Different readers, different texts, different processes : the effects of reader and text properties on text processing
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Chapter 02

Individual Differences in Reading Comprehension

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and

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2.1 Introduction

People read texts for many different purposes, for example, for pleasure, to learn for school, to understand phenomena, or to obtain instructions. For all of these purposes, it is essential that the reader *comprehends* the text. However, individuals differ tremendously in their ability to do so and, hence, in their ability to attain their purposes. Comprehension of a text can be defined in various ways. It may refer to the ability to reproduce (parts of) the text, the ability to analyze the information in the text, the ability to use or apply the information, as well as a range of other abilities. For example, Bloom's taxonomy of learning objectives describes levels of processing of texts and other learning materials that range from memory for the text to critical evaluation and even the production of information (Airasian et al., 2001; Bloom, 1956). Likewise, the PISA reports define *Reading Literacy* as "Reading literacy is understanding, using, evaluating, reflecting on and engaging with texts in order to achieve one's goals, to develop one's knowledge and potential and to participate in society" (PISA report, OECD, 2017, p. 51). In these conceptualizations, a crucial step in comprehending a text is that the reader first creates a mental representation of the meaning of the text. Individual differences in the representation of a text reverberate through all other comprehension-related activities. This chapter discusses sources of individual differences in reading comprehension abilities, with focus on the meaning-representation aspects of comprehension.

**2.2 Comprehension: Inferences and the construction of a coherent representation**

Comprehension of a text involves the construction of a mental representation of the meaning of the text. To understand individual differences in reading comprehension, it is useful to consider both the *product* of reading, the mental representation, and the *process* by which such a representation is constructed. The Landscape Model of Reading Comprehension (Helder, van den Broek, Van Leijenhorst, & Beker, 2013; van den Broek, Risden, Fletcher, & Thurlow, 1996) captures both product and process in an integrative account of reading comprehension, by combining research findings from many investigators. We summarize the model here.

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2.2.1 The reader's representation of a text

With regard to the product of reading, in a successful representation the reader combines parts from the text with information from background knowledge that he or she has recruited during reading. Together, these elements do not simply form a list –a crucial aspect of text comprehension is that the elements in the mental representation are interconnected by means of meaningful relations, thereby resulting in a *coherent* representation (Coté, Goldman, & Saul, 1998; Graesser & Clark, 1985; Kintsch & Van Dijk, 1978; McNamara, E. Kintsch, Bulter Songer, & W. Kintsch, 1996; Trabasso, Secco, & van den Broek, 1984). Meaningful relations occur between individual text and background knowledge elements but also between larger text units, such as paragraphs, sections, and chapters. For example, textbooks may elaborate on a newly introduced concept by explaining components of the concept in separate paragraphs. To grasp the concept, the reader must recognize the relations between the components across paragraphs. This will be explained on the basis of an example represented in Table 2.1 and Figure 2.1 (from Trabasso, Secco, & van den Broek, 1984).

Table 2.1 Text elements of the Epaminondas Story (Trabasso, Secco, & van den Broek, 1984)

Epaminondas	
1.	Once there was a little boy,
2.	who lived in a hot country.
3.	One day his mother told him to take some cake to his grandmother.
4.	She wanted him to hold it carefully
5.	so it wouldn't break into crumbs.
6.	The little boy put the cake in a leaf under his arm
7.	and carried it to his grandmother's.
8.	When he got there
9.	the cake had crumbled into tiny pieces.
10.	His grandmother told him he was a silly boy
11.	and that he should have carried the cake on top of his head
12.	so it wouldn't break.
13.	Then she gave him a pat of butter to take back to his mother's house.
14.	The little boy wanted to be very careful with the butter
15.	so he put it on top of his head
16.	and carried it home.
17.	The sun was shining hard
18.	and when he got home
19.	the butter had melted.
20.	His mother told him he was a silly boy
21.	and that he should have put the butter in a leaf
22.	So that it would have gotten home safe and sound.

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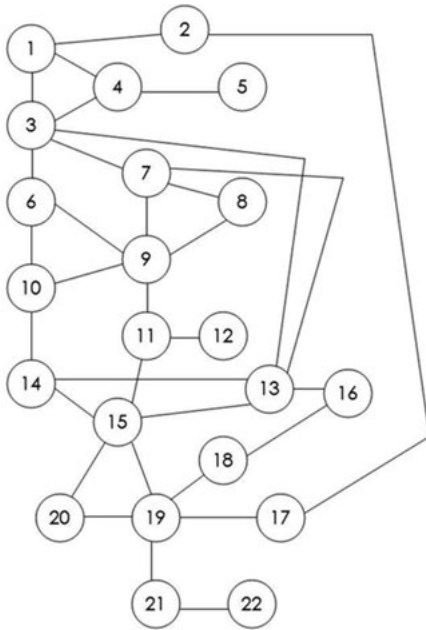
Figure 2.1. Example of a possible mental text representation of the Epaminondas story. The numbers in the circles correspond with the numbers of the text elements in Table 2.1. The lines represent the connections that the reader can make between these text elements. Connections that the reader can make with his/her background knowledge are not represented in Figure 2.1 (from Trabasso, Secco, & van den Broek, 1984).

