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The role of reading strategies in scientific text comprehension and academic achievement of university students

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The aim of the study was to explore the relations between comprehension strategies engaged in different aspects of comprehension processing, and to examine the relationship of these strategies and text comprehension to academic achievement. The participants in the study were 112 undergraduate psychology students (10 male and 102 female). Text comprehension was assessed on three short scientific paragraphs on topics from cognitive psychology. A self-explanatory task was applied for assessing the use of three reading strategies: paraphrasing, bridging inferences and elaborations. Additionally, question generation and summarizing tasks were administered. Grade point average (GPA) was used as an indicator of academic achievement. Relations between reading strategies indicated grouping of the strategies that foster different aspects of comprehension processing from the text-base level to the situation model of the text. Students typically use paraphrases, regardless of their reading comprehension level; however, good comprehenders use more strategies that help readers to build global representation of the text compared to poor comprehenders. The use of elaboration strategies and the use of summarizing strategy were the best predictors of text comprehension. The effects of reading strategies on GPA were mediated by reading comprehension.

Key words: reading strategies, text comprehension, academic achievement

Studying at the university level typically requires reading and learning from challenging expository texts on specific science domain. Research shows that reading comprehension predicts specific course performance and even overall college performance (Royer, Marchant, Sinatra, & Lovejoy, 1990). Yet students' ability to comprehend scientific texts is often inadequate (Snow, 2002), as reading such a text is a complex cognitive task (Nist & Holschuh, 2000). To perform this task efficiently, students must possess accessible conceptual knowledge about a particular domain and must apply text processing strategies. When the conceptual knowledge is inadequate and when the familiarity with the text is low, reading strategies are particularly important (McNamara, 2004; Scardamalia & Bereiter, 1984). There is evidence that even experienced readers face some difficulty in applying elaborate comprehension strategies during reading complex scientific text (Graesser, 2007). In Wood, Motz, and Willoughby's study (1998) students indicated that their experience with sophisticated strategies did not occur until high school, and perhaps even later.

Reading comprehension strategies are "cognitive or behavioral actions that are enacted under particular contextual condition, with the goal of improving some aspects of comprehension" (Graesser, 2007, p. 6). Alexander, Graham, and Harris (1998) stated that strategies are procedural, purposeful, effortful, willful, and facilitative in nature.

McNamara, Ozuru, Best, and O´Reilly (2007) proposed the 4-Pronged comprehension strategy framework for classifying reading strategies. This framework is based on the general premise that reading strategy use is intrinsically metacognitive, with the monitoring of comprehension as its core. Comprehension monitoring is linked to the use of the other four categories of strategies that relate to different aspects of comprehension processes. The first category includes strategies to prepare to read, including setting the goals of reading. The second category regards strategies to interpret words, sentences, and ideas in text that help reader to develop a coherent text-base level of comprehension. The third category includes strategies to go beyond the text by connecting the text content with reader's prior knowledge that help reader to develop a situation model of text. The fourth category comprises strategies to organize, restructure, and synthesize the information from the text in order to facilitate global processing.

In this research paper we focus on strategies which readers use during and after reading the text (e.g., Paris, Wasik,

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& Turner, 1996.): paraphrasing, bridging inferences, elaborations, question generation, and summarizing, that make the second, third, and fourth category in the 4-Pronged comprehension strategy framework.

The reading strategies that make the second and third category are employed during reading and they enable students to develop text-base understanding and construct situation model of text, which are two levels of comprehension specified in the construction-integration model (Kintsch, 1998). The construction-integration model assumes that multiple levels of representation get constructed during comprehension: the surface code (the exact wording and syntax of the sentence), the propositional text-base (logical form that preserves the meaning of sentences), the situation model (the referential content that the text is describing), and the text genre (the type of discourse).

There is evidence that explaining the text while reading is an effective way of promoting active processing of the text and text comprehension (Chi, 2000; Chi, de Leeuw, Chiu, & LaVancher, 1994). Self-explanation of text content during reading is considered to be a strategy that goes beyond the text and encourages the use of prior knowledge. McNamara's (2004) conceptualization of self-explanation is somewhat broader and includes several different strategies: monitoring of comprehension, paraphrasing, linking separate ideas in the text (i.e., bridging inferences), and relating the ideas to pre-existing knowledge (i.e., elaborations).

