Psicología Educativa
ISSN: 1135-755X
ISSN: 2174-0526
Colegio Oficial de la Psicología de Madrid

Moreno, José David; León, José A.; Kaakinen, Johanna K.; Hyönä, Jukka

Relevance Instructions Combined with Elaborative Interrogation Facilitate Strategic Reading: Evidence from Eye Movements

Psicología Educativa, vol. 27, no. 1, 2021, pp. 51-65
Colegio Oficial de la Psicología de Madrid

DOI: https://doi.org/10.5093/psed2020a20

Psicología Educativa (2021) 27(1) 51-65

Psicología Educativa

https://journals.copmadrid.org/psed

Relevance Instructions Combined with Elaborative Interrogation Facilitate Strategic Reading: Evidence from Eye Movements

José David Moreno[a], José A. León[a], Johanna K. Kaakinen[b], and Jukka Hyönä[b]

[a]Universidad Autónoma de Madrid, Spain; [b]University of Turku, Finland

ARTICLE INFO

Article history:
Received 29 June 2020
Accepted 26 September 2020
Available online 12 November 2020

Keywords:
Eye-tracking
Relevance instructions
Elaborative interrogation
Reading comprehension
Strategic processing
Expository texts

A B S T R A C T

The aim of the present study was to examine effects of relevance instructions and elaborative interrogation on the processing of and memory for expository texts. Eye movements of 132 undergraduate students were tracked while they read expository texts. After reading each text, they produced an oral summary. Participants were divided into four experimental conditions that differed by the presence or absence of the why question and the specific or general relevance instruction they received. Results showed that readers who received the why question embedded in the texts and also received the specific instruction of answering the question demonstrated more strategic reading, as reflected in their first-pass and look-back reading times and also in their better recall of question-relevant information. These results can be readily applied to real-life learning contexts, as they suggest that employing specific relevance instructions in combination with elaborative interrogation may elicit more efficient and strategic reading.

Las instrucciones de relevancia en combinación con la interrogación elaborativa facilitan la lectura estratégica: evidencias desde los movimientos oculares

Palabras clave:
Seguimiento visual
Instrucciones sobre la relevancia
Preguntas elaboradas
Comprensión lectora
Procesamiento estratégico
Textos expositivos

R E S U M E N

El objetivo del presente estudio fue examinar el efecto de las Instrucciones de relevancia y de Interrogación elaborativa en el procesamiento y el posterior recuerdo de textos expositivos. A tal fin se registraron los movimientos oculares de 132 estudiantes universitarios mientras leían textos expositivos. Después de leer cada texto, realizaron un resumen oral del mismo. Se asignó a los participantes a cuatro condiciones experimentales que se diferenciaban por la presencia o ausencia de una pregunta de tipo "por qué" y la instrucción específica o general de relevancia que recibieron. Los resultados mostraron que los lectores que recibieron la pregunta de tipo "por qué" insertada en los textos y que también recibieron la instrucción específica de contestar a la pregunta mostraron unos patrones de lectura más estratégicos, como quedó reflejado en sus tiempos de lectura inicial y de refijaciones y también en su mejor recuerdo de la información relacionada con la pregunta. Estos resultados pueden aplicarse fácilmente a contextos reales de aprendizaje, ya que sugieren que emplear instrucciones específicas de relevancia en combinación con interrogación elaborativa puede facilitar y potenciar estilos de lectura más eficientes y estratégicos.

One of the crucial questions in educational contexts is how to help learners to acquire important information from written texts. There are two approaches to this question. First of all, a textbook writer may use typographical signals to cue important information in the text. They may also use an advanced organizer in the form of a question presented at the beginning of the text, for which the learner is encouraged to find an answer in the text. In order to answer such a question, it is often necessary to integrate pieces of information from different parts of the text. Thus, the question is purported to guide the learner to pay particular attention to text information pertinent to the question. Second, a teacher may also give instructions as to how to deal with a reading assignment. For example, they may instruct the students to learn the main points of the text. Alternatively, the teacher may ask the students to focus on answering a question presented in the text.

In the present study we were interested in examining how why-questions inserted in the text and the instructions given to readers guide the reading process. For that end, we recorded adult readers' eye movements when they read six expository texts. A subset of participants read texts where a why question was inserted in the

Cite this article as: Moreno, J. D., León, J. A., Kaakinen, J. K., & Hyönä, J. (2021). Relevance instructions combined with elaborative interrogation facilitate strategic reading: Evidence from eye movements. *Psicología Educativa, 27*(1), 51-65. https://doi.org/10.5093/psed2020a20

Funding: The work reported in this manuscript was supported by Grant PSI2013-47219-P from the Ministry of Economic and Competitiveness (MINECO) of Spain.
Correspondence: davi_mp@msn.com; josedavid.moreno@uam.es (J. D. Moreno).

introductory paragraph, while another group of participants read texts without why questions. We also manipulated the reading assignment by giving a subset of study participants a general reading instruction ("Understand as much of the text as possible and learn the main points") and another group of participants a specific reading instruction ("Answer a question"). In all, we had four groups of readers: (a) participants reading texts with why questions combined with specific instructions, (b) participants reading texts without why questions and with specific instructions, (c) participants reading texts with why questions combined with general instructions, and (d) participants reading texts without why questions and with general instructions (see Appendix B for the instructions given to the study participants). Before discussing possible outcomes of the present study, we first review prior studies on the effects of why questions, followed by a discussion of the effects of reading instructions. We particularly focus on the studies examining these effects on the text comprehension process with methods that reveal the time-course of processing, such as eye tracking.

Effects of Elaborative Interrogation

An efficient method to facilitate learning from an expository text is to instruct readers to ask and answer questions during the course of reading (e.g., Graesser & Lehman, 2011). Especially answering "why?" questions, which typically require a synthesis of text information and prior knowledge, are likely to enhance comprehension that goes beyond merely encoding the text information at the "surface" or propositional level (e.g., Graesser, 2007). Reading in order to answer questions that require elaboration of the text information has been called "elaborative interrogation". A considerable amount of research has demonstrated its benefits on the reading processes and on improving the quality of text memory and comprehension (Callender & McDaniel, 2007; Cerdán et al., 2009; Graesser, 2007; Graesser & Lehman, 2011; Kaakinen et al., 2015; León, Moreno, Escudero, & Kaakinen, 2019; León, Moreno, Escudero, Olmos, et al., 2019; Levin, 2008; Lewis & Menskink, 2012; Martin & Pressley, 1991; Smith et al., 2010; Wiley et al., 2010; Woloshyn et al., 1992; Wood et al., 1999).

As regards the effects of elaborative interrogation on reading processes, Lewis and Mensink (2012) showed in an eye-tracking study that participants increased first-pass fixation times and look-back durations for question-relevant sentences in response to questions given prior to reading. Readers also included more information from question-relevant sentences in their subsequent recall protocol. In the study of Smith et al. (2010), students who received why questions while they were reading expository texts obtained better results in a comprehension task than students who only reread the text materials without being exposed to why questions. Wiley et al. (2010) showed that rereading is an elementary aspect of a "smart" processing strategy induced by elaborative interrogation instructions. They examined how readers inspected websites that were rated either as reliable or less-reliable sources of information and found that readers who were instructed to produce explanatory arguments engaged in more rereading of trustworthy sites. Finally, in an eye-tracking study of Kaakinen et al. (2015), readers were asked to read short expository texts that either had a why question (e.g., "Why is recycling important?") or a statement (e.g., "Recycling is important") as a title. The texts did not contain specific question-relevant segments, as answering the why question required the readers to integrate different pieces of text information together. Adult readers demonstrated faster first-pass reading times and higher probability of look-backs within the passage when the title was a why question than when it was a statement. These results suggest that why questions facilitate initial reading of the passage and increase integrative processing of the text contents.

Effects of Reading Instructions

Providing cues that help learners to form a clear goal structure and to engage in goal-focused processing of text information can be helpful in instructional and learning contexts to enhance comprehension of and learning from expository text materials (Britt et al., 2017). One efficient way of facilitating goal-focused processing during reading is having a specific reading perspective in mind when processing an expository text. A considerable amount of research has been devoted to examine possible effects of the adopted reading perspective on reading behavior and on the emerging mental representation of the text. In the seminal study of Anderson and Pichert (1978), the authors did not find consistent effects of the reading perspective on text recall. However, subsequent research succeeded in detecting a perspective effect both on text memory and text processing (Anderson, 1982; Baillet & Keenan, 1986; Goetz et al., 1983; Hyönä et al., 2002; Kaakinen et al., 2001, 2002, 2003; Kaakinen & Hyönä, 2005, 2007, 2008, 2011; Kardash et al., 1988; Lapan & Reynolds, 1994; Lorch et al., 1987; McCrudden, 2011; McCrudden et al., 2010; McCrudden & Schraw, 2007, 2009; McCrudden et al., 2005; Postman & Senders, 1946; Rothkopf & Billington, 1979; van den Broek et al., 2001).

As an example of studies examining the processing of text information, in the eye tracking study Kaakinen et al. (2002) instructed adult participants to adopt a specific reading perspective: they were asked to consider the good and bad sides of one of the four countries described in the text as a possible new home country. Kaakinen et al. found that the perspective given before reading the text elicited readers to recall more information related to the perspective-relevant country than to the other countries. Moreover, the eye movement patterns showed that readers spent more time reading the perspective-relevant sections than perspective-irrelevant sections of the text. In another study, Kaakinen and Hyönä (2005) analyzed the eye movement patterns and the text recall of participants who read an expository text about several rare illnesses. Participants were given a specific perspective related to one of the illnesses before reading the text. Again, the reading perspective generated longer fixation times on perspective-relevant sentences, whose effect emerged already during their initial reading. This resulted in better recall for perspective-relevant than for perspective-irrelevant text information.

