Reading comprehension in elementary school children: cognitive studies of the reader, the text, and the task

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Chapter 6

Summary and General Discussion

6.1 Summary of Results

The empirical studies in this dissertation provide insight in cognitive processes in reading and language comprehension in primarily upper elementary school children. By engaging in different reading processes, readers build a situation model of the text in their mind. The situation model represents events, characters, and situations depicted in the text. We examined how cognitive situation-model building processes are related to reader, text, and task characteristics. Furthermore, we describe the relations among these three factors. Educators know the importance of constructing good learning contexts for students. In their mission to do so, the question "what makes some students succeed and others not?" is an everyday issue. Together with previous research, this dissertation helps in understanding the relations between the three factors and dealing with such questions and the complexity in educational practice and educational science. In this general discussion, I first present a summary of the results from the four empirical papers. Thereafter I discuss the interrelations between reader, text, and task, as well as implications for future research and for education.

In the **second chapter** we studied how children (9-11 years old) differ in online inference generation, and how these differences relate to children's underlying reader characteristics, and text genres. Generating inferences is an elaborated way to build a situation model. Based on think-aloud data, we identified three profiles of readers that differ in both number and types of inferences they generate. Elaborating Readers generated different types of inferences; they used text connecting inferences, elaborative inferences, and predictive inferences while reading. Paraphrasing Readers predominantly repeated the text by paraphrasing it. In addition, they also generated some inferences. Literal Readers mainly repeated the text literally; in fact, 60% of responses from children in this profile were literal text repetitions. Literal Readers generated few inferences. On ancillary measures, Elaborating Readers, showed significantly higher scores on word reading and nonverbal reasoning measures than did Paraphrasing, and Literal Readers. These results show that both lower- order cognitive processes (such as word reading) and higher-order cognitive processes (such as reasoning ability) underpin children's differences in online reading processes. Children generally showed the same reading profiles for both narrative and expository texts. However, generally expository texts elicited fewer elaborative reading processes than narrative texts. For example, there was a smaller number of predictive inferences made when reading expository texts. In addition, a larger number of invalid elaborative inferences were found for expository texts than narrative texts. Because generating fewer elaborative inferences and generating more invalid inferences are likely to impede comprehension, these findings indicate that upper elementary school children are still

developing skills to comprehend expository texts. To sum up, the current findings are in line with previous research (e.g. Kraal et al., 2017; McMaster et al., 2012) that has found reader profiles in which children build either a situation model that closely resembles the text or a situation model that is enriched by inferences. In this study, we expand on previous research by showing that such profiles can be found in a group of children with heterogenous underlying cognitive and language abilities, and that these abilities differ between the profiles. In addition, we show that children produce a very similar set of think-aloud responses across text genres that results in the same profiles across the different texts. There were however differences in the number of inferences generated between the text genres. Hence, the results suggest a certain stability in children's text approaches with room for situational differences related to text genre demands.

In the **third chapter** we studied how online processes of children (9-11 years old) in the three reader profiles relate to their offline text memory. Because the offline text memory is an important indicator for learning in school, research of reading profiles needs to consider the quality of resulting memory representations. Offline memory of narrative and expository texts was studied by examining whether children remembered more central information, the gist, than peripheral information, i.e. whether they showed a centrality effect. Inferences help in making connections between text parts, which is important to understand the gist of a text. Therefore, we anticipated that children who generate a larger number of online inferences would show a larger centrality effect in their offline recall, compared to children who generate fewer online inferences. Meaning we hypothesized Elaborating Readers would show a larger centrality effect than Paraphrasing Readers and Literal Readers, and that Paraphrasing Readers would show a larger centrality effect than Literal Readers. First, all groups of children showed a centrality effect for narrative texts. Elaborating Readers showed a larger centrality effect than Paraphrasing Readers. However, neither Elaborating Readers nor Paraphrasing Readers differed from Literal Readers. We suggest that these findings can not be explained only by the number of inferences generated during reading, but we also consider ancillary measures. Elaborating readers proved to achieve higher scores on word decoding and non-verbal reasoning than both Paraphrasing, and Literal Readers. We suggest that children in each profile engage in the online reading processes that suit the cognitive capacities that underpin reading. Although Paraphrasing Readers score lower on word decoding and reasoning tests than Elaborating Readers, Paraphrasing Readers try out some inferences while reading. Possibly, trying out inferences while having relatively underdeveloped word reading and general reasoning abilities hinders Paraphrasing Readers from achieving an offline memory representation similar to that of Elaborating Readers. Second,

