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Abstract

The goal was to test whether cognitive flexibility moderates the relation between reading strategy use and reading comprehension during the elementary years. Seventy-five second through fifth grade students completed a think aloud task and a metacognitive questionnaire to measure reading strategies, two card-sorting tasks to measure general and reading-specific cognitive flexibility, and one standardized measure of reading comprehension, as well as measures of oral reading fluency and vocabulary. As expected, oral reading fluency and vocabulary predicted reading comprehension, as did reading-specific flexibility. Importantly, reading-specific flexibility had a significant moderating effect, over and above the other effects. Specifically, weak reading-specific flexibility skills were associated with a negative relation between reading strategy use during think aloud and reading comprehension, suggesting that children with weak flexibility skills are less adept at using reading strategies effectively.

Keywords: reading comprehension, reading strategies, cognitive flexibility, reading-specific flexibility, elementary years

Reading-Specific Flexibility Moderates the Relation Between Reading Strategy Use and Reading Comprehension During the Elementary Years

Successful reading requires mastery at multiple levels. Reading comprehension involves constructing meaning from text by bringing together details from the text, the reader, and the situation. According to the simple view, reading comprehension draws on two separate components that are necessary though not singly sufficient for success: decoding and linguistic comprehension (Hoover & Gough, 1990). For example, children use basic decoding skills to distinguish and manipulate sounds in written text, to understand the relation between specific letters and sounds, and to read with accuracy and speed. Additionally, reading performance is enhanced by knowledge of words and their meanings (National Reading Panel, 2000). Oral language skills such as narrative comprehension and receptive vocabulary also support reading comprehension (Kendeou, van den Broek, White, & Lynch, 2009; Rapp et al., 2007).

Promoting reading success is important, including documenting factors that support reading comprehension. Previous research findings indicate that reading strategy use is related to reading comprehension (e.g., Kolic-Vehovic & Bajasanski, 2006; Schellings, Aarnoutse, & van Leeuwe, 2006); however, details about the nature of this relation remain unclear. That is, why might strategies support reading comprehension? Moreover, do strategies operate similarly for novice and expert readers or for struggling and proficient readers? The conceptual goal of this project was to understand the mechanisms by which reading strategies support comprehension during the elementary years. In particular, we focused on how cognitive flexibility—the ability to switch fluidly between activities—may contribute to the effective implementation of reading strategies. Growth in cognitive flexibility has been linked to gains in reading comprehension (Cartwright, 2002; Cartwright, Isaac, & Dandy, 2006), but the combined role of reading strategies and cognitive flexibility has not been assessed. As such, our empirical goal was to test whether cognitive flexibility moderates the relation between reading strategy use and reading comprehension during the elementary years, over and above the known effects of age, oral reading fluency, and vocabulary. We predicted this moderating relation based on our assertion that without flexibility, students would have difficulty accessing strategies, utilizing the strategies effectively, and reaping benefits from the strategies to facilitate reading comprehension. In short, they would have difficulty focusing on integrating the various demands of decoding and linguistic comprehension necessary for reading comprehension of narrative texts.

It is not surprising that substantial growth in reading comprehension is evident throughout the elementary and middle school years. For example, Aarnoutse, van Leeuwe, Voeten, and Oud (2001) explored the development of reading comprehension in a longitudinal study spanning first through sixth grades, finding the steepest increase in reading comprehension in third grade. Kolic-Vehovec and Bajsanski (2006) tested fifth through eighth grade students' reading comprehension with a cloze task, which consisted of a paragraph of sentences with missing words for which participants selected a word to fit in each blank, and a task in which participants read a short passage and answered open-ended questions. Students exhibited clear gains in reading comprehension from fifth to eighth grade.

One factor that may contribute to reading success is reading strategies. In both research and practical settings, reading strategies encompass a range of activities that support reading success, from prompts used for word decoding to metacognitive techniques (e.g., Baker, 2005; Farrington-Flint, Coyne, Stiler, & Heath, 2008; Paris & Flukes, 2005). For instance, McEwan (2004) described deliberative cognitive strategies—behaviors and thoughts—that make reading and learning more efficient. We know that students use multiple strategies for reading, which may differ over age, reading level, and context (Baker, 2005; Brenna, 1995; Brown, Pressley, Van Meter, & Schuder, 1996; Gersten, Fuchs, Williams, & Baker, 2001; Kragler & Martin, 2009; Paris & Flukes, 2005). In the present project, text-level strategies (rather than word-level strategies) were our main focus.

Previous research findings have documented a strong relation between reading strategies and reading comprehension (Cain, 1999; Dermitzaki, Andreou, & Paraskeva, 2008; Graesser, 2007; Kolic-Vehovic & Bajsanski, 2006; Paris & Jacobs, 1984; Schellings et al., 2006; Vidal-Abarca, Mañá, & Gil, 2010). For example, Schellings et al. (2006) assessed third grade students' knowledge about reading strategies by focusing on their skills in identifying main ideas, making connections between text fragments, identifying the type of text, and regulating the reading process. In addition, students completed a standardized measure of reading comprehension utilizing a question-answering format. Reading strategy knowledge explained a significant portion of variance in reading comprehension. Additionally, good readers reported knowing more about reading strategies than did poor readers.

