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High-achieving ninth grade students' self-reported strategy use and its relation to strategic reading behavior

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Abstract
Strategies in reading are viewed as essential tools needed to increase comprehension and learning from text. Especially in large-scale assessments, reliable and economic measures of reading strategies are needed which are valid to assess the strategy-performance relation. Questionnaire-based self-report measures are very popular but often fail to establish a positive relation between strategy use and performance. Nevertheless, these measures are objective and content valid as well as efficient in use. One explanation for this fact may be that, depending on students' individual approaches to reading, various strategies may lead to better performance. Then, self-report questionnaires of strategy use (SRQs) would assess differences in strategic approaches of students which are not (necessarily) linked to performance. The aim of the present study was to investigate whether students' differences in self-reported strategy use correspond to different strategic approaches in reading. The present study compares strategic reading behavior of a homogeneous sample of 22 high-achieving ninth grade students with superior performance in reading who were chosen for their high reading-related strategy knowledge and their difference in self-reported strategy use, assessed via questionnaire. Eleven students reported frequent strategy use (FSU) and 11 students reported seldom strategy use (SSU). For both groups, strategic reading behavior was assessed in an unobtrusive way using a computer-based multiple-choice reading test. Even though both groups showed little to none differences in reading performance, results indicate that FSU and SSU students differ in processing of text during initial reading and while re-reading text passages. In addition, they differed in how they proceed with reading tasks.

Keywords Strategic reading · Reading behavior · Assessment of reading strategies · Self-reported strategy use

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Introduction

Strategies and strategic processes in reading have gained much attention in research over the past three decades (e.g., Baker, 2005; Brown & Smiley, 1978; Cerdán et al., 2011a, b; Cross & Paris, 1988; Garner, 1987; McNamara et al., 2007; Paris et al., 1983). As the promotion of reading strategies constitutes a promising way to improve reading comprehension and learning from text, studies investigating learners' use of strategies and their usefulness in order to improve reading outcomes have been highly recognized in educational research (see McNamara, 2011; Schmitt, 2005) and indicate the benefit of strategy use especially when task demands increase (Naumann & Goldhammer, 2017).

Questionnaires and Likert scales are among the most popular assessment tools for reading strategies (Jacobs & Paris, 1987; Merchie et al., 2014; Mokhtari & Reichard, 2002; Schmitt, 1990, 2005). These instruments measure students' self-reported use of reading strategies but regularly fail to uncover a direct link between strategy use and performance (Lind & Sandmann, 2003; Muis et al., 2007). There has been an ongoing discussion about why this is the case (e.g., memory biases, specificity of the items). On the one hand, this missing link appears to indicate that the same level of performance can be achieved regardless of differences in self-reported strategy use. On the other hand, it shows that students with the same level of performance report differences with respect to the frequency of their strategy use. Research with think-aloud data and unobtrusive measures, such as trace data or eye-tracking, uncovered a diversity in strategic reading behavior which indicates that different approaches taken can lead to the same performance (Ardoin et al., 2019; Merchie & Van Keer, 2014). Taking into account that self-report measures are objective and reliable (Schellings & Van Hout-Wolters, 2011), the findings impose the assumption that self-reported strategy use, at least to a certain degree, corresponds to actual strategic behavior when reading and taking a comprehension test, even though it is not necessarily reflected in the performance.

The selection of strategies depends not only on strategic behavior but also on the level of reading performance: Poor readers are likely to choose among other strategies for reading and text comprehension (Artelt & Neuenhaus, 2015) as well as for task-related strategic behavior (Naumann & Salmerón, 2016). Additionally, they exhibit less understanding of comprehension tasks (Cerdán et al., 2013) which makes it difficult to compare strategic reading and task-related behavior of readers that have different levels of performance within one sample. To overcome this variance, the present study investigates the reading and text comprehension with a sample of powerful readers who possessed superior strategy knowledge but even though differed in their self-reported strategy use. High achievers were chosen over low achievers because they possessed better strategy knowledge and their reading performance appeared to be less effected by the individual issues such as mental stress or motivation. In the selected sample, reading behavior as well as reading comprehension for easy and difficult reading tasks was measured unobtrusively and objectively in a computer-based environment. Before this study is presented, both questionnaire-based and process-based assessments of reading strategies are discussed.

Questionnaire-based assessment of reading strategies

Reading strategies are activities that readers use to achieve a reading-related goal (see Afflerbach et al., 2008). Examples for well-known reading strategies are underlining, summarizing, or re-reading difficult text (e.g., Afflerbach & Cho, 2009). Reading strategies

have been categorized into several approaches. Often, strategies are divided into surface-level strategies and deep strategies (e.g., Marton & Säljö, 1976; Murphy & Alexander, 2002). Surface-level strategies stay close to the text surface, while deep strategies include a transformation or personalization of the text (e.g., Murphy & Alexander, 2002; Coutinho & Neuman, 2008; Neuenhaus et al., 2018). Overall, these taxonomies imply that strategical behavior varies with at least two levels or between two poles of processing depths. Other approaches differentiate strategies into cognitive strategies, metacognitive strategies, and management strategies (e.g., Pintrich et al., 1993; Schneider, 2010).

One method of assessing the use of reading strategies is the use of self-report questionnaires (SRQs). In these questionnaires, the students usually have to rate on a Likert scale a variety of reading strategies with regard to how often they use them. In most cases, they rate this in general terms, i.e., independent of any specific context. This procedure implies the assumption that the use of reading strategies is a stable characteristic, like a trait or predisposition (see Biggs, 1993), that is activated in a concrete situation, thus leading to specific behavior and influencing performance.

