variance (see Hyönä, Lorch, & Kaakinen, 2002; Rayner, 1998).

(central–peripheral) as within-participants factors. In addition, we conducted a series of supplementary independent-samples *t* tests to compare the reading time of the whole text (across information centrality) under the reading goals which were manipulated in a between-participants design (i.e., entertainment–OQ test; entertainment–CQ test; presentation–OQ test; presentation–CQ test). Because each reading goal condition was compared to the other reading goal conditions using three separate statistical tests, we adopted a stricter *p* value of .017 for the reading goal comparisons based on the Bonferroni correction computation. For the information centrality analyses, *p* value was left .05.

Total reading time

A significant main effect of information centrality was observed in the 2-way ANOVA of the Entertainment and Presentation conditions, $F(1,31) = 7.0$, $MSE = 14$, $p < .01$, $\eta_p^2 = .18$, with no significant interaction with reading goals ($F < 1$) (see Table 1; Fig. 1). This effect indicated that the reading times for the central information ($M_{\text{Entertainment}} = 43.1$ ms/char, $M_{\text{Presentation}} = 59.5$ ms/char) were longer than the reading times for the peripheral information ($M_{\text{Entertainment}} = 41.5$ ms/char, $M_{\text{Presentation}} = 57.6$ ms/char) in these two reading goal conditions. In the other 2-way ANOVA of the OQ and CQ tests conditions, both the main effect of information centrality and the interaction with reading goals did not reach significance (*Fs* < 1). These results suggest that readers spent more time in reading the central information than the peripheral information when reading for entertainment and presentation, but not when reading for OQ and CQ tests.

In addition, the 2-way ANOVAs revealed two significant main effects of reading goal, with longer reading times in the Presentation (M = 58.5 ms/char) compared to the Entertainment condition (M = 42.3 ms/char), $F(1,31) = 36.1$, $MSE = 234$, $p < .001$, $\eta_p^2 = .55$, and longer reading times for OQ test (M = 54.5 ms/char) compared to CQ test condition (M = 50.7 ms/char), $F(1,62) = 10.8$, $MSE = 49$, $p < .01$, $\eta_p^2 = .26$ (see Table 2). The supplementary independent-samples *t* tests revealed that the reading times in the Entertainment condition were significantly shorter than those observed in the OQ test condition, $t(62) = 3.7$, $SE = 3.3$, $p < .001$, Cohen's $d = .09$, and the CQ test condition, $t(62) = 2.7$, $SE = 3.1$, $p < .01$, Cohen's $d = .07$. The reading times observed in the presentation condition were not significantly different from the reading times observed in the OQ test condition, $t < 1$, and the CQ test condition, $t(62) = 1.9$, $SE = 4.3$, $p = .06$, Cohen's d = .05. These results indicate that readers spent more time when they read for studying (test or presentation) than when they read for entertainment. Moreover, readers spent more time in reading the texts for an OQ test than for a CQ test.

First-pass reading time

The effect of information centrality on the first-pass reading times was robust and consistent. The 2-way ANOVAs yielded significant main effects of information centrality, both in the analysis of Entertainment ($M_{\text{central}} = 26.0$ ms/char, $M_{\text{peripheral}} = 23.7$ ms/char) and Presentation ($M_{\text{central}} = 27.6$ ms/char, $M_{\text{peripheral}} = 24.8$ ms/char) conditions,

Table 1 Means of each of the study's dependent measures for central and peripheral information as a function of reading goal

Dependent measurement	Reading goals							
	Entertainment		Presentation		CQ test		OC test	
	Central information	Peripheral information	Central information	Peripheral information	Central information	Peripheral information	Central information	Peripheral information
Total reading time (ms/char)	43.1	41.5[a]	59.5	57.6[a]	51.1	50.4	54.5	54.6
First-pass reading time (ms/char)	26.0	23.7[a]	27.6	24.8[a]	21.8	20.5[a]	24.3	20.6[a]
Rereading time (ms/char)	14.1	13.7	30.5	30.8	25.7	26.5	27.5	29.5
Average fixation duration (ms)	228	226[a]	228	225[a]	224	222	227	224
Number of fixations (no/char)	0.185	0.183	0.259	0.254	0.227	0.226	0.238	0.241
Average forward saccade length (°)	2.34	2.43[a]	2.51	2.60[a]	2.56	2.65[a]	2.48	2.63[a]
Answer accuracy in MCQ test (%)	0.72	0.57[a]	0.76	0.64[a]	0.85	0.69[a]	0.88	0.63[a]

[a] The difference between the means of the central and peripheral information was significant

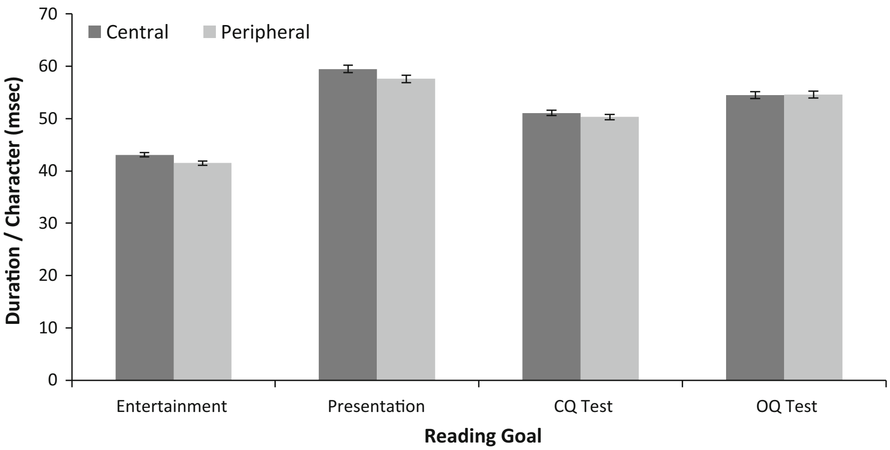

Fig. 1 The total reading time (per character) of information units in milliseconds as a function of reading goal and information centrality