Readers coordinate many strategies and processes to achieve success in reading. For example, they use decoding and word-level processing as well as linguistic comprehension and passage-level processing to facilitate understanding of texts. Coordinating these processes requires cognitive flexibility—the ability to switch fluidly between activities—which is one component of executive functioning (Best & Miller, 2010; Cragg & Chevalier, 2012; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). Previous research suggests that flexibility increases across childhood, especially during the elementary years, and evinces wide individual variation regardless of age (Bock, Gallaway, & Hund, 2015; Cartwright, Marshall, Dandy, &

Isaac, 2010; Cartwright, 2008; Huizinga & van der Molen, 2011). These gains have been found for both general flexibility—domain-general aspects of shifting commonly included as one aspect of executive functioning (Bock et al., 2015; Cantin, Gnaedinger, Gallaway, Hesson-McInnis, & Hund, 2016)—and reading-specific flexibility—domain-specific aspects of coordination relevant for reading (Cartwright et al., 2010; Diaz et al., 2009).

We know that reading-specific flexibility is related to reading comprehension, as evidenced by research with early readers (Cartwright, 2002; Cartwright et al., 2010; Colé, Duncan, & Blaye, 2014; Diaz et al., 2009) and college students (Cartwright, 2007; Cartwright et al., 2006). Importantly, Cartwright (2002) found that reading-specific flexibility contributed to reading comprehension, even after controlling for age, domain-general flexibility, decoding skill, and verbal ability. Moreover, training participants to note both phonemic and semantic properties (i.e., reading-specific flexibility) resulted in gains in reading comprehension, even after controlling for factors such as age and general flexibility (see also Cartwright et al., 2016). This overall pattern of findings was replicated in French-speaking children (Colé et al., 2014). Some studies find robust relations between domain-general cognitive flexibility and reading comprehension (Cantin et al., 2016; see Yeniad et al., 2013 for a recent review); however, studies probing the roles of both reading-specific flexibility and general flexibility suggest that reading-specific effects on reading comprehension are evident over and above effects of general cognitive flexibility (Cartwright, 2002, 2007).

To date, the combined role of reading strategies and cognitive flexibility in predicting reading comprehension has not been assessed. We know that implementation of metacognitive strategies involves both knowledge of how the strategies work and monitoring of strategic processing in service of the goal (e.g., Baker & Brown, 1984). Moreover, we know that readers use decoding and linguistic comprehension skills to achieve success. It is our contention that integrating the many aspects of reading strategies and processes to facilitate comprehension thereby would benefit from flexibility—the executive functioning component related to fluid shifting and integration of multiple aspects of processing (see also Rapp et al., 2007). The primary goal of the current study was to determine whether flexibility moderates the relation between reading strategies and reading comprehension during the elementary years. Participants were second through fifth grade students who were asked to complete a think aloud task and a metacognitive questionnaire to assess reading strategies, two card-sorting tasks to assess reading-specific and general flexibility, and one standardized measure of reading comprehension, as well as measures of oral reading fluency and vocabulary. We predicted that the relation between reading strategies and reading comprehension would be moderated by reading-specific flexibility, but not general flexibility, over and above effects of age, oral reading fluency, and vocabulary.

Method

Participants

Participants included 75 children (28 boys, 47 girls) in second through fifth grade (*M* = 9 years 2.59 months, *SD* = 13.25 months). Data from one female participant were omitted because there were insufficient reading outcome measures for analysis. Three other participants had one piece of missing data but were retained in the final data set, which included 18 second grade students, 35 third grade students, 14 fourth grade students, and 7 fifth grade students. Eighty-one percent of children were White, 3% were Asian, 4% were Black, 4% were Hispanic or Latino, and 6% were Biracial. No racial/ethnic information was reported by 2% of participants. Overall, mothers of participants in this sample were highly educated, with 84% of them earning a bachelor's degree or higher. Eleven percent of participants came from a household with less than $50,000 annual income, 35% came from a household with annual income between $50,000 and $100,000, 43% came from a household with annual income between $100,000 and $200,000, and 5% came from a household with annual income greater than $200,000. Six percent of parents did not provide this information.

G*Power 3 (Buchner, Erdfelder, Faul, & Lang, 2009) was utilized to calculate power estimates *a priori*. Assuming an effect size of .15, alpha of .05, and beta of .80, the power analysis suggested that 68 participants would be sufficient to detect significant effects. Approval from the Institutional Review Board was secured. Participants were recruited from a child participant pool maintained by the psychology department at a public university, as well as from flyers distributed by local schools and businesses serving children and families. Parents provided written consent for their participation and permission for child participation. Children provided written assent prior to participation.

Materials

Think aloud task. One reading passage from Pearson Longman (Hamm, 2012) and two passages from Teacher Vision (2012) were used for the think aloud procedure. The sample passage, a shortened version of "Julie's Race" (Hamm, 2012), contained 111 words and had a Flesch-Kincaid grade level readability estimate of 2.6. One of the test passages, "Trading Places" (Teacher Vision, 2012) contained 284 words and had a Flesch-Kincaid grade level readability estimate of 2.8. The other test passage, "My Day as a Pancake" (Teacher Vision, 2012), was comparable, with 285 total words and a Flesch-Kincaid grade level readability estimate of 3.1. The passages were made into booklets using laminated white paper (8 ½' x 11') with black print. The title and author of the passage were displayed on the first page, and each subsequent page contained a short section of text. For the sample passage, think aloud cues (three question marks) occurred after the title page and after each of the first two paragraphs containing 75 and 36 words. In the “Trading Places” (Teacher Vision, 2012) passage, each page (excluding the title page) included a single paragraph, with 84, 79, and 121 words. Think aloud cues occurred after the title and at the end of each paragraph. The “My Day as a Pancake” (Teacher Vision, 2012) passage contained dialogue, increasing the total number of paragraphs. Existing paragraph breaks were used to divide the passage into three sections with 79, 121, and 87 words per section. Think aloud cues occurred after the title page and at the end of each section.