Self-report questionnaires of strategy use have been strongly criticized (Cromley & Azevedo, 2006; Veenman, 2011). One of the main concerns regarding self-report instruments is that they usually fail to uncover the positive relation between strategies and performance (Lind & Sandmann, 2003; Muis et al., 2007; Artelt & Schneider, 2015). From a theoretical point of view, strategies are supposed to support and increase performance (Borkowski et al., 2000; Efklides, 2008; Leopold & Leutner, 2015). Potential explanations for the low criterion-related validity are diverse. The most popular explanations for this phenomenon have been that the questionnaires readily provide the strategies which have to be judged and that the assessment of strategy is performed outside the context of their application (Pintrich et al., 1993; Schraw & Dennison, 1994).

In such, the frequency-of-use judgments draw on students' recognition of strategies rather than on their available and accessible strategy knowledge (Leopold & Leutner, 2002). Therefore, the instruments are prone to memory biases as well as to social desirability (Pintrich et al., 2000; Schraw, 2000). They require readers to report what they "usually" do while reading and thus imply the readers' ability to draw generalized conclusions regarding their strategic behaviors across time and across situations. Students' responses to self-report measures are affected by (1) students cognitive skills, (2) their individual learning experiences, (3) their readiness to analyze and reflect own learning or reading processes, (4) their attitudes towards task demands, and (5) their awareness of strategy use (Lompscher, 1995). In an extensive study on younger secondary school students, Artelt (2000) assessed strategy use via direct observation and via retrospective interviews and compared these data to self-report data. Self-report data and strategy use data turned out to be largely unrelated. The strategy use data revealed a tendency of students to be distinctive in their strategy choice. Students tended to select either surface strategies or elaborative strategies implicating differences in their depth of processing approaches (see Elliot et al., 1999).

SRQs provide no information about students' knowledge regarding characteristics of strategies such as the match to certain task demands or situations and they leave open whether students have the ability to adequately select strategies in order to meet a given requirement or whether they are able to apply them effectively (Artelt & Neuenhaus, 2010). Appropriate strategy use depends on the quality of a student's strategy selection (Meneghetti et al., 2007) while the effectivity of a well-chosen strategy depends on the quality of its performance (Winne, 1996). For instance, the frequent use of a strategy, such as underlining, will only benefit readers' comprehension or learning from text if readers

appropriately select and underline text parts that are highly relevant. The same holds true for other overt strategies such as note taking or summarizing as well as for covert strategies such as re-reading. Reader's level of reading performance and the knowledge about reading strategies affect the choice of appropriate strategies as well as the quality of the results (e.g., quality of notes and summaries, selectivity of re-reading). To overcome the variance in text processing and respective strategy utilization due to reading performance or the strategy knowledge, the present study was conducted with a selective sample of high-performing readers possessing a high level of strategy knowledge in reading. The sample of high achievers was chosen over a sample of low achievers because they possessed less strategy knowledge overall, and the reasons for low achievement in reading in a sample of ninth graders are varied, often confounded by general school-related difficulties or individual factors such as lack of motivation, mental handicaps, or a different language background, making it difficult to sample so that groups can be compared.

Process-based measures of reading strategies and their relation to self-report data

Evidence for the widely accepted assumption that reading strategies support and increase reading comprehension and performance in reading comprehension tests is mainly gained from studies using rather unstandardized, concurrent measures, such as think-aloud protocols (see Artelt & Neuenhaus, 2010; Pressley, 2000), observations (Bannert & Mengelkamp, 2007), or trace data (Bråten & Samuelstuen, 2007). Since think-aloud protocols enable insights on cognitive processes (Cromley & Azevedo, 2006), they are valuable for the investigation of strategies that are difficult to observe (covert strategies). For the assessment of observable strategic behavior (overt strategies), such as underlining, note taking, and summarizing, findings collected via trace data support the assumption of a strong relation existing between the quality of reading strategies and performance (Bol et al., 2005).

In order to assess covert reading strategies such as re-reading, elaboration and the drawing of local or global inferences in a more unobtrusive way than the think-aloud protocols, eye movements, pen movements, or computer-based tracing of reading behavior have been used. All these measures provide valuable opportunities to investigate strategic behavior during reading (Cerdán et al., 2011a, b; Magliano et al., 2011; Vidal-Abarca et al., 2010).

Reading times are usually viewed as an indicator of cognitive processes and it is assumed that the longer we look at particular words and sentences, the longer they are cognitively processed (eye-mind assumption: Just & Carpenter, 1980). Therefore, the overall time needed to complete a task is an indicator of strategy use, but it is also an indicator of task difficulty and individual reading skills (Goldhammer et al., 2014; Naumann & Goldhammer, 2017).

When reading a text in order to answer questions afterwards (question-driven processing or task-oriented reading, see Cerdán et al., 2011a, b), the overall time taken on the task can be broken down into text skimming, first-time text reading, re-reading the text, processing the question, and question-driven re-reading of the text. Skimming refers to reading over the text in a quick manner in order to get a general idea of the content (Rayner et al., 2016). As such, it is an important strategy in order to deal with a huge amount of information (see Paris et al., 1983). However, as compared to normal reading, comprehension is impaired during skimming (for an overview see Rayner et al., 2016). Reading a text prior to answering text-related questions increases deep comprehension and facilitates recall (Cerdán

et al., 2009). Yet, this only translates into performance in a comprehension test when the text is not available during test taking (Schroeder, 2011). Second to the initial reading, the selective re-reading of information is also an important strategy for understanding (see van den Broek & Helder, 2017). Re-reading can be seen as a metacognitive strategy of dealing with comprehension problems (see Cho et al., 2018; Greene & Azevedo, 2007).