Paraphrasing is rewording some portion of the text by using different words that are more familiar to the reader. It fosters the text-base comprehension (McNamara, Ozuru, et al., 2007). McNamara (2004) found a positive correlation between inaccurate paraphrases and poor comprehension. Paraphrasing also helps readers monitor their comprehension (McNamara, O'Reilly, Rowe, Boonthum, & Levinstein, 2007).

Bridging inferences help readers to make connections among concepts, arguments, and theories in the text, in order to build a global representation of the text (McNamara, O'Reilly, et al., 2007). Studies indicated that bridging inferences play an important role in the comprehension of and learning from text (Anderson, R. C., & Pearson, 1984; Cain, Oakhill, Barnes, & Bryant, 2001). Students that lack knowledge about the topic could bridge ideas only between adjacent sentences (McNamara, 2004).

Student-generated elaborations are considered to be strategies that go beyond the text and include examples, analogies, inferences, and explanations of the relationship between concepts in the text. Several studies have demonstrated that self-generated elaborations can significantly improve students' learning (Simpson, Olejnik, Tam, & Supattathum, 1994; Woloshyn, Willoughby, Wood, & Pressley, 1990). Chi et al. (1994) argued that self-explanation prompting encouraged learners to use many other strategies, e.g., to summarize the text and to question themselves about the text. Those strategies are likely to facilitate multiple cognitive processes during comprehension including comprehension monitoring that allows readers to test their understanding of the text.

Question generation fosters readers to identify main ideas, and involves readers in active comprehension inducing them to go beyond the text and engaging them in deep processing of text material (McNamara, Ozuru, et al., 2007). It has been well demonstrated that generating and answering self-questions improves text comprehension (King, 1992; Palincsar & Brown, 1984; Rosenshine, Meister, & Chapman, 1996; Symons, Richards, & Green, 1995). Besides, effective question generation heightens self-awareness of their comprehension adequacy (a metacognitive feature). By generating and answering questions concerning the text key points, readers can identify and resolve inadequate or incomplete comprehension.

Like question generation, text summarizing also promotes self-monitoring during reading (Brown & Day, 1983; Garner, 1982; Palincsar & Brown, 1984), which may signal comprehension breaks and invite readers to initiate fix-up strategies to repair breaks in comprehension (Winne & Hadwin, 1998). Furthermore, as a complex strategy that requires omitting unimportant information, as well as condensing and organizing text information, summarizing serves several purposes. Wittrock (1990) suggested that the process of generating summaries helps readers build relations between concepts contained in a text as well as link these concepts to prior knowledge. McNamara, Ozuru, et al. (2007) claimed that summarizing helps readers organize text content at the macro level, and improves comprehension by helping readers to focus their attention on the more important information in a text, as also suggested by others (Anderson, T. H., & Armbruster, 1984; Friend, 2001; Pearson & Fielding, 1996). Therefore, summarizing represents the fourth category of strategies aimed at organizing, restructuring, and synthesizing the information from the text in order to facilitate global processing.

Although the relation between reading strategies, reading comprehension and academic achievement is found in many studies, there is a paucity of studies that simultaneously examined strategies tapping different aspects of comprehension processing (King, 1992; O'Reilly, Symons, & MacLatchy-Gaudet, 1998).

Therefore, the first aim of the study was to explore relations between comprehension strategies engaged in different aspects of comprehension processing. Accordingly, different strategic tasks were applied. Self-explanations produced during reading could be a good indicator of efficiency in use of several strategies: paraphrasing, and bridging infer-

ences that represent second-category strategies (to interpret words, sentences, and ideas in text), as well as elaborations, that represent third-category strategies (that go beyond the text). Question generation, which is also included in the third category of strategies, was assessed by additional specific tasks, on which summarizing, as the fourth-category strategy, was also assessed.

The second aim of the study was to examine relationship between different strategies and reading comprehension. First, we compared frequencies of different self-explanation strategies in students differing in text comprehension, and second, we examined the contribution of different reading strategies to the scientific text comprehension.