Metacognitive questionnaire. Participants completed a metacognitive questionnaire as a self-report measure of perceived reading strategy use. The measure contained one sample item and 10 additional items, each using a 3-point Likert response format. The items represented five strategies—activating prior knowledge, setting goals, monitoring comprehension, making predictions, and questioning—with two items for each strategy. Participants viewed a laminated response card (8 ½’ x 11’) with a blank circle (‘almost never’), a half-filled circle (‘sometimes’), and a completely filled circle (‘often’) representing the three response options. The researcher noted participants’ responses on a data sheet.

Modified dimensional change card sorting task (DCCS). General flexibility was measured using a modified version of the DCCS task using 12 cards (Best & Miller, 2010; Bock et al., 2015). Each card was 3 ¾ inches x 2 ½ inches and printed on white paper with lamination. Four cards had a solid border around the shapes, four cards had a dashed border, and four cards had no border. Three white, plywood trays were used. They were 4-½ inches long x 3 ½ inches wide x 5 inches tall on the back and 2 inches tall on the front. Each tray was labeled with a card displaying the types of cards to be placed there: one card had two blue circles, one card had four red squares, and one card had six yellow triangles. The three cards were mutually exclusive so that only one tray was correct for each trial.

Reading-specific multiple classification task (RMC). Reading-specific flexibility was measured using a multiple classification task created by Cartwright (2002). It included three sets containing 12 cards each. The laminated cards were 5 inches x 4 ½ inches and were printed on white paper with a construction paper background. One set of 12 cards was used for training, and two sets of 12 cards each were used for the actual task. Each card set contained three cards for each of the four possible groups (e.g., food words that start with /b/, food words that start with /c/, animal words that start with /b/, and animal words that start with /c/). A 2 x 2 matrix was created using two wooden sticks (10 inches long x 1/5 inch wide x 1/5 inch tall).

Standard materials were utilized to assess reading comprehension (MAZE, AIMSweb, 2012), oral reading fluency (AIMSweb, 2012), and vocabulary (*WISC-IV* vocabulary subtest, Wechsler, 2003).

Procedure

Demographic details including gender, age, grade in school, race/ethnicity, and family income were gathered from parents. Children completed a set of activities to measure reading strategies, flexibility, reading comprehension, oral reading fluency, and vocabulary. All measures were administered during one session, lasting 75 to 90 minutes, at a university children's research laboratory. Researchers administered tasks in the following order: curriculum-based measure of comprehension (MAZE), DCCS, RMC, metacognitive questionnaire, think aloud, oral reading fluency (ORF), and vocabulary. A single order was chosen consistent with an individual difference approach. Short breaks were offered between tasks to keep the sessions manageable for child participants.

Think aloud procedure. Reading strategy usage was measured using a think aloud procedure. This type of procedure is frequently used to allow participants to explain their thinking as reading occurs (Caldwell & Leslie, 2010; Kendeou & van den Broek, 2007; McCrudden, 2012; Schellings, 2011; Schellings et al., 2006). First, the researcher explained the task to participants, informing them they would be asked to read three texts and then verbalize what they were thinking while reading. Although participants were encouraged to verbalize thoughts as they occurred, visual cues (i.e., dashed lines with three question marks) added after the title and after each paragraph of the passages prompted students to verbalize any thoughts aloud. Next, participants were given a short practice passage containing the think aloud cues. Participants practiced the thinking aloud process, and the researcher answered any questions. Then, participants read two test passages. Each time participants reached the question marks at the end of the page (i.e., after the title and after each paragraph), they were asked to state their thoughts (i.e., "Tell me what you are thinking."). If participants responded, "I don't know," or provided no verbal response, the researcher provided another verbal prompt such as, "Tell me something you are thinking about the story." After each response, researchers asked, "Is there anything else?" to elicit all available responses from participants. Participants were encouraged to continue reading when they responded, "No," indicating they did not have additional thoughts about their reading.

Each test passage contained four cues for verbal report. All responses were recorded to facilitate transcription and coding. Think aloud responses were divided into idea units, consistent with the coding strategy used by Schelling et al. (2006), and coded by strategy type based on the content of each idea unit. If an idea unit contained more than one strategy, it was included in all strategy types that applied. Based on previous research using think aloud protocols (Coté &

Goldman, 2004; Kolic-Vehovic & Bajsanski, 2006; Schellings et al., 2006) and other sources on reading strategies (Almasi, 2003; Almasi, Garas-York, & Hildreth, 2007; Gaskins, Satlow, & Pressley, 2007; McEwan, 2004), the following strategy types were used for coding think aloud responses: activating prior knowledge, setting goals, monitoring comprehension, making predictions, questioning, paraphrasing/summarizing, making inferences, and other. Researchers summed the number of instances of each strategy type for both passages to create an overall strategy score. Inter-rater reliability was assessed by calculating the Kappa coefficient based on two raters' independent coding of 20 participants' responses on the two think aloud passages. A Kappa of .77 was observed, indicating adequate inter-rater reliability.

Metacognitive questionnaire. A metacognitive questionnaire was used as a self-report measure of perceived reading strategy use. Items were developed based on conceptual considerations and previous iterations of the *Metacognitive Awareness of Reading Strategies Inventory* (Mokhtari & Reichard, 2002). Researchers read directions aloud to participants and placed the response card in front of them. The researcher then read the sample item to ensure participants understood the task. Next, the ten items were read individually to the participants, and the researcher noted their responses (e.g., "I ask myself questions when I read" and "When I read, I try to guess what will happen in the story"). Responses of 'almost never' were awarded one point, responses of 'sometimes' were awarded two points, and responses of 'often' were awarded three points. A total score including all items was calculated. Internal consistency for the scale (10 items) was .76, indicating acceptable internal consistency.

