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

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Chapter 1

General Introduction

1.1 General Introduction

Reading comprehension is a multifaceted skillset important to acquire in order to participate in modern society; to learn at school, for work related communication, for social digitized interactions, and to keep up to date with news. Important developmental change in this skillset occurs between the ages of 9 and 12, when elementary school children go from learning to read to reading to learn. In this phase educators start expecting the children to use their reading comprehension skillset to gather knowledge about many different topics. This knowledge helps children in understanding their current surroundings as well as prepares them for future possibilities of employment. However, children are of course not alone on their journey to become proficient readers. A great deal of research and educational resources are mobilized to help them on their way. With this doctoral dissertation I aim to enlarge the scientific knowledge of reading comprehension and aid educational practitioners who ground their pedagogical work in scientific literature. This gathering of four empirical papers presents research from a cognitive scientific perspective on three elements that are important to understand reading comprehension in scientific and educational contexts: the reader, the text, and the task (Snow & RAND, 2002; van den Broek, Fletcher, & Risden, 1993).

Within cognitive science, gaining deep comprehension of a text is described as the construction of a mental model, a situation model (Johnson-Laird, 1983; van Dijk & Kintsch, 1983). This means that the situations, events, and characters that are depicted in the text need to be envisioned in the reader's mind. Being able to construct a situation model depends on reader characteristics, text characteristics, and task demands. Many cognitive skills and strategies are needed for a reader to construct a situation model. An example of a crucial skill needed to construct a situation model is the ability to make inferences from the text (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Graesser, Kintsch, 1994; Singer, & Trabasso, 1994). Inference generation entails reading between the lines. This requires the reader to connect different parts of the text to other parts of the text, and to connect parts of the text to their previous knowledge. By generating inferences, i.e. seeing how sentences are interconnected and enriching the situation model with previous knowledge, the reader understands that the text is not just a string of words, but that it tells a story with evolving events and with causes and effects. In addition, differences in text topic, difficulty, and length have an impact on what a reader can extract from the text, and thereby how rich the situation model becomes that they are constructing (e.g. van den Broek et al., 1993). In reading an easy text, for example a text that uses everyday language and has clear structure, the reader can easily construct a rich situation model. Thereby, the reader achieves a good understanding of the content. However, as soon as the text becomes more

demanding, perhaps introducing new words and concepts, the reader needs to work harder to achieve a good understanding of the text. Finally, the task that the reader is given, or takes on, while reading will have an impact on the ability to construct a rich situation model (e.g. van den Broek & Kendeou, 2017). Reading a text at own free pace and being able to revisit sentences that are hard to understand, will rule a different outcome in comprehension than when trying to understand the same text but without the ability to control the speed with which the text is presented. For example, when being read to or when using a digital read-aloud device. The many complex cognitive processes that contribute to the development of reading comprehension, such as the ability to make inferences during reading, likely interact with reader, text, and task characteristics (Rapp & van den Broek, 2005).

A fair amount of scientific knowledge on the interaction of reader characteristics, text characteristics, and task demands has been gathered studying adult readers, often university students who are quite proficient readers. The research in this dissertation builds on the existing research by predominantly focusing on 9-12-year-old children's abilities to construct a situation model of text. This is an important phase in a child's reading development. 9-12-year olds in many western educational systems, as in the Dutch school system, transition from learning to read to reading to learn (e.g. Chall 1983; 1996; Poolman, Leseman, Doornenbal, & Minnaert, 2017). In the first phase, much of reading instructions focus on the relationship between phonemes and graphemes to decode letters and words; this enables the reader to decipher what the written signs in the text represent. In this first phase of learning to read, children often encounter simple texts. In the second phase, reading to learn, children are expected to have become fluent in word-decoding skills, and are given texts with the aim to teach content. However, these texts also require additional reading processes compared to the simple texts used in the first phase. Reading tasks that the children encounter in upper elementary school lay the knowledge foundation that is necessary for profession-oriented education later in life. With careful consideration of how reading instructions are constructed by educational practitioners, children can learn about many topics and start building knowledge in fields of their interest. The more proficient readers feel, the more motivated they are to keep reading and gather knowledge in fields of their interest (e.g. Willingham, 2015). However, a phenomenon called the fourth-grade slump, in which children's reading performance drops, indicates that the increased demands that come with reading more complicated texts is not gradual (Chall 1983; 1996). Although children at upper elementary school may experience increased demands and opportunities driven by school and home environment, their cognitive system is still developing. Executive functions, and