Along similar lines, McCrudden et al. (2010) investigated the effect of relevance instructions on readers' goals, text processing, and memory by giving readers two different relevance instructions related to specific countries. The results were consistent with previous studies by showing that readers spent more time reading instruction-relevant than instruction-irrelevant information and also recalled more information about instruction-relevant contents of the text.

Models of Goal-focused Reading

As reviewed above, both elaborative interrogation in the form of why questions and specific reading instructions guide adult readers to pay more attention to text information relevant to the question or reading assignment. Based on a comprehensive review of the existing literature on the effects of relevance instructions on reading processes, McCrudden and Schraw (2007) and McCrudden (2011) proposed a model in which they identified two main categories of relevance instructions: specific relevance instructions prompting readers to focus on specific segments of information and general relevance instructions prompting participants to read for a broader purpose. Their goal-focusing model of relevance establishes four different stages in order to explain how relevance instructions affect text comprehension and learning from texts. In the first stage, the relevance instructions signal what kind of information is relevant in

the text. In the second stage, readers generate a reading goal on the basis of the relevance cues. During the third stage, readers selectively allocate and direct their attention in order to identify and process the goal-relevant information of the texts. Finally, the fourth stage is related to the construction of the mental representation of the text.

Britt et al. (2017) recently proposed an intentional reading model that goes beyond the goal-focusing model of McCrudden and Schraw (2007), named as the RESOLV framework. According to this framework, intentional reading consists of a problem-solving situation, which can be understood as goal-directed activity embedded in a situational context. The authors propose that purposeful reading is always based on the mental representation readers construct about the task and the context and that these internal representations lead to specific reading decisions and processes. Once the reading context has been interpreted by the reader, this context and also the specific motivation of the reader determine the reading goal and subsequently what kind of information the reader will extract from the text. Britt et al. propose that readers construct three different mental representations during the reading process, named context model, task model, and documents model. The context model is the first level of mental representation for which readers receive signals during reading that they encode and interpret based on the physical and social situation. The second level of representation is the task model, which is the readers' internal representation of the reading goals and the strategies to reach these goals. In this stage, the readers make decisions about what to read and how to read it. Finally, the third level of representation is the documents model, consisting of readers' internal representation about textual information, including representations about content itself as well as information sources.

Present Study

In the present study, we were interested in finding out how why-questions inserted in the text influence the learning process when combined with two kinds of reading instructions: specific instructions emphasizing the why questions and general instructions not mentioning the why questions. Even though previous research suggests that elaborative interrogation instructions influence both processing of and memory for question-relevant text information, little is known about whether the effects are related to specific instructions to answer the question, or whether the effects are related simply to the presentation of the question, which may trigger the readers to spontaneously concentrate on question-relevant information.

In this study, eye movements of college students were tracked while they read six different expository texts about general-knowledge topics. In addition, they were asked to provide an oral summary about the main contents of each text after reading. Two different instructions were given to the participants prior to reading. A subset of participants were instructed to read in order to provide an oral summary focusing especially on text contents in order to answer a why question presented in each text (specific relevance instruction). Another group of participants were instructed to read in order to provide an oral summary about main contents of texts (general relevance instruction). In addition to the reading instruction, we also manipulated the presence of the why question in text. Thus, roughly a half of the participants in the two reading instruction groups read texts in which a why question was presented at the end of the first paragraph (question-present condition) and another half read texts in which the why question was replaced by a neutral sentence (no question-present condition). Participants in the specific relevance instruction condition who did not receive the question in text received the question only after reading the texts.

Based on our study design, we employed multiple comparisons to examine effects of elaborative interrogation and reading instructions. First, in order to study the mere presence of a question inserted in the text, we can pay special attention to the comparison between the general instruction + question-present condition and the general instruction + no question-present condition. This comparison can inform us whether there is any effect of the embedded question in the absence of instructions that explicitly orient readers to the question.

What could be predicted for the condition where the presence of a why question was combined with general instructions prompting to comprehend the text as well as possible? The general comprehension instructions do not encourage for selective processing, whereas an embedded why question in the text prompts the reader to guide text processing toward question-relevant contents. Yet, in the initial task model constructed by the readers will be identical in both conditions. It is only when the readers later encounter in the text a why question when they may possible modify their task model to focus specifically to question-related text information. If they do so, the effects may materialize only later in the processing timeline, as indexed by increased number of look-backs to question-relevant contents. Alternatively, it is possible that we observe no signs of selective processing of question-relevant information over question-irrelevant information in either condition.

Our second comparison is between the specific instruction + question-present condition and the general instruction + question-present condition. This comparison is informative in determining how important the reading instructions (specific vs. general) are with respect to prompting readers to focus on the embedded question.

In line with RESOLV (Britt et al., 2017) and the goal-focusing model (McCrudden, 2011; McCrudden & Schraw, 2007), we expected that presenting a why question in the beginning of the text and also instructing the readers before reading to specifically pay attention to that question should result in a task model that elicits selective text processing with special attention allocated to the question-relevant contents. This way, in the specific instruction + question-present condition the reader has a well-defined task model emphasizing selective attention to and better memory for question-relevant information. Thus, the reader will be constantly evaluating the text in the light of the task model and their developing memory representation of the text contents (i.e., documents model), which should manifest as increased first-pass fixation times on question-relevant contents and also as more numerous look-backs both to and from that region. Look-backs to question-relevant contents and to the introduction containing the why question would reflect rehearsal of that information in memory, possibly in order to integrate the question and question-relevant content with the rest of the text to gain a sufficient documents model to fulfill task demands. As a consequence of such selective processing, question-relevant contents should be learned better: question-relevant contents should be better represented in oral summaries than question-irrelevant contents.

In the present study, we were particularly interested in the comparisons and predictions outlined above. Yet, the experimental design also allowed us to examine whether general comprehension instructions would guide the participants to read the text differently than when participants prepare themselves to answer a specific question they do not know before reading. It is possible that the latter instructions prompt the participants to read the text more carefully, as indexed by more rereading of text contents. This can be tested focusing on the comparison between the general instruction + no question-present condition and the specific instruction + no question-present condition. This comparison can be also informative in order to know whether there is an effect of instructions in the absence of a question.

We used eye-tracking to study selective processing during text comprehension. It is preferable to sentence reading time measurements, as readers are free to proceed in the text without the

need for using a task extraneous to reading (e.g., button pressing). Moreover, it provides a protocol of the reading process as it evolves through time and space. Indeed, eye tracking has proven to be a reliable and informative method to analyze a large variety of processes related to reading (e.g., Hyönä et al., 2003; Rayner, 1998; Rayner & Liversedge, 2011). As reviewed above, it has also been successfully applied to the study of text comprehension. When applied to the present context, it allows us to analyze the time course of selective processing in response to reading instructions, and specifically to elaborative interrogation.

All eye movement analyses were done at paragraph-level. Every text conformed to the following structure (see Appendix A for translated versions of the texts). The first paragraph introduced text topic; in text versions containing why questions, it appeared at the end of the introductory paragraph. The second paragraph contained information relevant to why questions, while the third paragraph contained question-irrelevant information (their mutual order was counterbalanced between participants). We extracted the following processing measures from the eye movement record: first-pass fixation time, look-back fixation time, and total fixation time. These measures were computed for question-relevant and question-irrelevant paragraphs. First-pass fixation time is an index of the time spent reading a paragraph before proceeding to the next. Look-back fixation time sums up all the fixations that return back to the paragraph from another paragraph. Total fixation time is the sum of first-pass and look-back fixation time. Finally, we also analyzed number and duration of look-backs to the introductory paragraph from the following paragraphs.

Method

Participants

One-hundred-thirty-two psychology students (39 males; age range: 20-23 years) enrolled at a Spanish public university served as participants. All participants had volunteered to participate in the experiment and received course credit as compensation. All procedures were approved by the Universidad Autónoma de Madrid's ethics committee and conducted in accordance with the Declaration of Helsinki. All participants were native speakers of Spanish (the language used in the materials) and had normal or corrected-to-normal vision.

Apparatus

Eye movements were recorded with an EyeTech™ Digital Systems VT2 infrared eye-tracker. The VT2 has two infrared light sources and an integrated infrared camera. It connects via USB to a Windows computer and captures eye gaze location (X, Y coordinates) at a sampling rate of 80Hz. Registration was binocular and, for cases that it not was possible, monocular. The camera was fixed under a 15-inch laptop computer on which stimuli were presented to each participant.