The process of question-driven processing of documents is described in the TRACE model (Rouet, 2006): The question is read (step 1) and a task model is constructed (step 2). Afterwards, it is decided whether external information is needed (step 3). If not, the internal response model is updated (step 7). If yes, information is selected (step 4), processed (step 5), and a decision is made as to whether or not the information is relevant (step 6). If not, steps 4–6 are repeated. If the information is relevant, the internal response model is updated (step 7), the completeness of the answer is checked (step 8), and the output is created (step 9). Based on this model, the time spent on understanding the question (step 1) and the time spent on question-driven re-reading of the text (step 5) are of interest (see Cerdán et al., 2009; Higgs et al., 2017). Moreover, also, the task difficulty should play a role. In the case of more difficult tasks, a strategic reader should re-read the text more frequently than he or she does when answering an easier task.

Still, only few studies exist investigating the relation between self-reported strategy use in reading and process-based measures of reading strategies (Hyona et al., 2002). One example is the study by Bråten and Samuelstuen (2007). They compared a task-specific self-report of reading strategies with trace data, which covered underlining and organizing. They found close relationships of self-report and trace data, plus reasonably high correlations of self-reported and trace data organization strategies with performance. However, as discussed before, self-report questionnaires usually assess general habits and not task-specific actions. Little is known so far about the relation between SRQs and reading time-based indicators of strategic behavior, such as text skimming or selective re-reading of text. As discussed above, self-reported strategy use can be understood as a general habit, thus reflecting the characteristics of a strategic reader when assessed in a decontextualised way (Pressley et al., 1989; see McNamara, 2011).

Aim of the study and research hypotheses

The aim of the present study was to investigate differences in the strategic reading behavior between high-achieving students with superior strategy knowledge who reported frequent strategy use (FSU) and those who reported seldom strategy use (SSU) in a general reading-related strategy questionnaire. The high-achieving and strategy-knowing students of the selected sample are supposed to choose adequate strategies and to possess the cognitive capacity to utilize them. With the selection of the sample, we explicitly ruled out that differences found for strategic reading behavior are due to students' level of reading performance, because none of the participants in the present sample had to struggle with basic text processing demands. Due to their superior level of strategy knowledge, all of them had appropriate strategies available to read the text and solve the tasks in their strategically preferred way. We expect that differences in the self-reported strategy use reflect individual preferences in strategic reading behavior.

In order to investigate differences between FSU students und SSU students in terms of different aspects of strategic reading behavior, we examined the first reading of text (initial reading with skimming; initial thorough reading) as well as task-related behavior

(frequency of task-related re-reading, selectivity of task-related re-reading) while working through easier and more difficult tasks of a multiple-choice reading test. We expect SSU students to thoroughly read through the text in order to engage in deep strategic processing or comprehension, while FSU students rather skim through the text to achieve a surface-level comprehension in order to selectively re-read passages after task exhibition. Therefore, especially re-reading of parts of the text to reassure oneself before answering difficult tasks can be viewed as strategic behavior, because when uncertain, affirming the response to a multiple-choice item is advisable. As the use of strategies is most appropriate and effective when task demands are sufficiently high, we expect differences between the FSU and SSU students to become particularly obvious for difficult reading tasks.

Our hypotheses were as follows:

Hypothesis 1: FSU and SSU students show different reading behaviors for initial text reading. We expect seldom strategy user to engage in reading that is more thorough while frequent strategy user is expected to rather skim the text in order to strategically re-read task-relevant text passages later on.

Hypothesis 2: FSU and SSU students differ in their task-related behavior, (a) with respect to the frequency of task-related re-reading and (b) with respect to their selectivity for re-reading paragraphs containing task-relevant information (re-reading of target passages).

Hypotheses 3: Task difficulty influences the task-related re-reading behavior of FSU and SSU students such that the strategic reader in particular (FSU)—but to a lesser extend also the less strategic reader (SSU)—should re-read the text more frequently when answering difficult tasks than he or she does when answering an easier task.

Method

Sample and design

Our sample consisted of 22 ninth grade students (16 female; 6 male). The students were recruited as a follow-up sample of a longitudinal study with originally 578 students. Therefore, we already had data on reading performance and strategy knowledge for the recruiting. The grade level was chosen to use the full potential of the sample for the selection of the subsample. Compulsory schooling ends after ninth grade in Germany, which means that ninth grade was the latest possible grade level to easily reach the students via school. The selection based on the data from the longitudinal study ensured that all participants were excellent readers with a distinguished strategy knowledge. Based on the longitudinal sample (Schneider et al., 2017), 82 students with very good reading comprehension scores and a high score in strategy knowledge (top quartile) were invited to participate in our computer-based test session: 33 with a very high level of self-reported strategy use (top quartile) and 49 with a very low level of self-reported strategy use (bottom quartile). Altogether, 22 ninth grade students with a regular school carrier (usually 15 years old) participated and all of them received a reward of 20 Euro. Eleven of these students reported very high strategy use (top quartile), while another 11 students reported very low strategy use (bottom quartile). Therefore, 11 students (8 female and 3 male) were assigned to the frequent strategy user group (FSU students) and 11 students (8 female and 3 male) were assigned to the seldom strategy user group (SSU students).

Procedure

All participants worked through a computer-based reading test comprising of an expository text with six paragraphs and 10 multiple-choice items. In the test introduction, they were asked to read the text and answer the subsequent multiple-choice questions. They were not explicitly asked to show any strategic behavior. During reading, they could navigate freely through the text and jump from one paragraph to any other paragraph. While task taking, the text was available only on demand, via a go back button, and only one multiple-choice task (question and all possible answers) was shown at the time. The participants had to provide a response in order to move on to the next task.