brain networks supporting language skills and executive functions, continue to develop in older children and well into late adolescence (e.g. Diamond, 2013; Gathercole, Pickering, Ambridge, Wearing, 2004; Huizinga, Dolan, & van der Molen, 2006; Zielinski, Gennatas, Zhou, & Seeley, 2010). Executive functions can be described as an umbrella term for cognitive processes that allow control of thoughts and behavior (Diamond, 2013). The main executive functions are working memory, cognitive flexibility, and inhibition. Working memory can be seen as a mental workspace that enables keeping information in mind, defined by a certain storage capacity, and manipulating this information by processes such as updating the content in working memory (Daneman & Merikle, 1996; Diamond, 2013). Behavioral studies of working memory show that its development continues throughout childhood and adolescence (e.g., Diamond, 2013; Gathercole, 1999; Huizinga et al., 2006). Working memory is important in the context of reading comprehension as it underlies the capacity and processes necessary to retain and update the content of the story as the reader proceeds through the text (e.g., Carretti, Borella, Cornoldi, & De Beni, 2009; Daneman & Merikle, 1996). For educational institutes to enable school children to become proficient readers and thereby take part in society, it is important that science provide answers to which processes and strategies children at this age use successfully and unsuccessfully during reading, and under which circumstances (Snow & RAND, 2002). Pinpointing differences between readers in applying such strategies and processes helps understanding why some readers succeed and some struggle with comprehending text. Together, the four papers in this dissertation aim to help in understanding the effect of reader characteristics, text characteristics, and of task demands on reading comprehension in upper elementary school children.

1.2 The Reader

Readers engage in various cognitive processes during reading. Cognitive reading research distinguishes between online processes during reading and the resulting offline situation model. Online processes define what the reader does during reading, whereas offline comprehension defines the gathered understanding that the reader has built up when having finished reading. In this section I describe online processes that readers engage in to build a situation model, and why they are important to study in a developmental population. Although models on reading comprehension differ in the specifics of the relationship between online processes and the offline situation model, a consensus has emerged that online reading processes affect the reader's offline situation model (McNamara & Magliano, 2009). In addition, readers differ in their use of online processes (voluntarily or automatically), which means they may end up with differences in their mental model of the text

(McNamara & Magliano, 2009). Various online processes are needed for a reader to construct a situation model to understand the text. In cognitive science, a distinction is made between lower-order and higher-order online cognitive processes. According to the simple view of reading (e.g. Hoover & Gough, 1990), word decoding entails lower-order processes such as orthographic and phonological awareness. These processes are crucial to transform the written letters into speech sounds and hence decipher the words in a text. Higher-order processes are necessary for the reader to understand the meaning of the text as a whole. An example of a higher-order process is inference generation: readers make backward inferences, i.e. connecting the focal sentence with previous text, and forward inferences, i.e. predicting upcoming content of the text (e.g. van den Broek et al., 1993). Further examples of higher-order processes are keeping track of temporal, spatial and causal dimensions of the text, and updating our understanding of the text (Zwaan, Langston, & Graesser, 1995). Whereas lower-order processes often become automatic with sufficient practice, higher-order processes require a higher degree of executive control, making demands on for example a readers' working memory (Daneman & Merikle, 1996; Daneman & Carpenter, 1980; McNamara & Magliano, 2009). Therefore, it is important to research the relation between reading and working memory. Especially in an age group in which working memory is still developing. In this dissertation, the focus is on studying higher-order cognitive processes, in part in relation to working memory, for an enhanced scientific understanding of comprehension processes in developing readers.