no centrality effects were found when the children read expository texts. In sum, expository texts elicited fewer inferences in online processes (second chapter) and no profile differences in offline comprehension (third chapter). It is possible that extracting central information in expository texts requires additional online processes to inference generation that our measures did not capture.

In the **fourth chapter** we examined children's (9-12 year old) ability to use temporal connectives when building a situation model of sentences such as "Before you add or subtract a number, you should solve the multiplication". Such sentences can be grammatically complex and therefore taxing for working memory. Previous research has brought contradicting hypotheses of the role of working memory for comprehending these sentences. To expand on previous research, we examine how comprehension interacts with both working memory capacity and working memory updating ability. In two experiments we varied the position of the connectives "before" and "after" in the sentences. In the first experiment we asked participants to answer the question "what happened first?" and in the second experiment we asked participants to answer the question "what happened last?". By these sentence and task manipulations we could investigate whether comprehension was affected by familiarity of the connective, by the position of connective, by the position of the answer (main clause, subordinate clause, or recent clause), and by sentence chronology. Across both experiments, we found that upper-elementary school children's comprehension was affected by clause salience, rather than the familiarity of the connective. The children were sensitive to whether the correct answer to the comprehension question was situated in the main clause or the subordinate clause. Importantly, the second experiment showed that comprehension was qualified by children's working memory updating ability and working memory capacity. Children with high working memory updating showed a main clause advantage, i.e. they performed well when the correct answer was situated in the main clause. Children with low working memory updating showed a sentence-chronology effect i.e their comprehension benefits from chronologically written sentences. The alternative explanation we propose to the sentence-chronology effect, is that children with low working memory updating showed a recency effect, i.e. their comprehension was better when the correct answer was positioned at the end of the sentence. Furthermore, the position of the connective influenced comprehension and, importantly, interacted with working memory abilities. When reading sentences with sentence-initial connectives, readers need to hold information about the connective in working memory for a longer time. For these sentences, children with higher working memory capacity succeeded better in doing so. When reading sentences with sentence-medial connectives,

readers need to update their mental representation mid-sentence. For these sentences, children with higher working memory updating ability succeeded better in doing so. Together, these findings indicate that upper-elementary school children's comprehension of sentences containing temporal connectives fits with a working memory capacity-constrained framework of reading comprehension where there are dissociable contributions of working memory capacity and working memory updating.

In the **fifth chapter** we examined comprehension of sentences with target words of high and low predictability in two modalities: reading and listening. Comparing literature on comprehension in pre-school and elementary school children can be difficult as the former may use listening tasks whereas the latter may use reading tasks. Therefore, we examine higher-order cognitive processes in both modalities to better understand differences and similarities between the two comprehension tasks. We started this examination in an adult population. Using ERP, eye-tracking, and a working memory updating task, we investigated whether working memory is taxed differently when reading or listening to sentences leading up to a highly or moderately predictable word. We predicted that a reading task taxes working memory less than a listening task as the reader has the possibility to go back and reread target words that seem less predictable. Indeed, results indicate that working memory is more taxed in the listening task than in the reading task, and comprehension is related to both individual differences in working memory, and task demands such as the possibility to revisit the text. In the reading task, the group of participants with high working memory and the group of participants with low working memory looked equally long at highly and moderately predictable words at first gaze. In addition, both groups of participants looked back at less predictable words equally often. In the listening task, only participants with low working memory showed a pronounced N400 effect towards less predictable words. These results have two alternative explanations. First, participants with low working memory may have difficulties to use both global and local context to predict the target words and focus only on the local context while listening. Participants with high working memory use both global and local context while listening. Second, participants with low working memory have difficulties inhibiting their initial prediction, whereas participants with high working memory area able to inhibit their initial prediction while listening. Because we used a working memory updating task it is more plausible to assume that participants with low working memory updating may have difficulties to use both global and local context. I.e., they are less able to update their understanding depending on the context. However, with these data it is unclear exactly what aspects of working memory updating are concerned (Ecker et al., 2010), or how they were used qualitatively. Further