Before the actual test session started, all participants had to work through a demo version of the test in order to learn how to proceed with the reading tasks. After this instruction, they worked through the experimental text and the related reading tasks. The participants had to provide answers to all of the questions in order to finish the test (forced choice) without taking notes. The test automatically closed after answering the final test task.

The test session took place at the university as group testing with three to six persons. The test was administered via laptops provided by the experimenter. The computer-based test took about 60 min with no time restrictions. At each session, a faculty member introduced the test to the participants.

Instruments

Prior reading comprehension, metacognitive knowledge, and self-reported strategy use

Prior reading comprehension, metacognitive knowledge, and self-reported strategy use were assessed in an earlier study (Schneider et al., 2017). In order to identify high-performing readers, a reading comprehension test with 30 multiple-choice items across three different texts (318 to 552 words) was used (Cronbach's $\alpha = .82$). The first two texts were expository texts (one about Tanzania, the second about brain development) and the third an essay from Berthold Brecht. For each text, some of the items captured information selection, while others either captured the drawing of local or the drawing of global inferences.

Metacognitive strategy knowledge was assessed by means of a scenario-based and domain-specific metacognitive knowledge test for reading (Neuenhaus et al., 2011; Artelt et al., 2012) with a maximum score of 38 points. All participants received five reading scenarios describing typical challenges in reading. Each of the scenarios was accompanied by a list of strategies. The strategies varied in their appropriateness to solve the situation described in the scenario. Participants were asked to rate the quality of the strategy in comparison to the other strategies provided on a 6-point scale analog to the German grade system (1 = very good to 6 = faulty). To evaluate the responses, we computed pairwise comparisons of the strategy ratings based on the results of an expert survey (Neuenhaus et al., 2011). For the scoring, one point was given each time superior strategies received a better rating than an inferior strategy. No point was given when strategy pairs received the same rating or when the inferior strategy was rated as better than a superior one (Cronbach's $\alpha = .82$).

Frequency of strategy use was assessed with seven items on a 5-point Likert scale ranging from very seldom to very often (Cronbach's $\alpha = .73$). In line with other general strategy questionnaires (e.g., Pintrich et al., 1993), we constructed statements regarding

the situation-independent overall use of reading strategies relevant for the age group under investigation (see Table 1).

Process-based assessment of reading strategy use

The assessment of initial reading and task-related reading behavior took place using a computer-based multiple-choice reading test. The reading test comprised an expository text about climate change with 551 words and 10 multiple-choice items. The text was divided into five content paragraphs (plus a headline and a final statement which was not included in any analysis). The paragraphs contained between 68 and 137 words. The Fletscher readability index for all paragraphs indicated a high level of text difficulty (university level). Students could freely choose the paragraphs and the order of reading. In order to assess the reading times per paragraph, the text we provided was masked (unreadable) and could only be uncovered paragraph by paragraph via mouse click (for details see Cerdán et al., 2009). It was not required to read any text passages at all before processing through the first question (but all students read some of the text first). For later analyses of reading times and for comparisons of reading times across paragraphs, the reading times per word were calculated for each paragraph. The 10 multiple-choice items were provided separately, one task per page, in a forced choice format. While participants answered the multiple-choice items, they were able to revisit the text and to select all passages for re-reading. The frequency of re-reading and the duration of re-reading (reading time) were logged and performance across all ten multiple-choice items (sum score) was computed to serve as an indicator of test performance. For each of the multiple-choice items, the task difficulty was available from an independent sample of $N = 444$ ninth grade students (Pfost et al., 2013). Based on this data, the items were divided into five easy tasks with an average item difficulty of 0.60 and five difficult tasks with an average item difficulty of 0.36.

Reading times and frequencies of reading served to create the reading strategy indicators relevant for the present analysis. The reading times were computed to seconds per word to make them comparable across paragraphs. We excluded data of reading times below the level of recognition and potential random mouse clicking behavior by filtering data beyond a threshold level for text skimming. Therefore, reading time per word was set to a minimum of 0.12 s per word according to the criteria for skimming provided by Muter and Maurutto (1991). If a participant looked only very shortly at a specific paragraph and did not meet this criterion, the data for the paragraph for this participant was excluded.

Specifically, we created the following indicators of reading strategy use:

Table 1 Items for frequency of strategy use

When I read,
1. I summarize the content in my own words
2. I repeatedly check if I understand what I read
3. I ask myself what I already know about the topic of the text
4. I verbalize the main points of the text
5. I underline the most important parts of the text
6. I re-read difficult sentences more often and with special attention
7. I think about how to proceed through the text before I start reading

(1) Reading times per paragraph for *initial reading with skimming*. For each paragraph, reading times below the level of skimming (0.12 s per word according to Muter & Maurutto, 1991) were excluded before the initial reading with skimming time was calculated. The selected reading times were summed up across paragraphs.
(2) Reading times per paragraph for *initial thorough reading*. For the reading times of each paragraph, only reading times above the criterion for thorough reading (0.30 s per word according to Muter & Maurutto, 1991) were included. The score of reading times per paragraph was summed up across all paragraphs.
(3) Frequency of task-related re-reading. For each participant, it was counted how many times they re-read a paragraph after viewing a particular question.
(4) Reading times for task-related re-reading. Sum score of time spent on re-reading paragraphs after task viewing.
(5) Time spent on the multiple-choice tasks. Sum score of time spent on all tasks and their answer options.
(6) Frequency of task-related re-reading of target paragraph. Participant-wise count of how many times they re-read paragraphs containing relevant information to answer the task after it has been viewed, summed up across all tasks.
(7) Reading times for task-related re-reading of target paragraph. Sum score of time spent on re-reading paragraphs containing relevant information to answer the task previously viewed, summed up across all tasks.
(8) Frequency of task-related re-reading for easy and difficult tasks. Count on how many times participants re-read a paragraph after viewing easy tasks and after viewing difficult tasks.
(9) Reading times for task-related re-reading of easy and of difficult tasks. Sum score of time spent on re-reading paragraphs related to easy items and paragraphs related to difficult items.