1.2.1 Generating Inferences When Building a Situation Model

The ability to generate the correct inferences during reading is crucial for successful text comprehension (for an anthology on the topic see O'Brien, Cook, & Lorch, 2015). Written (and spoken) communication often assumes that the receiver of the message has some previous or contextual knowledge on the topic. A text usually contains conceptual gaps with implicit meaning. Therefore, to understand a text fully, readers need to fill in these gaps by generating inferences. When making inferences, readers can use previous text, previous knowledge, and text structure knowledge to understand the focal sentence and to make predictions of the text to come. Cognitive reading models describe that from the moment the reader encounters the first sentence in a text, there is a spread of activation of associations to other knowledge in the reader's memory to make these inferences (McNamara & Magliano, 2009). To put it differently, the information that is coming in reminds the reader of other knowledge they have. Processes that enable the reader to evaluate whether the new information can be fitted into their existing understanding

of the world (e.g. Cook & O'Brien, 2014) follow this spread of activation. Thereafter the reader integrates the new information with their already existing knowledge to build a stronger knowledge representation of that specific topic, now including what they just read. Thereby, the knowledge representation becomes interconnected. This updated knowledge representation is then used when the reader proceeds to the next sentence, or chapter, to connect the new text with previous text and with the reader's previous knowledge (e.g. van den Broek, Young, Tzeng, & Linderholm, 1999). In this chain of reading processes, inference generation plays an important part in updating the understanding of the text and connect the text parts to create a whole. Without drawing on previous knowledge and generating inferences, readers end up with a superficial understanding of the text in which they understand the meaning of words, however, may not see how different parts of the text are connected. When generating inferences readers gain a deeper text understanding and build an interconnected representation of the text, i.e. a situation model (Johnson-Laird, 1983; van Dijk & Kintsch, 1983).

There are different types of inferences and while reading full texts, each inference the reader makes will affect the next. Together the inferences affect the offline understanding of the text (Hyönä, Lorch, & Kaakinen, 2002; van den Broek et al, 1999). A few of the most common inferences studied are text-connecting, knowledge-based, and predictive inferences. Text-connecting inferences refer to backward inferences by which the reader connects the focal text with the previous text. Knowledge-based inferences refer to inferences where the reader uses their own previous knowledge to fill in conceptual gaps of missing information. Predictive inferences refer to forward inferences by which the reader makes a prediction of the upcoming text. These inferences have often been studied by examining single inferences in isolation of other reading processes that are involved when the reader is making sense of a text, usually these studies also focus on reading a few sentences. However, various types of inferences are used in combination when the reader proceeds through a full text (Hyönä, Lorch, & Kaakinen, 2002; McNamara & Magliano, 2009). Because upper elementary school children learn content knowledge from reading texts, not only a few sentences, we studied children's inference generation while reading full texts. Similar studies concerning children's inference generation in full text have identified subgroups of readers that differ in the online processes they use (e.g. McMaster et al., 2012; Kraal et al., 2017). These studies focused on groups of developing readers with either a high or a low level of reading comprehension. In the current dissertation we aim to investigate subgroups of readers in a more heterogeneous group that is likely to have a larger resemblance to classroom populations. By studying differences in the number and type of inferences children produce we get a better understanding of how they

build their situation model when reading and how these efforts relate to good offline reading comprehension.