Table 2 Means of each of the study's dependent measures as a function of reading goal across centrality

Dependent measurement	Reading goals				Significant differences
	Entertainment (E)	Presentation (P)	CQ test	OQ test	
Total reading time (ms/char)	42.3	58.5	50.7	54.5	E < P, CQ, OQ CQ < OQ
First-pass reading time (ms/char)	24.8	25.7	21.2	22.5	CQ < E, P
Rereading time (ms/char)	13.9	30.7	26.1	28.0	E < P, CQ, OQ
Average fixation duration (ms)	227	227	223	226	CQ < OQ
Number of fixations (no/char)	0.18	0.26	0.23	0.24	E < P, CQ, OQ CQ < OQ
Average forward saccade length (°)	2.41	2.56	2.61	2.55	E < P
Answer accuracy in MCQ test (%)	0.64	0.70	0.75	0.77	E < CQ, OQ

$F(1,31) = 18.0$, $p < .001$, $MSE = 17$, $\eta_p^2 = .37$, and in the analysis of OQ test ($M_{central} = 24.3$ ms/char, $M_{peripheral} = 20.6$ ms/char) and CQ test ($M_{central} = 21.8$ ms/char, $M_{peripheral} = 20.5$ ms/char) conditions, $F(1,31) = 15.5$, $MSE = 12$, $p < .001$, $\eta_p^2 = .34$ (see Fig. 2; Table 1). The interactions of information centrality with reading goal in each of these ANOVAs did not reach significance, either in the analysis of Entertainment and Presentation conditions, $F(1,31) = 2.6$, $MSE = 9$, $p = .12$, $\eta_p^2 = .07$, or in the analysis of OQ test and CQ test conditions, $F(1,31) = 3.9$, $MSE = 12$, $p = .06$,[3] $\eta_p^2 = .11$. These results indicate that information centrality had a strong effect on first-pass

[3] This trend towards a significant interaction (compared to a p value of .05) indicated on a stronger information centrality effect for the OQ test compared to the CQ test condition.

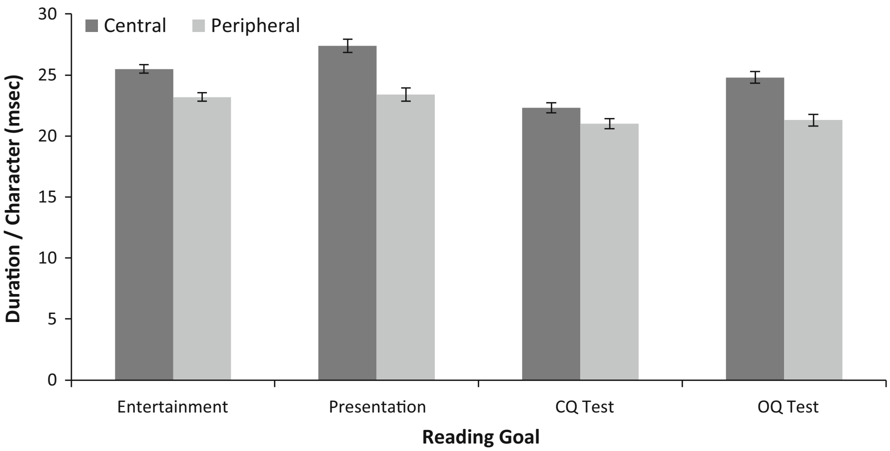

Fig. 2 The first-pass reading time (per character) of information units in milliseconds as a function of reading goal and information centrality

reading time under all reading goal conditions. Central information was processed more slowly than peripheral information in first-pass reading.

The 2-way ANOVAs did not yield significant main effects for reading goal, both when comparing the Presentation (M = 25.7 ms/char) and the Entertainment (M = 24.8 ms/char) conditions ($F < 1$) and when comparing the OQ (M = 22.5 ms/char) and the CQ (M = 21.2 ms/char) tests conditions, $F(1,31) = 1.9$, $MSE = 28$, $p = .18$, $\eta_p^2 = .06$ (see Table 2). The supplementary independent-samples t tests revealed that the reading times in the CQ test condition were significantly shorter than those observed in the Presentation condition, $t(62) = 3.7$, $SE = 1.4$, $p < .001$, Cohen's d = .09, and in the Entertainment condition, $t(62) = 2.8$, $SE = 1.4$, $p < .01$, Cohen's d = .07. There was no significant difference between the OQ test and the Presentation conditions, $t(62) = 1.7$, $SE = 1.6$, $p = .09$, Cohen's d = .04, or between the OQ test and the Entertainment conditions, $t(62) = 1.6$, $SE = 1.6$, $p = .11$, Cohen's d = .04. These analyses indicate that reading goal had an effect on the first-pass reading times in the CQ test condition when compared to the Presentation or Entertainment condition. This pattern of results does not match the pattern of results observed in the total reading time measure.

