The Roles of Motivation and Engagement in Computer-Based Assessment of Children's Reading Comprehension

Miia Ronimus[1], Asko Tolvanen[2], Jarkko Hautala[1]

[1] Niilo Mäki Institute, Jyväskylä

[2] Methodology Centre for Human Sciences, University of Jyväskylä

Highlights

- Two studies tested if engagement mediates the effect of motivation on reading
- Reading comprehension was evaluated by a time-efficient computer-based maze task
- Online-measures of task engagement retrieved from log files were used
- Response strategy was a significant mediator of the effect of motivation on reading

Abstract

The present study investigates whether task engagement mediates the effects of reading-related self-efficacy and motivation on reading comprehension. Finnish-speaking students from Grades 3 and 4 performed a computer-based reading comprehension task. Engagement was measured by two indicators retrieved from log files: time-on-task (behavioral engagement) and response strategy (cognitive engagement). Two studies were conducted. Study 1 included mostly fluent readers (N = 108), and Study 2, which served as a conceptual replication of Study 1, included both fluent and dysfluent readers (N = 308). The results of both studies suggest that cognitive engagement mediates the effect of reading enjoyment on reading comprehension. In Study 2, the effect of self-efficacy on reading comprehension was mediated by both types of engagement but only when the effect of reading enjoyment was not controlled for. Overall, the results provide further clarification of the mechanism by which motivation affects children's task-oriented reading.

Keywords: motivation, self-efficacy, engagement, computer-based assessment, reading comprehension

The Roles of Motivation and Engagement in Computer-Based Assessment of Children's Reading Comprehension

Most reading comprehension theories acknowledge the importance of reader's self-efficacy and motivation for successful text comprehension (Rouet et al., 2017). Children who are confident in their reading skills and enjoy reading are expected to be more persistent readers and more likely to engage in deep processing of texts than children who find reading aversive (Guthrie et al., 2012; Guthrie et al., 2013; Klauda & Guthrie, 2015; Schiefele et al., 2012). Existing research suggests that both behavioral (e.g., persistent involvement in reading activities) and cognitive (e.g., use of "deep" reading strategies) aspects of engagement contribute to reading comprehension (for a review, see Guthrie et al., 2012). However, there is a scarcity of evidence concerning the indirect effects of reading motivation on reading comprehension via engagement (see Schiefele et al., 2012). It is particularly unclear whether this mediation also holds true in task-oriented settings, where the main goal of reading is performing a specific task (Vidal-Abarca et al., 2010). It may be difficult to predict students' behavior in specific reading situations based on their general reading motivation, as specific tasks may (or may not) trigger situational interest (i.e., increased focus and persistence), irrespective of the students' predispositions (Hidi, 2006).

The present paper aims to clarify the importance of students' reading motivation and reading-related self-efficacy for students' engagement while they work with a challenging computer-based reading comprehension task. Two constructs—reading enjoyment and extrinsic motivation—are used to define reading motivation. Reading enjoyment is used as an indicator of intrinsic motivation, measuring the degree to which students find reading an enjoyable activity. Extrinsic motivation reflects the degree to which students engage in reading tasks for extrinsic reasons (to meet the teacher's expectations) instead of their own will. Students' engagement is measured by two indicators—time-on-task and response

strategy—retrieved from log files. The aim is to investigate whether these "objective" on-line indicators of engagement mediate the effects of self-efficacy and motivation on outcome scores. There are concerns that objective on-line measures (i.e., not assessed by self-report) may not capture the effortful aspect of task processing but would be mostly indicators of lower-level processing and skill (Bråten et al., 2019). The present study sheds light on this issue by investigating the extent to which individual variance in these measures can be explained by motivational factors after controlling for reading fluency.

Next, we review how self-efficacy, intrinsic motivation, and extrinsic motivation contribute to reading engagement and reading comprehension according to existing research.

1.1 Self-efficacy, Engagement, and Reading Comprehension

Self-efficacy, a central concept of Bandura's (1997) social cognitive theory, is defined as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Self-efficacy determines which goals people choose to pursue, how avidly they pursue their goals, and how persistent they are in the face of failures (Bandura, 1997). Self-efficacy can be seen as a necessary condition for intrinsic motivation: students need to experience themselves as competent readers before they can enjoy reading (Ryan & Deci, 2000).

Existing research suggests that children's reading self-efficacy relates to reading achievement in the early years of primary school (Lee & Jonson-Reid, 2016; Liew et al., 2008; McTigue et al., 2019; Peura, Aro, et al., 2019). Concerning the effect of self-efficacy specifically on the reading comprehension of primary school students, Hornstra et al. (2013) found that growth in self-efficacy was related to growth in reading comprehension. In the cross-sectional study of Solheim (2011), self-efficacy predicted reading comprehension, after controlling for word reading ability, listening comprehension, and nonverbal ability. Unrau et al.'s (2018) meta-analysis found a strong positive association between reading self-efficacy

and reading comprehension (based on 21 studies), although it was not possible to draw conclusions about the directionality of the effects.

Self-efficacy has been associated with cognitive engagement in reading in the form of self-reported use of reading strategies (Anmarkrud & Bråten, 2009; Lau & Chan, 2003), as well as behavioral engagement indicated by reading amount (Lau, 2009). Students who have higher self-efficacy seem better able to self-regulate their learning and persist in challenging achievement situations (Liew et al., 2008; Usher et al., 2019). There is also evidence that engagement mediates the effect of self-efficacy on academic achievement (Galla et al., 2014; Honicke & Broadbent, 2016; Jung et al., 2017), but to the authors' knowledge, no previous study has investigated whether engagement mediates the effect of self-efficacy specifically on primary school students' reading comprehension, either in general or in task-oriented settings.

1.2 Intrinsic and Extrinsic Motivation, Engagement, and Reading Comprehension

Intrinsic motivation refers to a situation in which a person engages in an activity for its own sake, as it is enjoyable, whereas extrinsically motivated behavior is regulated by external contingencies, such as rewards or punishments (e.g., Ryan & Deci, 2016). Extensive research suggests that intrinsic motivation in reading (reading enjoyment) is positively associated with reading achievement, but regarding extrinsic motivation, the findings are less consistent, suggesting either a negative or nonsignificant relationship with reading achievement (see the review of Schiefele et al., 2012).

Several studies have aimed to clarify the directionality of the associations between intrinsic/extrinsic motivation and reading comprehension. Cross-sectional studies have found evidence of intrinsic motivation positively predicting reading comprehension (McGeown et al., 2015; Stutz et al., 2016; Taboada et al., 2008; Wang & Guthrie, 2004), whereas extrinsic motivation seems to be a negative predictor (Schaffner et al., 2013; Stutz et al., 2016; Wang

& Guthrie, 2004), and similar results have also been obtained with longitudinal data (Troyer et al., 2019). Some longitudinal studies have suggested that the relationship between intrinsic motivation and reading comprehension is bidirectional (Hebbecker et al., 2019; Miyamoto et al., 2018; Schiefele et al., 2016). In the case of extrinsic motivation, evidence of bidirectionality is more inconsistent. The study by Becker et al. (2010) supports a reciprocal association, but Schiefele et al. (2016) found only a unidirectional effect from reading comprehension to extrinsic motivation, suggesting that students with higher reading comprehension skills were less extrinsically motivated (competition-oriented) in the future. In the study of Hebbecker et al. (2019), extrinsic motivation and reading comprehension were unrelated.

According to Ryan and Deci (2016), intrinsic motivation is a "natural tendency and energy to engage in behaviors that people find challenging and interesting" (p. 96). Based on existing research, intrinsically motivated students are typically behaviorally engaged in reading (e.g., they read more in their leisure time than their less intrinsically motivated peers), as well as cognitively engaged, by tending to use more sophisticated reading strategies (Guthrie et al., 2012; Guthrie et al., 2013; Klauda & Guthrie, 2015; Schiefele et al., 2012). Intrinsic motivation seems to associate positively with reading amount even after controlling for prior reading achievement, gender, parent's educational level, and other relevant variables, but extrinsic motivation and reading amount are nonsignificantly or negatively associated with each other when intrinsic motivation is controlled for (see the review by Schiefele et al., 2012). Previous studies have also provided relatively consistent evidence that intrinsic motivation is positively associated and extrinsic motivation is negatively associated with the use of reading strategies (Schiefele et al., 2012). Intrinsic goals and autonomy-supportive climates have also been found to predict deeper processing, higher persistence, and better performance in the conceptual understanding of texts (Vansteenkiste et al., 2004).

By contrast, extrinsic incentives may distract the reader and lead the reader's attention elsewhere, which results in shallow processing of the text and the use of surface-level strategies (Schaffner et al., 2013; Schiefele et al., 2012; Stutz et al., 2016; Wang & Guthrie, 2004).

Both cross-sectional (Becker et al., 2010; Schaffner et al., 2013; Stutz et al., 2016) and longitudinal (Miyamoto et al., 2018; 2019) studies have found support for reading amount being a significant behavioral mediator of the effect of intrinsic motivation on reading comprehension. In the study of van Ammel et al. (2021), ninth graders' self-reported reading frequency mediated the effect of autonomous motivation (conceptually close to intrinsic motivation) on reading comprehension, but self-reported reading engagement (e.g., attention, effort, and persistence in reading activities) was not a consistent mediator. Concerning extrinsic motivation, Schaffner et al. (2013) found that its effect on reading comprehension was significantly mediated by reading amount, but Stutz et al. (2016) and Becker et al. (2010) found no support for this.

The role of cognitive engagement as a mediator has received less research attention. In the study by van Ammel et al. (2021), self-reported reading strategy use mediated the effect of autonomous motivation on reading comprehension, but surprisingly, also the effect of controlled motivation (conceptually close to extrinsic motivation) on reading comprehension was also positively mediated by strategy use. Van Ammel et al. (2021) speculate that this could relate to declining autonomous reading motivation in adolescence, which may increase the importance of controlled reading motivation. Miyamoto et al. (2019) found that students' metacognitive knowledge of strategy use mediated the effect of intrinsic motivation on reading comprehension among Grade 6 and Grade 7 students. Taken together, it seems that both behavioral and cognitive aspects of engagement are potential mediators of

the effect of intrinsic motivation on reading comprehension. In the case of extrinsic motivation, the indirect relationship remains unclear.