Modified DCCS task. A modified version of the DCCS task was used to measure general flexibility (Best & Miller, 2010; Bock et al., 2015). Participants sorted cards by color (i.e., red, blue, yellow), shape (i.e., circle, square, triangle), or number (i.e., two, four, six), depending on the type of border (i.e., solid, dashed, none) on each card in one mixed trial block containing 12 trials. Sorting rules and tray placement was randomized across participants. For each trial, the researcher labeled the type of border on the card (e.g., "This card has a solid border. Where does it go?") while placing the card on a designated place on the table. The participant then moved the card from the table to the appropriate tray based on the sorting rule and characteristics of the card. For instance, if the solid border meant to play the shape game, then a correct sort involved placing a card with a solid border and two blue triangles into the tray for triangles. Researchers used video recordings to code participants' sorting errors, which were summed across trials. Two researchers independently coded the responses for 20 of the 74 participants. An intraclass correlation was used to assess inter-rater reliability, yielding a correlation of 1.0.

RMC task. A reading-specific multiple classification task (RMC) was utilized to measure participants' reading-specific, simultaneous flexibility. Based on the protocol developed by Cartwright (2002), the task required participants to sort cards into a 2 x 2 matrix along dimensions of initial sound and word meaning (e.g., sorting words that start with /c/ and /b/ and are foods and animals). The researcher demonstrated the sorting rules during an initial training phase, sorting 12 cards into the appropriate categories. During the test phase, the researcher presented two sets of 12 cards and asked the participant to sort the cards into the matrix. If the placement was correct (i.e., the participant sorted by initial sound on one axis and meaning on the other, resulting in one box each of /c/ foods, /b/ foods, /c/ animals, and /b/ animals), the participant was asked to explain the reasoning for the sort. A correct explanation included reference to both classification standards (i.e., initial sound and meaning). If the placement was incorrect, the researcher corrected the sort and asked the participant to explain the reasoning for the new sort. One point was awarded for a correct sort, and two points were awarded for a correct justification, yielding scores ranging from 0 to 3. Primary coding was completed live. A subset of 20 sessions was coded independently from video recordings to assess inter-rater reliability. The intraclass correlations was 1.0, indicating high inter-rater reliability.

MAZE, a curriculum-based measure of reading comprehension. Reading comprehension was assessed using MAZE probes from AIMSweb (2012). Researchers administered passages based on grade level and followed standard administration rules. They showed participants how to select one option from the three bold words presented in parentheses at every seventh word. Participants then completed several more sample items before beginning the actual measure. Participants read one passage and selected the appropriate word each time they reached a set of word in parentheses. They were permitted to work for 3 minutes. Researchers scored correct responses according to standard protocol, with participants earning one point per correct response. Accuracy for attempted items was calculated and used in analyses.

Oral reading fluency (ORF). ORF was assessed using AIMSweb (2012) probes. Researchers administered passages based on grade level and followed standard administration rules. Participants read a passage for one minute while researchers recorded errors. Words read correctly per minute was calculated and used as a control variable (Sesma et al., 2009). ORF data were not available for one participant due to stopwatch malfunction.

Vocabulary. The vocabulary subtest from the *WISC-IV* (Wechsler, 2003) was administered and scored according to standard procedures. Vocabulary words of increasing difficulty were read aloud by the researcher, and participants were asked to provide definitions orally. Vocabulary was used as a control variable (Sesma et al, 2009).

Demographic questionnaire. Parents completed a demographic questionnaire that included child's birthdate/age, gender, race/ethnicity, and current grade level, as well as family income, and parent education.

Results

Descriptive statistics and Pearson correlations for variables of interest can be seen in Table 1. As expected, age was significantly correlated with vocabulary and MAZE reading comprehension scores. Moreover, oral reading fluency and vocabulary were strongly correlated with each other and with reading comprehension, as would be expected given extensive documentation of strong relations between fluency, vocabulary, and comprehension (Abbott, Wills, Miller, & Kaufman, 2012; Cutting, Materek, Cole, Levine, & Mahone, 2009). These correlations confirmed our decision to enter age, oral reading fluency, and vocabulary in the first three steps of the hierarchical, mean-centered cross-product regression analyses that follow. Reading strategy scores were entered in Step 4, and flexibility was entered in Step 5. Finally, the Reading Strategy x Flexibility interaction term was entered in Step 6 to test moderation (Baron & Kenny, 1986). The regression analyses were conducted separately for general and reading-specific flexibility (given we expected stronger findings for reading-specific flexibility) and for the two reading strategy scores (given low correlations between the strategy scores derived from these divergent measures). As expected, oral reading fluency and vocabulary significantly increased the explained variance. The summaries below focus on the subsequent models (i.e., Models 4, 5, and 6), which tested our key hypotheses.

Does Reading-Specific Flexibility Moderate the Relation between Reading Strategies and Reading Comprehension?

When using reading strategies evident in the think aloud task as our predictor, the addition of reading strategy use (in Step 4) did not significantly contribute to the variance explained over and above age, fluency, and vocabulary. Adding reading-specific flexibility to the model (i.e., Step 5) resulted in a marginally significant increase in variance explained. Furthermore, the interaction between reading strategies evident in the think aloud and reading-specific flexibility produced a significant increase in explained variance; thus, reading-specific flexibility partially moderated the relation between reading strategy use and reading comprehension (see Table 2). Tests of simple slopes indicated that when flexibility was one standard deviation above the mean, reading strategies yielded a standardized regression coefficient of .14, $p = .35$, indicating that the slope was not significant. In contrast, when flexibility was one standard deviation below the mean, reading strategies yielded a standardized regression coefficient of -.42, $p < .001$, indicating that the slope was significant. These findings suggest that weak reading-specific flexibility skills are associated with a negative relation between reading strategy use and reading comprehension, suggesting that children with weak reading-specific flexibility skills are less able to use reading strategies effectively.