Materials

Six expository texts were used as the experimental stimuli and two additional texts were included to practice. Texts were 200-250 words long and discussed eight different expository topics (the Thames, Mediterranean diet, suitcase evolution, popcorn history, urban growth, detective novel, insomnia, and the greenhouse effect). Each text consisted of three paragraphs equated for length in terms of number of words. The first of them was always an introduction to the topic (named introductory paragraph) and the other two paragraphs developed the topic of each text (an example of one of the expository texts is presented in Appendix A). There were two different versions of each text: in one version, a why question was inserted at the end of the first paragraph ("question in text"), and in the other version that question was omitted and replaced by a neutral sentence ("no question in text"). The topic was developed in the following two paragraphs: one of them included relevant information to answering the question (named relevant paragraph) and the other one contained information that was as such relevant to the topic of the text, but irrelevant for answering the question (named irrelevant paragraph). The order of presentation of texts were counterbalanced for each participant and the order of presentation of relevant and irrelevant paragraphs were also counterbalanced in each text by creating two text versions. Each text was presented on a single page on a computer screen, with a maximum of 20 lines of text per screen.

Relevance Ratings

A norming study was conducted in order to verify that particular paragraphs are more relevant than others with respect to the task instructions given to the participants. Fifteen participants (3rd year psychology students) who did not participate in the actual experiment volunteered to get an extra course credit. Participants were presented with the instructions used in the actual experiments and asked to select the paragraphs they thought were relevant with respect to the instructions. Each participant rated each of the six experimental texts in the version in which the why question was presented at the end of the introductory paragraph. The consistency in rating task relevance of the text paragraphs was very high: 97.8% of the given ratings overlapped with our pre-set definition of relevance. In only 2.2% of the responses the introductory paragraph was rated as the most relevant; it is worth highlighting that none of the responses indicated the irrelevant paragraph as the most relevant section of the text.

Eye Movement Measures

The following paragraph-level eye movement measures were computed from the eye-tracking data (see Hyönä et al., 2003). "Total fixation time" (measured in seconds) is the total time spent reading the paragraph. "First-pass reading time" (measured in milliseconds) is the summed duration of fixations made on the paragraph during first-pass reading of it before moving to the subsequent paragraph. "Look-back duration" (measured in milliseconds) is the summed duration of fixations returning back to the paragraph after the reader has viewed another paragraph. "Number of returns to the introductory paragraph" refers to the number of times that the reader returned to the introductory paragraph from subsequent parts of the text. "Duration of look-backs to the introductory paragraph" (measured in milliseconds) is the summed duration of fixations made during these returns. As the number of fixations and duration measures were very highly correlated, only duration measures will be reported here. Note that the number of returns to the introductory paragraph is not the number of fixations done during look backs; it indicates how many times the reader visited the introductory paragraph after the first-pass reading.

Procedure

Before the experiment, the eye-tracker was calibrated using a 16-point calibration scheme. Calibration was repeated after every two texts to preserve the accuracy of measurement. Participants were instructed to read the texts in order to be able to summarize the main contents of the passage. Moreover, participants received one of the two additional instructions. In the "specific relevance

Table 1. Means and Standard Deviations for the Eye-tracking Measures as a Function of Relevance and Instruction (question in text and no question in text)

		Question in text				No question in text			
		General		Specific		General		Specific	
Measure	Paragraph	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Total	Relevant	8.21	5.74	11.55	8.79	8.60	5.49	8.59	5.10
	Irrelevant	8.85	6.43	6.06	4.74	9.03	5.23	8.73	5.50
1st pass	Relevant	6,586	4,000	7,212	5,291	7,102	4,585	7,898	5,177
	Irrelevant	6,652	4,372	5,209	4,001	7,217	4,496	8,186	5,559
Look-backs	Relevant	2,008	3,975	4,333	7,041	1,407	2,701	695	1,738
	Irrelevant	1,776	4,340	850	2,761	1,893	3,380	541	1,610
Returns	Relevant	0.54	0.89	0.98	1.26	0.44	0.73	0.28	0.52
	Irrelevant	0.63	0.81	0.41	0.67	0.45	0.69	0.28	0.75
Look-backs to intro	Relevant	1,572	3,469	1,086	2,399	1,524	2,610	658	2,130
	Irrelevant	1,808	3,902	864	2,793	1,637	2,704	446	1,369

Note. Total = total fixation time (s); 1st pass = first-pass reading time (ms); look-backs = look-back duration (ms); returns = number of returns to the introductory paragraph; look-backs to intro = duration of look backs to the introductory paragraph (ms).

instruction" condition participants ("question in text", n = 40; "no question in text", n = 27) were instructed to read the texts in order to provide an oral summary focusing especially on the main contents to answer a why question presented in the first paragraph of each text. Note that for participants in the "specific relevance instruction" and "no question in text" condition the question was only presented after reading the texts. On the other hand, in the "general relevance instruction" condition ("question in text", n = 32; "no question in text", n = 33) participants were asked to provide an oral summary about the main points of each text, but they were not asked to focus specifically on the question presented in the introduction. The instructions can be found in Appendix B.

Two practice texts preceded the first experimental text to adjust the participants to the eye-tracking equipment. Participants were allowed to read the texts at their own pace. After each text, participants were asked to provide a summary of the text (based on the instructions previously received), and the responses were orally recorded with a voice recorder. The experimental session took approximately 20 minutes per participant.

The summaries were later scored for the number of words that corresponded with the information presented in the three text paragraphs (introduction, question-relevant, and question-irrelevant). Two independent raters who were blind to the experimental condition scored 30 randomly selected summaries, and as the inter-rater reliability was high (93%; Cohen's kappa = .83), only one rater scored the rest of the protocols.

Results

Data Preparation and Statistical Analyses

Data were analyzed with linear mixed effects models using the lme4 package (version lme4_1.1-13; Bates et al., 2015) for R statistical software (version 3.6.2; R Development Core Team, 2019). Separate models were fitted for each dependent measure: total fixation time, first-pass reading time, look-back duration, number of returns to the introductory paragraph, duration of look-backs to the introductory paragraph, and summary task performance (word count). As the number of fixations and the duration measures were very highly correlated (rs .98-.99), only duration measures are reported here for total reading time, first-pass reading time, and look-back time. Note that the number of returns to the introductory paragraph indicates the number of visits to the introductory paragraph after first pass reading—it is thus not a fixation count measure. Instruction (general vs. specific), Relevance (relevant vs. irrelevant paragraph), Presence of Question (question in text vs. no question in text) and their interaction term were entered as fixed effects to the models of the eye-tracking measures. Instruction, Relevance, and Presence of Question were dummy-coded with the general instruction group, the irrelevant paragraph, and no question in text as the baselines. For the model of the summary task performance (word count), Instruction, Paragraph (introductory vs. irrelevant vs. relevant), and Presence of Question were entered as dummy-coded fixed effects with the general instruction group, the introductory paragraph, and no question in text as the baselines. To analyze the number of returns to the introductory paragraph, data were modeled with a generalized linear mixed effects model using Poisson distribution. Random intercepts for participants and texts were included in the random part of the models [i.e., dependent measure ~ relevance × instruction × presence of question + (1|participant) + (1|text)].

Significant interactions were followed up by computing simple slopes for each summary group. |T|-values > 1.96 were considered to indicate a statistically significant effect. The models for each dependent measure are presented in Appendix C. The descriptive statistics of the eye movement measures as a function of relevance, instruction, and presence of question are presented in Table 1.

In presenting the eye movement data, we follow the processing timeline by first presenting data for first-pass fixation time followed by look-back and total fixation time.

First-pass Reading Time

The analysis of the first-pass reading time yielded an interaction between Instruction (specific), Relevance (relevant paragraph), and Presence of Question (question in text), b = 2390.87, 95% CI [1018.85, 3762.89], t = 3.42. As can be seen in Figure 1, the specific instruction group showed longer first-pass reading times on relevant than irrelevant paragraphs when the question was presented in the text, b = 2011.7, 95% CI [1510.13, 2513.35], t = 7.86. On the other hand, the general instruction group, b = -122.3, 95% CI [-849.02, 604.50], t = -.33, did not show a significant relevance effect when the question was presented in the text. Neither the specific instruction group, b = -375.2, 95% CI [-1145.40, 394.97], t = -.96, nor the general instruction group, b = -115.72, 95% CI [-822.87, 591.44], t = -.32, showed an effect of relevance when the question was not presented in the text.

Look-back Duration

The results for the look-back duration demonstrated an interaction between Instruction (specific), Relevance (relevant paragraph), and Presence of Question (question in text), b = 2636.1, 95% CI [1327.81, 3944.30], t = 3.95. Figure 2 shows that readers in the spe-