1.2.2 Structuring Events When Building a Situation Model

To attain a coherent situation model of the text, the reader keeps track of and updates several dimensions of events unfolding in the text, such as when and where they play out, and what caused these events (e.g. van den Broek, 1990; Zwaan, et al., 1995). The ability to flexibly update one's understanding of the temporal order of two or several events in the text is important to continuously build an accurate situation model as the text unfolds. For example, a sentence like "Before you add or subtract a number, you should solve the multiplication" instructs the reader how to calculate correctly and is crucial for a child to understand in their math education. Research on understanding temporal relations of events has provided information about readers' ability to manipulate and update their situation model. Therefore, a great deal of research has been devoted to children's (e.g. Blything, Davies, & Cain, 2015; Cain & Nash, 2011; Natsopoulos & Abadzi, 1986; Pyykkönen & Järvikivi, 2012; Van Silfhout, Evers-Vermeul, & Sanders, 2015) and adults' (e.g. Münte, Schiltz, & Kutas, 1998; Ye, Kutas et al, 2012) understanding of temporal connectives such as *before* and *after*. The research field has seen different, sometimes competing, conclusions depending on the age of participants and the measurements used. Conclusions have differed on whether working-memory capacity or working-memory updating is taxed by these sentences. Conclusions have also differed on what textual demands are difficult for readers' to understand; grammatical complexity or the chronology of the text. Children's ability to understand temporal relations has often been researched in younger children using offline comprehension listening tasks or older children using reading tasks, whereas studies in adults have often used online reading tasks but with a limited set of materials. We aim to provide more clarity to differing conclusions by using extended measurements. We study reading processes of temporal relations in 9-12-year olds because it allows us to achieve important insights into both online and offline comprehension processes, in a period of life when language comprehension development interacts with the development of working memory. Because the ability to correctly comprehend temporal relations is important, especially in educational contexts, the seemingly contradictory findings in previous studies on this topic should be resolved, and the role of working memory should be clarified.

1.2.3 Building a Situation Model in Working Memory

Models of working memory generally agree that this is a system for the temporary storage and manipulation of information (for an anthology on models of working

memory, see Miyake & Shah, 1999). Therefore, working memory is essential for situation model building (Daneman & Carpenter, 1980; Daneman & Merikle, 1996). Working memory is one of what are called executive functions in cognitive science (e.g. Diamond, 2013). Executive functions is an umbrella term for several general mental processes that help coordinate actions and control behavior to stay on task and go about daily life. An everyday example is to read and execute the instructions of a recipe when cooking. Although executive functions allow control of behavior, they come with limitations. For example, the storage capacity of working memory is limited. Consider all the details and bits of information that are contained in a single book; it is impossible for a reader to, at any given moment, keep every detail in a book active in working memory. Instead, concepts in the text are fluctuating in how active they are in the reader's mind while reading (e.g. van den Broek et al., 1999). The limitations of working memory can fluctuate within a reader but have also proven to differ between individuals and to be related to their reading comprehension. For example, children with a larger working memory capacity have better text comprehension (e.g. Cain, Oakhill, & Bryant, 2004; Christopher et al., 2012; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000; Swanson, Zheng, & Jerman, 2009).

Much of research on the role of working memory in developing readers has focused on the limitations of working memory capacity. However, theoretical models based on adult readers' reading comprehension not only entail a limited-capacity space that holds information in a heightened state of availability, but also considers the processes necessary to update the contents of this workspace. These processes aid readers as they continuously modify their mental representations of the text (Linderholm, Virtue, Tzeng, & van den Broek, 2004; McNamara & Magliano, 2009; van Dijk & Kintsch, 1983). Through a process of spread of activation (e.g. Collins & Loftus, 1975; Linderholm et al., 2004), concepts from the text and/or long-term memory that are automatically activated above a certain threshold may enter the focus of the reader's attention, i.e., working memory (van den Broek et al, 1999). Information useful to the reader is integrated in the situation model whereas information deemed not important becomes inhibited or forgotten (e.g. Kintsch, 1994; Wylie et al., 2018). Spread of activation is an efficient way of building comprehension because it consumes little of the reader's cognitive resources. However, syntactically or semantically complex sentences, requiring integration and sequencing of multiple pieces of information, often demand more than automatic processes. These types of sentences often involve strategic processing, i.e. reader-initiated processes, by which the reader consciously evaluates what is important (e.g. van den Broek & Helder, 2017). Keeping several units of information active in mind, while simultaneously trying to manipulate and analyze

these pieces of information may be overtaxing children's developing cognitive resources (e.g. Blything et al., 2015).