There are various kinds of meaningful relations that provide coherence to texts. For most texts, the most crucial relations are *referential* relations, and *causal* and *logical* relations (van den Broek, 1994; van den Broek, Helder, & Van Leijenhorst, 2013). The line between text elements 3 and 1 (see Figure 2.1) is an example of a referential relation; the words 'his' and 'him' refer to the boy who is introduced in text element 1 (see Table 2.1). The line between text elements 19 and 17 is an example of a causal relation; the fact that the butter had melted (text element 19) is a result of the bright shining sun in text element 17. To make this causal relation, the reader the reader has to use his/her background knowledge. That is, the reader has to realize that the sun is hot is that butter melts when it is hot. Causal relations are often not explicitly mentioned in the text, as in this example, but can only be made if the reader addresses his/her background knowledge. These kinds of relations can be made between successive parts of the text, but also between parts of text that are further apart. An example of a relation between text elements that are further apart is the relation between text element 2 (warm country) and text element 17 (sun was shining very brightly) in the Epaminondas

story. Other types of relations, such as spatial, emotional, and temporal, may also contribute to the overall coherence of the representation of the text.

The elements from the text and from background knowledge, together with their relations, form a network of interconnected and mutually dependent events and facts. Some events and facts feature prominently in the network by having many connections to other parts of the representation. In the text in Table 2.1, for example, text element 9 (that the cake was crumbled) with five connections to other text elements is more important for the structure of the text than text element 8 (that the boy arrived at his grandmother's house) with two connections. Highly connected elements are *structurally central* to the meaningful representation of the text. Proficient readers tend to judge these elements as more important, and remember or include them in summaries of the text more often than elements with few connections (Graesser & Clark, 1985; Trabasso & van den Broek, 1985). Building a coherent mental representation of a text is therefore essential for successful reading comprehension; it is the basis for learning and application of knowledge. Struggling comprehenders may fail to identify all important relations and, as a result, arrive at an impoverished representation and compromised ability to utilize the textual information. This is because readers draw on their representation when they perform tasks based on their reading. These tasks include experimental tasks such as recall or judgments tasks, but also everyday life tasks such as retelling to others what they have read, applying the knowledge gained from reading, and comparing information across multiple texts or multiple media.

2.2.2 Comprehension processes: Inferring relations

The construction of a mental representation of the text is the result of a rich set of coherence-building processes by which the reader identifies relations between textual elements and between elements and his or her background knowledge. The study of these processes is not only theoretically interesting, but also has profound implications for educational practice. The processes are the mechanisms by which representations are constructed and, therefore, determine success and failure of comprehension. To be effective, interventions aimed at improving comprehension must impact the processes that take place *during* reading.

There are several factors that limit a reader's ability to identify the relations in a text. One major factor is that most semantic relations are not explicitly marked in the text and, therefore, need to be inferred by the reader. For example, texts frequently have sentence

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pairs such as "The inhabitants suffer from frequent torrential rain falls. Farming is a challenge", in which the causal relation between the two facts is not explicitly stated. To comprehend, the reader must *infer* the relation. A second major factor is the fact that readers have limited attentional or working-memory capacities and, therefore, can only maintain a subset of all potentially relevant events and facts from the text as they proceed to subsequent sentences. The likelihood that the relation between two events or facts will indeed be recognized by the reader is increased when the two are presented closely together in the text or when the earlier event/fact is repeated. A third limiting factor is that, even when a semantic relation is marked and working memory is not overextended, the background knowledge necessary for the inference may be lacking (in the above example: Repeated heavy rain fall may wash crops off farmland). We will return to these and other limitations in the next section.

As a reader progresses through a text, each new sentence elicits a new reading cycle with automatic processes and, possibly, strategic processes. With respect to the *automatic* processes, the concepts in the sentence trigger a passive, spread-of-activation process that activates additional concepts from the reader's memory for the preceding sentences and from his or her general background knowledge. The latter involves individual facts and events, but also the 'filling in' of conceptual gaps through activation of schemes or scripts (Anderson & Pearson, 1984). These activations are 'for free' in that they do not require effort or conscious processing by the reader. Together with concepts, events, and facts processed in the preceding reading cycle and those in the currently read sentence, these activated concepts allow the reader to make coherence-building (and other) inferences (Helder et al., 2013; van den Broek, Risden, et al., 1996).