Analysis

The data set contained missing data neither on test performance due to the multiple-choice format of the test nor on the behavior measures during the computer-based test. To test differences between the FSU and SSU students on reading times and re-reading behavior, independent sample *t*-tests were conducted. To analyze interaction effects between student groups (FSU/SSU) and task difficulty (easy/difficult), 2×2 repeated measure ANOVAS were applied. To control for the violation of normal distribution due to the small sample size, the results were verified using Mann–Whitney *U* tests. Findings of the nonparametric tests are only reported when they are in conflict to the findings of the ANOVAS. All analyses were done with SPSS 21.

Results

Independent sample *t*-tests were conducted to control for differences in overall test time and test performance. These revealed neither a significant difference in test performance ($t=0.62$; $df=20$; $p=0.545$; $d=0.27$) between FSU students ($N=11$; $M=5.82$; $SD=1.60$) and SSU students ($N=11$; $M=6.36$; $SD=2.46$) nor a significant difference in test time ($t=0.04$; $df=20$; $p=0.973$; $d=0.02$) between FSU students ($N=11$; $M=587.46$; $SD=108.72$) and SSU students ($N=11$; $M=585.82$; $SD=112.76$).

Hypothesis 1: differences in first reading of text

To address the first research hypothesis (differences between groups in initial reading with skimming and thorough reading), differences in reading times during initial reading were analyzed using independent sample *t*-tests. The findings revealed no significant differences in overall reading time between FSU students ($N=10$; $M=161.87$; $SD=58.96$) and SSU students ($N=11$; $M=211.48$; $SD=89.90$) when reading times included skimming ($t=1.48$; $df=19$; $p=0.156$; $d=0.63$). When skimming of text was excluded and only the reading times for thorough reading were analyzed, differences between the FSU students ($N=10$; $M=142.24$; $SD=70.64$) and the SSU students ($N=10$; $M=220.71$; $SD=75.18$) were significant ($t=2.41$; $df=18$; $p=0.027$; $d=0.96$). For a visualization of these findings, see Fig. 1.

Hypothesis 2: task-related re-reading

The analysis of task-related behavior addressing the second research question revealed a significant difference in the frequency of task-related re-reading (FSU: $N=11$; $M=6.09$; $SD=1.70$; SSU: $N=11$; $M=3.91$; SD = 2.81; $t=2.20$; $df=20$; $p=0.039$; $d=0.86$) and in the frequency of re-reading the target passage (FSU: $N=11$; $M=2.36$; $SD=1.21$; SSU: $N=8$; $M=0.63$; $SD=0.74$; $t=3.60$; $df=17$; $p=0.002$; $d=1.29$), as shown in Fig. 2. No difference was found for the overall time spent on the tasks ($t=1.28$; $df=20$; $p=0.217$; $d=0.54$) between FSU students ($N=11$; $M=440.30$; $SD=124.57$) and SSU students ($N=11$; $M=374.34$; $SD=117.90$).

Hypothesis 3: adaptation to task difficulty

To address the third research hypothesis (whether differences in task-related re-reading behavior between FSU students and SSU students were influenced by task difficulty) and to check for differences in task-related behavior between the two groups of students, their re-reading for difficult and easy items was compared. The 2×2 repeated measure ANOVA for the frequency of re-reading of text (Fig. 3) revealed a significant main effect for the between-subject factor *student group* (F (1, 20) = 4.86; $p=0.039$; $\eta_p^2=0.20$). No significant main effect was found for the repeated measure factor *task difficulty* ($\Lambda=0.937$; F (1, 20) = 1.34; $p=0.261$; $\eta_p^2=0.06$) or for the interaction between task difficulty and group (F (1, 20) = 0.75; $p=0.396$; $\eta_p^2=0.04$). The easy tasks were on average re-read (FSU: $N=11$; $M=3.09$; $SD=0.83$; SSU: $N=11$; $M=2.27$; $SD=1.35$) alike the difficult tasks (FSU: $N=11$; $M=3.00$; $SD=1.48$; SSU: $N=11$; $M=1.64$; $SD=1.69$). The 2×2 repeated measure ANOVA for the frequency of re-reading of the target passage (Fig. 4) showed significant main effects for the repeated measure factor task difficulty (F (1, 14) = 10.48; $p=0.006$; $\eta_p^2=0.43$) and the between-subject factor student group (F (1, 14) = 7.48; $p=0.016$; $\eta_p^2=0.35$), but no significant interaction was found between task difficulty and group (F (1, 14) = 0.087; $p=0.773$; $\eta_p^2=0.01$). The FSU students re-read the target passages more frequently for both the easy tasks (FSU: $N=10$; $M=1.70$; $SD=0.95$; SSU: $N=6$; $M=0.83$; $SD=0.75$) and the difficult tasks (FSU: $N=10$; $M=0.70$; $SD=0.82$; SSU: $N=6$; $M=0.00$; $SD=0.00$) than the SSU students.