The exact role of various working memory processes during text comprehension in development is still unclear (e.g. Kidd, 2013). This is partly due to controversies regarding the definition and operationalization of working memory (Cowan, 2017) as well as the attention that is given to storage components and to processing components in working memory. For typically developing readers, research has predominantly focused on storage and processing capacity similar to the span task addressed in the seminal paper by Daneman and Carpenter in 1980 (e.g. Seigneuric et al., 2000). A few examples also measure other executive functions such as inhibition (e.g. Christopher et al., 2012). However, to my knowledge, reading research generally does not include working memory tasks in which participants have to update their mental model of new information in a way that would simulate working memory processes as defined by models on reading comprehension (also noticed by Carretti, Cornoldi, De Beni, & Romanò, 2005).

The exact role of working memory in reading comprehension is likely to depend on the type of reading task. In a meta-analysis, Daneman and Merikle (1996) showed that working memory better predicted reading tasks that were specific (i.e. reading shorter pieces of text to understand the referent of a pronoun, to make a certain inference, or to revise inconsistencies) compared to more global text comprehension (i.e. reading a full text and drawing conclusions, and answering questions about the author's intent). Global comprehension of a full text indeed entails a wealth of different processes taking place in working memory. Therefore, if wanting to understand cognitive processes that underlie a certain reading task, researchers need to consider what aspect of working memory is believed to predict performance in specific reading processes. Researchers need to have specific hypotheses of why a certain working memory measurement is related to a specific reading task to optimally explain the relationship between the two. For example, a reading task when the reader needs to hold information in working memory for a certain period until resolving a reference, and a reading task when the reader needs to continuously update a cycle of events require comparison to different working memory tasks. To summarize, a limited capacity and processes for updating and modifying the content of the mental representation, influence text comprehension (Daneman & Carpenter, 1980; Daneman & Merikle, 1996). However, there is a need to clarify the relation between reading and these two different aspects of working memory in developing readers.

1.3 The Text

Texts vary on multiple levels, on macro levels such as discourse genre and text structure, and on micro levels such as sentence difficulty including word frequency and syntax complexity. Children's reading comprehension is predicted by their text structure knowledge, and interventions on text structure knowledge improve comprehension (e.g. Bogaerds-Hazenberg, Evers-Vermeul, & van den Bergh, 2020; Meyer, 1987; Meyer & Ray, 2011). Adults' guidance in choice of reading material can enhance the possibility of a positive challenge in children's reading advances and may sometimes be crucial to understanding the content (e.g. Snow & Rand, 2002). Knowledge on how children build their situation models in different texts helps educators when they choose, or help children choose, reading material. Knowledge on how children build their situation models in different texts is also useful when helping them find strategies suitable for the specific text types (Meyer, 1987). In the current dissertation, we study children's ability to build a situation model in texts that differ on macro levels and on micro levels.

1.3.1 Macro-Level Variation: Text Genre Differences

Children are generally exposed to narrative texts when learning to read and encounter expository texts later in their elementary-school years. Longstanding research of differences in text structure in narrative and expository texts shows that elementary school children find expository texts more difficult and explicit instruction is very much needed (e.g. Williams & Pao, 2011). Hence, when educators choose expository texts with the goal of teaching new content, they need to pay attention to the reading processes children already utilize and actively instruct on reading strategies to enhance learning (e.g. Lorch, 2015; Williams & Pao, 2011). For example, because expository text often is educative and explains new concepts, it is less likely that readers are able to connect the focal sentence with previous text unless explicitly instructed to generate these kind of backward inferences (Noordman, Kempf, & Vonk, 1992). In secondary-school students, inference generation is affected by reader proficiency, text accessibility and text genre (Denton et al., 2015). In college students, inference generation occurs less often for expository text than for narrative text (Lorch, 2017). To summarize, converging evidence shows that reading processes are, in part, modulated by text genre across childhood and early adulthood. By including various text genres in reading research, we are able to understand to what extent children's approach to text is stable and dependent on reader specific factors and to what extent their approach to text is dependent on text input.