1.3 On-line Measurement of Task Engagement

Students' processing during task performance can be measured using either on-line or off-line approaches. On-line assessment refers to measurements taken concurrent with task performance, whereas off-line measurements are collected before or after performance. On-line measures refer either to self-reports (e.g., think-aloud protocols, questioning during task performance, diary methods) or more objective measurements (e.g., reading times, eye movements) (Bråten et al., 2019). A common criticism of self-reports is that they may be distorted by incorrect memories and prompt readers to identify strategies they did not actually use (Veenman, 2011), whereas objective measures may not differentiate effortful strategic processing from lower-level processing and skills (Bråten et al., 2019).

Computer-based assessment of academic skills provides opportunities for the on-line measurement of process behaviors with the aid of log files (Gil et al., 2015; Goldhammer et al., 2014; Vidal-Abarca et al., 2010). Log data are particularly appealing when studying children, as their use does not interfere with task performance or require students to verbalize their processing. Only a few previous studies have addressed the effects of motivation on students' processing while working with computer-administered tests, especially concerning the mediating role of process behaviors. Kupiainen et al. (2014) investigated the effect of ninth graders' time-on-task during a computer-based assessment of reasoning skills. The results indicated that motivational attitudes affected students' time-on-task so that students with mastery attitudes (i.e., agency belief in effort and internalized value of education and high attainment) used more time to complete the task, but the indirect effect on the test score was not significant. However, the effect of detrimental attitudes (i.e., means-end beliefs in chance and ability, self-handicapping) on test scores was significantly mediated by time-on-

task, suggesting that students with more negative learning-related self-beliefs used less time in the assessment, which resulted in a lower score. Bråten et al. (2014) used a noncomputerized setting involving multiple-text reading to investigate whether students' processing during the task mediated the effects of various individual difference variables on reading comprehension. Among their findings, effort (measured by reading time) significantly mediated the effect of individual interest on reading comprehension, whereas self-reported use of deeper-level strategies mediated the effects of the need for cognition and prior knowledge. Thus, both studies suggest that student processing assessed by on-line measures is potentially a significant mediator of motivation on performance.

1.3.1 Measurement of Task Engagement in the Present Studies

The two studies reported in this paper use a computer-based maze task to assess students' reading comprehension. A maze task is a brief cloze-type assessment of reading performance (see, e.g., Tolar et al., 2011). In a maze task, students read sentences/passages with some missing words and fill in the gaps by choosing the best-fitting word from a few alternatives. Maze tasks are commonly used in the assessment of elementary school students' reading comprehension, and based on previous studies, mazes are generally valid and reliable (Shin & McMaster, 2019).

In the present maze task, students read short vignettes, each with four carefully selected word gaps, and fill them in so that the text becomes consistent and meaningful. Successful completion of each vignette requires looking back at the preceding text for relevant information and identifying connections between different parts of the text, that is, engagement in strategic processing to build a coherent mental representation of the text (see Kendeou et al., 2014; van den Broek & Espin, 2012). The present studies use two indicators of engagement retrieved from the log files. First, time-on-task is used to measure the amount of time students invest in responding to the items of the task. It has been found that in easy

digital reading tasks, low time-on-task is typically related to higher performance, whereas in cognitively demanding tasks, higher time-on-task is often required, but these relationships are also affected by ability levels; thus, especially poor digital readers and poor comprehenders seem to benefit from high time-on-task (Goldhammer et al., 2014; Naumann & Goldhammer, 2017). The ability to regulate time allocation according to task demands requires strategic processing skills and motivation to invest more time in challenging tasks (Naumann, 2019). Thus, time-on-task should be considered a relatively complicated indicator of student processing, being affected by cognitive and metacognitive skills as well as student motivation. The present maze task is challenging, considering the age and reading skill level of the participants. Thus, higher time-on-task is expected to be more beneficial to performance.

The second process indicator used in the present studies is the response strategy students use while completing the maze task. Very short responses were considered manifestations of rapid guessing behavior, that is, indications that the student did not thoroughly read the text and the response options (see Wise & Kong, 2005) and thus used a shallow response strategy. Successful completion of the present maze task requires not only time but also flexibility, such as rereading of the preceding text and reconsideration of the selected responses. A nonlinear approach to completing the task was considered an indicator of a deeper reading strategy and mental investment in finding coherent solutions to the items of the test. A linear approach to reading online texts has previously been associated with poorer reading comprehension skills (Minguela et al., 2015).

Taken together, time-on-task is seen to reflect the *behavioral* aspect of engagement (a student's persistence in performing the maze task), whereas response strategy is considered to reflect students' strategic choices, that is, their *cognitive* engagement while working with the task. Because deeper cognitive involvement (e.g., careful consideration of different response

options, rereading of the vignette) in the task requires longer time-on-task, the two process indicators are expected to overlap; thus, they are not considered as manifestations of two separate constructs but as two complementary aspects of the same phenomenon.

1.4 Present Studies

The aim of both studies reported in this paper is to test the hypothesis that children's engagement while working on a reading comprehension task mediates the effects of self-efficacy, reading enjoyment, and extrinsic motivation on performance. Because reading fluency is a lower-level process necessary for successful reading comprehension (Kendeou et al., 2014), its effect is controlled for in the analyses. Study 1 is the initial test of the hypothesis, aiming to provide information about the relationships among the variables of interest. Study 2 is a conceptual replication of Study 1 and aims to clarify the specific roles of each predictor.

Both studies were conducted as part of a larger research project (project name removed for blind review) investigating the effect of a drama education-based reading program (Reader's Theater) on the development of reading skills and reading motivation. Both studies were carried out following the guidelines of the Finnish National Board on Research Integrity for research involving human participants. The research plan of the project was reviewed by the ethical committee of the local university (name removed for blind review). Permissions for conducting the research were obtained from the participating municipalities and the principals of the participating schools. Written informed consent was obtained from the participants and the guardians of the participants.

Study 2 partially utilizes the same dataset as a recent publication focusing on the effects of Reader's Theater (Author et al., 2022). The overlapping variables include reading fluency (measured by a sentence verification task), reading comprehension (measured by a maze task), self-efficacy in reading fluency, and self-efficacy in reading comprehension. The

results by Author et al. (2022) suggest that Reader's Theater is effective in supporting the development of oral reading skills, whereas no training effects appeared in self-efficacy, reading fluency, or reading comprehension. Author et al. (2022) did not investigate the potential moderating or mediating effects of motivation or engagement on the scores of the assessments. Thus, the present paper provides a unique contribution by investigating whether motivation and self-efficacy affect children's engagement and performance in the reading comprehension task—the knowledge that can be used, for example, to develop new intervention programs aiming to improve both reading comprehension and reading motivation.

1.4.1 Hypotheses

Based on existing research, self-efficacy can be expected to predict both behavioral and cognitive engagement in reading (Anmarkrud & Bråten, 2009; Lau, 2009; Lau & Chan, 2003). More self-efficacious students can be expected to show higher time-on-task and a nonlinear response strategy in the maze task because self-efficacy has been associated with higher persistence and self-regulation in academic tasks (Liew et al., 2008; Usher et al., 2019). Existing studies also suggest that behavioral engagement is a significant mediator of the effect of self-efficacy on academic achievement (Galla et al., 2014; Honicke & Broadbent, 2016; Jung et al., 2017). Thus, we hypothesize that time-on-task and response strategy mediate the effect of self-efficacy on reading comprehension.

Reading enjoyment (i.e., intrinsic motivation in reading) has been found to positively predict both behavioral and cognitive engagement, whereas extrinsic motivation is more likely to have a negative influence on both types of engagement (e.g., Schiefele et al., 2012). Based on existing literature (Becker et al., 2010; Miyamoto et al., 2018, 2019; Naumann, 2019; Schaffner et al., 2013; Stutz et al., 2016; van Ammel et al., 2021), it can be hypothesized that the effect of reading enjoyment on reading comprehension is mediated by

behavioral engagement because children are willing to invest more time in activities they find enjoyable, and this increased time should show as an improved score in the cognitively demanding maze task (see Naumann & Goldhammer, 2017). Similarly, cognitive engagement (strategy use) is a possible mediator of reading enjoyment (Miyamoto et al., 2019; van Ammel et al., 2021). In the case of extrinsic motivation, the study of Kupiainen et al. (2014) suggests that time-on-task in a computer-based assessment is a potential mediator of detrimental motivational attitudes on achievement; hence, the negative effect of extrinsic motivation on reading comprehension could be mediated by lower behavioral engagement in the maze task. Extrinsic motivation has also been associated with the use of surface-level strategies (Schiefele et al., 2012). Thus, although past research is scarce and relatively inconsistent, extrinsic motivation can be cautiously hypothesized to have a negative indirect effect on reading comprehension via behavioral and cognitive engagement.

2 Study 1

The original purpose of collecting the dataset in Study 1 was to investigate the validity of the computer-based assessments to be used during the larger research project mentioned above. In the present study, the data are used for the initial testing of the hypothesis that engagement mediates the effects of self-efficacy and motivation on reading comprehension.

2.1 Method

2.1.1 Participants and Procedure

The participants were recruited from a primary school located in an urban area in Central Finland. The school volunteered to participate in the validation study of the computer-based assessment system. Six participants were excluded because they did not speak Finnish as their first language. The final analytic sample included 108 students (50 girls and 58 boys) from Grade 3 (n = 38) and Grade 4 (n = 70), aged 9–10. Most of the

poorest readers in the Grade 3 classrooms (reading fluency below or at the 20th percentile) were not included in the sample because they participated in another study.

The computer-based assessment of approximately 45 minutes took place during regular school hours and was supervised by two members of the research team. Each student worked independently on a laptop and received both spoken and written instructions via headphones and on screen. Students answered the questions using a mouse; no typing was required. The assessment included two tests of reading fluency and a reading comprehension test. One of the reading fluency tests was experimental, and its results are not used in the present study. The paper-and-pencil motivation questionnaire was administered in a separate session.