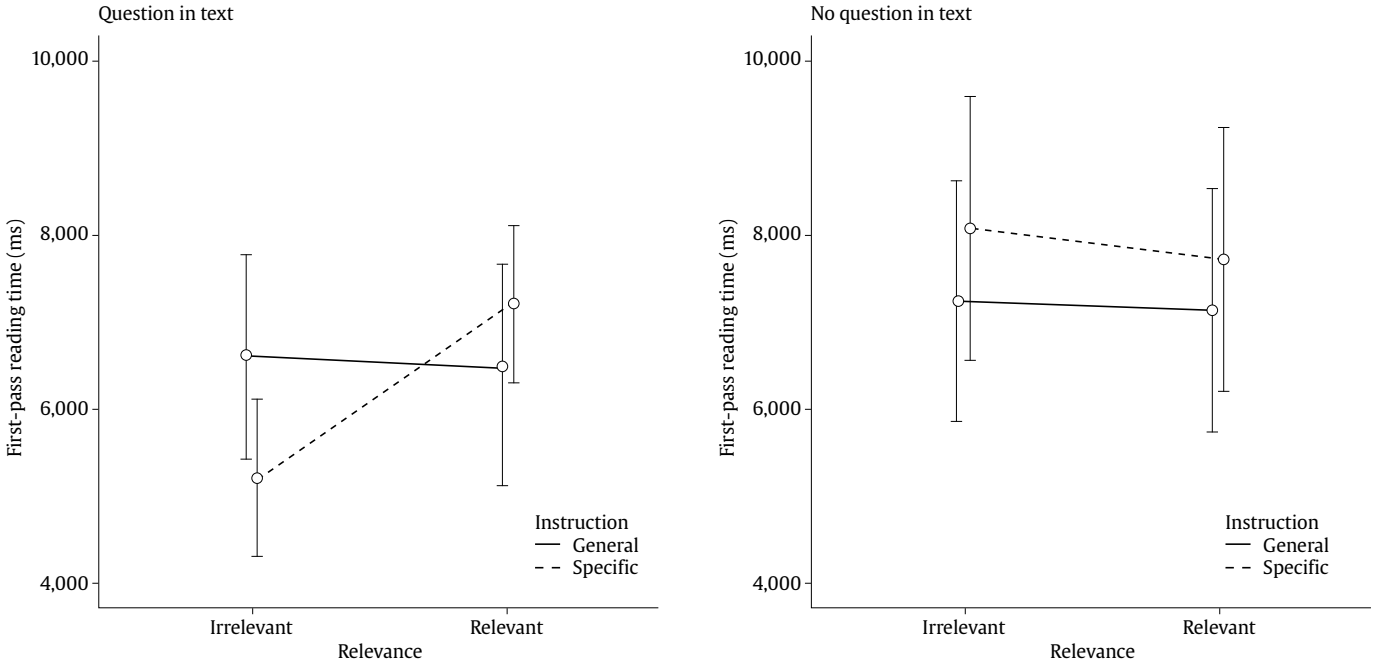

Figure 1. Model Estimates for First-pass Reading Time on Relevant and Irrelevant Paragraphs as a Function of Instruction (question in text and no question in text). Error bars represent 95% CIs.

cific instruction group produced a clear relevance effect, b = 3477, 95% CI [2925.65, 4028.27], t = 12.36, indicating longer look-back durations on relevant than irrelevant paragraphs when the question was presented in the text. In contrast, the general instruction group did not show an effect of relevance when the question was presented in the text, b = 203.9, 95% CI [-594.84, 1002.71], t = 0.50. Neither the specific instruction group, b = 151.4, 95% CI [-321.10, 623.96], t = 0.63, nor the general instruction group, b = -485.3, 95% CI [-1159.64, 188.97], t = -1.41, showed an effect of relevance when the question was not presented in the text.

Total Fixation Time

The analysis of the total fixation time showed an interaction between Instruction (specific), Relevance (relevant paragraph), and Presence of Question (question in text), b = 5.85, 95% CI [4.12, 7.59],

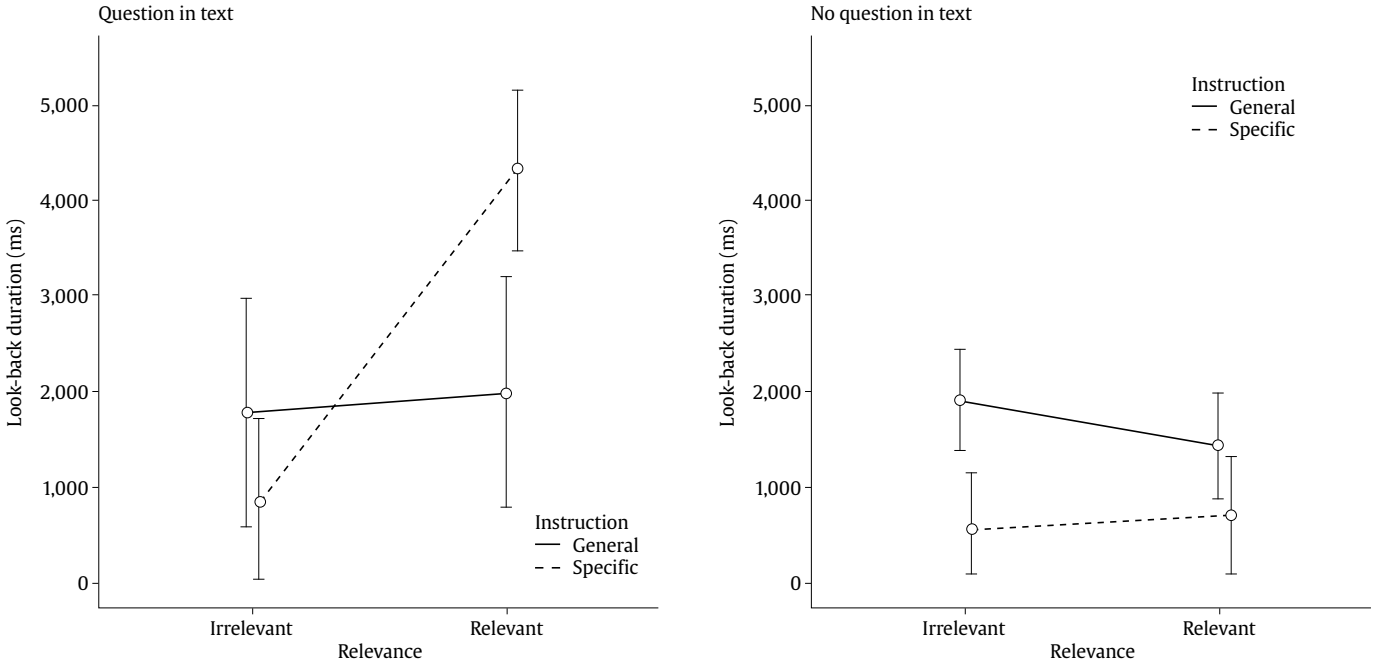

Figure 2. Model Estimates for Look-back Duration for Relevant and Irrelevant Paragraphs as a Function of Instruction (question in text and no question in text). Error bars represent 95% CIs.

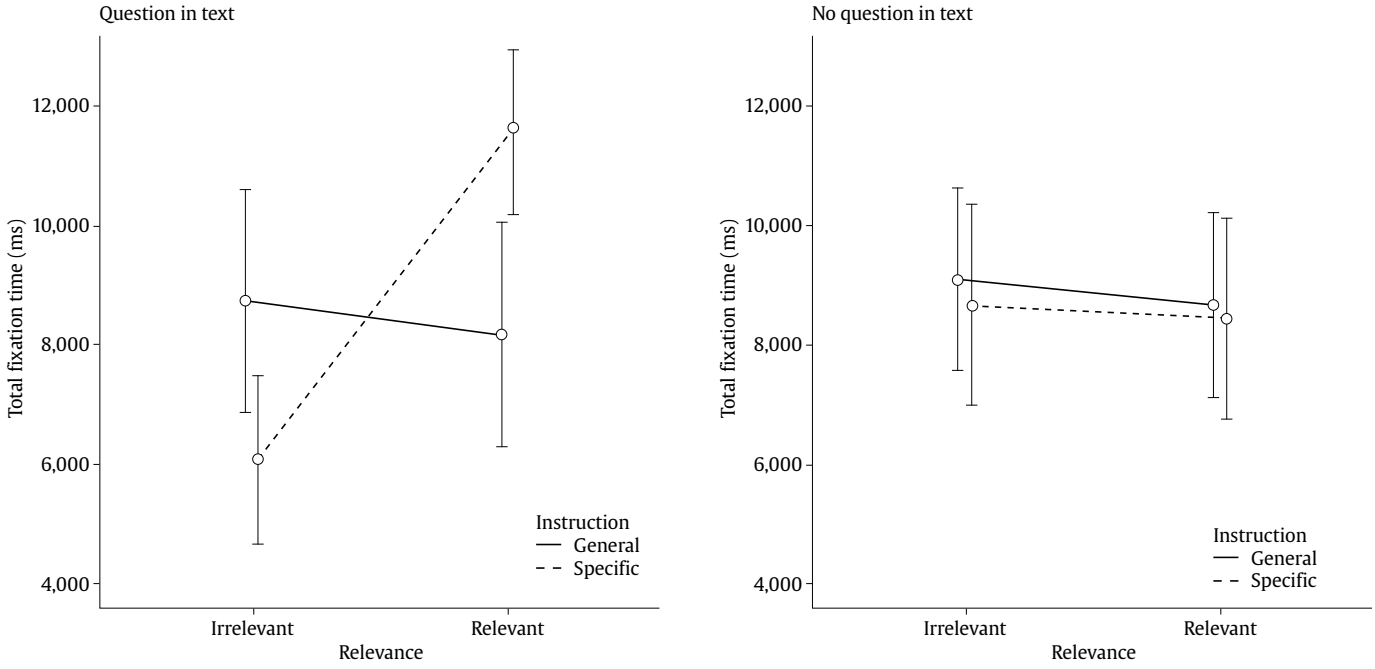

Figure 3. Model Estimates for Total Fixation Time for Relevant and Irrelevant Paragraphs as a Function of Instruction (question in text and no question in text). Error bars represent 95% CIs.

t = 6.61. Figure 3 shows that the specific instruction group (i.e., the group that were prepared to answer the question inserted in the text) had a sizable relevance effect with longer fixation time on relevant than irrelevant paragraphs when the question was presented in the text, b = 5.49, 95% CI [4.81, 6.17], t = 15.74. In contrast, the general instruction group, b = -0.57, 95% CI [-1.56, .42], t = -1.13, did not show an effect of relevance when the question was presented in the text. Neither the specific instruction group, b = -.23, 95% CI [-1.05, 0.59], t = -0.55, nor the general instruction group, b = -0.43, 95% CI [-1.32, .36], t = -0.94, showed an effect of relevance when the question was not presented in the text.