When the metacognitive questionnaire replaced the think aloud as the measure of reading strategies, only fluency and vocabulary significantly increased the explained variance, and reading-specific flexibility produced a marginally significant increase in variance explained (see Table 3).

Does General Flexibility Moderate the Relation between Reading Strategies and Reading Comprehension?

To answer this question, the regression models were identical to those described above except that general flexibility scores from the modified dimensional change card sorting task

(DCCS) replaced reading-specific flexibility scores from the reading multiple classification task. Only oral reading fluency and vocabulary significantly increased the variance explained, providing no evidence that general flexibility moderated the relation between reading strategies and reading comprehension. These findings are consistent with our prediction that general flexibility would be less predictive of comprehension than would reading-specific flexibility.

Discussion

The goal of the current study was to clarify the influence of reading strategies and cognitive flexibility on reading comprehension, especially during the elementary years. Cognitive flexibility was investigated as a potential moderating variable between reading strategy use and reading comprehension. We predicted that the relation between reading strategy use and reading comprehension would become stronger as reading-specific flexibility skill increased, but the relation would not be affected by general flexibility. These predictions were based on our assertion that without flexibility, students would have difficulty accessing reading strategies, utilizing the strategies effectively to coordinate the many aspects of successful reading, and reaping benefits from the strategies to facilitate reading comprehension.

As predicted, reading-specific flexibility moderated the relation between reading strategy use and reading comprehension. In particular, the interaction between reading strategies evident in the think aloud task and reading-specific flexibility was significant, explaining 4% of variance. Interpretation of simple slopes indicated that weak reading-specific flexibility skills were associated with a negative relation between reading strategy use and reading comprehension. This negative relation suggests that children with weak reading-specific flexibility skills are less able to use reading strategies effectively. That is, even if they have the same knowledge of reading strategies as children with stronger reading-specific flexibility skills, students with weak flexibility have more difficulty successfully implementing the skills. This possibility is consistent with recent claims that care must be taken to document the mechanisms by which strong and struggling readers undertake the reading process to fully understand the processes involved, because processes may differ across readers (Rapp et al., 2007). In fact, visual inspection of Table 4 suggests that children with weak reading-specific flexibility skills demonstrated fewer overall strategies in the think aloud task relative to peers with stronger reading-specific flexibility skills. The difference was most pronounced for activating prior knowledge, paraphrasing/summarizing, and making inferences, consistent with the notion that children with weak flexibility skills use fewer strategies in support of reading comprehension. We chose not to analyze this pattern quantitatively given the relatively small number of observations involved and the absence of *a priori* predictions regarding specific strategies.

Another possible explanation is that attempting to utilize strategies hinders reading comprehension for children with low reading-specific flexibility. It could be that their resources are spent thinking through and switching between strategies, and that parts of the text meaning, links to relevant background knowledge, and inferences that support models of understanding are lost. The idea that strategy use is at first not helpful but improves over time has been described as a utilization deficiency (see Miller, 2000). The initial time of implementation when the strategy is not at all effective is likely brief. The developmental period that follows, however, generally is much longer, as the strategy becomes more and more useful with time and practice (Miller, 2000). These ideas surrounding utilization deficiency are consistent with the developmental lag between understanding metacognitive strategies and using them effectively and efficiently that has been well documented in research and practice (Roebers et al., 2012; Schneider, 2010), again pointing toward an interactive role of executive functioning and strategic processing for academic success. In general, these ideas are consistent with theoretical notions that more complex executive processes, such as metacognitive monitoring and strategy usage, depend on simpler processes, including working memory, inhibition, and flexibility, suggesting that flexibility may set the stage for successful planning and implementation of strategies in support of goals (Dawson & Guare, 2010; Meltzer, 2007, 2010). Although our findings cannot pinpoint the exact nature of the relation between strategies and flexibility in supporting comprehension, the commonality across explanations is that reading-specific flexibility skills are beneficial for using strategies to support reading comprehension.

Results from this study also provided further support for the notion that reading-specific flexibility and reading comprehension are related. In particular, reading-specific flexibility explained 4% of variance in reading comprehension above and beyond that accounted for by age, fluency, and vocabulary when using either the think aloud or the metacognitive measure of strategies. Although only marginally significant, these findings suggest that reading-specific flexibility has practical importance in predicting successful reading comprehension. These findings are consistent with previous literature demonstrating the unique importance of reading-specific flexibility in supporting reading comprehension (Cartwright, 2002, 2007; Cartwright et al., 2006; Cartwright, Hodgkiss, & Isaac, 2008). It is important to note that although our reading-specific flexibility measure encompassed aspects of decoding and meaning—two common predictors of reading comprehension—flexibility explained additional variance beyond that explained by our control measures of fluency (decoding) and vocabulary (meaning). As such, we assert that our findings add to the growing body of literature supporting the role of flexibility (and executive functioning more broadly) in reading success (Cartwright, 2008). In contrast, as expected, general flexibility did not contribute significantly to the variance in reading comprehension explained above and beyond age, reading fluency, vocabulary, and reading strategies entered in the previous steps. These results suggest that general flexibility did not add unique predictive value for reading comprehension. This finding is consistent with previous results reported by Cartwright et al. (2010), which found that general flexibility did not uniquely contribute to reading comprehension beyond that explained by age, phonological and semantic processing, and reading-specific flexibility. Furthermore, the regression models showed no significant interaction between reading strategies and general flexibility, indicating no moderating role of general flexibility.