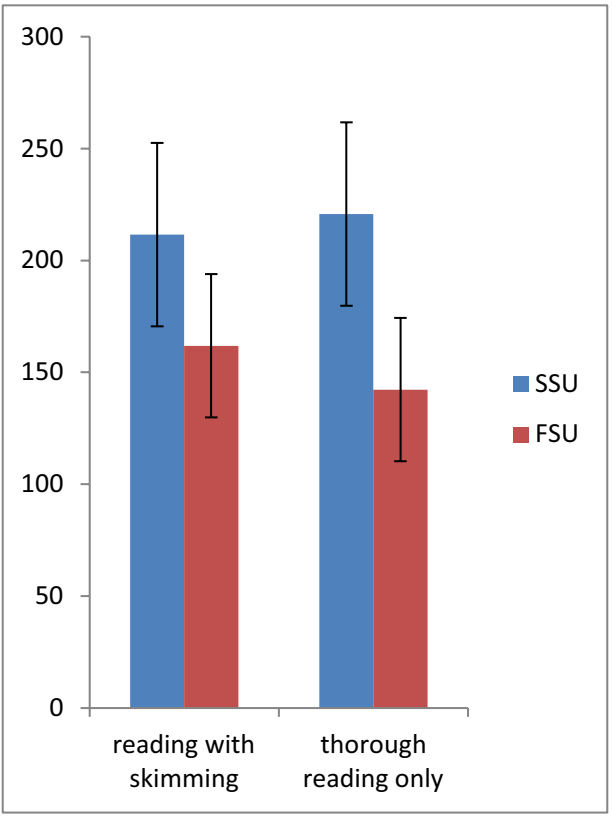

Fig. 1 Initial reading with skimming and initial thorough reading—mean sum score of reading times in seconds for SSU und FSU students

The 2×2 repeated measure ANOVA for the time students spent on easy and difficult tasks revealed no significant main effect of the repeated measure factor task difficulty (F (1, 20)=4.15; p=0.055; η_p^2=0.17) and the between-subject factor student group (F (1, 20)=1.63; p=0.217; η_p^2=0.08). The interaction effect between student group and task difficulty was not significant either (F (1, 20)=0.44, p=0.513; η_p^2=0.02). The 2×2 repeated measure ANOVA for test performance on easy and difficult tasks showed a significant main effect for the repeated measure factor task difficulty (F (1, 20)=6.15; p=0.022; η_p^2=0.24), that is, the participants solved more of the easy tasks (N=22; M=3.41; SD=1.18) than of the difficult tasks (N=22; M=2.68; SD=1.32). No significant main effect was found for the between-subject factor student group (F (1, 20)=0.38; p=0.545; η_p^2=0.02) nor was there a significant interaction effect between task difficulty and student group (F (1, 20)=3.46; p=0.078; η_p^2=0.15).

Discussion

The aim of the present study was to investigate the relation between self-reported strategy use and strategic reading behaviors in a homogeneous group of high-achieving students with superior knowledge about reading strategies, but very different self-reports on

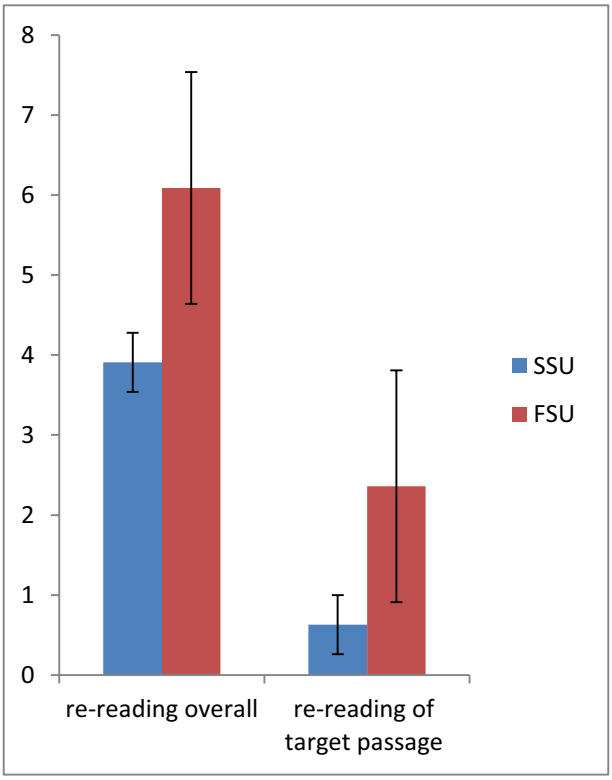

Fig. 2 Frequency of task-related reading (absolute values)

the frequency of reading-related strategies in the SRQ. With the log-file data from the computer-based test on strategic reading behavior, we first compared the initial reading behavior of the two groups. Afterwards, we tested for differences in task-related re-reading behavior and analyzed the effects of task difficulty on re-reading behavior of FSU and SSU students.

Our findings indicated that the students' self-reported strategy use corresponds to reading-related behavior during initial reading as well as to strategic behavior during the multiple-choice reading task. The SSU students spent more time on initial thorough reading of the text than FSU students. The FSU students on the contrary showed a tendency to re-read more (overall). They especially re-read significantly more task-specific passages (hypothesis 2) whereas the re-reading behavior was not significantly affected by task difficulty (hypothesis 3).