The final aim was to examine the contribution of these strategies and text comprehension to academic achievement of university students.

According to previously mentioned studies, we hypothesized that strategies fostering similar comprehension processes will be more strongly correlated. For example, production of bridging inferences and elaborations, which are relevant to sentence and text comprehension, should be related to better text summarizing and question generation. Furthermore, we expected that students will use more text-based strategies than strategies that help build global text representation, yet we also expected that strategies that tap multiple comprehension processes, i.e., summarizing and question generation, will be better predictors of text comprehension. We also expected that good comprehenders would produce more strategies that go beyond the text on self-explanation task than poor comprehenders. Finally, as reading comprehensions predicts learning performance at college level (Royer et al., 1990), it was expected that the use of reading strategies would indirectly, through reading comprehension, predict academic achievement.

METHOD

Participants

The participants in the study were 112 undergraduate psychology students (mean age = 20.4) who participated for course credit. There were 10 male and 102 female participants.

Measures and scoring

Reading comprehension. Reading comprehension was assessed on three complex texts adapted from scientific papers from cognitive psychology field: the neural basis of working memory (192 words), category specific semantic deficit (213 words), and theories of recognition (177 words). After they had read each text, students answered five short-answer questions about text content. Answers ranged from few words to several clauses. Some of the questions were text-based and required the reader to retrieve information that can be found in a single sentence of the text, and some of the questions were situation model questions and required the reader to retrieve both explicit content and inferred relationships. Two points were assigned to correct and complete answers and one point was assigned to incomplete answers. The maximum possible reading comprehension score was 30.

Self-explanation task. The text for the self-explanation task was adapted from a book about the evolutionary origin of thinking. The text was difficult for undergraduate level, and it was chosen because we expected that a text of this kind would enhance reading strategy use. The text included 12 sentences, which were presented in booklet form, with one sentence per page. Students were asked to write a self-explanation of each sentence. They were instructed to ex-

Table 1
Examples of self-explanation coding

Self-explanation category	Example	Criteria for coding
Target sentence	That system includes instinctive behaviors that are genetically programmed, and processes of associative learning.	
Paraphrase	The system refers to instinctive behaviors that are inherited and behaviors learned through association.	There is no new information added. Produced sentence is restatement of the target sentence.
Bridging inference	The system of universal cognition, that is common for humans and animals, includes instinctive behaviors and processes of associative learning.	The content of the produced sentence referred to the information mentioned in previous sentences.
Elaboration	That system includes instinctive behaviors, that means that they are inherited, i.e., they are non-learned and they are specific for particular species. The system also includes processes of associative learning, that probably means conditioning.	Produced sentence integrated information from the text with previous knowledge.

plain the sentence content, the relation of that content to the text meaning, and to their previous knowledge of the topic.

Two independent coders analyzed the self-explanations in order to identify the strategy being used by the student. Disagreements were resolved by discussion. We adopted a broader conceptualization of self-explanation as explaining the meaning of a text (McNamara, 2004). The criteria for coding self-explanations were based on criteria suggested by Best, Ozuru, and McNamara (2004) and McNamara (2004). Each self-explanation was analyzed in terms of comprehension monitoring, paraphrasing, bridging inferences and elaboration (examples of self-explanation coding are presented in Table 1).

Self-explanation was coded as comprehension monitoring when it incorporated the monitoring of students' understanding. (e.g., "I don't understand", "I am not sure what this is about"). However, the monitoring score on the self-explanation task was not included in the analysis because only six participants produced a self-explanation which contained a monitoring statement, for a total of 20 monitoring statements.

An explanation was categorized as paraphrase if it was a restatement of the target sentence using similar words. The coding of the bridging inferences and elaborations was based on whether the self-explanations included any ideas that were not explicitly present in the target sentence. Self-explanation was identified as bridging inference when it made reference to an idea presented in previous sentences, or as elaboration when it made reference to previous knowledge. Paraphrases, bridging inferences, and elaborations were further coded for accuracy as inaccurate or accurate, and the frequencies of inaccurate and accurate self-explanations in each category were counted for each participant.