Rereading time

Information centrality had no significant effect on the rereading times for central and peripheral information. The main effect of information centrality in the ANOVA of Entertainment and Presentation conditions was not significant ($F < 1$). It is worth noting that the second ANOVA of OQ and CQ tests conditions yielded a trend[4] towards a reverse effect of centrality, $F(1,31) = 3.4$, $MSE = 19$, $p = .07$,

[4] Compared to a p value of .05 that was adopted in the information centrality analyses.

$\eta_p^2 = .10$, in which the rereading times of peripheral information ($M_{CQtest} = 26.5$ - ms/char, $M_{OQtest} = 29.5$ ms/char) were longer than the rereading times of central information ($M_{CQtest} = 25.7$ ms/char, $M_{OQtest} = 27.5$ ms/char). This trend is in the opposite direction of the centrality effect found in the first-pass reading time under the same conditions (see Fig. 3; Table 1). Taken together these two opposite effects explain the balance found in the total reading time between central and peripheral information. The interactions of information centrality and reading goals in both ANOVAs did not reach significance (Fs < 1).

A significant main effect of reading goal was observed in ANOVA1, indicating longer rereading times in the Presentation condition (M = 30.7 ms/char) than in the Entertainment condition (M = 13.9 ms/char), $F(1,31) = 34.4$, $MSE = 261$, $p < .001$, $\eta_p^2 = .53$. In ANOVA2, the rereading times of the OQ (M = 28.0 ms/char) and the CQ (M = 26.1 ms/char) tests conditions did not differ significantly, $F(1,31) = 3.0$, $MSE = 61$, $p = .09$, $\eta_p^2 = .09$ (see Table 2). The supplementary independent-samples t tests revealed that the rereading times in the Entertainment condition were significantly shorter than those observed in the OQ test condition, $t(62) = 5.4$, $SE = 2.7$, $p < .001$, Cohen's d = 1.4, and the CQ test condition, $t(62) = 4.9$, $SE = 2.4$, $p < .001$, Cohen's d = 1.2. The two remaining comparisons (Presentation vs. OQ test and Presentation vs. CQ test) did not reach significance (ts < 1.3). Consistent with the *total* reading time data, these results show that readers invested more time in rereading the textual ideas when they read for study (test or presentation) than when they read for entertainment.

Fixations and saccades

In addition to the aggregated reading time measures we analyzed single fixations and saccades data using the following measures: (1) average fixation duration—the total reading time of an information unit divided by the number of all fixations landed within that information unit, (2) total number of fixations—the number of all fixations landed within an information unit, and (3) average forward saccade length—the averaged distance (in visual angle units) covered by saccades that were directed to the right (i.e., forward in the text) within an information unit. The total number of fixations was divided by the number of characters in the information unit because the number of fixations was correlated with the number of characters to the same extent as reading time (rs = 0.54 and 0.57, respectively).

For the three measures, we computed the means for each participant in each of the eight experimental conditions (4 reading goals × 2 levels of information centrality). Data points which were more than two standard deviations above or below the mean of the experimental condition were excluded from the analyses (7.1 % of cases). Similar to the reading time analyses, we conducted two separate 2-way factor analyses of variance (ANOVAs) with reading goals (ANOVA1: entertainment–presentation; ANOVA2: OQ test–CQ test) and information centrality (central–peripheral) as within-participants factors. In addition, we conducted a series of supplementary independent-samples t tests to compare the number and durations of fixations (across information centrality) under the reading goals which were manipulated in a between-participants design (i.e., entertainment–OQ test;

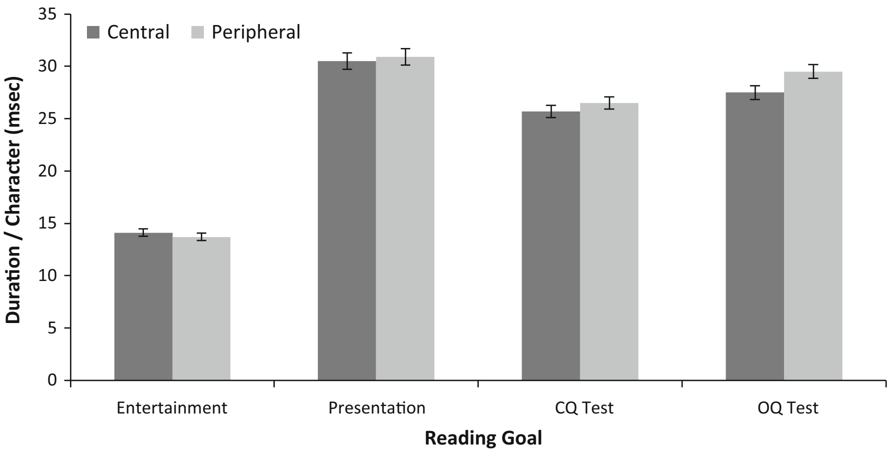

Fig. 3 The rereading time (per character) of information units in milliseconds as a function of reading goal and information centrality

entertainment–CQ test; presentation–OQ test; presentation–CQ test). A stricter *p* value of .017 was adopted for the reading goal comparisons. For the information centrality analyses, *p* value was left .05.