Contrary to predictions, our findings did not support the notion that reading strategies contribute to the variance explained for reading comprehension above and beyond that accounted for by age, fluency, and vocabulary. This pattern of results differs from the extant literature, especially the findings of Schellings et al. (2006), who found strong relations between reading strategies and reading comprehension in third grade students. In contrast to the metacognitive reading strategy tasks included in the current study, Schellings et al. (2006) used a knowledge-based measure of reading strategies, where participants were asked to apply skills by identifying main ideas and making connections between text fragments. Reading comprehension was measured using a question-answering format. Schellings et al. (2006) found that reading strategy knowledge explained a significant amount of variance in reading comprehension. It is possible that differences in overall patterns of results stem from differences in measuring reading strategies and comprehension. Specifically, Schellings et al. (2006) measured reading strategies with a knowledge-based task, whereas the current study measured reading strategy usage through a think aloud task and a self-report measure focused on metacognition. Moreover, our work used a curriculum-based MAZE task to measure reading comprehension. These findings may suggest that knowledge of strategies is necessary but not sufficient for demonstrating skillful use of strategies during reading. Details about the relation between reading strategies and reading comprehension must be considered carefully, so additional work in research and practice is warranted. Focusing on a variety of passage types and skill levels would be beneficial, consistent with the renewed interest in strategies and comprehension among expert readers in a variety of domains (Pressley & Lundeberg, 2008; see also Lundeberg, 1987; Shearer, Lundeberg, & Coballes-Vega, 1997; Wyatt et al., 1993; see also Rapp et al., 2007).

Despite promising results, the present findings must be interpreted in light of several limitations. First, the sample was relatively homogeneous in terms of racial and ethnic background and family income/education. The current study included mostly White participants with highly educated mothers. We know that demographic characteristics such as race and parental education are related to reading practices and outcomes (Yarosz & Barnett, 2001). It is not clear whether the pattern of findings obtained here would generalize to children beyond this limited sample. Future studies should explore the role of reading strategies and cognitive flexibility in supporting reading comprehension among children from diverse backgrounds and with diverse cognitive abilities and reading levels. Classroom- and clinic-based reading approaches might be beneficial in recruiting larger, more diverse samples. Second, our design included one task order, consistent with an individual differences approach. Although it is possible that fatigue may have limited children’s performance on our measures, it is important to note that our last measure—vocabulary—was the strongest overall predictor of comprehension. As such, we do not believe that this design limitation negatively impacted our overall findings. Nonetheless, future research should utilize a variety of measures implemented in careful temporal order(s) to fully understand reading comprehension.

Another limitation of the current study stems from the novelty of the measures of reading strategy use. Both the think aloud protocol and the metacognitive questionnaire were new measures adapted from previous studies. Think aloud protocols are commonly used in studies in which researchers are looking for insight to the participants' cognitions during problem-solving and decision making (Chrysikou & Weisberg, 2005; Ericsson & Simon, 1984; Halali, Bereby-Meyer, & Leiser, 2013), and the use of think aloud protocols to assess processes associated with reading has been well documented (Caldwell & Leslie, 2010; Kolic-Vehovec & Bajsanski, 2006; Pressley & Afflerbach, 1995; Pressley & Lundeberg, 2008; Schellings et al., 2006). The passages used to assess reading strategies were fictional narrative passages with one reading level. Given participants' strong oral reading fluency and vocabulary skills, these passages likely were quite easy for them to read, which may have limited their use of strategies to improve comprehension. It is important to note that visual inspection of the strategies evinced by students in each grade during the think aloud (see Table 5) revealed growth in several domains (i.e., activating prior knowledge, paraphrasing/summarizing, and making inferences), especially with regard to complex strategies integrating background knowledge and making inferences to build models of understanding, and little decline (i.e., making predictions) over the elementary grades included here. We chose not to analyze these findings quantitatively given the small and variable number of participants and strategies evident in each grade. These strategy domains are the same ones that evinced sensitivity to differences in reading-specific flexibility, again highlighting their importance for reading comprehension. Including a variety of passage types (including expository texts) adapted based on instructional reading level is an important future direction for research (Kendeou & van den Broek, 2007). The metacognitive questionnaire included 10 items, with two items included for each of the five subscales. Though the overall reliability for all 10 items was acceptable, the reliabilities for specific subscales were low to adequate. It is possible that these low reliabilities could be addressed by editing current items to improve clarity and/or by including additional items. Clearly, future research is needed to measure strategy knowledge and use effectively. In particular, it is important to understand how children select appropriate strategies and implement them effectively to facilitate reading comprehension involving a variety of passage types. Similarly, we used a MAZE task to measure comprehension. Question and answer formats also are common, as our tasks that rely on retelling of stories, gleaning main ideas, and identifying meaningful connections between aspects of texts and relevant background knowledge (van den Broek et al., 2005). Future research should assess reading comprehension from a variety of perspectives.

Despite these limitations, our findings offer several implications for practice. First, the relation between reading-specific flexibility and reading comprehension makes reading-specific flexibility a viable screening target to identify students at risk for potential reading comprehension difficulties. Furthermore, reading-specific flexibility can be targeted for intervention. In fact, relatively brief interventions targeting cognitive flexibility have been shown to improve reading comprehension in young readers (Cartwright, 2002, 2006). In particular, second through fourth grade students completed five 15-minute sessions on consecutive days. Participants were provided with sets of cards for sorting. The reading-specific cards included words that could be classified based on initial sound and word meaning. The general cards included pictures of objects that could be classified based on color and object type. Each intervention session included two phases. In the first phase, participants were asked to perform two successive classifications of the cards. For example, for the reading-specific cards, the participant would first sort cards into two categories based on initial sound (e.g., /t/ and /s/), then mix them up, and then sort into two categories based on word meaning (e.g., foods and vehicles). In the second phase, researchers completed three of the four spaces in a 2x2 matrix, and participants were asked to complete the matrix with the appropriate card, which required simultaneous classification. When presented with three words in a given matrix, participants were asked to fill in the fourth word to complete the matrix. The same phases were included for the general flexibility task, though the sorts were based on color and object type for the picture cards.