Number of Returns to the Introductory Paragraph

The analysis of the number of returns to the introductory paragraph revealed an interaction between Instruction (specific), Relevance (relevant paragraph), and Presence of Question (question in text), b = 0.96, 95% CI [0.37, 1.55], z = 3.19. As can be seen in Figure

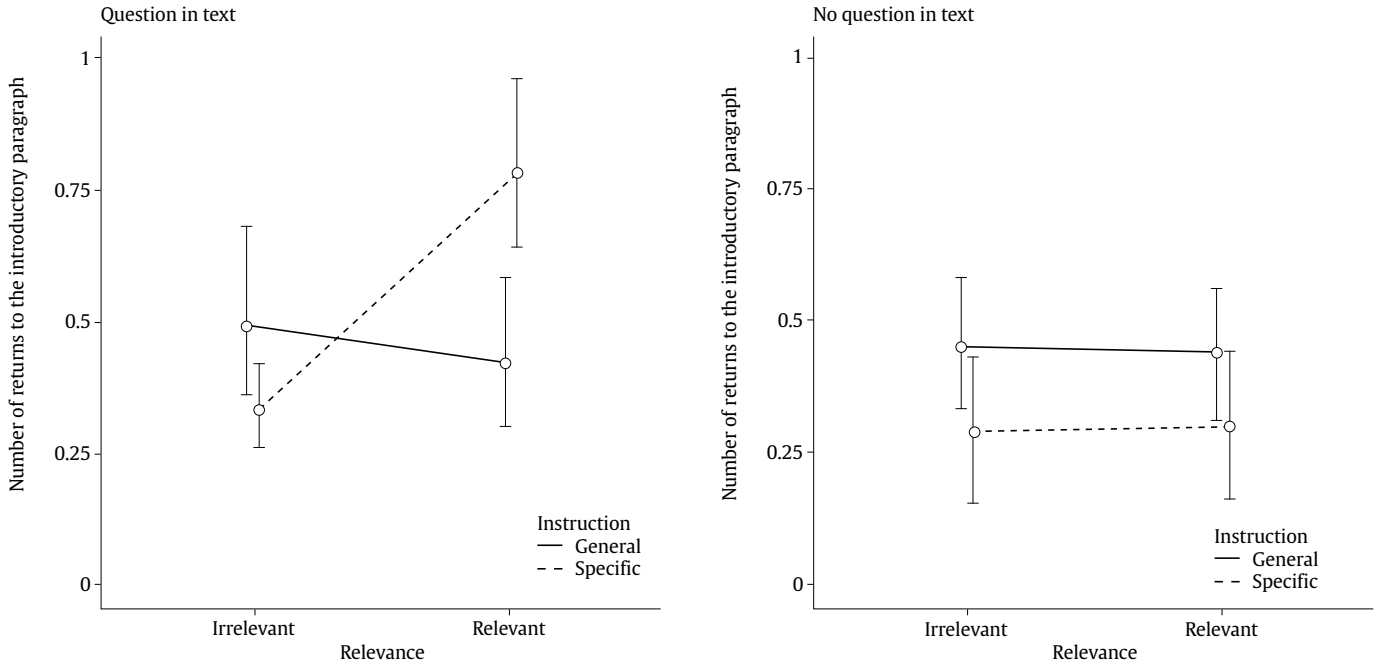

Figure 4. Model Estimates for Number of Returns to the Introductory Paragraph from Relevant and Irrelevant Paragraphs as a Function of Instruction (question in text and no question in text). Error bars represent 95% CIs.

4, the specific instruction group demonstrated a clear relevance effect, b = 0.86, 95% CI [0.68, 1.04], z = 9.44; the readers in this group made a significantly greater number of returns to the introductory paragraph from the relevant than irrelevant paragraphs when the question was presented in the text. The general instruction group, b = -0.17, 95% CI [-0.43, 0.09], z = -1.27, did not show an effect of relevance when the question was presented in the text. Neither the specific instruction group, b = 0.01, 95% CI [-0.13, 0.15], z = -0.09, nor the general instruction group, b = -0.03, 95% CI [-0.32, 0.26], z = -0.23, showed an effect of relevance when the question was not presented in the text.

Duration of Look Backs to the Introductory Paragraph

There were no effects in the duration of look-backs to the introductory paragraph (all t's < 1.96).

Summary Task Performance

Finally, we analyzed the number of words retrieved from the three paragraphs (introductory, relevant, and irrelevant paragraphs) of each text. In order to fit the model, paragraph type (introductory, relevant, and irrelevant paragraph) was dummy coded with the introductory paragraph serving as the baseline. Means and standard deviations for the word count measure as a function of instruction, paragraph type, and presence of question are presented in Table 2.

Table 2. Means and Standard Deviations for the Summary Task Performance (word count) Measure as a Function of Relevance and Instruction (question in text and no question in text)

	Question in text				No question in text			
	General		Specific		General		Specific	
Paragraph	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Introductory	31.13	20.17	2.11	8.33	34.56	15.84	2.37	8.23
Irrelevant	24.83	21.10	1.90	7.09	25.64	19.29	0.28	2.52
Relevant	47.08	26.09	36.97	21.54	37.18	19.50	21.57	15.10

The analysis of the summary task performance revealed an interaction between Instruction (specific) and Relevance (relevant paragraph), b = 16.60, 95% CI [12.55, 20.66], t = 8.02, and also an interaction between Presence of Question (question in text) and Relevance (relevant paragraph), b = 13.35, 95% CI [9.48, 17.22], t = 6.76. There was a clear effect of relevance (relevant paragraph) in the specific instruction group when the question was presented in the text, b = 34.83, 95% CI [32.86, 36.80], t = 34.60, and also for the general instruction group, b = 15.95, 95% CI [13.08, 18.82], t = 10.89. The specific instruction group, b = 19.19, 95% CI [16.34, 22.03], t = 13.21, also showed a significant effect of relevance when the question was not presented in the text, but the general instruction group, b = 2.60, 95% CI [-0.10, 5.30], t = 1.89, did not show an effect of relevance when the question was not presented in the text. In addition, as can be seen in Figure 5, regardless of the presence or absence of the question in the text, the groups mainly differed in the number of words they produced in their summaries concerning the information of irrelevant paragraphs: readers of the specific instruction group produced significantly less words contained in introductory and irrelevant paragraphs than readers of the general instruction group.

Discussion

In the present study we examined effects of elaborative interrogation and relevance instructions on learning of and memory for question-relevant and question-irrelevant information presented in expository texts. The main result was that readers who received the why question located in the first paragraph of the texts and also received the specific instruction of answering the question demonstrated more strategic reading (Hyönä et al., 2002) than readers who were presented with the question in the text but who received a general instruction before facing the texts. More specifically, readers enrolled for the former condition demonstrated selective reading behavior both in first-pass and look-back fixation measures. During the first-pass reading, the relevance effect emerged as less time devoted to the question-irrelevant paragraph, whereas during the second-pass reading the effect emerged as additional time dedicated to the question-relevant paragraph and as increased returns to the introductory paragraph containing the question. On the other hand, readers enrolled for the latter condition showed no signs of selective processing. It is noteworthy that participants who received the specific relevance instruction and the question inserted in the text were the only group that showed a relevance effect in reading.

Readers assigned to specific reading instructions and a why question were also very selective in the information they reported in their oral summaries. They primarily reported question-relevant information and very little other text information. Although it may be tempting to interpret this effect to reflect their mental representation of the text, it is unlikely that they would have practically no representation of the text information presented in the introductory or question-relevant paragraph (see Figure 5). It is more likely the case that they have interpreted the summary instruction to mean that they only ought to focus on reporting information relevant to the question. It is also noteworthy that, although this group was highly selective both in text processing and in summarizing the text contents, their summary of the question-relevant text information was not better than for the two groups that received general comprehension instructions. This means that at least with rather short expository texts (three paragraphs) general comprehension instructions yield a good mental representation of relevant text information.

An effect of the mere presence of a why question could be estimated by comparing general instructions + question present condition to general instructions + no question present condition. The results indicated that neither condition demonstrated a relevance effect in text processing. Thus, our prediction that the presence of an embedded question may show a relevance effect in later processing stages was not supported by data. Thus, simply presenting a question in the text without prompting readers to find answers to it does not affect text processing.

Finally, we also found that the two groups who read the texts without why questions but with different reading instructions processed the text similarly. In the Introduction, we hypothesized that learning in preparation to answer a specific question without knowing what it is may result in more detailed reading of the text, perhaps in the form of additional rereadings. The obtained evidence did not bear out this prediction. If anything, there was a tendency in look-back fixation time for the general instruction readers to spend more time reading question-irrelevant information than the specific instruction group not knowing the question during reading. An analogous pattern was observed in their oral summaries. The specific instruction group was very selective in their reporting of text contents focusing only on question-relevant information, whereas the general instruction group produced a more comprehensive recall of the text contents.