research should clarify these aspects to bring further clarity to the interpretations of results. Finally, there was a moderate positive correlation between the first gaze and N400 measures. This finding indicates that higher-order reading processes, such as predictive inference generation at word level, have commonalities between modalities and are also modality-specific. For the latter, different working-memory demands are made on predictive inferences during reading and listening. Further research should include elementary school children to disentangle conclusions in previous research based on the use of different research methods. Because children's working memory is still developing, it is difficult to make direct comparisons of results concerning an adult population. In addition, research concerning modality differences in children has educational benefits as listening devices are sometimes used in schools as reading aids.

6.2 Interactions Between Reader, Text, and Task Characteristics

As has been pointed out in the introduction to this dissertation and made clear from the results presented in the four empirical chapters, reading comprehension and reading comprehension processes are dependent on at least three sets of factors; namely characteristics of the reader, the text, and the task (see the Venn diagram in Figure 6.1; modified from Snow & RAND, 2002). In this part of the dissertation, I discuss how the four chapters relate to each other; how results indicate an intricate relation between the three factors and how these results could lead to further research and have educational implications. I concentrate on the intersections between the three factors, and pinpoint how our findings contribute to understanding these intersections further. In this discussion, I begin with results related to reader characteristics, reader profiles and working memory, and end with suggestions for further research. In addition, I discuss how the results have educational implications.

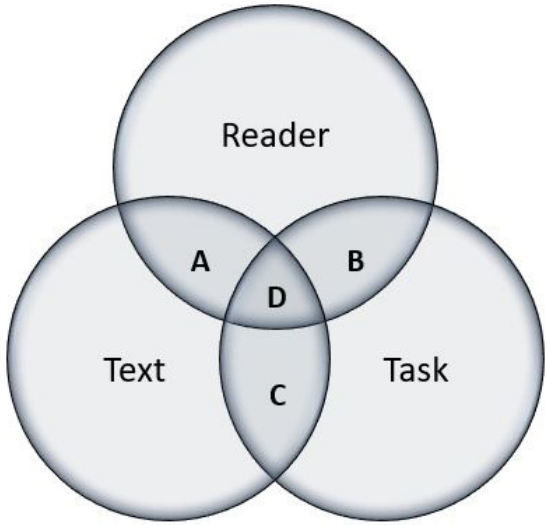

Figure 6.1. Venn diagram depicting three important factors that influence reading comprehension and their interactions: reader, text, and task characteristics.

6.2.1 Reader Profiles

Learning depends on a multidimensional set of skills, and classrooms typically contain a heterogeneous group of students (Hickendorff, Edelsbrunner, McMullen, Schneider, & Trezisee, 2018). Similarly, learning to read requires a multidimensional set of skills and developing readers form a heterogeneous group. Because practical limitations in a classroom context may prevent instruction that is specific to each student, it can be helpful to consider subgroups of developing readers that are similar in some important respects. For example, by identifying reader profiles based on the number and types of inferences that developing readers generate, we were able to make visible relatively homogenous subgroups of elementary-school children and understand how they behave qualitatively different when reading. In addition, by exploring how these subgroups made use of online reading processes and build their offline mental representations in different text genres (field D, figure 6.1) we detected both differences and similarities between these subgroups. Extracting such differences and similarities extends our knowledge on states and traits in elementary-school children's reading abilities. Below I will further discuss these states and traits, and what this implies for future research.