Results indicated that after five days of intervention, participants who receiving reading-specific flexibility training demonstrated significantly higher post-treatment reading comprehension scores. No significant gains were observed for students in the general-flexibility training condition. These training results align with the current findings in that reading comprehension appears related to reading-specific flexibility but not to general flexibility. The brevity of Cartwright's (2002) intervention and the straightforward implementation make it a viable option for in-school treatment. In fact, recent findings demonstrate the effectiveness of this intervention when implemented by teachers to help third grade students with reading comprehension difficulties (Cartwright et al., 2016). In particular, teachers provided individualized training once per week for five weeks for students with reading comprehension difficulties. These students showed significant growth in reading comprehension from before to after the intervention and did not differ from the control group without reading comprehension difficulties by the end of the school year. It is possible that some children who struggle with reading comprehension have difficulty flexibly considering both the decoding aspects and the meaning of text, consistent with the growing body of work demonstrating the unique contributions of reading-specific flexibility. Moreover, they may struggle to select and implement appropriate strategies. Despite this importance, we cannot lose sight of the many other factors that are important. As a result, effective reading curricula should include a variety of instructional components, including phonemic awareness, phonics, vocabulary, fluency, and linguistic comprehension (Armbruster, Lehr, & Osborn, 2001; Duke & Pearson, 2008; Muter, Hulme, Snowling, & Stevenson, 2004; National Reading Panel, 2000). Focusing on helping teachers and students select and implement appropriate reading strategies also would be beneficial (Baker, 2005).

In conclusion, the goal of the current study was to measure the potential moderating role of flexibility on the relation between reading strategies and reading comprehension. Overall, our findings support the relevance of reading-specific flexibility for reading comprehension. In particular, reading-specific flexibility uniquely predicted reading comprehension, above and beyond age, oral reading fluency, and vocabulary. Additionally, reading-specific flexibility moderated the relation between reading strategies and reading comprehension. Specifically, weak reading-specific flexibility skills were associated with a negative relation between reading strategy use and reading comprehension. This negative relation suggests that children with weak reading-specific flexibility skills are less able to use reading strategies effectively. In contrast, general flexibility did not predict reading comprehension. Overall, these results highlight the importance of reading-specific flexibility for reading comprehension during the elementary years.

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Appendix A: Reading Strategy Coding

Activating prior knowledge included statements related to passage content but not specifically included in the text (e.g., Earth is the third planet from the sun.), similar to the association category described by McCrudden (2012).

Setting goals included statements of personal goals for reading, such as "I hope I get to learn about outer space."

Monitoring comprehension included evaluations or comments about the reader's understanding of the text, such as, "That doesn't make sense," similar to McCrudden (2012).

Making predictions included responses expressing expectations of what was to come next in the passage. Example responses for this category included, "I bet this story is about outer space," or "The girls are probably going to buy apples at the store."

Questioning included questions to self or others relating to the passage (e.g., "Didn't Flora say that she was meeting Fauna in the produce section?"), consistent with the description provided by Schellings et al. (2006).

Paraphrasing/summarizing included descriptions of information presented in the story, using either the reader's own words or words from the story. Statements such as, "Flora and Fauna are sisters, but Flora is really Super Girl," were coded as paraphrasing/summarizing. Previous researchers included categories for paraphrasing and summarizing in their think aloud coding systems (Caldwell & Leslie, 2010; Schellings et al., 2006).

Making inferences included conclusions drawn from text or connections made using text content (e.g., "I think she's excited but scared because she doesn't know what people think about her.").

Other strategies included responses that did not fit into the other categories listed here.

Table 1

Correlation Matrix and Descriptive Statistics for Variables of Interest

Measure	1	2	3	4	5	6	7	8
(1) Age in Months	---							
(2) Fluency (ORF)	.19	---						
(3) Vocabulary	.57**	.61**	---					
(4) TA Strategy Score	.16	.23	.28*	---				
(5) MQ Total Score	.08	-.15	-.09	.29*	---			
(6) Gen Flex Errors	-.10	-.30**	-.52**	-.15	.06	---		
(7) Reading Flex	.14	.42**	.46**	.16	-.00	-.19	---	
(8) MAZE Comp	.24*	.67**	.56**	.22	-.15	-.31**	.33**	---
Mean	110.59	97.65	12.91	21.88	2.07	3.91	1.79	19.36
Standard Deviation	13.25	2.83	2.74	11.45	.41	2.39	1.05	8.36

Note. * $p < .05$, ** $p < .01$. Fluency (ORF) = Words Read Correctly on the Oral Reading Fluency (ORF) task; Vocabulary = Vocabulary Raw Score from the *WISC-IV*; TA Strategy Score = Overall Strategy Score from the Think Aloud (TA) task; MQ Total Score = Overall Strategy Score on the Metacognitive Questionnaire (MQ); Gen Flex Errors = General Flexibility Error score from the Dimensional Change Card Sorting (DCCS) task; Reading Flex = Reading-Specific Flexibility score from the Reading Multiple Classification (RMC) task; MAZE Comp = Comprehension raw score from the MAZE task

Table 2
Summary of Hierarchical Regression Analysis for Think Aloud Reading Strategies and Reading-specific Flexibility Predicting MAZE Reading Comprehension