Average fixation duration

A significant main effect of information centrality was observed in ANOVA1 of the Entertainment and Presentation conditions, $F(1,31) = 5.9$, $MSE = 29$, $p < .05$, $\eta_p^2 = .16$, with no significant interaction with reading goals ($F < 1$) (see Table 1). This effect indicated that the fixation durations for the central information ($M_{Entertainment} = 228$ ms, $M_{Presentation} = 229$ ms) were longer than the fixation durations for the peripheral information ($M_{Entertainment} = 225$ ms, $M_{Presentation} = 226$ ms) in these two reading goal conditions. In ANOVA2 of the OQ and CQ tests conditions, the main effect of information centrality approached significance, $F(1,31) = 4.0$, $MSE = 40$, $p = .06$, $\eta_p^2 = .11$, and the interaction with reading goal was not significant ($F < 1$). These results indicate that central information induced longer fixations than peripheral information particularly under reading goals that induced longer reading times for the central information compared to peripheral information.

With regard to the main effect of reading goal, the average fixation duration in ANOVA1 of the Entertainment (M = 227 ms) and the Presentation (M = 227 ms) conditions did not differ significantly ($F < 1$). A significant main effect of reading goal was observed in ANOVA2, indicating longer fixation durations in the OQ test condition (M = 226 ms) than in the CQ test condition (M = 223 ms), $F(1,31) = 4.58$, $MSE = 52$, $p < .05$, $\eta_p^2 = .13$ (see Table 2). The supplementary independent-samples *t* tests did not reveal any further significant differences (*t*s < 1). These results suggest that the shorter total reading time observed in the entertainment condition compared to the other reading goal conditions was due to fewer fixations rather than shorter fixations.

Total number of fixations

The main effects of information centrality and the interactions of information centrality with reading goals did not reach significance in both ANOVA1 (entertainment and presentation) and ANOVA2 (OQ and CQ tests) (all *F*s < 1.5, *p*s > .23; see Table 1). These results suggest that the longer total reading time observed for the central information compared to peripheral information in the entertainment and presentation conditions were due to longer fixations rather than a greater number of fixations.

Consistent with the total reading time data, the 2-way ANOVAs revealed significant main effects of reading goal, with a larger number of fixations in the Presentation (M = 0.26 no/char) compared to the Entertainment condition (M = 0.18 no/char), $F(1,31) = 44.9$, $MSE = .004$, $p < .001$, $\eta_p^2 = .59$, and in the OQ test (M = 0.24 no/char) compared to CQ test condition (M = 0.23 no/char), $F(1,62) = 8.8$, $MSE = .001$, $p < .01$, $\eta_p^2 = .20$ (see Table 2). The supplementary independent-samples *t* tests revealed that the number of fixations in the Entertainment condition were significantly lower than those observed in the OQ test condition, $t(62) = 4.5$, $SE = .013$, $p < .001$, Cohen's $d = 1.14$, and the CQ test condition, $t(62) = 3.7$, $SE = .012$, $p < .001$, Cohen's $d = .94$. The number of fixations observed in the presentation condition were not significantly different from the number of fixations observed in the OQ test condition, $t < 1$, and in the CQ test condition, $t(62) = 1.8$, $SE = .2$, *ns*, Cohen's d = .46. These results indicate that the difference in the total reading time observed in the different reading goals conditions was mainly a result of differences in the number of fixations.

Average forward saccade length

The 2-way ANOVAs yielded significant main effects of information centrality, indicating shorter forward saccades for central information compared to peripheral information, both in the analysis of Entertainment ($M_{central} = 2.34°$, $M_{peripheral} = 2.43°$) and Presentation ($M_{central} = 2.51°$, $M_{peripheral} = 2.60°$) conditions, $F(1,31) = 17.7$, $p < .001$, $MSE = .07$, $\eta_p^2 = .36$, and in the analysis of OQ test ($M_{central} = 2.48°$, $M_{peripheral} = 2.63°$) and CQ test ($M_{central} = 2.56°$, $M_{peripheral} = 2.65°$) conditions, $F(1,31) = 25.7$, $MSE = .05$, $p < .001$, $\eta_p^2 = .47$ (see Table 2). The interactions of information centrality with reading goal in each of these ANOVAs did not reach significance, neither in the analysis of Entertainment and Presentation conditions, $F(1,31) = 1.8$, $MSE = .01$, *ns*, $\eta_p^2 = .06$, nor in the analysis of OQ and CQ test conditions, $F(1,31) = .02$, $MSE = 12$, *ns*, $\eta_p^2 = .25$.

Additionally, a significant main effect of reading goal was observed in ANOVA1, indicating shorter forward saccades in the Entertainment (M = 2.41°) than in the Presentation (M = 2.56°) condition, $F(1,31) = 11.1$, $MSE = .07$, $p < .01$, $\eta_p^2 = .26$ (see Table 1). In ANOVA2, the average forward saccades length in the OQ (M = 2.55°) and the CQ (M = 2.61°) test conditions did not differ significantly, $F(1,31) = 1.6$, $MSE = .05$, *ns*, $\eta_p^2 = .05$. The supplementary independent-samples *t* tests did not reveal any further significant differences (*t*s < 1.6, *p*s > .10).

Text memory

To examine the effect of reading goals and information centrality on text memory, we computed the mean accuracy (measured as proportions) of each participant in answering the ten questions about central information and the ten questions about peripheral information in the final MCQ test. Similar to previous analyses, we conducted two separate 2-way ANOVAs with reading goals (ANOVA1: Entertainment–Presentation; ANOVA2: OQ test–CQ test) and information centrality (central–peripheral) as within-participants factors. In addition, we conducted a series of independent-samples *t* tests in order to compare the answer accuracies (across information centrality) under the reading goals which were manipulated in a between-participants design. Again, a stricter *p* value of .017 was adopted for the reading goal comparisons. For the information centrality analyses, *p* value was left .05.