Studying differences in the number of inferences children produce when reading and what they remember from these texts, helps to better understand how online reading processes relate to offline text representation. Together, the empirical papers based on think-aloud data (chapter two) and recall data (chapter three) help us understand this relation. The results from the think-aloud study clarify some aspects of the intersection of reader characteristics and text characteristics (field A, figure 6.1). For example, the appearance of similar reading profiles across two text genres shows that developing readers display a certain stability of reading behavior across different texts and could point to reader traits. The children in the three profiles consistently displayed a similar approach to all texts. Literal Readers stayed very close to the literal meaning of all texts, Paraphrasing Readers took a further step away from the texts by making paraphrases, and Elaborating Readers enriched their situation model of texts furthermore by focusing on inferences. In addition, we found that well-developed skills in both lower-order (word reading ability) and higher-order (reasoning ability) cognitive processes are underpinning the ability to generate inferences in both narrative and expository texts. These findings support the notion of stability in reading behavior displayed across text genres. Although we expand on previous studies by examining these profiles across text genres, the findings resemble previous research as children differ in how close they stay to the literal text and how many inferences they make (e.g. Kraal et al., 2017; McMaster et al., 2012). However, all children responded to a more difficult text genre in a similar way. Expository texts generally introduce new words and conceps to the reader compared to narrative texts and are often considered more difficult (Best et al., 2008; Britton & Pelligrini, 1990). The expository texts elicited fewer inferences for all children. The fact that young readers (have to) partly change their online reading approach in the face of different text demands point to situational states and flexibility. Together, these results indicate both stability and situational states, or in other words continuity and change, in use of inferences across different text genres.

The results from the recall study clarify some aspects at the intersection of reader characteristics and text characteristics as well as at the intersection of reader characteristics and task characteristics (field A and B, figure 6.1). Children in all three profiles remembered more central information than peripheral information after having read narrative texts, i.e. they showed a centrality effect. However, they did not show a centrality effect for expository texts. Possibly, inferences help in building a text representation focusing on central aspects of narrative texts, but other processes may be needed for remembering central aspects of expository texts (Lorch, 2017). The fact that children in all reading profiles displayed a centrality

effect for narrative texts but not for expository texts shows similarities in the ability to recall central text elements across reading profiles. Measures from ancillary tasks allow us to speculate why there are large differences between the profiles in the online reading task but not the offline memory representation. In line with previous research (Jonsson et al., 2014; Turley-Ames & Whitfield, 2003), I suggest that children make use of the online reading processes that suit their cognitive abilities. Literal and Paraphrasing Readers showed lower scores on both lower-order and higher-order cognitive abilities compared to Elaborating Readers. These cognitive abilities underpin the ability to make inferences during reading (Carlson et al., 2014; de Leeuw et al., 2016; Naglieri, 2001; Olson, 1985; Rapp et al., 2007). However, for these age-appropriate texts children in all groups are able to create a similar offline text representation. Although similar, there was an important difference between Elaborating Readers and Paraphrasing Readers. Elaborating Readers showed a larger centrality effect than Paraphrasing Readers. These findings could indicate that Paraphrasing Readers are developing or testing inferential online processes that do not yet entirely match their lower and higher order cognitive skills underpinning inference generation. In this, we may call it, exploratory phase, Paraphrasing Readers' online reading efforts are not enough to remember central information from a text in the same way as Elaborating Readers do. Instead, when Paraphrasing Readers use inferences that stretch beyond the base of other cognitive abilities, this may give rise to a somewhat uncertain offline text representation. To summarize, being able to compare performance on different text genres (narrative and expository) and different tasks (online and offline reading measures, and ancillary measures of cognitive capacities) make similarities and differences between the reader profiles visible. In addition, a difference between Elaborating and Paraphrasing Readers in text recall suggests that Paraphrasing Readers use inferences perhaps exploratorily. This raises new research questions on how continuity and change across contextual demands develop over time. Below I will further discuss these questions.