1.3.2 Micro-level variation: Sentence level differences

On sentence and word levels, the reader uses text cues to build and update a situation model. Examples of such cues are temporal connectives that determine the order of events and causal cues that help the reader see the relation between events. Consider the sentences "*Before* you add or subtract a number, you should solve the multiplication", and "You should add or subtract a number *after* you solve the multiplication". When reading these two-clause sentences representing two events in a certain temporal order, readers use the temporal connectives *before* or *after* to understand in which order the two events occurred. However, micro-level variations in these cues may also impose processing costs that affect comprehension negatively. Research in pre-school children (Blything & Cain, 2016; Clark, 1971) and adults (e.g. Münte, Schiltz, & Kutas, 1998) shows that temporal connectives are not equally helpful. The connectives can impose certain demands that the reader needs to process, which can lead to a worsened reading comprehension. For example, conflicting ideas have been proposed by previous research regarding the position of the temporal connective. Sentence-initial-connectives may place a higher load on working memory capacity because the reader needs to hold that information active while reading the rest of the sentence (Blything & Cain, 2016). However, sentence-medial connectives may impose a working memory processing cost, because the reader needs to update the situation model they are building midsentence (Pyykkönen & Järvikivi, 2012). We set out to disentangle demands imposed by these micro level variations that can impede 9-12-year-old readers' comprehension of sentences containing temporal connectives.

1.4 The Reading Task

Reading is usually done with a certain purpose, be it for enjoyment, studying, or directly applying the information, such as using a cooking recipe. Because of variations in purposes and tasks connected to the reading experience, comprehension of the same text can be different. In other words, the task driving the reading scenario influences what the reader comprehends (Snow & RAND, 2002). For example, readers that do not routinely generate inferences may do so when prompted (Noordman et al., 1992). Task instructions, task demands, and how texts are presented are important aspects to consider for both scientific and educational practice. Methodological choices in a scientific study mean that we steer our understanding of the studied phenomena in a certain direction (van den Broek et al., 1993). Similarly, choices of instructional material or assessment material influence children's abilities to learn from text (Kendeou, van den Broek, Helder, & Karlsson, 2014). In both contexts, comparing various methods and materials yield

a more complete picture of reading comprehension. In the current dissertation, we study readers' ability to comprehend text in various tasks.

1.4.1 Online and Offline Tasks

Cognitive reading models suggest that the online processes that the reader utilizes during reading will largely determine the outcome of the offline understanding of the text. For example, engaging in inference generation during reading causes deep comprehension; after an inference training, children improve their reading comprehension (Elleman, 2017). However, not in all instances do online processes seem to result in improved or changed offline comprehension (e.g. Rapp & Mensink, 2011). Online task instructions and online task demands may cause the reader to focus on a certain aspect of the text in a moment-to-moment text representation, whereas offline tasks may offer the possibility to focus on other or several aspects of the text in hindsight. In addition, readers may be unable or even unwilling to shift focus or reinterpret text during reading, whereas after having read the whole text they may do so. Including online and offline tasks clarifies how readers build a situation model of the text and may inform the research community of how methodological choices may interact with reader characteristics (e.g. Rapp & Mensink, 2011). Similarly, educational systems rely on instructing and assessing students using both online and offline reading tasks. Therefore, it is important to include both online and offline measures to fully apprehend how developing readers' text comprehension is formed.