Analyses revealed a strong effect of information centrality on memory performance (see Fig. 4; Table 1). In both ANOVAs a significant main effect of information centrality was observed (*F*s > 23.5, *p*s < .001). This effect indicated that the accuracy on the central information questions ($M_{Entertainment} = .72$, $M_{Presentation} = .76$, $M_{CQtest} = .85$, $M_{OQtest} = .88$,) was significantly higher than the accuracy on the peripheral information questions ($M_{Entertainment} = .57$, $M_{Presentation} = .64$, $M_{CQtest} = .69$, $M_{OQtest} = .63$). The interactions of information centrality and reading goals were not significant in either ANOVA (*F*s < 1). These centrality effects further suggest that reading time is not necessarily associated with memory performance. Central information was better recognized than peripheral information even when the two types of information were processed for the same duration, as in the case of the OQ and CQ tests conditions.

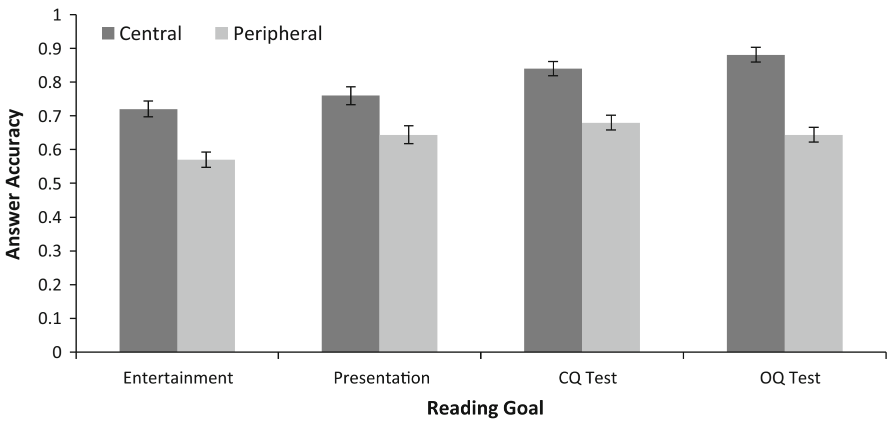

Fig. 4 The accuracy proportions in answering the final multiple-choice questions as a function of reading goals and information centrality

With regard to the effect of reading goal, the two ANOVAs did not yield significant main effects. Answer accuracies were not significantly different between the Entertainment (M = .64) and the Presentation (M = .70) conditions, $F(1,31) = 2.3$, $MSE = .05$, $p = .13$, $\eta_p^2 = .07$, or between the CQ (M = .75) and OQ (M = .77) test conditions ($F < 1$). However, the supplementary independent-samples t tests revealed that the answer accuracy in the Entertainment condition was significantly lower than the accuracies obtained in the OQ test condition, $t(62) = 2.7$, $SE = .04$, $p < .001$, Cohen's d = .07, and in the CQ test condition, $t(62) = 2.7$, $SE = .04$, $p < .001$, Cohen's d = .07 (see Table 2). The difference observed between the accuracies in the Presentation and OQ test conditions, $t(62) = 1.8$, $SE = .03$, *ns*, Cohen's d = .46, and between the Presentation and CQ test conditions, $t(62) = 1.7$, $SE = .03$, *ns*, Cohen's d = .46, did not reach significance. Consistent with the total reading time data, these results show that the lowest performance was observed in the Entertainment condition in which the reading time of the whole text was the shortest. However, inconsistent with the total reading time data, performance was not higher in the OQ test and Presentation conditions compared to the CQ test conditions, although a longer time was spent on processing the texts in the OQ test and Presentation conditions compared to the CQ test conditions. These results suggest that the online processing time of textual information is only partially corresponds with the offline memory performance (see the General Discussion section for further discussion).

To examine the correspondence between text memory and reading time more directly, we computed correlations between the answer accuracies in the final MCQs test and the total reading times obtained for each participant. Across centrality and reading goals, we found a significant positive correlation between reading times and answer accuracies, $r(128) = .26$, $p < .001$. That is, longer reading time of a text was generally associated with higher answer accuracy in the final MCQs test. However, when we examined this correlation for each reading goal separately (across centrality), it reached significance only in the CQ test condition, $r(32) = .42$, $p < .05$ ($r_{\mathrm{OCtest}}(32) = .26$, $r_{\mathrm{entertainment}}(32) = .10$, $r_{\mathrm{presentation}}(32) = .20$), in which participants received the exact reading task they were expecting during reading. When we examined this correlation separately for central and peripheral information, we found that reading time significantly predict memory in the case of peripheral information ($r = 0.27$, $p < .001$) but not of central information ($r = 0.13$). As described earlier, central information is remembered better than peripheral information irrespective of any reading time differences. Taken together, these results suggest that the reading time of textual ideas is a significant but relatively minor factor in determining the strength of textual ideas in the reader's memory representation.

Discussion

The present study examined the effect of four types of common reading goals—entertainment, presentation, studying for close-ended questions (CQ) test, and studying for open-ended questions (OQ) test—on (a) the selective reading time of central versus peripheral information, (b) the reading time of the whole text, (c) the time course of the reading goals and information centrality effects, and (d) the correspondence between reading time and memory of textual information. Reading times were examined using eye-tracking methodology and text memory was examined using MCQ at the completion of reading.