Contrary to our predictions, Literal Readers showed similarities to readers with the other reading profiles in the recall task. However, as expected, Elaborating and Paraphrasing Readers differed from one another. These results raise the question whether different reader profiles depict developmental phases. There is evidence of both stable continuous reading traits and change through contextual demands and development. On the one hand, research of reading profiles based on inferential processes during think-aloud tasks may be pointing to a fairly stable way to describe inter-individual differences. In this study, stability has been shown when children generally kept their profile identity across text genres. In addition, reading profiles in elementary school children have occurred in several studies. Reading

profiles have been studied as a means to understand individual differences in 7-8 year olds (Kraal et al., 2017), inference assessment in 8-11-year olds (Carlson et al., 2014), and targeted interventions in 9-10-year olds (McMaster et al., 2012). In addition, a study of university students indicates similar reading profiles exist later in life where groups of readers differ in their use of constructive inferences while reading (Kopatich & Santuzzi, 2018). On the other hand, research of reading development shows a continuously growing ability to use inferences with age, which points to intra-individual changes (Ackerman, 1986; 1988; Kendeou et al., 2008; van den Broek & Kendeou, 2017). In addition, a difference between Elaborating and Paraphrasing Readers in text recall in this study suggests that Paraphrasing Readers use inferences perhaps exploratorily. Therefore, one can speculate whether different reader profiles possibly depict developmental phases. An interesting approach could be to examine the development of these reader profiles over time in longitudinal studies in which we examine intra-individual differences over time in addition to the inter-individual differences.

To sum up this section, extracting differences and similarities across reader profiles, across text genres, and across tasks extends our knowledge on states and traits in elementary-school children's reading abilities. Generally, children in the three profiles used the same approach to text consistently across two text genres. These findings support the notion of stability in reading behavior displayed across text genres. However, the expository texts elicited fewer inferences for all children. The fact that young readers partly change their online reading approach in the face of different text demands point to situational states. Children in all profiles showed a centrality effect in their recall of narrative texts, but not for expository texts. Although children in all profiles resembled each other, there was an important difference between Elaborating and Paraphrasing Readers. Paraphrasing Readers' online reading efforts are not enough to remember central information from a text as well as Elaborating Readers do. This could suggest that Paraphrasing Readers use inferences in an exploratory way that stretches beyond the base of other cognitive abilities and may give rise to a somewhat uncertain offline text representation. Whereas some results point to stable reader traits, other results show change in the face of text demands. Taken together these results call for future studies that are longitudinal to map out continuity and change in these types of reading profiles.

6.2.2 The Role of Working Memory

Working Memory (WM) is seen as an important mental workspace for many cognitive processes, such as reading, writing, and math (Diamond, 2013). However, not everyone would agree on the importance of studying working memory. There have been debates on what working memory actually contains (Cowan, 2017; Diamond, 2013; Miyake & Shah, 1999), and some question whether it is necessary to divide memory in several functions and definitions (e.g. Säljö, 2015), and some empirical data suggest that there may not be a strong relation between working memory capacity and reading (e.g. LARCC & Logan, 2017). However, the results reported in this dissertation show that when we consider under which circumstances working memory plays a role in reading and language comprehension, we can better understand the influence of reader, text, and task. For example, considering the study of children's reading comprehension of temporal relations (chapter four), we found that two aspects of working memory interacted with different textual features. Working memory capacity (holding information in WM while receiving a secondary task) and working memory updating (continuously updating changing information in WM) made separate contributions to children's comprehension of temporal connectives in sentence-initial and sentence-medial position. In addition, children's reading comprehension was modified by individual differences in working memory updating. Furthermore, in adult participants (chapter five), individual differences in working memory updating interact with task demands. In a reading task with relatively low task demands comprehension was not modified by working memory. However, in a listening task with higher task demands working memory modulated adults' comprehension. Hence, studying working memory in relation to variations in contextual demands, such as text and task demands, helps to understand interactions between reader, text, and task.