The results reported in this work are congruent with previous research on reading instructions and elaborative interrogation (e.g., Graesser & Lehman, 2011; Kaakinen et al., 2002, 2003; Kaakinen & Hyönä, 2008; Lewis & Menskink, 2012; McCrudden et al., 2010; McCrudden & Schraw, 2007). In the present study, the why question was demonstrated to guide the readers to process more deeply information relevant for answering that question, and at the same

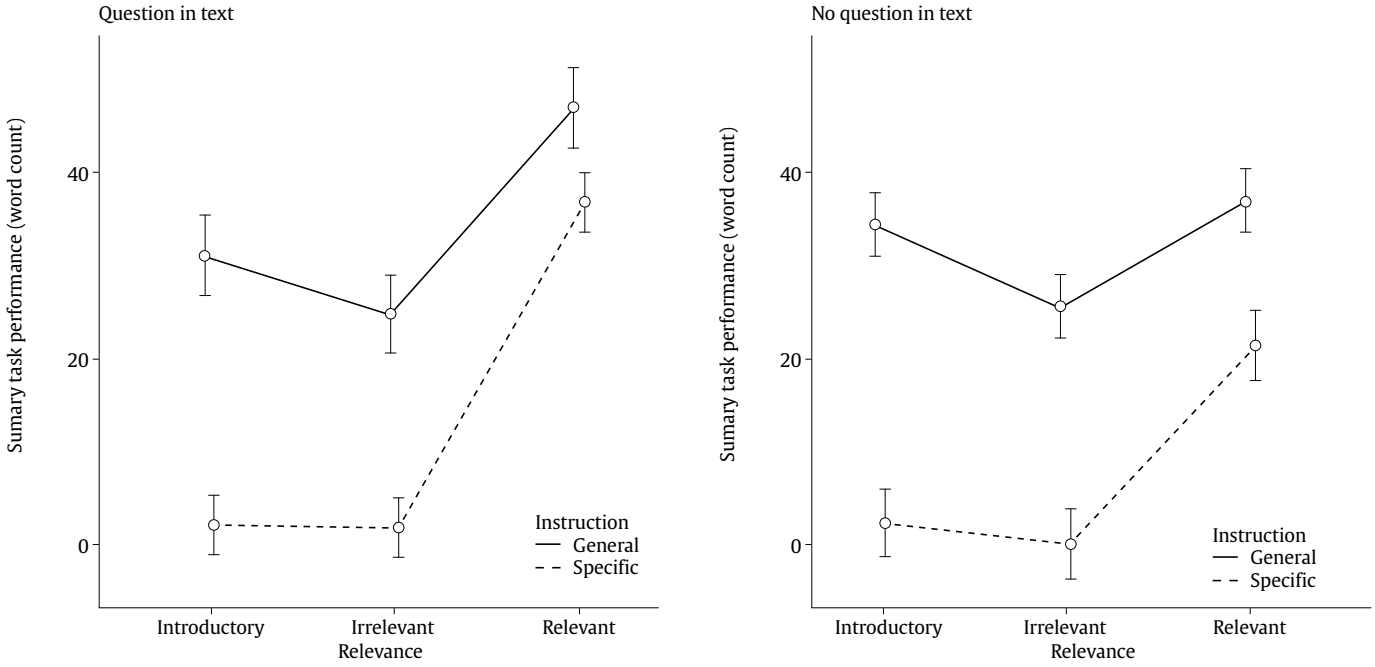

Figure 5. Model Estimates for Summary task Performance (word count) for Relevant, Irrelevant and Introductory Paragraphs as a Function of Instruction (question in text and no question in text). Error bars represent 95% CIs.

time to process less central information more superficially. Similarly, Lewis and Mensink (2012) showed that participants devoted increased first-pass and look-back fixation time to question-relevant sentences in response to questions presented prior to reading, which in turn led to improved memory for information contained in question-relevant sentences. Moreover, taking into account some complementary and current studies, there can be also shown additional applications of the results reported in our study, as reading instructions and elaborative interrogation could facilitate the comprehension of visual narrative in a coherence/incoherence paradigm (Martín-Arnal et al., 2019), to improve strategies to comprehension in expository texts (Fonseca et al., 2019; Jiménez-Taracido & Manzanal-Martínez, 2018), as self-question to improve metacomprehension skills (León, Martínez-Huertas, et al., 2019), and to improve writing and oral summaries (Martínez-Huertas et al., 2018).

The present results are also congruent with the goal-focusing model proposed by McCrudden and Schraw (2007) and McCrudden (2011). Stage 1 of the model is related to the relevance instructions given to the readers. In the present study, instructing a group of participants before reading to pay special attention to the question presented at the end of the first paragraph gave them specific cues about what information is relevant and irrelevant in the text, as opposed to giving the readers general instructions of understanding as much of the text as possible.

Stage 2 is referred to as goal formation; readers generate reading goals based on the relevance cues activated by the instructions. In this study, readers who had in mind a specific instruction about focusing on the why question adopted a goal to specifically answer that question, whereas readers who received general comprehension instructions adopted a wider goal for processing the text, as the instructions did not specify any relevance cues.

In Stage 3, readers allocate their attention in order to detect goal-relevant information. In the present study, readers who received the specific relevance instruction about explicitly answering the question directed their attention to question-relevant information and away from question-irrelevant information. The processing timeline was such that during the first-pass reading of text paragraphs they read the question-irrelevant paragraph more superficially and only during the second-pass reading indexed by look-back fixation time spent additional time in reading the question-relevant paragraph. They also looked back to the introductory paragraph, perhaps to remind themselves of the question to be answered. On the other hand, readers who received general relevance instructions (and readers who did not receive the question) did not show selective processing during reading. It is noteworthy that the mere presence of a why question did not selectively guide readers' attention toward question-relevant information.

Finally, Stage 4 is related to the construction of a memory representation of the information read. As applied to the present study, Stage 4 materialized for readers who received the specific instruction about focusing on the question as better report of question-relevant information than question-irrelevant information, which was clearly underrepresented in their memory. As argued above, the underrepresentation of question-irrelevant information at least partly reflect their interpretation of the task requirements and not merely their mental representation of irrelevant text contents. The other groups, on the other hand, showed relatively good recall of information presented in the introductory and question-irrelevant paragraphs, indicating that they constructed a more representative memory of the text. They also reported question-relevant text contents to the same degree than the specific instruction group. Thus, it may be argued that, at least with short expository texts, general comprehension instructions may be favored over specific instructions, as they produce good recall of the overall text contents. This appears to be the case at least with competent adult readers. In the future, it is worth examining whether this would also be the case with less experienced learners.

The findings of the present research can also be understood from the perspective of the RESOLV framework proposed by Britt et al. (2017). A key idea in the framework is that readers construct a task model on the basis of the learning instructions and/or their reading goal. Specific reading strategies are then chosen to fulfill the task demands. The task model thus guides what kind of information is selected for processing, and processing resources are directed toward goal-relevant text

contents and away from goal-irrelevant information. The task model constructed by the readers given general learning instructions is likely to guide processing toward comprehensive coverage of all text contents. On the other hand, the task model built by the readers given specific learning instructions to seek answers to the why question inserted in the text directs processing toward question-relevant text contents and away from question-irrelevant contents. As pointed out above, readers in this group used the adopted task model to pay less attention first to question-irrelevant information, followed later by the allocation of increased attention to question-relevant information during the rereading phase.

Regarding the limitations of the present study, the eye-tracking device employed in this research allowed us to analyze eye movement patterns on a paragraph level, not on the sentence or word level. Despite of this limitation, we managed to detect robust effects of reading instructions and elaborative interrogation on the reading behavior. Employing a more accurate eye-tracking apparatus would allow a finer level of analysis in order to inspect in more detail the moment-to-moment processes taking place during the course of reading. Nonetheless, analyzing eye movement patterns in paragraph level showed in a consistent way how specific relevance instructions encourage strategic and selective reading at least among competent adult readers. The present results may be used as benchmark data to examine the extent to which less experienced learners can utilize task instructions to guide their text processing.

To conclude, the present results show that employing specific relevance instructions in combination with elaborative interrogation in the form of a why question elicit selective and strategic reading that in turn has consequences to the constructed mental representation of the text contents. On the other hand, only presenting a why-question in text is not sufficient to induce selective processing, but it is necessary to present them in combination in order to elicit selective and strategic reading behavior among adult learners. In other words, providing cues that help readers to form a clear goal structure and to engage in goal-focused processing of text information seems to be helpful (see also Britt et al., 2017). Thus, training students to form clear reading goals and to employ processing strategies to fulfill those goals is a potentially fruitful instructional method to improve reading efficiency and learning from expository texts. The present results can be applied when designing materials for instructional and learning platforms that would maximally support student learning. Indeed, prompting students to answer questions is a common feature in many computer-based learning environments (Graesser et al., 2005). Understanding how instructions to answer questions impact processing of and subsequent memory for text is important when improving the efficacy of these learning methodologies (see, e.g., Tawfik et al., 2020).

Conflict of Interest

The authors of this article declare no conflict of interest.

Acknowledgements

We are thankful to all Turku EyeLabs people for their support, help, and advice during the accomplishment of this study.

References

Anderson, R. C. (1982). Allocation of attention during reading. In A. Flammer & W. Kintsch (Eds.), *Discourse processing* (pp. 292-305). North Holland.