Overall, the present findings indicate that reading goals affect both the selective reading time of central and peripheral information as well as the reading time of the whole text. We found that readers devoted more time to processing central information compared to peripheral information under some (i.e., entertainment and presentation) but not all (i.e., OQ and CQ tests) reading goals, and devoted more time to processing the whole text when the reading goal was more demanding (e.g., study compared to entertainment). These findings support the hypothesis that readers adjust their processing of textual ideas in accordance with their reading goals, both generally (of the whole text) and more selectively to central and peripheral information.

Additionally, the present findings revealed that reading goals and information centrality affects reading time in different phases of the reading process by different manners. Reading goals mainly affect rereading of textual information by altering the amount a reader fixates on the text. Information centrality affects mainly initial reading of textual information by altering the duration of the fixations. These findings suggest that reading goals affect reading later and in a more controlled strategic manner, whereas information centrality affects reading early and in a more spontaneous manner.

Finally, comparing the results for reading time and memory allowed us to explore the role attention allocation may play in determining the strength of textual ideas in the reader's memory representation. We found that reading time did not necessarily relate to memory performance. That is, longer reading time of the whole text did not always result in a better memory performance (e.g., when comparing OQ and CQ tests conditions) and equal reading time of central and peripheral information (as found in the OQ and CQ test conditions) did not influence the typical advantage found for memory of central information. Moreover, the correlations obtained between reading time and memory were relatively low and unstable across the different experimental conditions. These findings suggest, different from the selective attention hypothesis (Britton et al., 1979), that attention allocation is only a minor factor in determining the memory strength of textual ideas. Nonetheless, the comparison of reading time and memory performance should be interpreted with caution consider the limited number and scope of items used in the memory test compared to the broader data sample used for the reading time. The next sections elaborate on each of these sets of findings within the relevant theoretical and empirical contexts.

Reading time of central versus peripheral information

The total reading time measure reveals two patterns of processing for central and peripheral information. Under the reading goals of entertainment and presentation, readers spent more time processing central information than peripheral information.

That is, when readers were allowed to construct their own representation of the text, as in the entertainment condition, or when they were asked to retell the text content in their own words, as in the presentation condition, they tend to focus more on central ideas, which are more crucial for basic comprehension and reconstruction (i.e., retelling) of the content. Under the reading goals of studying for OQ and CQ tests, the processing times for central and peripheral information did not differ. Apparently, under conditions in which readers can not anticipate the type of information (i.e., main ideas or elaborative details) they are asked to provide, they process the central and peripheral ideas in the text equally. Together, these findings suggest that readers strategically regulate the amount of attention they allocate to central and peripheral information. Thus, readers take into account both text-based factors, such as information centrality, and task-based, such as reading goals, when allocating their attention.

These findings are in part consistent with the findings of Birkmire (1985), who used a sentence-by-sentence reading paradigm to examine the effect of three types of pre-reading questions—read for general understanding, focus on central information, or focus on peripheral information—on the reading time of central and peripheral information corresponding to those questions. Consistent with the present findings, she found that readers can adjust the time they dedicate to process the peripheral information when this was explicitly called for by the task. However, in contrast to the present and previous findings (e.g., Cirilo & Foss, 1980), Birkmire did not observe a centrality effect when the questions were on central information, but found a reverse centrality effect (i.e., slower reading of the peripheral sentences) in the condition in which readers were prompted to focus on the peripheral sentences. Birkmire suggested that the use of expository texts instead of narratives may be responsible for the apparent differences. However, the present study showed that centrality effects are observed with expository texts as well. Investigation of the effect of Birkmire's tasks on reading time using eye-tracking methodology may shed more light on this unresolved issue.

Reading time of the whole text

Examining the main effects of reading goals on the reading time of the whole text reveals two main differences in the processing of textual ideas. First, readers spent more time reading the texts for a study purpose (test or presentation) than for an entertainment purpose. This is consistent with previous findings that demonstrated that when they read for study, readers become more committed and employ a deeper mode of text processing (e.g., generating more inferences and engaging in deeper meta-comprehension processes) than when they read for entertainment (e.g., Linderholm & van den Broek, 2002). Second, readers spent more time reading the texts for the OQ test than for the CQ test. This is consistent with previous studies that showed that students were more likely to employ a surface learning mode when learning was assessed by close-ended items, such as MCQ, and a deeper learning mode when learning was assessed by an open-ended type of tasks, such as writing an essay (e.g., Scouller, 1998; Tang, 1992; Thomas & Bain 1984; Watkins, 1983). Likewise, McConkie et al. (1973) found that the reading time of texts was longer when participants expected to answer deep-level questions (e.g., inferential questions) compared to surface-level questions (e.g., questions about numerical details). In a recent intervention study, Ozuru, Briner, Kurby, and McNamara (2013) found that the quality of elaborations (i.e., the proportions of inferential and integrative elaborations) during reading made a greater contribution to the performance in an OQ test than in a CQ test. Together, these studies suggest that OQ tests elicit deeper-level processing of texts than CQ tests, which, according to the present research, consumes more time.