2.1.2 Assessments

2.1.2.1 Reading Fluency. Students' reading fluency was assessed using a computer-based sentence verification test. In this task, short sentences appear one at a time on the computer screen, and the student is encouraged to read the sentence as quickly as possible and determine if the sentence is true or not (e.g., "*Apples grow on trees"* and *"Dishwashers are fixed in hospitals"*). The test started with five practice items, after which the students responded to as many items as they could within 120 seconds. The sentences were presented in random order, and the maximum score was 70. To calculate the final score, the incorrect responses were subtracted from the correct responses. The test is adapted from the Woodcock–Johnson Reading Fluency task (Woodcock et al., 2001). High Cronbach's alphas (α = .94–.95) have been reported for the Finnish text-based version of the test, as well as high correlations (r = .76–.81) with tests of oral reading speed (Eklund et al., 2013). The computer-based version of the test has been shown to have high test–retest correlation (r = .89) and high factor loading (.75) for the reading fluency factor (Author et al., 2020).

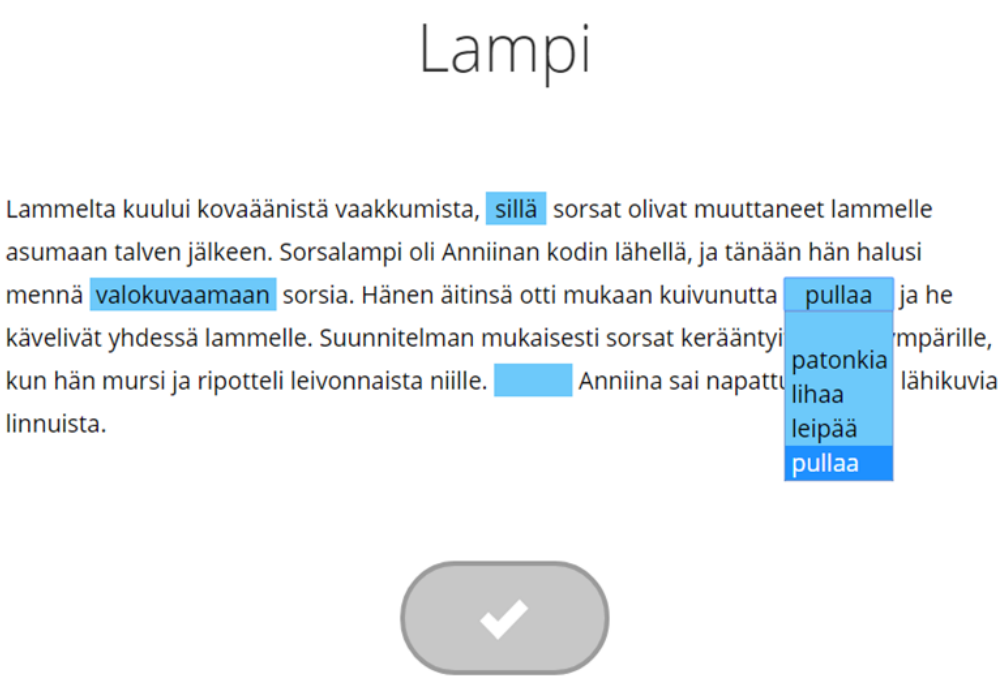
2.1.2.2 Reading Comprehension. This maze task included 16 short vignettes, which were presented in random order. Each vignette, prepared by the research team, included 33–59 words and described an everyday life situation assumed to be familiar to children. Each vignette included four word gaps, and the students were expected to fill in each gap by choosing the most suitable word from the four alternatives (see Figure 1). The four alternatives were given in a drop-down menu in fixed random order. Finding the correct word required careful analysis of the full text, as hints for the correct answer were often not provided in the same sentence. At the beginning of the test, the students were instructed that they would be able to fill in the gaps in any order and that the responses could be changed after the first selections. One practice vignette with feedback was presented before the test items.

Two of the word gaps in each vignette concerned connectives between sentences or clauses, and two of the other gaps concerned the semantic content of the text. The alternatives typically included one correct option, two options that were grammatically correct but inconsistent with some parts of the text, and one grammatically incorrect option. The student received 1 point for a correct answer and 0 points for an incorrect answer. Therefore, each vignette received a score ranging from 0 to 4. The test-taking time was limited to 20 minutes, and for this reason, some participants (n = 20) failed to complete all the texts. Based on an unpublished master's thesis (Mäenpää & Radwan, 2019), using the same dataset as the present study, the correlation between this task and a standardized paper-based reading comprehension test (i.e., reading a lengthy text and answering multiple-choice questions about its contents) was .61, which is approximately the same as the mean correlation between maze tasks and reading comprehension (r = .60) in the meta-analysis of Shin and McMaster (2019). To estimate the reliability of the test, we used McDonald's omega, which was

calculated using the OMEGA macro for SPSS by Hayes and Coutts (2020). The reliability of the test was satisfactory, ω = .80, 95% CI [.73, .86].

Figure 1

An Example of a Vignette Used in the Reading Comprehension Test



Note. The text (given in Finnish here, like in the original test) tells a short story of a girl, Anniina, and her mother, who walk to a nearby pond to photograph and feed ducks. The test taker fills in each gap by clicking on the empty space, which activates a drop-down menu that includes four alternative words. For example, in one of the word gaps shown here, the test taker determines whether Anniina's mother takes a baguette, meat, bread, or sweet buns with them to feed the ducks. The hint for the correct answer (*pullaa* = sweet buns) is given in the next sentence (*leivonnaista* = pastry). After all the gaps have been filled, the icon on the bottom of the screen activates, and the test taker can proceed to the next vignette.

2.1.2.3 Time-on-Task. This measure was calculated based on the information available in the log file. The time stamp of the final response of each vignette was used as the indicator of time-on-task on the vignette. McDonald's omega for the time-on-task measure was .90, 95% CI [.85, .94].

2.1.2.4 Response Strategy. The response strategy measure aims to capture the depth of students' cognitive involvement in the reading comprehension task. First, we determined the threshold for responses that would indicate rapid guessing behavior (see Wise & Kong, 2005). To determine the threshold, we inspected the shortest response times of the vignettes that had received at least a score of 3 to estimate the minimum time required for a score, which is unlikely a result of guessing (the probability of obtaining 3–4 points by guessing is approximately 5%). These shortest response times ranged from 6.27 secs to 45.83 secs, with the mean being 30.09 secs. After removing two response times that clearly deviated from the others (6.27 secs and 16.28 secs), the mean was 32.77 seconds. Based on these numbers, the threshold for rapid guessing behavior was rounded to 30 seconds, and the vignettes finished in less than 30 seconds received a score of 0 in the response strategy variable.

If the vignette was completed in more than 30 seconds, the response strategy was scored according to the order in which the student had filled in the word gaps (based on time stamps). If the student had filled in the word gaps in a linear order, starting from the first and finishing with the fourth gap, the student received a score of 1, suggesting that based on used time, the student may have processed the text to some degree, but there was no clear evidence of the use of deep reading strategies. If there was a single deviation from this linear pattern, a score of 2 was given, as this would indicate that the student had probably looked back at the text, reread at least some parts of the text, and reconsidered their answers, which have been associated with deeper strategic processing (Kendeou et al., 2014; Minguela et al., 2015; van

den Broek & Espin, 2012). Thus, each vignette received a score between 0 and 2. McDonald's omega for the response strategy measure was .87, 95% CI [.76, .92].

2.1.2.5 Self-efficacy. Self-efficacy in reading was measured using six items (see Appendix, Table A1). The students were asked to evaluate how certain they were that they could complete various reading-related tasks. The scale was adapted from the self-efficacy questionnaire used by Peura, Viholainen, et al. (2019) and Peura, Aro, et al. (2019). McDonald's omega for the self-efficacy scale was .70, 95% CI [.58, .77].

2.1.2.6 Reading Enjoyment. A scale of three items (see Appendix, Table A2) was used to assess enjoyment of reading, adapted from the Achievement Emotions Questionnaire–Elementary School developed by Lichtenfeld et al. (2012). McDonald's omega for the reading enjoyment scale was .87, 95% CI [.81, .91].

2.1.2.7 Extrinsic Motivation. To assess extrinsic motivation, the students were asked to think about their reasons for completing various reading-related school assignments. Three items reflecting extrinsic reasons formed the scale (see Appendix, Table A2). The scale was adapted from the Academic Self-Regulation Questionnaire (Ryan & Connell, 1989). McDonald's omega for the extrinsic motivation scale was .70, 95% CI [.61, .88].

2.1.3 Data Analysis

The data were analyzed with a structural equation model (SEM) using the Mplus statistical program (Version 8.2). The model had six latent factors (self-efficacy, extrinsic motivation, reading enjoyment, time-on-task, response strategy, and reading comprehension) and one manifest variable (reading fluency). Because the students were nested within classes, the COMPLEX method in Mplus was used to obtain unbiased standard error estimates.

The model fit was evaluated with the comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square error (SRMR). These indexes are shown to be appropriate for a complex model. For a

good model fit, CFI and TLI should be close to .95, RMSEA should be close to .06, and SRMR should be lower than .08 (Hu & Bentler, 1999).

2.1.3.1 Parceling. Because of the complexity of the model (the number of observed variables compared to the sample size), the 16 items (vignettes) of the reading comprehension test were divided into three parcels (subsums) to estimate the reading comprehension, response strategy, and time-on-task indicators (see Little et al., 2013). Below, we describe how the parcels were built.

Reading Comprehension. First, a one-factor model was made. In this model, standardized loadings ranged from .27 to .61. The model fit was satisfactory: CFI = .92, TLI = .90, RMSEA = .046, and SRMR = .07. Second, three parcels were built so that each parcel had as many low-, moderate-, and high-loading items. Items with correlating residuals were included in the same parcel.