The contribution of bridging inferences and elaborations to comprehension. The contribution was also classified into three categories according to their relevance to the comprehension: irrelevant (0 points), relevant to the comprehension of the target sentence (1 point), and relevant to the comprehension of overall text (2 points). For example, the elaboration from Table 1 contributed to comprehension of the target sentence, but it did not contribute to the global level of comprehension-to do that, the elaboration should include a premise about the distinction from the other system mentioned in the text. The contribution of bridging inferences to comprehension, as well as the contribution of elaborations, was calculated for each participant as the sum of contribution scores for all sentences.

Question generation. Five scientific texts (from 191 to 248 words long) on different topics adapted from learning materials for high-school students were used for assessing the question generation. The text topics were: methods for crime scene investigation, dinosaurs, African history, Ruđer Bošković, and the nature of matter. After they had read each text, students had to create a question about the main idea of the text. Two independent coders analyzed the questions. Disagreements were resolved by discussion. The criteria for the evaluation of the quality of questions were based on criteria for question construction used by Chi et al. (1994). If the question was categorized as referring to the main idea in the text, it was further coded as a question requiring simple recall or recognition of facts explicitly presented in the text (1 point, e.g., "Which are most important dinosaur fossil sites?"), a question requiring the integration of information within a paragraph but without explicitly referring to the main idea of the text (2 points, e.g., "What information can we obtain by examination of fossils?"), or a question referring to the target text main idea and requiring the integration of information presented in the text with prior knowledge (3 points, e.g., "How researches draw direct and indirect conclusions about characteristics of dinosaurs?"). The quality of questions score was calculated as the sum of quality scores for each question.

Summarizing. Summarizing skill was assessed on the same five texts used for assessing the question generation. After they had read each text, students had to summarize the main ideas. Two independent coders analyzed the summaries. Disagreements were resolved by discussion. The criteria for the evaluation of summaries were mainly adopted from Friend (2001) and from Kozminsky and Graetz (1986). Each summary was coded for two indicators of summarizing: construction of a main idea, and integration. Main idea construction was coded for accuracy on three levels (incomplete, approximate, and correct and complete main idea, 1-3 points, respectively). Summary integration was also coded on three levels (poorly, averagely, and well integrated and cohesive summary, 1-3 points, respectively). Summaries were classified as poorly integrated if they contained a list of unconnected phrases (e.g., "There are many fossils sites; we can make inferences about the behavior of dinosaurs based on their anatomy; …"). Averagely integrated summaries contained meaningfully connected, but simple sentences (e.g., "The conclusions about the dinosaurs' appearance could be drawn from their fossilized remains. The conclusions about their behavior could be drawn from their anatomy and from their living relatives.") Well integrated summaries were cohesive texts containing complex sentences that integrated different parts of a text (e.g., "The most valuable source of information about dinosaurs are their fossilized remains from which researchers can draw conclusions about the anatomy and behavior of dinosaurs. Insights about behavior can also be gained from living relatives of dinosaurs [birds and crocodiles].") The summary main idea score as well as integration of summaries score were calculated as the sums of main idea and integration scores for each summary.

Academic achievement. Grade point average (GPA) was used as a measure of academic achievement. A year GPA relies on achievement in nine psychology subjects assessed by tests and oral examinations. GPA was obtained from university records.

Procedure

The tasks were administered to groups of 15 to 20 students in two one hour sessions. During the first session, reading comprehension task was applied. During the second session, the self-explanation task and summarizing and questioning tasks were administered.

RESULTS

Relations among measures of reading strategy use

Descriptive statistics for measures of performance on self-explanation task, question generation and summarizing tasks are shown in Table 2. A correlation analysis was performed in order to explore the relationship between measures of strategic reading (Table 3). Students who produced better bridging inferences also produced more integrated summaries. Better elaborations were correlated with more successful identification of summary main idea. Question generation was significantly correlated with summary main idea and summary integration. Two measures of summarizing were highly correlated.