Aspects from the intersection of reader and text characteristics (field A, figure 6.1) can be made more comprehensible by the results from the study including a population of upper-elementary school children in chapter four. When studying comprehension processes concerning the temporal order of events, clause complexity proved to be a factor that had a negative impact on upper-elementary school children´s reading comprehension. These results show that children of this age do not fully comprehend temporal relations in text. Importantly, the complexity of the text and the children´s understanding for the text interact with their working memory. This interaction shows for both capacity limitations and updating processes in children's working memory. As proposed in the introduction of this dissertation, previous studies of young populations seldomly examine the role of both these aspects of working memory in relation to reading, although models on

reading comprehension based on adult populations account for both (see for example McNamara & Magliano, 2009). Our results show that both working memory updating and working memory capacity are positively related to comprehension. Hence, high scores in either working memory test were related to good reading comprehension. Furthermore, distinctions were made between working memory updating and working memory capacity showing that they make separate contributions to the demands of various sentence constructions. When reading sentences making demands on processes necessary to update the content, children with better working memory updating ability performed better, no differences were seen for children's limitations in capacity. And reversed, when reading sentences making demands on a limited-capacity space that holds information in a heightened state of availability, children with better working memory capacity performed better, no differences were seen for updating ability. Together, these results support the idea that models of reading comprehension that include both a capacity limitation and updating processes can be applied on developing populations. Hence, studying interactions between text characteristics, the children's text comprehension, and their working memory makes our theoretical models more comprehensible.

Above I suggest that studying working memory updating, in addition to working memory capacity, is promising for elaborating on reading models in developing populations. This suggestion is strengthened when considering results showing that children of varying working memory updating ability focus their attention on different parts of sentences (chapter four). Children with relatively low working memory updating ability were able to point out the correct answer when it was situated at the end of the sentence. A limited ability to keep and update information in working memory is likely to bias these children to focus on local understanding of sentences, i.e. the last clause read before answering the comprehension question (a so called recency effect; e.g. Naveh-Benjamin, Moscovitch, & Roediger, 2001). Children with a relatively higher working memory updating ability, however, used the main clause as a cue to understand the main message. A good ability to keep and update information in working memory is likely helpful to see past what is most recently read and be able to focus on what is most important. Although this approach did not always render the correct solution, it shows that a larger working memory updating ability helps approach these sentences on a more global level. Gaining understanding for global coherence is important for a reader to create a situation model that includes relations between text parts (van den Broek, Espin, McMaster, & Helder, 2017). Therefore, examining individual differences in understanding global coherence by studying working memory updating makes important contributions to reading research in young populations.

The study including adult readers (chapter five) helps clarify the interaction between reader characteristics and text and task demands (field D, figure 6.1). In addition, it enbles to further elaborate on above mentioned results regarding comprehension of local and global coherence. While reading highly or moderately predictable sentences, participants could control at what speed and how long they engaged in these sentences by, for example, rereading. In this reading situation, there were no differences in reading behavior between participants with low and high working memory updating. However, while *listening* to the same type of sentences they had no possibility to control the speed with which they received the message and no possibility to listen again. Thus, the listening task meant higher demands on working memory and resulted in differences between the two groups. Participants with relatively low working memory updating used the same standards to predict the different types of sentences throughout the listening task, resulting in an N400 response for sentences with lower predictability. Their comprehension response suggests that their relatively low working memory limited their ability to understand the task as a whole. Instead, they were biased towards understanding each sentence separately, i.e. understanding local coherence. By contrast, adults with relatively high working memory could comprehend global coherence. Possibly, a higher working memory allowed them to understand the task as a whole and flexibly interpret sentences of higher or lower predictability. Hence, task demands interact with individual differences in working memory and textual demands. These findings warrant further research on working memory updating and its interaction with task demands in adults. Examining whether adults adopt a certain strategy towards task demands as the task is progressing, and whether potential learning effects differ between adults with high and low working memory, could possibly strengthen models on reading comprehension aiming to explain strategic, reader-initiated, processes. A possible hypothesis is that readers with low working memory updating would be biased towards focusing on local coherence throughout the task, whereas readers with high working memory updating would eventually evolve an understanding for the task as a whole and start using more strategic processes aiming for a global understanding of the task and its demands.