Response Strategy. In the one-factor model, standardized loadings ranged from .28 to .73. After adding four residual correlations, the model fit was satisfactory: CFI = .92, TLI = .91, RMSEA = .045, and SRMR = .07. The same items (i.e., derived from the same vignettes) as in the case of reading comprehension were included in each parcel, resulting in each parcel having approximately the same number of highly, moderately, and weakly loading items.

Time-on-Task. In the one-factor model, standardized loading ranged from .52 to .78. The model required four residual correlations, and after adding them, the model fit was passable: CFI = .88, TLI = .86, RMSEA = .083, and SRMR = .06. Because the standardized loadings were high and the correlations of the suggested residuals were small, parceling could be made based on the same items (i.e., vignettes) as in the cases of the two previous variables, with each parcel including approximately the same number of highly loading items.

2.1.3.2 Model Specification. The model was specified so that reading comprehension was regressed on reading fluency, self-efficacy factor, reading enjoyment and extrinsic

motivation factors, time-on-task, and response strategy factors. Time-on-task and response strategy factors were regressed on reading fluency, self-efficacy, reading enjoyment, and extrinsic motivation factors. Time-on-task and strategy factors were allowed to correlate with each other. Reading fluency, self-efficacy factor, reading enjoyment factor, and extrinsic motivation factor were also allowed to correlate with each other.

The possible mediator effects of reading fluency, self-efficacy, reading enjoyment, and extrinsic motivation via response strategy or via time-of-task to reading comprehension were tested.

The estimator used was full information maximum likelihood (FIML), which uses all observations in the data. The missing data are supposed to be missing at random (MAR); the assumption is required in FIML. In FIML, all the data can then be used in the estimation. The estimator chosen (MLR in Mplus) is robust against non-normality.

2.2 Results and Discussion

Descriptive statistics for the variables are provided in Table 1, and correlations are provided in Table 2.

Table 1

Descriptive Statistics for the Variables of Study 1

	n	*M*	*SD*	Min	Max	Skewness	Kurtosis
Reading fluency	107	29.06	8.39	13.00	54.00	0.50	0.06
Self-efficacy	108	4.27	0.49	2.86	5.00	-0.66	0.19

Reading enjoyment	108	3.55	0.99	1.00	5.00	-0.56	-0.22
Extrinsic motivation	108	3.04	1.01	1.00	5.00	-0.03	-0.74
Time-on-task (s)	105	898.25	199.59	244.99	1174.90	-0.74	0.46
Response strategy	105	1.15	0.26	0.06	1.80	-1.44	4.26
Reading comprehension (%)	107	50.89	13.80	10.94	85.94	-0.39	-0.34

Note. Mean scores of scale items are used, apart from time-on-task (sum score) and reading fluency (outcome score). Due to technical reasons, the data of the reading comprehension test are missing from one student, and the data of the reading fluency test from another student. The data about the response strategy in the reading comprehension test are missing from two additional students.

Table 2

Correlations between the Variables of Study 1

	1.	2.	3.	4.	5.	6.
1. Reading fluency	1					
2. Self-efficacy	.35***	1				

3. Reading enjoyment	.10	.45***	1			
4. Extrinsic motivation	-.10	-.30*	-.10	1		
5. Time-on-task	-.42***	.04	.20	-.21*	1	
6. Response strategy	.13	.20	.27**	-.30**	.63***	1
7. Reading comprehension	.43**	.49***	.32***	-.23*	.38*	.72***

Note. Variables are latent, apart from reading fluency.

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

The model fit was satisfactory: CFI = .93, TLI = .91, RMSEA = .061, and SRMR = .071. Figure 2 shows the statistically significant standardized coefficients. Factor loadings ranged from medium to high except for item 33 ("I do my reading assignments because they must be done"), which loaded both to reading enjoyment and extrinsic motivation factors. A few residual correlations were added to the model to improve its fit (see *Note* of Figure 2). These correlations suggest that Item 3 of the self-efficacy scale (reading a long book) correlated with response strategy and time-on-task stronger than the other items of the scale. Some correlations were specific to a certain parcel; for example, the time-on-task of parcel 1 correlated with the response strategy of parcel 1.

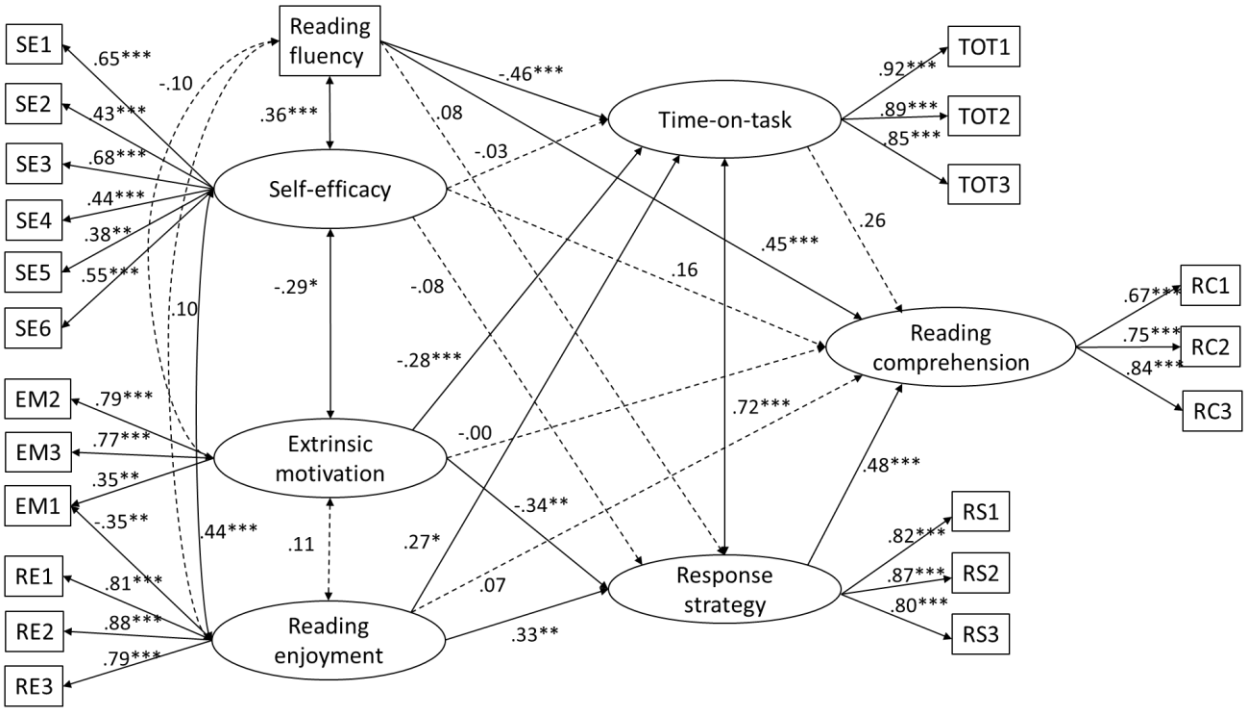
Based on the model, self-efficacy was not related to engagement or reading comprehension but was moderately associated with both reading enjoyment and extrinsic motivation. Reading enjoyment positively predicted both time-on-task and response strategy. The indirect association via time-on-task to reading comprehension was not significant (standardized coefficient = .070, $p = .166$), but the indirect association via response strategy was significant (standardized coefficient = .155, $p = .026$), suggesting that students who enjoy reading tended to use a deeper strategy in the task, which positively affected their performance. Extrinsic motivation predicted both time-on-task and response strategy. The

indirect association from extrinsic motivation to reading comprehension via time-on-task was not significant (standardized coefficient -.073, p = .097), but the indirect association via response strategy was significant (standardized coefficient -.163, p = .001), suggesting that extrinsically motivated students were less cognitively engaged (i.e., used a shallower strategy), which negatively affected their performance in the task. As expected, reading fluency was a strong direct predictor of reading comprehension, but it also negatively predicted time-on-task. The indirect association from reading fluency to reading comprehension via time-on-task was almost significant (standardized coefficient = -.119, p = .050), suggesting that higher processing speed in the reading fluency (sentence verification) task may also reflect a tendency to respond fast in tasks that require longer reflection times, which negatively contributes to performance in them.

The model explains 68% of the variance in reading comprehension, 30% of the variance in time-on-task, and 18% of the variance in the response strategy factor.

Figure 2

Associations between the Variables in Study 1



Note. Solid lines represent significant paths, and dashed lines represent nonsignificant paths. The following residual correlations were included in the model (not depicted): SE3 with Time-on-task (.39), SE3 with Response strategy (.40), TOT1 with RS1 (.33), TOT2 with EM3 (.48), TOT3 with RS3 (.45), TOT3 with SE2 (-.38), SE5 with SE2 (.26), and RS2 with EM3 (-.40).

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

3 Study 2

Because Study 1 included a relatively small sample and a new measure of cognitive engagement (response strategy), another study was conducted as a conceptual replication of Study 1 to gain information about the consistency of the findings, as well as to clarify the specific contribution of each predictor to engagement and reading comprehension. In conceptual replication, the same hypothesis is tested using a different methodology (Schmidt, 2009). Study 2 includes a larger sample consisting of both dysfluent and fluent readers, a

shorter reading comprehension test than in Study 1, and the scales used to assess extrinsic motivation and self-efficacy were slightly modified (described in more detail below).

The dataset was collected approximately one year after Study 1, originally to serve as pretest data for the Reader's Theater intervention implemented as a part of the larger research project (see Author et al., 2022).

3.1 Method

3.1.1 Participants and Procedure

A similar procedure was followed in the recruitment of participants as in Study 1, with some differences described below. Participants were recruited from 10 schools in Central Finland, both from urban and rural areas. The school that had participated in Study 1 was excluded; therefore, no student participated in both studies. Five participants did not complete the pretest, and another five participants were excluded from the analysis because they did not speak Finnish as their first language, resulting in an analytic sample of 308 students (178 girls and 130 boys) who came from Grade 3 (n = 128) and Grade 4 (n = 180) classrooms. Approximately 46% of the students in this sample had oral reading fluency at or below the 20th percentile. Unlike in Study 1, the motivation questionnaire was computerized and administered during the same session as the skill tests. The students had the option to listen to all the texts of the questionnaire via headphones.