Variable	*B*	*SE B*	β	R^2	ΔR^2	*F* for change in R^2	Degrees of Freedom	*p*
Step 1				.02	.02	1.39	(1, 71)	.24
Age	.10	.08	.14					
Step 2				.15	.13	11.04	(1, 70)	.001**
Age	.05	.08	.07					
Oral Reading Fluency	.10**	.03	.37					
Step 3				.22	.07	6.16	(1, 69)	.02*
Age	-.08	.09	-.11					
Oral Reading Fluency	.04	.04	.16					
Vocabulary	.49*	.20	.40					
Step 4				.25	.03	2.65	(1, 68)	.11
Age	-.08	.09	-.11					
Oral Reading Fluency	.05	.04	.18					
Vocabulary	.54**	.20	.44					
Reading Strategies	-1.65	1.02	-.18					
Step 5				.29	.04	3.85	(1, 67)	.054+
Age	-.06	.09	-.08					
Oral Reading Fluency	.03	.04	.13					
Vocabulary	.43*	.20	.35					
Reading Strategies	-1.70	1.00	-.18					
Reading-specific Flexibility	2.19+	1.11	.23					
Step 6				.33	.04	4.18	(1, 66)	.045*
Age	-.05	.09	-.07					
Oral Reading Fluency	.02	.04	.07					
Vocabulary	.43*	.20	.35					
Reading Strategies	-2.05	.99	-.22					
Reading-specific Flexibility	2.69	1.12	.29					
Reading Strategies x Reading-specific Flexibility Interaction	2.34*	1.14	.22					

Note. +p < .08, *p < .05, **p < .01.

Table 3
Summary of Hierarchical Regression Analysis for Metacognitive Questionnaire Reading Strategies and Reading-specific Flexibility Predicting MAZE Reading Comprehension

Variable	*B*	*SE B*	*β*	R^2	ΔR^2	*F* for change in R^2	Degrees of Freedom	*p*
Step 1				.02	.02	1.39	(1, 71)	.24
Age	.10	.08	.14					
Step 2				.15	.13	11.04	(1, 70)	.001**
Age	.05	.08	.07					
Oral Reading Fluency	.10**	.03	.37					
Step 3				.22	.07	6.16	(1, 69)	.02*
Age	-.08	.09	-.11					
Oral Reading Fluency	.04	.04	.16					
Vocabulary	.49*	.20	.40					
Step 4				.22	.00	.05	(1, 68)	.82
Age	-.08	.09	-.08					
Oral Reading Fluency	.04	.04	.16					
Vocabulary	.50*	.20	.41					
Reading Strategies	.23	1.02	.02					
Step 5				.26	.04	3.51	(1, 67)	.07+
Age	-.06	.09	-.08					
Oral Reading Fluency	.03	.04	.11					
Vocabulary	.39+	.21	.32					
Reading Strategies	.10	1.00	.01					
Reading-specific Flexibility	2.14+	1.14	.23					
Step 6				.26	.00	.07	(1, 66)	.79
Age	-.05	.10	-.07					
Oral Reading Fluency	.03	.04	.12					
Vocabulary	.38+	.21	.31					
Reading Strategies	.09	1.01	.01					
Reading-specific Flexibility	2.14+	1.15	.23					
Reading Strategies x Reading-specific Flexibility Interaction	-.32	1.19	-.03					

Note. +$p < .08$, *$p < .05$, **$p < .01$.

Table 4

Mean Number of Strategies Demonstrated in the Think Aloud Task By Participants Low and High in Reading-Specific Flexibility

Strategy	Low Reading-Specific Flexibility	High Reading-Specific Flexibility
Activate Prior Knowledge	1.21 (1.85)	2.00 (2.52)
Set Goals	.05 (.23)	.03 (.17)
Monitor Comprehension	1.03 (1.95)	1.11 (1.63)
Make Predictions	4.76 (5.79)	4.61 (5.31)
Question	2.53 (4.81)	2.83 (3.92)
Paraphrase/Summarize	2.26 (3.02)	4.92 (4.96)
Make Inferences	3.37 (4.96)	5.22 (5.01)
Other	3.87 (4.50)	4.11 (7.44)
Total	19.07 (9.40)	24.83 (12.75)

Note. A median split on the overall score from the reading multiple classification task (Median = .04) was used to divide the sample into low and high reading-specific flexibility groups (n = 38 and n = 36, respectively). Standard deviations are listed in parentheses.

Table 5
Mean Number of Strategies Demonstrated in the Think Aloud Task By Participants in Each Grade

Strategy	Grade 2	Grade 3	Grade 4	Grade 5
Activate Prior Knowledge	1.06 (1.51)	1.34 (1.68)	2.21 (3.21)	3.00 (3.27)
Set Goals	.11 (.32)	.03 (.17)	.00 (.00)	.00 (.00)
Monitor Comprehension	.39 (1.04)	1.09 (1.58)	1.71 (2.43)	1.43 (2.57)
Make Predictions	5.50 (5.77)	5.00 (6.00)	3.50 (5.19)	3.43 (2.57)
Question	2.06 (3.00)	2.86 (4.72)	3.21 (5.25)	2.29 (4.35)
Paraphrase/Summarize	1.72 (3.98)	4.34 (4.65)	4.14 (3.21)	3.14 (4.10)
Make Inferences	3.39 (3.07)	3.80 (3.86)	6.14 (7.37)	5.14 (8.17)
Other	4.44 (4. 21)	2.69 (3.56)	6.50 (11.54)	4.29 (3. 45)
Total	18.67 (8.17)	21.14 (9.97)	27.43 (15.18)	22.71 (15.40)

Note. Standard deviations are listed in parentheses.