1.4.2 Reading and Listening Comprehension

Although we aim to measure a certain type of comprehension process, different measurements may impose different demands on the reader. Thereby, different conclusions may be drawn that are not only related to the reading process of interest, but also related to individual differences in working memory (van den Broek et al., 1993). For example, contradicting hypotheses state, on the one hand, that sentence-initial connectives are more demanding for working memory and, on the other hand, that sentence-medial connectives are more demanding for working memory (Blything & Cain, 2016; Pyykkönen & Järvikivi, 2012). As these studies discuss different aspects of working memory, namely working memory capacity and working memory updating, they call for studying these sentences in relation to both these working memory measures. However, the predictions from the contradicting research stemmed from comprehension measurements that differed in which modality they were recorded, listening and reading, each potentially posing different demands on working memory. For example, decoding letters and words in a text may tax readers' working memory and in some ways these processes

distract from understanding the meaning of the message, especially in developing readers (Kendeou et al., 2014). However, readers can control the speed with which they are encoding the written message. This allows them to slow down at difficult words or reread the text if necessary. These strategies can be vital in freeing up space in working memory for further comprehension processes. A listening task may be considered less demanding because listeners can concentrate on the message itself rather than on decoding letters and words (Kendeou et al., 2014). However, listeners do not have the opportunity to control the speed with which the message is conveyed, this depends on the speaker. Hence, listeners' working memory is taxed because they must try to keep the majority of the message active in working memory to comprehend the whole content. To better understand contradicting hypotheses and results from research using different presentation modalities, there is a need to map similarities and differences in comprehension of written and spoken communication.

In light of so-called Edtech advances, research on differences and similarities in comprehending written and spoken text is needed also to inform educational practices. In schools using digital learning platforms, 20% of the students are estimated to listen to digital read-aloud options as a help to understand text content (Magnusson Amu, 2020). The read-aloud options are popular amongst students; however, Edtech developers and researchers request more research of possible benefits of these practices (Grunér, Östberg, & Hedenius, 2018; Magnusson Amu, 2020; Wood, Moxley, Tighe, & Wagner, 2018). Because of these educational developments and the fact that working memory is still developing in older elementary school children, examining the role of working memory in comprehension in reading and listening tasks is valuable.

1.5 Outline of this Dissertation

The overarching aim of this dissertation is to examine cognitive reading comprehension processes in upper elementary school children. In doing so we study different situation-model building processes and how they are related to reader, text, and task characteristics. In the **second chapter** we study how children (9-11 years old) differ in online inference generation, and how these differences relate to text genres, and children's underlying reader characteristics. Therefore, we use a think-aloud task that allows readers to freely comment on the text while reading. From these data, we identify reader profiles that differ in both number and types of online inferences generated. This is done in both narrative texts and expository texts to understand whether reader profiles are stable traits or if children's inference generation changes depending on text genre. Furthermore, to understand underlying reader characteristics that may explain possible reader profiles, we

examine the children's word-decoding ability, general text comprehension ability, non-verbal reasoning ability, working memory, and vocabulary. In the **third chapter** we study how differences in online inference generation relate to children's (9-11 years old) offline text memory. Therefore, we investigate whether children in the reader profiles identified in the second chapter, differ in their ability to structure their offline memory representation. To do so, we examine whether children show a centrality effect in their recall of the texts used for the think-aloud task. A centrality effect means that the reader remembers more of the central information, the gist, than of the details of the text. We also examine whether relations between the online and offline performance are qualified by text genre, i.e. narrative and expository texts. In the **fourth chapter** we examine children's (9-12 year old) ability to use temporal connectives when building a situation model of the text. In doing so, we examine the influence of text features such as the sentence position and familiarity of connectives, and clause salience. By means of two experiments, we aim to disentangle the effects that connective familiarity and clause salience have on comprehension. Importantly, we investigate how comprehension of sentences that include temporal connectives is qualified by children's working memory and use both a working memory capacity task and a working memory updating task for this aim. Testing both working memory capacity and working memory updating allows us to examine contradicting findings of earlier studies. Previous studies with contradicting findings did not only differ in their conclusions, but also in methodological choices to gather data, with a listening or with a reading task. In the **fifth chapter** we examine whether two different modalities, reading and listening, are taxing the comprehenders' working memory differently. As a first step to do so, we study adult readers' ability to make predictive inferences while reading and listening and included a working memory task. Finally, in the **sixth chapter**, results and conclusions from the four empirical studies are discussed in a broader context related to the important elements: reader, text, and task characteristics.