3.1.2 Assessments

The assessments of reading fluency and reading enjoyment were identical to those in Study 1. In these data, McDonald's omega for reading enjoyment was .87, 95% CI [.83, .89].

3.1.2.1 Reading Comprehension. The test was otherwise similar to the version in Study 1, but it included only seven vignettes and had no time limit. McDonald's omega for this shorter test was .57, 95% CI [.48, .64].

3.1.2.2 Time-on-Task. Like reading comprehension, time-on-task was based on only seven vignettes in Study 2. McDonald's omega for the time-on-task variable was .91, 95% CI [.84, .95].

3.1.2.3 Response Strategy. The response strategy variable was also based on seven vignettes. The same 30-second threshold as in Study 1 was used for rapid guessing behavior, as the mean of the fastest response times for high-score vignettes was 29.00 seconds after removing two deviating response times. McDonald's omega for response strategy was .66, 95% CI [.57, .73].

3.1.2.4 Self-Efficacy. For Study 2, new items assessing self-efficacy in reading comprehension were added (see Appendix, Table A1). Separate scales for self-efficacy in reading fluency and self-efficacy in reading comprehension were initially formed, but because of their high correlation, the scales were combined by summing each fluency item with a comprehension item (item SE1 with SE5, item SE2 with SE6, item SE3 with SE7, and item SE4 with SE8; see Table A1) so that, eventually, four items, each assessing both fluency and comprehension, were used to measure self-efficacy. McDonald's omega for the self-efficacy scale was .85, 95% CI [.82, .88].

3.1.2.5 Extrinsic Motivation. For Study 2, the item that loaded both extrinsic motivation and reading enjoyment factors ("I do my reading assignments because they must be done") was changed to "…because the teacher makes me do them" to emphasize the extrinsic aspect of doing the assignments. McDonald's omega for this modified extrinsic motivation scale was .64, 95% CI [.57, .72].

3.1.3 Data Analysis

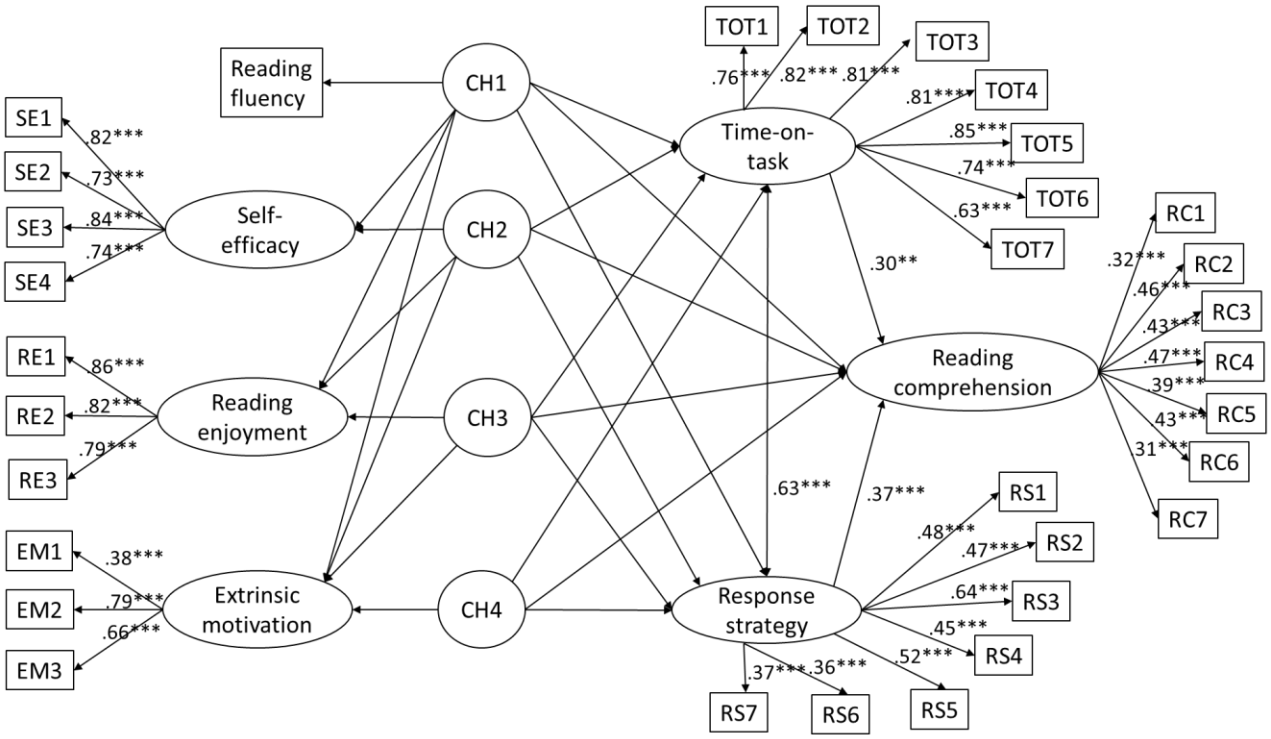
The data were analyzed with SEM using the Mplus statistical program (Version 8.2). First, a model similar to that in Study 1 was tested. Second, due to the high correlations between predictors, especially between self-efficacy and reading enjoyment, Cholesky

decomposition was used to clarify the unique contribution of each predictor to the outcome variables. Cholesky decomposition divides the variances into independent factors, which explain the outcome factors hierarchically (de Jong, 1999). Thus, Cholesky decomposition is comparable to hierarchical regression analysis.

The Cholesky factors were entered into the model in predetermined order, and four different orders were tested. In this way, the contribution of each predictor was tested as both the first predictor and the last predictor (i.e., representing the predictor's contribution after the effects of the other predictors were controlled for). An example of a Cholesky decomposition model in which reading fluency is entered as the first predictor and extrinsic motivation as the last predictor is given in Figure 3. Figure 3 also shows the standardized factor loadings and coefficients for the associations among the time-on-task, response strategy, and reading comprehension factors.

Figure 3

An Example of a Cholesky Decomposition Model



Note. The following residual correlations were included in the Cholesky models (not depicted): SE3 with SE1 -.36, RS1 with TOT1 .36, RS2 with TOT2 .29, RS2 with RC2 .36, RS3 with TOT3 .24, RS3 with RC3 .35, RS4 with TOT4 .26, RS4 with RC4 .22, RS5 with TOT5 .37, and RS7 with TOT7 .20.

** p < .01, *** p < .001

3.2 Results and Discussion

Descriptive statistics for the variables are given in Table 3, and correlations are given in Table 4.

Table 3

Descriptive Statistics for the Variables of Study 2

	n	*M*	*SD*	Min	Max	Skewness	Kurtosis
Reading fluency	307	27.50	11.10	-1.00	62.00	0.23	-0.01
Self-efficacy	308	7.80	1.42	3.50	10.00	-0.62	0.32
Reading enjoyment	308	3.49	1.07	1.00	5.00	-0.45	-0.63
Extrinsic motivation	308	2.40	0.97	1.00	5.00	0.49	-0.43
Time-on-task (s)	307	486.54	204.45	86.97	2063.63	2.13	11.49[a]
Response strategy	307	1.21	0.30	0.00	1.86	-0.75	1.93
Reading comprehension (%)	307	55.37	13.01	17.86	82.14	-0.32	-0.33

Note. Mean scores of scale items are used, apart from time-on-task (sum score) and reading fluency (outcome score). Due to technical reasons, the data of the reading fluency and reading comprehension tests are missing from one student.

[a] Caused by a few outliers, which based on data inspection, do not notably affect the correlations between time-on-task and other variables.

Table 4

Correlations between the Variables of Study 2

	1.	2.	3.	4.	5.	6.
1. Reading fluency	1					
2. Self-efficacy	.46***	1				
3. Reading enjoyment	.37***	.70***	1			
4. Extrinsic motivation	-.22**	-.23**	-.19**	1		
5. Time-on-task	-.48***	-.11	-.02	.01	1	
6. Response strategy	.32***	.35***	.38***	-.23*	.39***	1
7. Reading comprehension	.65***	.61***	.49***	-.18	.14	.74***

Note. Variables are latent, apart from reading fluency.

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

Table 5 reports the standardized loading of the tested models. These models fit the data well: CFI = .945, TLI = .936, RMSEA = .037, and SRMR = .054. As in Study 1, a few residual correlations were added to the model to improve the model fit. In most cases, these correlations appeared between items derived from the same vignette, such as response strategy in vignette 1 with time-on-task in vignette 1 (see Note in Figure 3). The standardized loadings of the predictors for the three outcome variables in the five different models are given in Table 5.