Anderson, R. C., & Pichert J. W. (1978). Recall of previously unrecallable information following a shift in perspective. *Journal of Verbal Learning and Verbal Behavior, 17*(1), 1-12. https://doi.org/10.1016/S0022-5371(78)90485-1

Baillet, S. D., & Keenan, J. M. (1986). The role of encoding and retrieval processes in the recall of text. *Discourse Processes, 9*(3), 247-268. https://doi.org/10.1080/01638538609544643

Bates, D., Maechler, M., Bolker, B., & Walker, S., (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*(1), 1-48. https://doi.org/10.18637/jss.v067.i01

Britt, M. A., Rouet, J. F., & Durik, A. M. (2017). *Literacy beyond text comprehension: A theory of purposeful reading.* Routledge.

Callender, A. A., & McDaniel, M. A. (2007). The benefits of embedded question adjuncts for low and high structure builders. *Journal of Educational Psychology, 32*, 339-348. https://doi.org/10.1037/0022-0663.99.2.339

Cerdán, R., Vidal-Abarca, E., Martínez, T., Gilabert, R., & Gil, L. (2009). Impact of question answering tasks on search processes and reading comprehension. *Learning and Instruction, 19*(1), 13-27. https://doi.org/10.1016/j.learninstruc.2007.12.003

Fonseca, L., Migliardo, G., Simian, M., Olmos, R. & León, J. A. (2019). Estrategias para mejorar la comprensión lectora: impacto de un programa de intervención en español. *Psicología Educativa, 25*, 1, 91 - 99. https://doi.org/10.5093/psed2019a1

Graesser, A. C. (2007). An introduction to strategic reading comprehension. In D. S. McNamara (Ed.), *Reading comprehension strategies: Theories, interventions, and technologies* (pp. 3-26). Lawrence Erlbaum Associates.

Graesser, A., & Lehman, B. (2011). Questions drive comprehension of text and multimedia. In M. T. McCrudden, J. P. Magliano, & G. Schraw (Eds.), *Text relevance and learning from text* (pp. 53-74). IAP Information Age Publishing.

Graesser, A. C., McNamara, D., & VanLehn, K. (2005). Scaffolding deep comprehension strategies through Point&Query, AutoTutor, and iSTART. *Educational Psychologist, 40*(4), 225-234. https://doi.org/10.1207/s15326985ep4004_4

Goetz, E. T., Schallert, D. L., Reynolds, R. E., & Radin, D. I. (1983). Reading in perspective: What real cops and pretend burglars look for in a story. *Journal of Educational Psychology, 75*(4), 500-510. https://doi.org/10.1037/0022-0663.75.4.500

Hyönä, J., Lorch, R. F., & Kaakinen, J. K. (2002). Individual differences in reading to summarize expository text: Evidence from eye fixation patterns. *Journal of Educational Psychology, 94*(1), 44-55. https://doi.org/10.1037/0022-0663.94.1.44

Hyönä, J., Lorch, R. F., Jr., & Rinck, M. (2003). Eye movement measures to study global text processing. In J. Hyönä, R. Radach, & H. Deubel (Eds.), *The mind's eye: Cognitive and applied aspects of eye movement research* (pp. 313-334). Elsevier Science.

Jiménez-Taracido, L., & Manzanal-Martínez, A. I. (2018). ¿Aplican los alumnos las estrategias de aprendizaje que afirman aplicar? Control de la comprensión en textos expositivos. *Psicología Educativa, 24*, 1, 7-13. https://doi.org/10.5093/psed2018a2

Kaakinen, J. K., & Hyönä, J. (2005). Perspective effects on expository text comprehension: Evidence from think-aloud protocols, eyetracking, and recall. *Discourse Processes, 40*(3), 239-257. https://doi.org/10.1207/s15326950dp4003_4

Kaakinen, J. K., & Hyönä, J. (2007). Perspective effects in repeated reading: An eye tracking study. *Memory & Cognition, 35*(6), 1323-1336. https://doi.org/10.3758/BF03193604

Kaakinen, J. K., & Hyönä, J. (2008). Perspective-driven text comprehension. *Applied Cognitive Psychology, 22*(3), 319-334. https://doi.org/10.1002/acp.1412

Kaakinen, J. K., & Hyönä, J. (2011). Online processing of and memory for perspective-relevant and irrelevant text information. In M. T. McCrudden, J. P., Magliano, & G. Schraw (Eds.), *Text relevance and learning from text* (pp. 223-242). IAP Information Age Publishing.

Kaakinen, J. K., Hyönä, J., & Keenan, J. M. (2001). Individual differences in perspective effects on text memory. *Current Psychology Letters: Behaviour, Brain & Cognition, 5*, 21-32.

Kaakinen, J. K., Hyönä, J., & Keenan, J. M. (2002). Perspective effects on online text processing. *Discourse Processes, 33*(2), 159-173. https://doi.org/10.1207/S15326950DP3302_03

Kaakinen, J. K., Hyönä, J., & Keenan, J. M. (2003). How prior knowledge, WMC, and relevance of information affect eye fixations in expository text. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*(3), 447-457. https://doi.org/10.1037/0278-7393.29.3.447

Kaakinen, J. K., Lehtola, A., & Paattilammi, S. (2015). The influence of a reading task on children's eye movements during reading. *Journal of Cognitive Psychology, 27*(5), 640-656. https://doi.org/10.1080/20445911.2015.1005623

Kardash, C. M., Royer, J. M., & Greene, B. A. (1988). Effects of schemata on both encoding and retrieval of information from prose. *Journal of Educational Psychology, 80*(3), 324-329.

Lapan, R., & Reynolds, R. E. (1994). The selective attention strategy as a time-dependent phenomenon. *Contemporary Educational Psychology, 19*(4), 379-398. https://doi.org/10.1006/ceps.1994.1028

León, J. A., Martínez-Huertas, J. A., Olmos, R., Moreno, J. D., & Escudero, I. (2019). Metacomprehension skills depend on the type of text: An

analysis from differential item functioning. *Psicothema, 31*(1)**,** 1, 66-72. https://doi.org/10.7334/psicothema2018.163

León, J. A., Moreno, J. D., Escudero, I., & Kaakinen, J. K. (2019). Selective attention to question-relevant text information precedes high-quality summaries: Evidence from eye movements. *Journal of Eye Movement Research, 12*(1), 6. https://doi.org/10.16910/jemr.12.1.6

León, J. A., Moreno, J. D., Escudero, I., Olmos, R., Ruiz, M., & Lorch, R. F. (2019). Specific relevance instructions promote selective reading strategies: Evidences from eye tracking and oral summaries. *Journal of Research in Reading, 42*(2), 432-453. https://doi.org/10.1111/1467-9817.12276

Levin, J. R. (2008). The unmistakable professional promise of a young educational psychology research and scholar. *Educational Psychologist, 43*(2), 70-85. https://doi.org/10.1080/00461520801942276

Lewis, M. R., & Mensink, M. C. (2012). Prereading questions and online text comprehension. *Discourse Processes, 49***(5)**, 367-390. https://doi.org/10.1080/0163853X.2012.662801

Lorch, R. F., Jr., Lorch, E. P., & Mogan, A. M. (1987). Task effects and individual differences in on-line processing of the topic structure of a text. *Discourse Processes, 10*(1), 63-80. https://doi.org/10.1080/01638538709544659

Martin, V. L., & Pressley, M. (1991). Elaborative-interrogation effects depend on the nature of the question. *Journal of Educational Psychology, 83*(1), 113. https://doi.org/10.1037/0022-0663.83.1.113

Martín-Arnal, L. A., León, J. A., Broek, P. V. D., & Olmos, R. (2019). Understanding comics. A comparison between children and adults through a coherence/incoherence paradigm in an eye-tracking study. *Psicología Educativa, 25*(2), 127- 37. https://doi.org/10.5093/psed2019a7

Martínez-Huertas, J. A., Jastrzebska, O., Mencu, A., Moraleda, J., Olmos, R., & León, J. A. (2018). Analyzing two automatic assessment LSA methods (inbuilt rubric vs. golden summary) in summaries extracted from expository texts. *Psicología Educativa, 24*(2), 85-92. https://doi.org/10.5093/psed2048a9

McCrudden, M. T. (2011). Do specific relevance instructions promote transfer appropriate processing? *Instructional Science, 39*(6), 865-879. https://doi.org/10.1007/s11251-010-9158-x

McCrudden, M. T., Magliano, J. P., & Schraw, G. (2010). Exploring how relevance instructions affect personal reading intentions, reading goals and text processing: A mixed methods study. *Contemporary Educational Psychology, 35*(4), 229-241. https://doi.org/10.1016/j.cedpsych.2009.12.001

McCrudden, M. T., & Schraw, G. (2007). Relevance and goal-focusing in text processing. *Educational Psychology Review, 19*(2), 113-139. https://doi.org/10.1007/s10648-006-9010-7

McCrudden, M. T., & Schraw, G. (2009). The effects of relevance instructions and verbal ability on text processing. *The Journal of Experimental Education, 78*(1), 96-117.

McCrudden, M. T., Schraw, G., & Kambe, G. (2005). The effect of relevance instructions on reading time and learning. *Journal of Educational Psychology, 97*(1), 88-102. https://doi.org/10.1037/0022-0663.97.1.88

Postman, L., & Senders, V. L. (1946). Incidental learning and generality of set. *Journal of Experimental Psychology, 36*(2), 153-165. https://doi.org/10.1037/h0061788

R Development Core Team. (2019). *R: A language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. http://www.R-project.org/

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin, 124*(3), 372-422. https://doi.org/10.1037/0033-2909.124.3.372

Rayner, K., & Liversedge, S. P. (2011). Linguistic and cognitive influences on eye movements during reading. In S. P. Liversedge, I. D. Gilchrist, & S. Everling (Eds.), *The Oxford handbook of eye movements* (pp. 751-766). Oxford University Press.