Table 2
Descriptive statistics for measures of text comprehension and strategic reading

	M	*SD*	Min	Max
Text comprehension	14.66	5.05	4	25
Self-explanations				
Contribution of bridging inferences	1.69	2.25	0	9
Contribution of elaborations	3.57	3.64	0	17
Question generation	7.86	3.17	0	13
Summarizing				
Main idea	10.69	1.93	7	15
Integration	8.86	1.92	5	13

Reading strategies and text comprehension

The analysis of the relationship between strategic processing and text comprehension was conducted in two ways. First, the frequencies of specific types of self-explanations in students differing in text comprehension level were compared, and second, variables of strategic reading were analyzed as predictors of reading comprehension.

Self-explanations: Comparison of students differing in text comprehension level. In order to compare frequencies of different self-explanation strategies in students differing in text comprehension, participants were grouped into three groups according to their comprehension level. Percentiles were used as the criterion for grouping, with approximately one third of students in each group. In the low comprehension group there were 35 students ($M = 8.71$, $SD = 2.58$), in the average group there were 38 students ($M = 14.79$, $SD = 1.02$), and in the good comprehension group there were 39 students ($M = 19.87$, $SD = 2.66$).

Table 4 shows the total number of correct and incorrect self-explanations (paraphrases, bridging inferences, and elaborations) in different reading comprehension groups. The total number of paraphrases highly exceeds the total number of bridging inferences and elaborations. The majority of self-explanations included paraphrases (80%), and most paraphrases were accurate (96%). In addition to

Table 3
Intercorrelations [and 95 % CI] between all variables in regression analyses ($N = 112$)

Comprehension strategies	1 Contribution of bridging inferences	2 Contribution of elaboration	3 Question generation	4 Summary main idea	5 Summary integration
3	.02 [-.17, .20]	.11 [-.08, .29]			
4	.12 [-.07, .30]	.25 ** [.07, .42]	.34 *** [.17, .49]		
5	.25 ** [.07, .42]	.13 [-.06, .31]	.24 * [.06, .41]	.62 *** [.49, .72]	
Text comprehension	.15 [-.04, .33]	.23 ** [.05, .40]	.19 [.01, .36]	.49 *** [.34, .62]	.47 *** [.31, .60]
GPA	.05 [-.14, .23]	.19 * [.01, .36]	.26 ** [.08, .43]	.33 *** [.15, .49]	.27 ** [.09, .43]

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4
Frequencies (and percentage) of correct and incorrect paraphrases, bridging inferences, and elaborations in three reading comprehension groups

Reading comprehension group	Type of self-explanation					
	Paraphrases		Bridging inferences		Elaborations	
	Accurate	Inaccurate	Accurate	Inaccurate	Accurate	Inaccurate
Low	336 (93)	24 (7)	48 (80)	12 (20)	94 (85)	17 (15)
Average	337 (96)	14 (4)	67 (92)	6 (8)	154 (85)	28 (15)
Good	340 (99)	3 (1)	78 (95)	4 (5)	179 (94)	11 (6)
Total	1013	41	193	22	427	56

paraphrases, 37% of self-explanation also included bridging inferences or elaboration, whereas 17% of the self-explanations produced were only bridging inferences or elaboration. The number of accurate paraphrases was similar in all three comprehension groups. However, the low comprehension group produced more inaccurate paraphrases than the average and good comprehension groups, $\chi^2(2, N = 112) = 17.95$, $p < .001$. Furthermore, the low comprehension group produced fewer accurate bridging inferences than good comprehenders, $\chi^2(1, N = 74) = 6.68$, $p = .01$. The good comprehension group produced more accurate elaborations than the other two comprehension groups, $\chi^2(2, N = 112) = 25.7$, $p < .001$.

Reading strategies as predictors of text comprehension. Correlations of measures of reading strategies with text comprehension are shown in Table 3. Contribution of bridging inferences was not significantly correlated with text comprehension, while better elaborations were related to better text comprehension. Furthermore, the question generation was not significantly related to the reading comprehension, but both measures of summarizing were positively related to reading comprehension. Since those two measures were highly correlated, the quality of main idea in the summarizing task was not included in the regression analysis as predictor of text comprehension.

A regression analysis was performed in order to examine the contribution of various aspects of strategic reading to reading comprehension. The predictors included in the analysis were: contribution of bridging inferences, contribution of elaborations, question generation, and summary integration. Predictor variables explained a significant proportion of the variance in reading comprehension ($R = .54$, $R^2 = .29$, $p < .001$) with contribution of elaborations ($\beta = .22$, $p < .05$) and summary integration ($\beta = .41$, $p < .01$) as significant positive predictors.