Table 5

Hierarchical Regression Analysis Predicting Time-on-Task, Response Strategy, and Reading Comprehension

SIP	β	Order 1	β	Order 2	β	Order 3	β	Order 4	β
Time-on-task									
Reading fluency (RF)	-.56***	RF	-.48***	SE	-.12	RE	-.02	EM	.01
Self-efficacy (SE)	.03	SE	.13*	RE	.07	EM	.01	RF	-.49***
Reading enjoyment (RE)	.16	RE	.11	EM	-.01	RF	-.51***	SE	.11*
Extrinsic motivation (EM)	-.08	**EM**	**-.07**	**RF**	**-.50*** **	**SE**	**.02**	**RE**	**.11**
Response strategy									
Reading fluency (RF)	.17	RF	.32***	SE	.35***	RE	.38***	EM	-.23*
Self-efficacy (SE)	.08	SE	.23**	RE	.19*	EM	-.16	RF	.28**
Reading enjoyment (RE)	.24*	RE	.18*	EM	-.14	RF	.17	SE	.21*
Extrinsic motivation (EM)	-.13	**EM**	**-.13**	**RF**	**.15**	**SE**	**.05**	**RE**	**.17***
Reading comprehension									
Reading fluency (RF)	.58***	RF	.68***	SE	.51***	RE	.35***	EM	-.10

Self-efficacy (SE)	.30***	SE	.22**	RE	-.00	EM	-.03	RF	.67***
Reading enjoyment (RE)	-.06	RE	-.05	EM	.02	RF	.59***	SE	.23**
Extrinsic motivation (EM)	.09	**EM**	**.09**	**RF**	**.51*** **	**SE**	**.21*** **	**RE**	**-.04**

Note. SIP = simultaneous inclusion of predictors in the model

* p < .05, ** p < .01, *** p < .001

First, all predictors were entered into the model simultaneously (see Table 5). In this model, reading enjoyment positively predicted response strategy, and self-efficacy positively predicted reading comprehension. Reading fluency was a negative predictor of time-on-task and a positive predictor of reading comprehension. The first hierarchical model (Order 1, Table 5) investigated the unique effect of extrinsic motivation on the outcome variables after the other predictors were controlled for. Based on this model, extrinsic motivation did not contribute to engagement or reading comprehension. The second model (Order 2) investigated the contribution of reading fluency, which was significant for time-on-task and reading comprehension but not for response strategy after controlling for the other predictors. The third model (Order 3) focused on the contribution of self-efficacy after the other predictors were controlled for. Self-efficacy significantly contributed to reading comprehension but not to time-on-task or response strategy. The fourth model (Order 4) investigated the unique contribution of reading enjoyment, which was significant for response strategy, but not for time-on-task or reading comprehension after controlling for the other predictors. These models explained 26% of the variance in the time-on-task factor, 20% of the variance in the response strategy factor, and 84% of the variance in the reading comprehension factor.

Concerning indirect effects, extrinsic motivation predicted engagement (response strategy) only when none of the other predictors were controlled for (Order 4). In this case, the negative indirect effect of extrinsic motivation on reading comprehension was significant (standardized coefficient = -.085, p = .033). Overall, this result suggests that the effect of extrinsic motivation on response strategy is not as strong as suggested by Study 1, which may be due to differences in the data analysis or the assessments between the two studies.

As in Study 1, reading fluency was a negative predictor of time-on-task, appearing significant regardless of its placement in the models. In the second model, where the unique

contribution of reading fluency on time-on-task was tested, the negative indirect effect on reading comprehension was significant (standardized coefficient = -.151, p = .004).

Self-efficacy did not contribute to engagement after controlling for the other three predictors but was a significant predictor of time-on-task and response strategy when only extrinsic motivation and reading fluency were controlled for (Order 4). In this model, the indirect effects of self-efficacy on reading comprehension were significant both via time-on-task (standardized coefficient = .035, p = .040) and via response strategy (standardized coefficient = .078, p = .021). As controlling for the effect of reading enjoyment made self-efficacy a non-significant predictor (Order 3), it seems possible that the effect of self-efficacy on task engagement is mediated by reading enjoyment.

Reading enjoyment was a significant predictor of response strategy in all tested models. In the fourth model, where the unique contribution of reading enjoyment after controlling for the other predictors was investigated, the indirect effect of reading enjoyment on reading comprehension via response strategy was very close to significance (standardized coefficient = .064, p = .050). This result is consistent with Study 1 and suggests that students who enjoy reading are more likely to get involved in strategic processing when performing a challenging reading comprehension task, which contributes to their reading comprehension. Reading enjoyment did not significantly predict time-on-task in any of the tested models.

4 General Discussion

The two studies reported in this paper tested whether children's task engagement mediates the effects of self-efficacy and motivation on reading comprehension. The results partially support the hypothesis that cognitive engagement, measured by response strategy, appeared as a significant mediator of motivation in both studies. In Study 1, cognitive engagement mediated the effects of reading enjoyment and extrinsic motivation on reading comprehension, and in Study 2, cognitive engagement mediated the effect of reading

enjoyment almost significantly, even when the other predictors were controlled for. Overall, the results align well with existing research, which has shown that intrinsic motivation and reading comprehension are associated (e.g., Hebbecker et al., 2019; McGeown et al., 2015; Schiefele et al., 2016; Taboada et al., 2008; Troyer et al., 2019; Wang & Guthrie, 2004) and that their relationship is mediated by reading engagement (Becker et al., 2010; Schaffner et al., 2013; Stutz et al., 2016; Miyamoto et al., 2018; Miyamoto et al., 2019; van Ammel et al., 2021).

Overall, the present results suggest that students who find reading in general an enjoyable activity are likely to put forth mental effort in strategic processing while performing challenging reading tasks, which contributes to their understanding of the texts. This result is consistent with van Ammel et al. (2021), who found that self-reported reading strategy use mediated the effect of autonomous motivation on reading comprehension, and Miyamoto et al. (2019), whose study suggested that students' metacognitive knowledge about reading strategies was a significant mediator of the effect of intrinsic motivation on reading comprehension.

Contrary to the hypothesis, self-efficacy did not appear as a significant predictor of engagement, which is likely because of the inclusion of the other motivation-related variables in the same model. Study 2 showed that although self-efficacy was a significant predictor of time-on-task and response strategy after reading fluency and extrinsic motivation were controlled for, it ceased to be significant when reading enjoyment was controlled for. This result is consistent with Lau and Chan (2003), who found that when eight motivation-related variables (including intrinsic motivation and self-efficacy) were entered into the same regression model, only intrinsic motivation and strategy attribution appeared as significant predictors of reading strategy use. Self-efficacy can be seen as a predecessor of reading enjoyment so that students need to experience themselves as capable readers before they can

find reading enjoyable (Ryan & Deci, 2000). To get properly involved in the strategic processing of the text, high self-efficacy alone probably does not suffice if the student does not find the task enjoyable, at least to some degree. Thus, it seems possible that the effect of self-efficacy on task engagement is mediated by reading enjoyment. It is worth noting that in Study 2, self-efficacy directly contributed to reading comprehension, even after reading fluency, reading enjoyment, and extrinsic motivation were controlled for. This suggests that self-efficacy plays an important role in reading comprehension, although the specific mechanism of its influence could not be clarified in the present studies.

The results suggest that extrinsic motivation also plays a role in task-oriented reading, although it seems smaller than that of reading enjoyment and self-efficacy. In Study 1, the negative effect of extrinsic motivation on reading comprehension was significantly mediated by cognitive engagement. In Study 2, when extrinsic motivation was entered as the first predictor, the response strategy mediated the effect of extrinsic motivation on reading comprehension. Thus, students who perform reading tasks mainly for extrinsic reasons are probably less cognitively involved in the task, which hinders their performance. They may be distracted by extrinsic incentives, resulting in shallow processing of text (Schaffner et al., 2013; Schiefele et al., 2012; Stutz et al., 2016; Wang & Guthrie, 2004), or they may possibly be over-reliant on external guidance. In the present studies, extrinsic motivation was measured by students' beliefs regarding the teacher's or other authorities' expectations for them. In the absence of explicit teacher guidance, the children may have chosen a linear response strategy, as this is often expected when completing worksheets at school. However, as shown in Study 2, extrinsic motivation was not a significant predictor when any of the other three predictors was controlled for. It should be noted that earlier studies have often used multicomponent scales to assess extrinsic motivation (e.g., different scales for recognition, grades, and competition; see Troyer et al., 2019). Future studies could clarify the

role of extrinsic motivation by using more extensive and multidimensional scales that could detect aspects of extrinsic motivation that are particularly relevant to engagement and reading comprehension.

As expected, fluent reading skill consistently predicted better reading comprehension in both studies. Efficient decoding skill is necessary for successful reading comprehension because it saves cognitive resources for higher-level processing (Goldhammer et al., 2014; Kendeou et al., 2014). Interestingly, an indirect negative effect of reading fluency on reading comprehension via time-on-task was also found in both studies. These somewhat paradoxical results seem to reflect the complex nature of the time-on-task variable, which is affected by both person- and task-related factors (Naumann & Goldhammer, 2017). The maze task used in the present studies can be considered challenging for readers of this age group (considering the relatively low average scores in the task). To perform well in the task, the students needed to realize that the items of the maze task required longer reflection times than the items of the preceding sentence verification task, which was used to assess reading fluency. The ability to allocate time according to task demands seems to develop with age (Dufresne & Kobasigawa, 1989), and the negative indirect relationship suggests that at least some of the third and fourth graders in these studies were unable to do this. These students probably continued to rely on the fast processing approach also in the maze task, which was not optimal for their comprehension of the texts.

In both studies, cognitive engagement (response strategy) was a stronger mediator of motivation than behavioral engagement (time-on-task). There is overlap in how behavioral and cognitive engagement have been defined in previous research (see, e.g., Fredricks et al., 2004), as well as in how these two aspects of engagement were operationalized in the present studies. The present response strategy variable included a behavioral time component, as the shortest answers were considered indicators of rapid guessing behavior and received a score

of 0. On the other hand, allocating time according to task demands requires strategic processing; thus, time-on-task should not be seen as a purely behavioral measure. As suggested by the negative indirect effect of reading fluency on reading comprehension via time-on-task, students of this age may have difficulties in time allocation. Thus, it is possible that the response strategy variable was better able to capture the cognitive aspect of the engagement of the students of this age and hence appeared as a stronger mediator. However, further research is needed to clarify the relative importance of the behavioral and cognitive aspects of engagement in children's task-oriented reading.

There were methodological differences between Studies 1 and 2, which should be briefly considered. First, Study 2 included a larger sample, including a more balanced ratio of dysfluent and fluent readers, whereas fluent readers were overrepresented in the sample of Study 1. While it is often assumed that motivation (and related lack of persistence) may affect the reading performance of poor readers more strongly than that of normal readers, the meta-analysis by Toste et al. (2020) found no evidence of sample type (at risk vs. typically developing) affecting the association between motivation and reading achievement. Therefore, the difference in the constitution of the samples is probably irrelevant when considering the present results. Second, the scale assessing self-efficacy was modified for Study 2 to better capture self-efficacy in reading fluency and reading comprehension, as both skills are needed in performing the maze task. Self-efficacy is known to be task-specific (Bandura, 1997), and previous studies by Peura, Viholainen, et al. (2019) and Peura, Aro, et al. (2019) showed that the level of specificity in measurement affects the power of self-efficacy as a predictor of reading achievement in primary school. This change may have contributed to the stronger direct association between self-efficacy and reading comprehension observed in Study 2.