The time course of reading goals and information centrality effects

The effects of reading goal and information centrality in initial reading and rereading suggest that both factors affect the processing of textual ideas in different phases of reading. Initial reading was mostly and robustly influenced by centrality. Under all reading goal conditions, central information was processed more slowly than peripheral information. However, rereading was mostly influenced by reading goals, and no centrality effect was observed in the reprocessing of central and peripheral information. Moreover, a trend towards a reverse centrality effect (i.e., slower reading of peripheral information) was observed under the OQ and CQ tests conditions. This may imply that readers adopted a corrective rereading strategy in favor of the peripheral information, which eventually removed the effect of centrality under the same test conditions that existed in initial reading. Traditionally, rereading of text elements is attributed to comprehension failure (Clifton, Staub, & Rayner, 2007; Frazier & Rayner, 1982) or comprehension difficulty (Blanchard & Iran-Nejad, 1987; Rayner et al., 2006; Vauras et al., 1992). Yet, others have also suggested that rereading reflects the need to reinstate to working memory prior text segments which are important to readers' reading goals (Kaakinen & Hyönä, 2005, 2008; Kaakinen et al., 2003). Reinstating information in working memory strengthens its traces in long-term memory and enhances the probability of its retrieval after reading (Kintsch, 1988, 1998).

Overall, these findings suggest that the processing time of textual ideas is primarily influenced by their centrality level in a direct, uncontrolled manner. This is compatible with the idea that central information is more complex and takes more time to process and integrate with the mental representation of the text than peripheral information, because central ideas more often introduce new information (e.g., a new subtopic) which is less connected with the preceding adjacent context (Cirilo & Foss, 1980; Clark, 1977; Lorch & Lorch, 1986; Thorndyke, 1977). This is consistent with the longer fixations and shorter forward saccades found for central information compared to peripheral information, reflecting conceptual integration difficulty in the eye-movement literature (Hyönä & Niemi, 1990; Rayner & Sereno, 1994; Vauras et al., 1992).

Reading goals, in contrast, are implemented later through regulated processes such as rereading of textual ideas and the use of more fixations (in total) to process the textual information. This possibility is suggested to some extent by the standards of coherence principle (e.g., van den Broek, Bohn-Gettler, Kendeou, Carlson, & White, 2011) which holds that part of the reading comprehension processes occur automatically and continuously without control or effort on the part of the reader, and that effortful strategic processes are initiated by the reader when the product of the automatic primary processes is not sufficient to attain the readers' goals (e.g., van den Broek et al., 2001; van den Broek, Rapp, & Kendeou, 2005; van den Broek et al., 2011).

Text memory performance and its correspondence with reading time

Examining the effects of information centrality and reading goals on the performance in the final MCQ test revealed that both factors influence text memory independently. Readers performed better on central information questions than on peripheral information questions, irrespective of reading goal, and preformed worst in the entertainment condition compared to other reading goals, irrespective of question type (central vs. peripheral). Moreover, we found that reading time and text memory were generally correlated across conditions. However, this correlation did not reach significance under all experimental conditions, and the pattern of results observed in text memory data partially diverged from the pattern observed in the reading time data. These findings suggest that the amount of attention allocated to process textual ideas, as manifested in reading time, has limited influence on the memory strength of textual ideas, and occasionally is overridden by more powerful factors such as the structural role of the textual ideas (centrality) and the goals with which the readers approach the text.

A centrality effect for text memory was found under all reading goal conditions, even though an equal amount of time was spent in processing the central and peripheral information in the OQ and CQ tests conditions. Consistent with these findings, Birkmire (1985) found that readers had a better memory of central information than for peripheral information under all conditions, even though readers spent equal or even less time in processing the central information. These findings suggest that factors other than processing time play a role in the advantage found for the memory of central information. Birkmire (1985) suggested that central information "fits" better with existing knowledge structures than peripheral information and therefore requires less processing time to be stored in long-term memory (e.g., Craik & Lockhart, 1972; Goetz et al., 1983). According to the causal network model (e.g., Trabasso & Sperry, 1985; van den Broek, 1988), central ideas are better remembered because they are connected with more ideas in the text than peripheral information is and therefore central ideas benefit from more retrieval cues. Finally, according to the construction–integration model (Kintsch, 1988, 1998), central ideas have a higher probability of being stored in long-term memory because they remain active during reading for a longer period than peripheral ideas. In this model, each processing cycle (i.e., the reading of a new idea) activates new ideas together with conceptually related older ideas. Because central ideas are related to more ideas in the text, they remain active over more processing cycles than peripheral ideas. Further research is needed to explore the online factors that influence the offline memory of central versus peripheral information, using different types of memory tests (e.g., free recall).

With regard to the effect of reading goals on text memory, the worst performance, in the entertainment condition, could be explained by the shortest reading time observed in this condition. However, the performance in the CQ test condition was not worse than in the OQ test and the presentation conditions, even though the reading times of the whole texts in the two latter conditions were longer (in the OQ test condition) or at least not shorter (in the presentation condition) than the reading times in the CQ test condition. This divergence might occur because the close-ended (multiple-choice) questions in the final memory test matched the expectations of the readers in the CQ condition but not in the two other conditions. This is supported by the strong significant correlation obtained between reading time and memory in the CQ test condition. Previous studies have shown that readers perform better in answering questions of the type they expect (e.g., a question on explicit information) than in answering questions of a different unexpected type (e.g., questions on inferential information), even when the unexpected questions require a shallower-level processing of the text (e.g., Ross, Green, Salisbury-Glennon, & Tollefson, 2006; Thiede, Wiley, & Griffin, 2011). This finding suggests that the readers in the CQ test condition adopted a learning strategy that was more appropriate to answering the MCQs appearing in the final test than the readers in the OQ test and presentation conditions. Therefore, the performance in the CQ test condition was not worse than that in the other conditions, even though readers invested less time in processing the texts in the CQ condition.