Predictors of academic achievement

Correlations of measures of strategic reading with GPA are shown in Table 3. Contribution of bridging inferences was not significantly correlated with GPA, while better elaborations were related to higher GPA. The question generation was significantly related to GPA, as well as both measures of summarizing.

Table 5
Hierarchical regression analysis predicting academic achievement ($N = 112$)

	R^2 change	β	p[a]
Step 1	.17		.002
Contribution of bridging inferences		.07	
Contribution of elaborations		.21	.051
Question generation		.19	.056
Summary integration		.22	.036
Step 2	.07		.005
Contribution of bridging inferences		.02	
Contribution of elaborations		.13	
Question generation		.17	
Summary integration		.09	
Text comprehension		.31	.005
Cumulative R^2	.24		< .001

[a]Only significant and marginally significant p values are shown.

In order to obtain further insights into the relative effects of reading strategies and reading comprehension on the academic achievement, a hierarchical multiple regression analysis was performed with academic achievement as the dependent variable (Table 5). In the first step, contribution of bridging inferences and elaborations, question generation, and summary integration were included in the analysis as predictors. These variables explained 17% of the variance of the GPA, with summary integration as a significant predictor. Contribution of elaboration and question generation approached the significance level. In the step two, reading comprehension was included in order to explore its effect on academic achievement over and above the variables that predict reading comprehension. A significant change in multiple R^2 was obtained (7%), and reading comprehension became the only significant predictor of GPA.

DISCUSSION

In general, the results obtained in the study supported the initial hypotheses. Specifically, strategies fostering similar comprehension processes were correlated, students used more text-based strategies than strategies that help build global text representation, good comprehenders produced more strategies that go beyond the text on self-explanation task than poor comprehenders, and the use of reading strategies indirectly, through reading comprehension, predicted academic achievement. The hypothesis that strategies that tap multiple comprehension processes will be better predictors of text comprehension was partially confirmed, i.e., summarizing was a better predictor of text comprehension than elaboration, but the same result for the question generation strategy was not obtained.

Obtained correlations between assessed reading strategies suggest some grouping between strategies that foster different comprehension processes. Summarizing, as a complex strategy that facilitates global processing as suggested in the 4-pronged framework for reading comprehension strategies (McNamara, Ozuru, et al., 2007), was correlated with all the other strategies. Generally, students who produced more self-explanations that contributed to comprehension also had a better summarizing skill. Specifically, the integration of information in summaries was related to accurate and contributing bridging inferences, while the identification of main idea was related to elaborations that contributed to comprehension. Although not high, these correlations imply that bridging inferences contribute to the integration of the text information in order to produce coherent text representation, and elaborations facilitate global processing in order to identify main idea and help reader to develop a situation model of the text.

Summarizing strategy was related to all other strategies. That finding is in accordance with claim that summarizing is a more general strategy that is likely to facilitate multiple cognitive processes underlying text comprehension (McNamara, Ozuru, et al., 2007). In contrast to summarizing, the question generation did not relate to strategy use during self-explanation, although it is considered to be a strategy that goes beyond the text. Our results suggested that question generation was a demanding strategy and students in this study produced low quality questions that comprised mostly text-based processing.

The comparison of groups differing in reading comprehension showed that they differ in strategies used during self-explanation task. All students, regardless of comprehension proficiency, mostly used paraphrases in their self-explanation. These results are in line with the results of the studies that found that learners typically rely on less sophisticated strategies, even when they have extensive strategic repertoires available to them (McNamara, O'Reilly, et al., 2007; Wood et al., 1998). Pressley (1995) claims that fully developed strategic reading is manifested only by domain experts when reading in their domain of expertise, but not by college students. However, the results of study conducted by Cromley, Snyder-Hogan, and Luciw-Dubas (2010) showed that even in college students background knowledge is a significant predictor of reading strategy use. Wood et al. (1998) found that 74% of university students reported using repetition strategies mostly-i.e., reading and rereading, while only a small number of university students (4%) reported using complex strategies such as elaboration to relate information to prior knowledge. Our result, showing that more than 60% of self-explanations were paraphrases, is in line with the reported results of other studies. Interestingly, students produced twice as more elaborations than bridging inferences. However, good comprehenders are characterized by the use of deeper and more accurate text processing strategies compared to poor comprehenders. This result is in line with other findings (Fergusson-Hessler & de Jong, 1990; Long, Oppy, & Seely, 1994; Singer, Andrusiak, Reisdorf, & Black, 1992) showing that good performing students tend to use deeper strategies such as integrating information, while poor comprehenders are more likely to use superficial strategies like rereading.