4.1 Limitations

There are limitations in the present studies that should be noted. First, because of the cross-sectional data, caution is needed when drawing conclusions about the directionality of the effects. The present study tested the hypothesis that motivation precedes task engagement, which contributes to performance, but longitudinal and experimental studies are needed to confirm the directionality of the effects.

Second, the reading comprehension maze test had a relatively low internal consistency in Study 2, suggesting that seven vignettes may be too few to provide enough information about reading comprehension skill. However, in the analysis, the measurement error was removed using the latent reading comprehension variable, which diminished its effect on the results.

Third, the measure of cognitive engagement (response strategy) in the studies was experimental, and more information about its validity is needed. It had strong correlations with reading comprehension, but future studies should investigate its relationship to other aspects of engagement, including self-reported cognitive engagement. The models explained a fairly small part of the variance in the response strategy variable (18% and 20% in Studies 1 and 2, respectively), suggesting that there are other factors besides self-efficacy, motivation, and reading fluency explaining children's choice of response strategy in this maze task. Overall, the results suggest that objective on-line measures, such as the utilization of log data, have much potential in the assessment of children's process behaviors during task performance, but more research is needed to establish their validity.

4.2 Conclusions

The importance of self-efficacy and motivation in reading comprehension has been demonstrated in existing research. The present studies advance this knowledge by showing that reading enjoyment and self-efficacy also facilitate children's engagement and reading

comprehension while working on a specific computer-based reading task. The studies also provide further clarification on the mechanism by which motivation affects reading comprehension by showing that students who enjoy reading seem more likely to invest mental effort to achieve a coherent mental representation of the text, which contributes to their reading comprehension.

References

Anmarkrud, Ø., & Bråten, I. (2009). Motivation for reading comprehension. *Learning and Individual Differences, 19*(2), 252–256. https://doi.org/10.1016/j.lindif.2008.09.002

Author et al. (2022). Reference blinded for review.

Author et al. (2020). Reference blinded for review.

Bandura, A. (1997). *Self-efficacy. The exercise of control.* Freeman.

Becker, M., McElvany, N., & Kortenbruck, M. (2010). Intrinsic and extrinsic reading motivation as predictors of reading literacy: A longitudinal study. *Journal of Educational Psychology, 102*(4), 773–785. https://doi.org/ä10.1037/a0020084

Bråten, I., Anmarkrud, Ø., Brandmo, C., & Strømsø, H. I. (2014). Developing and testing model of direct and indirect relationships between individual differences, processing, and multiple-text comprehension. Learning and Instruction, 30, 9–24. http://dx.doi.org/10.1016/j.learninstruc.2013.11.002

Bråten, I., Magliano, J. P., & Salmerón, L. (2019). Concurrent and task-specific self-reports. In D. L. Dinsmore, L. K. Fryer, & M. M. Parkinson (Eds.), *Handbook of strategies and strategic processing: Conceptualization, intervention, measurement, and analysis* (pp. 275–295). Routledge.

De Jong, P. F. (1999). Hierarchical regression analysis in structural equation modeling. *Structural Equation Modeling, 6*(2), 198–211. https://doi.org/10.1080/10705519909540128

Dufresne, A., & Kobasigawa, A. (1989). Children's spontaneous allocation of study time: Differential and sufficient aspects. *Journal of Experimental Child Psychology, 47*(2), 274–296. https://doi.org/10.1016/0022-0965(89)90033-7

Eklund, K., Salmi., P., Polet, J., & Aro, M. (2013). *LukiMat - Oppimisen arviointi: Lukemisen ja kirjoittamisen tuen tarpeen tunnistamisen välineet 2. luokalle. Tekninen*

opas. [A screening tool of reading and spelling for Grade 2. Technical manual]. Niilo Mäki Institute.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Galla, B. M., Wood, J. J., Tsukayama, E., Har, K., Chiu, A. W., & Langer, D. A. (2014). A longitudinal multilevel model analysis of the within-person and between-person effect of effortful engagement and academic self-efficacy on academic performance. *Journal of School Psychology, 52*(3), 295–308. http://dx.doi.org/10.1016/j.jsp.2014.04.001

Gil, L., Martinez, T., & Vidal-Abarca, E. (2015). Online assessment of strategic reading literacy skills. *Computers & Education, 82*, 50–59. https://doi.org/10.1016/j.compedu.2014.10.026

Goldhammer, F., Naumann, J., Stelter, A., Tóth, K., Rölke, H., & Klieme, E. (2014). The time on task effect in reading and problem solving is moderated by task difficulty and skill: Insights from a computer-based large-scale assessment. *Journal of Educational Psychology, 106*(3), 608–626. https://doi.org/10.1037/a0034716

Guthrie, J. T., Wigfield, A., & You, W. (2012). Instructional contexts for engagement and achievement in reading. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 601–634). Springer.

Guthrie, J. T., Klauda, S. L., Ho, A. N. (2013). Modeling the relationships among reading instruction, motivation, engagement, and achievement for adolescents. *Reading Research Quarterly, 48*(1), 9–26. https://doi.org/10.1002/rrq.035

Hayes, A. F., & Coutts, J. J. (2020). Use omega rather than Cronbach's alpha for estimating reliability. But…. *Communication Methods and Measures, 14*(1), 1–24. https://doi.org/10.1080/19312458.2020.1718629

Hebbecker, K., Förster, N., & Souvignier, E. (2019). Reciprocal effects between reading achievement and intrinsic and extrinsic reading motivation. *Scientific Studies of Reading, 23*(5), 419–436. https://doi.org/10.1080/10888438.2019.1598413

Hidi, S. (2006). Interest: A unique motivational variable. *Educational Research Review, 1*(2), 69–82. https://doi.org/10.1016/j.edurev.2006.09.001

Honicke, T., & Broadbent, J. (2016). The influence of academic self-efficacy on academic performance: A systematic review. *Educational Research Review, 17*, 63–84. http://dx.doi.org/10.1016/j.edurev.2015.11.002

Hornstra, L., van der Veen, I., Peetsma, T., & Volman, M. (2013). Developments in motivation and achievement during primary school: A longitudinal study on group-specific differences. *Learning and Individual Differences, 23*, 195–204. https://doi.org/10.1016/j.lindif.2012.09.004

Hu, L., & Bentler, P. M., (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Jung, K.-R., Zhou, A. Q., & Lee, R. M. (2017). Self-efficacy, self-discipline and academic performance: Testing a context-specific mediation model. *Learning and Individual Differences, 60*, 33–39. http://dx.doi.org/10.1016/j.lindif.2017.10.004

Kendeou, P., van den Broek, P., & Karlsson, J. (2014). A cognitive view of reading comprehension: Implications for reading difficulties. *Learning Disabilities Research & Practice, 29*(1), 10–16. https://doi.org/10.1111/ldrp.12025

Klauda, S. L., & Guthrie, J. T. (2015). Comparing relations of motivation, engagement, and achievement among struggling and advanced adolescent readers. *Reading and Writing, 28*(2), 239–269. https://doi.org/10.1007/s11145-014-9523-2

Kupiainen, S., Vainikainen, M.-P., Marjanen, J., & Hautamäki, J. (2014). The role of time on task in computer-based low-stakes assessment of cross-curricular skills. *Journal of Educational Psychology, 106*(3), 627–638. https://doi.org/10.1037/a0035507

Lau, K.-T. (2009). Reading motivation, perceptions of reading instruction and reading amount: a comparison of junior and senior secondary students in Hong Kong. *Journal of Research in Reading, 32*(4), 366–382. https://doi.org/10.1111/j.1467-9817.2009.01400.x

Lau, K.-T., & Chan, D.W. (2003). Reading strategy use and motivation among Chinese good and poor readers in Hong Kong. *Journal of Research in Reading, 26*(2), 177–190. https://doi.org/10.1111/1467-9817.00195

Lee, Y. S., & Jonson-Reid, M. (2016). The role of self-efficacy in reading achievement of young children in urban schools. *Child and Adolescent Social Work Journal, 33*, 79–89. https://doi.org/10.1007/s10560-015-0404-6

Lichtenfeld, S., Pekrun, R., Stupnisky, R. H., Reiss, K., & Murayama, K. (2012). Measuring students' emotions in the early years: The achievement emotions questionnaire-elementary school (AEQ-ES). *Learning and Individual Differences, 22*(2), 190–201. https://doi.org/10.1016/j.lindif.2011.04.009

Liew, J., McTigue, E. M., Barrois, L., & Hughes, J. N. (2008). Adaptive and effortful control and academic self-efficacy beliefs on achievement: A longitudinal study of 1st through 3rd graders. *Early Childhood Research Quarterly, 23*(4), 515–526. https://doi.org/10.1016/j.ecresq.2008.07.003

Little, T. D., Rhemtulla, M., Gibson, K., & Schoemann, A. M. (2013). Why the items versus parcels controversy needn't be one. *Psychological Methods, 18*(3), 285–300. https://psycnet.apa.org/doi/10.1037/a0033266

McGeown, S.P., Duncan, L. G., Griffiths, Y.M., & Stothard, S.E. (2015). Exploring the relationship between adolescents' reading skills, reading motivation and reading habits. *Reading and Writing, 28*(4), 545–569. http://dx.doi.org/10.1007/s11145-014-9537-9

McTigue, E. M., Solheim, O. J., Walgermo, B., Frijters, J., & Foldnes, N. (2019). How can we determine students' motivation for reading before formal instruction? Results from a self-beliefs and interest scale validation. *Early Childhood Research Quarterly, 48*(3rd Quarter), 122–133. https://doi.org/10.1016/j.ecresq.2018.12.013

Minguela, M., Solé, I., Pieschl, S. (2015). Flexible self-regulated reading as a cue for deep comprehension: evidence from online and offline measures. *Reading and Writing, 28*(5), 721–744. https://doi.org/10.1007/s11145-015-9547-2

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

Miyamoto, A., Pfost, M., & Artelt, C. (2019). The relationship between intrinsic motivation and reading comprehension: Mediating effects of reading amount and metacognitive knowledge of strategy use. *Scientific Studies of Reading, 23*(6), 445–460. https://doi.org/10.1080/10888438.2019.1602836

Mäenpää, M., & Radwan, R. (2019*). Cloze-testi luetun ymmärtämisen mittarina 3. ja 4. -luokkalaisilla.* [Cloze test as a measure of Grade 3 and 4 students' reading comprehension.] Master's thesis. University of Jyväskylä.