Overall, our findings on the high-achieving students indicated that students reporting frequent strategy use and students reporting seldom strategy use did not differ with respect to overall test performance or with respect to overall testing time during the computer-based test procedure. Instead, it turned out that differences between the two groups of students were visible in the way they processed the text and worked through the text-related comprehension tasks. In line with the assumption that students differ in their reading behavior (Hyona et al., 2002), our findings can be interpreted such that differences in self-reported strategy use correspond to strategically different ways of processing expository

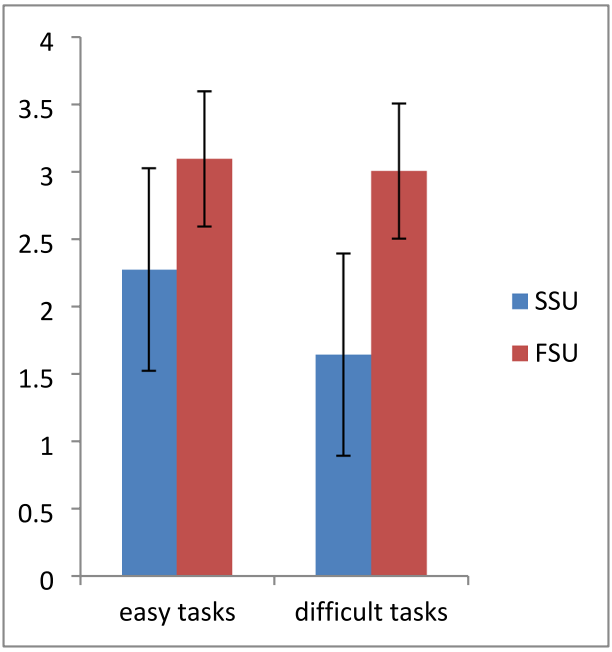

Fig. 3 Frequency of re-reading of text for easy vs. difficult tasks

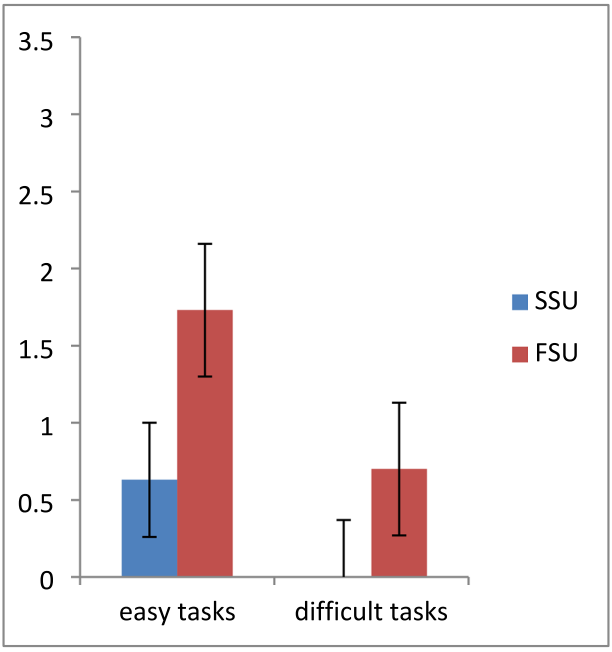

Fig. 4 Frequency of re-reading of target passages for easy vs. difficult tasks

text, both during initial reading and task-specific reading. Nevertheless, the different strategic ways of processing seem to lead to comparable reading performance and appear to be equally effective in terms of time invested to reach the performance level.

Findings in the present study are based on a small sample of students, bringing about disadvantages with respect to test power. Even though this limitation has to be considered and some of our findings are not significant, effect sizes are moderate to high and the significant findings indicate different patterns of strategic text processing for the two groups. It appears that FSU students skim through the text and strategically re-read relevant passages in order to provide correct responses. SSU students instead read the text more thoroughly during their initial reading but show less re-reading to check their responses. As pointed out in the "Introduction" section, differences in strategic processing could reflect the distinction drawn between deep processing strategies and surface processing strategies (Coutinho & Neuman, 2008) as well as between deep-level comprehension and surface-level comprehension of text (Neuenhaus et al., 2018). With this in mind, SSU students thoroughly read through the text while they may aim at deep strategic processing or comprehension. FSU students rather skim through the text and may aim at surface-level comprehension in order to selectively re-read passages after task exhibition. In line with findings regarding the text availability during reading comprehension tests, it has been shown that the availability of text during a reading comprehension test leads to a suboptimal representation of the text during reading but helps to solve the tasks strategically (Ozuru et al., 2007; Schroeder, 2011). Only when the text is not available for solving the tasks, the participants have to build up a good representation during the initial reading of the text (Schroeder, 2011). In our study, the text was available for all students during task solving. However, it seems that only FSU students took advantage of this and worked strategically through the test, while SSU students did the same they would have done if the text was not available for solving the tasks.

It is important to note that even though the two groups showed differences in their strategic text processing as well as in their task-related behavior, they did not differ in their test performance. These findings are in line with studies reporting little correlation between self-report measures and performance (Lind & Sandmann, 2003) and with studies reporting that different approaches to text learning are equivalent for performance (Merchie & Van Keer, 2014). Taking these findings into account, our results might suggest that self-report measures, at least to a certain degree, correspond with strategic behavior, even though different strategic approaches bring about little to no differences in performance. Thus, both a superficial initial reading combined with strategic task-solving behavior (FSU students) and a thorough reading approach without strategic task-solving behavior (SSU students) seem to lead to the same performance. Nevertheless, the students in our sample appear to favor one approach over the other. In further studies, it will be necessary to investigate if performance-independent differences in strategic text processing can be found for readers of all performance levels and if approaches depend on individual differences such as reading motivation and learning habits or on text characteristics such as genre or text difficulty. For strategy training in reading, it might be important to consider individual differences in the strategic approaches and to learn more about opportunities to foster students' strategic processing. Taking students' strategic preferences into account, it would be revealing to compare the effect of instructional methods for strategy use.

With respect to the validity of general SRQs for reading, the present findings indicate that self-reported strategy use corresponds to strategic behavior in a very general way. It appears that the students in our sample expressed their preference with their

self-report of strategy use. In such, the SRQs reflect their strategic behavior. Thus, the findings of the present study suggest that SRQs might be appropriate to assess strategical behavior in reading at least to some degree.