Concluding remarks

The present study examined the effect of information centrality on readers' attention and memory under various common reading goals. We found that centrality effects are preserved during initial processing and in the memory of central and peripheral information. Central information was processed longer and remembered better than peripheral information under all reading goals prompted in this study (cf. Birkmire, 1985). Nonetheless, under the two study reading goals (i.e., OQ and CQ tests), readers compensated for this initial preference for central information and compared the total processing time they spent processing central and peripheral information. Additionally, readers adjusted their total processing time of textual information (beyond centrality) in line with the required processing depth expected for the different reading goals (e.g., Linderholm & van den Broek, 2002; Ross et al., 2006). These findings suggest that readers can strategically regulate their overall engagement and selective attention allocation to central and peripheral information with accordance to their reading goals. Yet, the amount of attention directed to the processing of textual information is not necessarily associated with the extent that textual information is remembered. Further research is needed to explore the factors that influence text memory.

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Appendix 1

One text example divided into information units. Underlined are the central information units and in italics are the peripheral information units which received the highest agreement and thus were included in the analyses. Following the text, the two MCQs of the final test are presented. One question tapped central information and one question tapped peripheral information.

Mount Vesuvius

Mount Vesuvius is a volcano located between the ancient Italian cities of Pompeii and Herculaneum.

It has received much attention because of its frequent and destructive eruptions.

The most famous of these eruptions occurred in A. D. 79.

The volcano had been inactive for centuries.

There was little warning of the coming eruption,

although one account unearthed by archaeologists says that a hard rain and a strong wind had disturbed the celestial calm during the preceding night.

Early the next morning, the volcano poured a huge river of molten rock down upon Herculaneum,

completely burying the city

and filling in the harbor with coagulated lava.

Meanwhile, on the other side of the mountain, cinders, stone and ash rained down on Pompeii.

Sparks from the burning ash ignited the combustible rooftops quickly.

Large portions of the city were destroyed in the conflagration.

Fire, however, was not the only cause of destruction.

Poisonous sulphuric gases saturated the air.

These heavy gases were not buoyant in the atmosphere

and therefore sank toward the earth and suffocated people.

Over the years, excavations of Pompeii and Herculaneum have revealed a great deal about the behavior of the volcano.

By analyzing data, much as a zoologist dissects a specimen animal,

scientists have concluded that the eruption changed large portions of the area's geography.

For instance, it turned the Sarno River from its course

and raised the level of the beach along the Bay of Naples.

Meteorologists studying these events have also concluded that Vesuvius caused a huge tidal wave that affected the world's climate.

In addition to making these investigations,

archaeologists have been able to study the skeletons of victims

by using distilled water to wash away the volcanic ash.

By strengthening the brittle bones with acrylic paint,

scientists have been able to examine the skeletons

and draw conclusions about the diet and habits of the residents.
Finally, the excavations at both Pompeii and Herculaneum have yielded many examples of classical art,
such as jewelry made of bronze,
which is an alloy of copper and tin.
The eruption of Mount Vesuvius and its tragic consequences have provided us with a wealth of data about the effects that volcanoes can have on the surrounding area.
Today volcanologists can locate and predict eruptions,
saving lives and preventing the destruction of cities and cultures.

A MCQ on central information:
What happened to Herculaneum when Vesuvius erupted?
a. The city was completely buried.
b. The harbor was filled by lava.
c. Molten rock poured over the city.
d. All of the above.

A MCQ on peripheral information:
How did archeologists strengthen bones?
a. By cleaning them with distilled water.
b. By washing them with an alloy solution.
c. By painting them with acrylic paint.
d. By injecting calcium on the surface.

Appendix 2

Reading for entertainment was introduced by the following instructions:

> Imagine that you are reading just for fun. For example: you are sitting at home, nice and comfortable with your favorite music playing softly in the background, and you're reading a book. Or you're sitting on the shore of a small lake on a sunny day and decide to read a magazine. Try to imagine yourself in such a situation, pleasant and relaxed. You are going to read the next five texts just because you enjoy reading them. Afterwards you can tell us which one you enjoyed most.

Reading for presentation was introduced by the following instructions:

> Imagine that you are preparing for a presentation in front of your class. You have to present one of the five topics about which you are going to read in this session, as part of a course and to obtain credits. After the presentation your classmates can ask questions when things are unclear or if they want to know more about the topic. Imagine yourself sitting where you usually sit when you need to study: in the library or in your room. And start to prepare yourself for the presentation by studying these texts. Afterwards, you will be asked to present one of the texts in front of the experimenter, who can ask questions.

Reading for studying for an open-ended questions test was introduced by the following instructions:

> Imagine that you are studying a text. You know that the teacher always uses open-ended questions in tests and you will have to answer these as well as you can. Imagine yourself sitting where you usually sit when you need to study – in the library or in your room, and you start studying the texts to answer these open questions. Afterwards you will get a test with open-ended questions on the texts you read. Answer the questions as well as you can.

Reading for studying for a close-ended questions test was introduced by the following instructions:

> Imagine that you are studying a text. You need to know about the topic in order to answer multiple choice questions on a test. Imagine yourself sitting where you usually sit when you need to study – in the library or in your room, and you start studying as you would for the exam week. Afterwards you will get a test with multiple choice questions about the texts you read. Answer the questions as well as you can.

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