As there is potential for further research in adults concerning the impact of task demands on working memory and comprehension, I also suggest new research questions concerning task effects on developing readers' working memory and comprehension. Because children in modern schools can receive digital reading aids that read the text for the student (Magnusson Amu, 2020), it is important to study to which degree and why children's language comprehension could differ between reading tasks and listening tasks. To know when and how to employ such

read-aloud aids optimally, research that examines both reading and listening modalities is necessary. In the current dissertation, we found that both adults and children with high working memory updating seem able to focus on a global understanding of task and sentences. However, individuals with relatively low working memory updating seem biased towards local coherence, especially in the face of higher task or text demands. Therefore, I hypothesize that a listening task will be more demanding for children with low working memory compared to children with high working memory. Hence, if listening tasks are used as reading aids in school it is important to research possible demands they impose on children to know when and how to use these aids. Educators need to monitor differences between various reading devices to understand when they are helpful, and when they impose new challenges. For example, if children with low working memory are prone to focus on local text coherence, they need a reading or a listening context that helps them to also understand the global coherence of the text.

To summarize, the results reported in this dissertation show that when we consider under which circumstances working memory plays a role in reading and language comprehension, we can better understand the interaction of reader, text, and task. Whereas previous research in young populations often focused on working memory capacity, we tested both working memory capacity and updating. The results show that working memory capacity and updating make separate contributions to explain children's reading comprehension. Therefore, models on reading comprehension that include both a limited-capacity space holding information in a heightened state of availability and processes necessary to update the contents of this space can be applied to developing populations. Furthermore, individual differences in working memory are visible in both adults and children, the results presented in this dissertation indicate that working memory in interaction with both task and text demands modifies comprehension and to which parts attention is allocated. Children and adults with relatively low working memory updating are biased towards comprehension of local coherence. Children and adults with relatively high working memory updating could comprehend several parts of the task or sentences, which shows comprehension of global coherence. Based on these findings, I have suggested further research in adults and children that may help build our theoretical knowledge on the relation between working memory and global and local coherence and may have implications for educational practices.

6.3 Educational Implications

Reader characteristics, such as the ability to generate inferences and to store and use information in working memory, can best be explained when considered in relation to contextual demands, such as text and task characteristics. If scientific

methods can provide these explanations, they are useful to educational practice. Learners are a heterogeneous group and there are no 'one size fits all' solutions in educational situations. Therefore, scientific explanations need to consider the complexity of reading comprehension. Specifically, the results reported in this dissertation show under which circumstances inference generation and working memory are limited or enhanced in reading and language comprehension. By highlighting two educational implications from these results, this discussion aims to assist educators to create a suitable learning environment for students with various cognitive functioning. In both examples, using the Venn diagram is suggested as helpful because it visualizes three two-way interactions as well as the three-way interaction of reader, text, and task characteristics.

The first educational implication considers recognizing students' varying abilities to build a coherent mental model of a text under different circumstances. To understand and learn from texts, readers have to construct a coherent situation model of the text in their mind. For their situation model to be coherent, it needs to contain information elements from the text, and, importantly, semantic relations between these elements (e.g. van den Broek, et al., 2017). Although important, it is not enough to understand single sentences of a text, i.e. local coherence. Obtaining comprehension of global coherence is necessary to understand the meaning of the whole text. However, there are individual differences in how school children obtain global coherence. In the current dissertation, several results indicate differences in the ablity to obtain global coherence. For example, in the think-aloud study (chapter two), Elaborating Readers use text-connecting inferences, elaborate inferences, and predictive inferences as global coherence-building processes during reading. Paraphrasing Readers made fewer inferences than Elaborating Readers, and Literal Readers made fewer inferences than both previous groups during reading. In addition, when meeting expository texts, all children made fewer inferences. In the two later studies where we compare readers of varying working memory abilities (chapter four and five), both adult and young readers with high working memory were biased towards global coherence. However, adult and young readers with low working memory were biased towards local coherence, especially in a more demanding context. Hence, to foster development of comprehension processes it is important that educators are knowledgeable about and can create circumstances under which students easily learn and access both local and global coherence processes. To do so, educators could use the Venn diagram presented in the beginning of this chapter. By considering the interrelation between the three elements of reading comprehension, the reader, the text, and the task, educators can account for several spects when assessing what is needed for certain reading goals in different situations and for various students. The challenge of text

and task can be chosen both in relation to one another and in relation to the students' abilities and set the students up for successful learning.