Furthermore, Kletzien (1991) found that the use of reading strategies depends on text difficulty: strategy use declined for poor comprehenders as texts became more difficult. Good comprehenders also used more strategies on the easiest passage, but their strategy use was the same on the medium and difficult passages. The students' strategy use in the current study could also be affected by the difficulty of the text used in self-explanation task. The text was probably difficult for the poor comprehenders, and therefore they used fewer complex strategies, i.e., bridging inferences and elaborations, compared to good comprehenders.

Although elaborations produced in self-explanation task and summarizing skill contributed significantly to text comprehension, summarizing was shown to be the most important predictor of reading comprehension. This is in line with findings of a number of studies showing that summarizing improves students' text comprehension (Armbruster, Anderson, & Ostertag, 1987; King, 1992; Symons et al., 1995; Wittrock, 1990). However, our study is among the few (e.g., King, 1992) comparing the effects of different strategic processing on text comprehension. Summarizing is a complex strategy facilitating processing on different levels of text comprehension, from text-base processing to organizing, restructuring, and synthesizing the text content which helps the construction of the situation model.

Summarizing, in addition to question generation, also had significant positive correlations with academic achievement. However, results indicate that text comprehension mediated between strategic processing and academic achievement. Efficiency in text processing obviously affects academic achievement. These findings indicate that

advanced academic performance is tied to the availability and sophistication of strategy use (Wood & Hewit, 1993). Wood et al. (1998) also found that most of those students who had performed well reported using higher order strategies. Those strategies, especially question generation and summarizing, enhance not only text comprehension but also retention of text content, i.e., learning from text. Since the majority of students state that their strategies have been self-taught (Wood et al., 1998), even for university students, the role of the educator as a facilitator of expertise development in strategy use is crucial. In order for students to gain effective strategic knowledge, the students should be engaged in tasks requiring complex text processing strategies, such as summarizing, in dealing with demanding scientific texts.

However, when considering the implications of the results of the current study, one should be aware of several limitations. First, the participants of the study were psychology students, and the possibility of generalization to other students is limited due to the specific academic experiences. Second, the design of the study may have affected the results. In all strategic tasks students were required to apply a particular reading strategy. Although this procedure provides data on students' strategic ability, it certainly does not indicate the actual level of strategy use in various learning situations. The question is whether these students would have used these strategies if they had not been explicitly instructed to do so. Third, obtained results may be biased as a result of features of texts used in the study, for example, text difficulty.

Several conclusions could still be drawn from the results of the current study:

1. Relations between reading strategies assessed in the study indicated some grouping between the variables. However, summarizing was correlated with all the other strategies.

2. Regardless of their reading comprehension level, students typically used text-based strategies, i.e., paraphrases. Compared to poor comprehenders, good comprehenders use more strategies that help readers to build a global representation of the text (i.e., bridging inferences and elaborations).

3. The best predictors of text comprehension were strategies that facilitate global processing of the text in order to develop a situation model (i.e., elaboration strategies and summarizing).

4. Reading strategies were significantly related to academic achievement, however, those effects were mediated by text comprehension.

Considering the obtained results and recognizing the limitations of the study, some guidelines for the future research could be suggested. The future studies should focus on students with different educational backgrounds, should apply texts with different levels of difficulty, and assess reading strategies use in realistic settings. As reading strategies, especially more complex strategies like summarizing, have predicted academic achievement through facilitation of global processing during text comprehension even at undergraduate level, future studies should also focus on implementing and evaluating reading strategy trainings for undergraduate students.

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