Rothkopf, E. Z., & Billington, M. J. (1979). Goal-guided learning from text: Inferring a descriptive processing model from inspection times and eye movements. *Journal of Educational Psychology, 71*(3), 310-327. https://doi.org/10.1037/0022-0663.71.3.310

Smith, B. L., Holliday, W. G., & Austin, H. W. (2010). Students' comprehension of science textbooks using a question-based reading strategy. *Journal of Research in Science Teaching, 47(*4), 363-379. https://doi.org/10.1002/tea.20378

Tawfik, A. A., Graesser, A., Gatewood, J., & Gishbaugher, J. (2020). Role of questions in inquiry-based instruction: Towards a design taxonomy for question-asking and implications for design. *Educational Technology Research and Development*, 1-25.

van den Broek, P., Lorch, R. F., Jr., Linderholm, T., & Gustafson, M. (2001). The effects of readers' goals on inference generation and memory for texts. *Memory & Cognition, 29*(8), 1081-1087. https://doi.org/10.3758/BF03206376

Wiley, J., Goldman, S. R., Graesser, A. C., Sanchez, C. A., Ash, I. K., & Hemmerich, J. A. (2010). Source evaluation, comprehension, and learning in Internet science inquiry tasks. *American Educational Research Journal, 46*(4), 1060-1106. https://doi.org/10.3102/0002831209333183

Woloshyn, V., Pressley, M., & Schneider, W. (1992). Elaborative interrogation and prior knowledge effects of learning of facts. *Journal of Educational Psychology, 86*(1), 79-89. https://doi.org/10.1037/0022-0663.84.1.115

Wood, E., Willoughby, T., McDermott, C., Motz, M., Kasper,V., & Ducharme, M. (1999). Developmental differences in study behavior. *Journal of Educational Psychology, 91*(3), 527-536. https://doi.org/10.1037/0022-0663.91.3.527

Appendix A

One of the Experimental Texts (why-question inserted in the text) Translated from Spanish to English

The Thames

For centuries, London has been exposing the Thames to high levels of contamination. In 1849 it was found that salmon, like the rest of the flora and fauna, had disappeared from the river. The water, though, was still used for human consumption, a fact which led to over 35,000 deaths from diphtheria epidemics between 1831 and 1866. But how did the river become so contaminated?

Because London was a large, heavily populated and industrialized city, the pollution dumped into the river was of a mixed nature. First, the Thames received huge amounts of untreated organic waste from the sewers of London. Second, industries produced chemical waste (such as hydrocarbons, synthetic detergents, phenols, cyanide) that changed the pH of the water. Both types of pollution completely extinguished any form of life in the river.

The contamination led Londoners to avoid the Thames in summer. Every viscous drop of water that passed carried the smell of two centuries of urban pollution. And beneath the surface, the river was dead. In more than 70 kilometers, the water contained almost no oxygen, and fish and other living creatures that inhabited the river had been eliminated long ago. Until the 80s, the Thames was one of the most polluted rivers in the world.

Appendix B

Instructions for Participants in all Conditions

Specific Relevance Instruction Condition (question in text)

Participants in the specific relevance instruction condition were told: "You will read a set of short expository texts. We want you to read the text carefully, focus on the question that appears at the end of the first paragraph, and try to understand as much of the text as possible to answer the question. Later, after reading, you will be asked to give an oral summary about the main ideas of the text including information related to the question to see how well you understood what you have read".

Specific Relevance Instruction Condition (no question in text)

Participants in the specific relevance instruction condition (no question in text) were told: "You will read a set of short expository texts. We want you to read the text carefully, try to understand as much of the text as possible to answer a question that will appear after you read the text. Later, after reading the question, you will be asked to give an oral summary about the main ideas of the text including information related to the question to see how well you understood what you have read".

General Relevance Instruction Condition (question in text and no question in text)

Participants in the general relevance instruction condition were told: "You will read a set of short expository texts. We want you to read the text carefully, understanding as much of the text as possible. Later, after reading, you will be asked to give an oral summary about the main ideas of the text to see how well you understood what you have read."

Appendix C

1. Model for the Total Fixation Time

Random Effects			
Group	Variance	*SD*	
Participant	18.26	4.27	
Text	0.68	0.82	
Fixed Effects			
	b	95% CI	*t*
Intercept	9.07	[7.35, 10.79]	10.33
Relevance	-0.43	[-1.32, 0.46]	-0.94
Specific	-0.45	[-2.82, 1.93]	-0.37
Question in text	-0.35	[-2.61, 1.92]	-0.30
Relevance * Specific	0.21	[-1.13, 1.55]	0.31
Relevance * Question in text	-0.14	[-1.42, 1.13]	-0.22
Specific * Question in text	-2.23	[-5.31, 0.85]	-1.42
Relevance * Specific * Question in text	5.85	[4.12, 7.59]	6.61

2. Model for the Firstpass Reading Time

Random Effects			
Group	Variance	*SD*	
Participant	8859233	2976	
Text	442210	665	
Fixed Effects			
	b	95% CI	*t*
Intercept	7247.81	[5996.82, 8498.80]	11.36
Relevance	-115.72	[-822.87, 591.44]	-0.32
Specific	844.72	[-843.94, 2553.37]	0.98
Question in text	-640.633	[-2253.01, 971.74]	-0.78
Relevance * Specific	-253.514	[-1312.53, 805.50]	-0.47
Relevance * Question in text	-9.21	[-1016.92, 998.50]	-0.02
Specific * Question in text	-2249.65	[-4440.46, -58.83]	-2.01
Relevance * Specific * Question in text	2390.87	[1018.85, 3762.89]	3.42

3. Model for the Look-back Duration

Random Effects			
Group	Variance	*SD*	
Participant	6245013	2499	
Text	56453	237	
Fixed Effects			
	b	95% CI	*t*
Intercept	1906.9	[911.45, 2902.34]	3.76
Relevance	-485.3	[-1159.64, 188.97]	-1.41
Specific	-1369.1	[-2826.60, 88.48]	-1.84
Question in text	-130.4	[-1521.74, 1260.88]	-0.18
Relevance * Specific	636.8	[-372.97, 1646.62]	1.24
Relevance * Question in text	689.4	[-271.52, 1650.23]	1.41
Specific * Question in text	437.7	[-1453.00, 2328.33]	0.45
Relevance * Specific * Question in text	2636.1	[1327.81, 3944.30]	3.95

4. Model for the Number of Returns to the Introductory Paragraph

Random Effects			
Group	Variance	*SD*	
Participant	0.46	0.68	
Text	0.00	0.01	
Fixed Effects			
	b	95% CI	*z*
Intercept	-0.96	[-1.28 , -0.64]	-5.94
Relevance	-0.03	[-.32, 0.26]	-0.23
Specific	-0.57	[-1.08, -0.06]	-2.19
Question in text	0.26	[-0.18, 0.70]	1.15
Relevance * Specific	0.07	[-0.43, 0.57]	0.26
Relevance * Question in text	-0.13	[-0.52, 0.26]	-0.67
Specific * Question in text	0.17	[-0.47, 0.80]	0.51
Relevance * Specific * Question in text	0.96	[0.37, 1.55]	3.19

5. Model for the Duration of Look Backs to the Introductory Paragraph

Random Effects			
Group	Variance	*SD*	
Participant	1476983	1215.3	
Text	50319	224.3	
Fixed Effects			
	b	95% CI	*t*
Intercept	1631.5	[1062.83, 2200.09]	5.62
Relevance	-113.8	[-601.66, 374.03]	-0.46
Specific	-1174.6	[-1979.78, -369.40]	-2.86
Question in text	180.3	[-587.51, 948.02]	0.46
Relevance * Specific	332.8	[-397.71, 1063.31]	0.89
Relevance * Question in text	-136.5	[-831.67, 558.59]	-0.39
Specific * Question in text	225.8	[-818.02, 1269.60]	0.42
Relevance * Specific * Question in text	137.1	[-809.28, 1083.54]	0.28

6. Model for the Summary Task Performance (word count)

Random Effects			
Group	Variance	*SD*	
Participant	79.12	8.90	
Text	3.75	1.94	
Fixed Effects			
	b	95% CI	*t*
Intercept	34.58	[30.68 – 38.49]	17.35
Irrelevant	-8.95	[-11.65 – -6.25]	-6.50
Relevant	2.60	[-.10 – 5.30]	1.89
Specific	-32.22	[-37.58 – -26.87]	-11.79
Question in text	-3.41	[-8.56 – 1.74]	-1.30
Irrelevant * Specific	6.83	[2.78 – 10.88]	3.31
Relevant * Specific	16.60	[12.55 – 20.66]	8.02
Irrelevant * Question in text	2.67	[-1.20 – 6.54]	1.35
Relevant * Question in text	13.35	[9.48 – 17.22]	6.76
Specific * Question in text	3.15	[-3.82 – 10.13]	0.89
Irrelevant * Specific * Question in text	-0.79	[-6.05 – 4.47]	-0.29
Relevant * Specific * Question in text	2.28	[-2.99 – 7.55]	0.85