Limitations

Despite the contributions of the study, some limitations are to be considered. Even though we gained significant results on the strategic processing differences, our sample was quite small and selective. It was exclusively comprised of good readers with above-average metacognitive knowledge in reading. As it has been shown that high-achieving students use strategies more effectively and are more flexible in their strategy use than low achieving students (Vauras et al., 1994), the selection of our sample supported the investigation of strategic processes. In a next step, it will be necessary to increase the generalizability of the presented findings across students with different levels of performance and to learn more about the interplay between self-reported strategy use, strategy-related knowledge, and the application of strategies for less skilled readers and for students who report frequent strategy use but lack the strategy-related knowledge to select strategies appropriately reading.

As mentioned above, the small sample brought about disadvantages in terms of test power, which could be overcome by a sample selected on the basis of power analyses. In the present study, we took advantage of an available longitudinal sample in order to select participants and had to deal with the low participant rates, without the opportunity to resample. In future studies, it would therefore be recommended to choose national large-scale panel data, such as the national educational panel study (NEPS) to reach higher participant rates (Blossfeld & von Maurice, 2019).

Conclusion

The present study contributes to understanding the sometimes missing relationship of self-reported strategy use and performance in reading comprehension. It showed for a small and highly selective sample that self-reported differences in strategy approach come along with different strategic behaviors, and that these different ways of strategic approach both can lead to the same high performance. Further studies are necessary to generalize these findings across age groups, text genres, and readers across different performance levels. To meet these goals and to enable in-depth analysis of strategic processes during initial reading and during test taking, larger samples of students are required. Future studies are intended with a larger sample of university students, with the aim to further analyze the relation between strategic behavior, strategy knowledge, and reading performance.

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Declarations

Consent for publication Responsibility for the contents of this publication rests with the authors.

Conflict of interest The authors declare no competing interests.

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Dr. Nora Neuenhaus.

Current research:

Strategy Use in Reading, Metacognition and Self-regulation, Metacomprehension.

Most relevant publications in the field of Psychology of Education:

Edossa, A. K., Neuenhaus, N., Artelt, C., Lingel, K. & Schneider, W. (2018). Developmental Relationship between Declarative Metacognitive Knowledge and Reading Comprehension during Secondary School. /European Journal of Psychology of Education./https://doi.org/10.1007/s10212-018-0393-x.

Neuenhaus, N., Schneider, W., Lingel, K. & Artelt, C. (2018). Does metacognitive knowledge mediate the relation between goal orientations and educational achievement in secondary school students? / Electronic Journal of Research in Educational Psychology, 16/ (1), 5-33. https://doi.org/10.25115/ejrep.v16i44.1935.

Schneider, W., Lingel, K. Artelt, C. & Neuenhaus, N. (2017). Metacognitive Knowledge in Secondary School Students: Assessment, Structure, and Developmental Change. In D. Leutner, J. Fleischer, J. Grünkorn & E. Klieme (Hrsg.), *Competence Assessment in Education: Research, Models and Instruments: Methodology of Educational Measurement and Assessment*. Heidelberg: Springer.

Neuenhaus, N., Artelt, C., Lingel, K. & Schneider, W. (2011). Fifth graders metacognitive knowledge: general or domain specific? European Journal of Psychology of Education, 26, 163-178.

Felix Grobe.

Current themes of research:

Interviewer effects, survey methods.

Most relevant publications in the field of Psychology of Education:

Grobe, F. B. (2017): Prüfungsformen und Kompetenzbeförderung – Empfehlungen für ein „gutes Studium “ aus studentischer Perspektive. In: König, Kirsten (Hg.): Gut studieren? Heute! Spurensuche nach Bedingungen und Möglichkeiten eines gelingenden Studiums in Bologna-Strukturen. AVM.edition.

Dr. Cornelia Schoor.

Current research:

Multiple text comprehension, attitudes towards science, digital and data literacy.

Most relevant publications in the field of Psychology of Education:

Schoor, C., Rouet, J.-F., Artelt, C., Mahlow, N., Hahnel, C., Kroehne, U., & Goldhammer, F. (2021). Readers' perceived task demands and their relation to multiple document comprehension strategies and outcome. *Learning and Individual Differences, 88*, 102018. https://doi.org/10.1016/j.lindif.2021.102018.

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Schoor, C., Narciss, S., & Körndle, H. (2015). Regulation during cooperative and collaborative learning: A theory-based review of terms and concepts. *Educational Psychologist, 50*(2), 97-119.

Prof. Dr. Cordula Artelt.

Current themes of research:

Multiple Document Comprehension, Data Literacy and Digital Learning, Reading and text comprehension, Metacognition and Self-Regulated Learning, Methods of large-scale assessment, Teacher judgments.

Most relevant publications in the field of Psychology of Education:

Wicht, A., Durda, T., Krejcik, L., Artelt, C., Grotlüschen, A., Rammstedt, B. & Lechner, C. M. (2021). Low Literacy is Not Set in Stone: Longitudinal Evidence on the Development of Low Literacy During Adulthood. Zeitschrift für Pädagogik, 67. Beiheft. 109-132. https://doi.org/10.3262/ZPB2101109.

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Miyamoto, A., Pfost, M. & Artelt, C. (2018). Reciprocal Relations between Intrinsic Reading Motivation and Reading Competence: A Comparison between Native and Immigrant.

Students in Germany. Journal of Research in Reading, 41 (1), 176-196. https://doi.org/10.1111/1467-9817.12113.

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International Journal of Behavioral Development, 1-11. https://doi.org/10.1177/0165025416687412.

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