The second educational implication considers recognizing similarities and differences between teaching material and assessment material, and in doing so accounting for text and task demands. The studies of the think-aloud reading profiles may form an example. In the think-aloud study (chapter two), expository texts impede inference generation in all reading profiles, compared to narrative texts for which children could generate more inferences. In addition, in the offline task, children were not able to extract central information from expository text (chapter three). Together these results concur with previous research concluding that text genre influences comprehension and that expository texts are more difficult for developing readers compared to narrative texts (Best et al., 2008; Eason et al., 2012). Furthermore, whereas the online task seemed sensitive enough to assess individual differences in reading comprehension processes, the offline task seemed less sensitive. When combining the text and task perspective on reading comprehension processes, we see an interesting interaction. In the offline task investigating expository texts, there were no individual differences at all. Possibly the impeding effect of expository texts and the lower sensitivity of the offline task decreases the chances to assess and understand students' abilities. In an educational context, this has implications for various goals of teaching and assessing reading comprehension. For example, when teaching skills that are important for comprehension of a certain type of text (Lorch, 2017), the same text genre needs to be used in the assessment as well. If, however, the goal is to assess students' ability to transfer skills and apply their knowledge in other contexts, there is a need to use assessment material that is differing from the teaching material. In this latter situation, it is important to possess knowledge of the effect of that assessment material. I.e. it is important to understand the effects of text and task characteristics, to understand what skills the students actually transfer to another setting. For example, if teaching online inference generation in narrative text and assessing inference generation in another task or text genre, one must be aware that it is not only the students' abilities that are being tested, but that the task and text also provide certain restrictions for the students to apply their knowledge. Hence, learning can be evaluated by using both similar and differing material. However, the assessor needs to be sure of what the aim is, e.g. context-dependent or context-independent (transfer) learning, and the limitations of the material. Using the Venn diagram as a guide to choose assessment tools could be helpful in both situations. Knowledge about the three elements, reader, text, and task, and taking into account the possible ways they interact can help estimating what to expect from the assessment situation. In this sense, the Venn diagram ensures to always consider how

students with varying abilities react to teaching and assessment methods of varying characteristics to get a more complete picture of their learning possibilities.

6.4 Conclusion

In this dissertation, I report research on interacting effects of reader, text, and task characteristics in 9-12 year old children. Within this three-way interaction I have focused on how situation-model building cognitive processes differ in various reading profiles and in readers with low and high working memory. By defining subgroups of readers, either by the inferences they generate or cognitive capacities such as working memory, we gain understanding in how multifaceted and complex reading comprehension development is. In a heterogeneous group of children we found three reader profiles that use different approaches when trying to comprehend the text. Literal, Paraphrasing, and Elaborative Readers vary in the number of inferences they generate while reading. By investigating how these subgroups interact with text demands we understand that children keep their approach and thus behave similarly although facing different text genre demands. However, comparing the reader profiles on another task rendered more similarities between the groups than differences. Thereby, we can generalize profiles over text genres but not across tasks.

Research on individual differences and subgroups based on working memory capacity and working memory updating show that comprehension is modulated by working memory, especially in a context with higher demands. Differing hypotheses from previous research could be solved by examining both working memory capacity and working memory updating in young readers. Working memory capacity and working memory updating make different contributions to reading comprehension in interaction with textual factors. In addition, both adult and young readers are biased towards local or global comprehension depending on having low or high working memory updating abilities, respectively. Thereby, reading models considering both capacity limitations and updating abilities apply also to elementary-school children.

Finally, all four empirical papers show that subgroups differ in whether they focus predominantly on local coherence or try to comprehend global coherence of text. In addition to understanding local coherence, understanding global coherence allows the reader to build a more interconnected situation model of the text. Considering that both reader characteristics and contextual demands enable and limit abilities to comprehend global coherence, educational practices and research need to keep these elements in mind.