Naumann, J. (2019). The skilled, the knowledgeable, and the motivated: Investigating the strategic allocation of time on task in a computer-based assessment. *Frontiers in Psychology, 10*, Article 1429. https://doi.org/10.3389/fpsyg.2019.01429

Naumann, J., & Goldhammer, F. (2017). Time-on-task effects in digital reading are non-linear and moderated by persons' skills and tasks' demands. *Learning and Individual Differences, 53*, 1–16. https://doi.org/10.1016/j.lindif.2016.10.002

Peura, P., Aro, T., Viholainen, H., Räikkönen, E., Usher, E. L., Sorvo, R., & Aro, M. (2019). Reading self-efficacy and reading fluency development among primary school children: Does specificity of self-efficacy matter? *Learning and Individual Differences, 73*, 67–78. https://doi.org/10.1016/j.lindif.2019.05.007

Peura, P. I., Viholainen, H. J. K., Aro, T. I., Räikkönen, E. M., Usher, E. L., Sorvo, R. M. A., ... Aro, M. T. (2019). Specificity of reading self-efficacy among primary school children. *The Journal of Experimental Education, 87*(3), 496–516. https://doi.org/10.1080/00220973.2018.1527279

Rouet, J.-F., Britt, A., & Durik, A.M. (2017). RESOLV: Readers' Representation of Reading Contexts and Tasks. *Educational Psychologist, 52*(3), 200–215. https://doi.org/10.1080/00461520.2017.1329015

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology, 57*(5), 749–761. https://doi.org/10.1037/0022-3514.57.5.749

Ryan, R. M., & Deci, E. L. (2016). Facilitating and hindering motivation, learning, and well-being in schools. Research and observations from self-determination theory. In K. R. Wentzel, & D. B. Miele (Eds.), *Handbook of motivation at school* (pp. 96–119). Taylor & Francis.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*(1), 54–67. https://doi.org/10.1006/ceps.1999.1020

Schaffner, E., Schiefele, U., & Ulferts, H. (2013). Reading amount as a mediator of the effects of intrinsic and extrinsic reading motivation on reading comprehension. *Reading Research Quarterly, 48*(4), 369–385. https://doi.org/10.1002/rrq.52

Schiefele, U., Schaffner, E., Möller, J., & Wigfield, A. (2012). Dimensions of reading motivation and their relation to reading behavior and competence. *Reading Research Quarterly, 47*(4), 427–463. https://doi.org/10.1002/RRQ.030

Schiefele, U., Stutz, F., & Schaffner, E. (2016). Longitudinal relations between reading motivation and reading comprehension in the early elementary grades. *Learning and Individual Differences, 51*, 49–58. https://doi.org/10.1016/j.lindif.2016.08.031

Schmidt, S. (2009). Shall we really do it again? The powerful concept of replication is neglected in the social sciences. *Review of General Psychology, 13*(2), 90–100. https://doi.org/10.1037/a0015108

Shin, J., & McMaster, K. (2019). Relations between CBM (oral reading and maze) and reading comprehension on state achievement tests: A meta-analysis. *Journal of School Psychology, 73*, 131–149. https://doi.org/10.1016/j.jsp.2019.03.005

Solheim, O. J. (2011). The impact of reading self-efficacy and task value on reading comprehension scores in different item formats. *Reading Psychology, 32*(1), 1–27. https://doi.org/10.1080/02702710903256601

Stutz, F., Schaffner, E., & Schiefele, U. (2016). Relations among reading motivation, reading amount, and reading comprehension in the early elementary grades. *Learning and Individual Differences, 45*, 101–113. https://doi.org/10.1016/j.lindif.2015.11.022

Taboada, A., Tonks, S. M., Wigfield, A., & Guthrie, J. T. (2008). Effects of motivational and cognitive variables on reading comprehension. Reading and Writing, 22(1), 85–106. https://doi.org/10.1007/s11145-008-9133-y

Tolar, T. D., Barth, A. E., Francis, D. J., Fletcher, J. M., Stuebing, K. K., & Vaughn, S. (2012). Psychometric properties of maze tasks in middle school students. *Assessment for Effective Intervention, 37*(3), 131–146. https://doi.org/10.1177/1534508411413913

Toste, J. R., Didion, L., Peng, P., Filderman, M. J., & McClelland, A. M. (2020). A meta-analytic review of the relations between motivation and reading achievement for K–12 students. *Review of Educational Research, 90*(3), 420–456. https://doi.org/10.3102/0034654320919352

Troyer, M., Kim, J. S., Hale, E., Wantchekon, K. A., & Armstrong, C. (2019). Relations among intrinsic and extrinsic reading motivation, reading amount, and comprehension: a conceptual replication. *Reading and Writing, 32*(5), 1197–1218. https://doi.org/10.1007/s11145-018-9907-9

Unrau, N. J., Rueda, R., Son, E., Polanin, J.R., Lundeen, R., & Muraszewski, A.K. (2018). Can reading self-efficacy be modified? A meta-analysis of the impact of interventions on reading self-efficacy. *Review of Educational Research, 88*(2), 167–204. https://doi.org/10.3102/0034654317743199

Usher, E. L., Li, C. R., Butz, A. R., Rojas, J. P. (2019). Perseverant grit and self-efficacy: Are both essential for children's academic success? *Journal of Educational Psychology, 111*(5), 877–902. https://doi.org/10.1037/edu0000324

Van Ammel, K., Aesaert, K., De Smedt, F., & Van Keer, H. (2021). Skill or will? The respective contribution of motivational and behavioural characteristics to secondary

school students' reading comprehension. *Journal of Research in Reading, 44*(3), 574–596. https://doi.org/10.1111/1467-9817.12356

Van den Broek, P. & Espin, C. A. (2012). Connecting cognitive theory and assessment: Measuring individual differences in reading comprehension. *School Psychology Review, 41*(3), 315–325. https://doi.org/10.1080/02796015.2012.12087512

Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K.M., & Deci, E.L. (2004). Motivating Learning, Performance, and Persistence: The Synergistic Effects of Intrinsic Goal Contents and Autonomy-Supportive Contexts. *Journal of Personality and Social Psychology, 87*(2), 246–260. https://doi.org/10.1037/0022-3514.87.2.246

Veenman, M. V. J. (2011). Alternative assessment of strategy use with self-report instruments: A discussion. *Metacognition and Learning, 6*(2), 205–211. https://doi.org/10.1007/s11409-011-9080-x

Vidal-Abarca, E., Mañá, A., & Gil, L. (2010). Individual differences for self-regulating task-oriented reading activities. *Journal of Educational Psychology, 102*(4), 817–826. https://doi.org/10.1037/a0020062

Wang, J. H., & Guthrie, J. T. (2004). Modeling the effects of intrinsic motivation, extrinsic motivation, amount of reading, and past reading achievement on text comprehension between U.S. and Chinese students. *Reading Research Quarterly, 39*(2), 162–186. https://doi.org/10.1598/RRQ.39.2.2

Wise, S. L., & Kong, X. (2005). Response time effort: A new measure of examinee motivation in computer-based tests. *Applied Measurement in Education, 18*(2), 163–183.

Woodcock, R. W., Mather, N., McGrew, K. S., & Wendling, B. J. (2001). *Woodcock-Johnson III tests of cognitive abilities.* Riverside.

Appendix

Table A1

Self-Efficacy Scales

Study 1	**Study 2**
Self-efficacy in reading	Self-efficacy in reading fluency
How certain are that you can	How certain are that you can
● fluently read aloud in the class? (SE1)	● fluently read aloud in the class? (SE1)
● read all subtitles of TV shows? (SE2)	● read all subtitles of TV shows? (SE2)
● read a long book? (SE3)	● read a long book? (SE3)
● read a long text on the internet? (SE4)	● read a long text on the internet? (SE4)
● comprehend what is written in a newspaper? (SE5)	Self-efficacy in reading comprehension
● follow the storyline of a book? (SE6)	How certain are you that you can
	● follow the storyline of a long book? (SE5)
	● correctly understand the contents of your textbooks? (SE6)
	● comprehend what is written in a newspaper? (SE7)
	● to understand the moral of the story you are reading? (SE8)

Note. The original items were presented in Finnish. The child responded on a 5-point scale: totally certain that I can, quite certain that I can, maybe I can, quite certain I cannot, and totally certain I cannot. The item codes used in Figures 2 and 3 are given in parentheses.

Table A2

Reading Enjoyment and Extrinsic Motivation Scales

Study 1	**Study 2**
Reading enjoyment	Reading enjoyment
● I enjoy reading (RE1) ● I look forward to reading (RE2) ● When I read, I get in a good mood (RE3)	● I enjoy reading (RE1) ● I look forward to reading (RE2) ● When I read, I get in a good mood (RE3)
Extrinsic motivation	Extrinsic motivation
I do my reading assignments	I do my reading assignments
● because they must be done (EM1) ● because otherwise the teacher gets angry (EM2) ● because I will get in trouble if I don't do them (EM3)	● because the teacher makes me do them (EM1) ● because otherwise the teacher gets angry (EM2) ● because I will get in trouble if I don't do them (EM3)

Note. The original items were presented in Finnish in a fixed random order. The child responded with a 5-point-scale: not at all true, a little true, somewhat true, almost true, and very true. The item codes used in Figures 2 and 3 are given in parentheses.