In addition to the automatic processes, a reader may engage in *strategic,* coherence-based processes. These processes are initiated by the reader to establish coherence. They may involve the preceding text (such as looking back or searching in memory for information from the preceding text), background knowledge (e.g., searching for an explanation for an event or fact), or other sources of information altogether (e.g., internet, other texts). Strategic processes are acquired through experience or instruction, and some may become relatively automatized as a child becomes proficient in reading. Readers differ in their 'toolbox' of strategic processes. The strategic processes enable inference making beyond those already available through the automatic processes.

The degree to which a reader will engage in strategic processes, in addition to the automatic ones, is to a large extent determined by the reader's *standards of coherence*: For each reading situation (i.e., reading a particular text in a particular context), a reader implicitly or explicitly adopts a set of standards of coherence (McCrudden & Schraw, 2007; van den Broek, Bohn-Gettler, Kendeou, Carlson, & White, 2011a). These standards reflect the type (e.g., causal, referential, temporal, etc.) and strength of coherence the reader considers desirable. Standards of coherence have a family resemblance to comprehension monitoring, but an important difference is that standards often are implicit and operate without the reader's conscious awareness. A reader's standards depend on the reading situation (e.g., the reading task, instructions, presence of competing tasks), on the reader (e.g., reading goals, motivation, reading skills), and on the text (e.g., text genre, presence of text signals such as headers and connectives, and perceived source credibility; see van den Broek, Risden et al., 1996, van den Broek, Bohn-Gettler et al., 2011a, for reviews).

Thus, the reader is likely to draw on the coherence-building strategic processes in his or her repertoire when the automatic processes described above do not establish sufficient coherence between a newly read sentence and the reader's representation of the preceding text to meet the reader's standards. This is particularly likely when the text is difficult or when the reader has a particularly challenging goal for reading.

As the reader proceeds through the text, every new sentence elicits anew a combination of automatic and, possibly, strategic processes. The combinations change as a function of the properties of each newly read sentence and, thereby, create an unfolding landscape of inferential processes and fluctuating activations of concepts, events, and facts. Thus, the reading process is dynamic, with different combinations of processes taking place at different moments during reading, much like a cross-country runner whose body adjusts with every step to the unique combination of properties of the ground he is running on.

The reading process is dynamic in the sense that comprehension of a sentence and the gradual emergence of a mental representation continually interact with each other as the reader moves through the text. As each newly read sentence is processed and comprehended, the meaning derived from the sentence modifies the representation the reader has built of the text read so far. In turn, as we have seen, the representation built so far influences the processing of the next sentence. This reciprocal processing of sentence and text continues until the reader has finished reading the entire text.

2.3 Individual differences in inference generation and comprehension

The summary of the processes and products of comprehending a text in the preceding section provides a description of the modal reader but in reality individuals differ considerably in the extent to which they execute the various processes and, hence, in the representation they have created by the time their reading is completed. The sources of individual variation roughly fall into three categories: *general cognitive* factors, *comprehension* factors, and *text-specific* factors (for detailed reviews see Cain & Oakhill, 2007; Helder et al., 2013; van den Broek & Espin, 2012).

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2.3.1 General cognitive factors

As described, reading comprehension depends on a complex set of interacting processes. Not surprisingly, several general cognitive factors have been found to influence an individual's comprehension abilities and, hence, to cause individual differences. An important factor in determining a reader's ability to arrive at correct and deep understanding is his or her *background knowledge* about the information presented in the text. The inferential processes that allow a reader to identify semantic relations draw heavily on his/her prior knowledge. This is the case for both automatic and strategic processes. As a result, differences in background knowledge strongly influence the reader's comprehension and representation of a text: generally, the more knowledge the reader possesses on topics in the text, the richer and more interconnected his or her representation will be (Anderson & Pitchert, 1978; McNamara et al., 1996; Voss, Vesonder, & Spilich, 1980). In addition to the amount and depth of a reader's knowledge, the accuracy of knowledge plays an important role. For example, misconceptions influence the representation of a text just as accurate knowledge does (e.g., Dole & Smith, 1989; Kendeou & van den Broek, 2005; Mason, Gava, & Boldrin, 2008).

A second important source of individual differences concerns *working memory*. Differences in the capacity and efficacy of working memory have been found to affect comprehension in adults (Just & Carpenter, 1992; Linderholm & van den Broek, 2002; Virtue, van den Broek, & Linderholm, 2006; Whitney, Ritchie, & Matthew, 1991) as well as children (Cain & Oakhill, 2007; Reynolds, Cho, & Hutchinson, 2016). A greater working memory facilitates the maintenance and processing of more information from the text and background knowledge, thus supporting the generation of inferences and construction of a coherent

representation. Working memory is one component of the broader class of *executive functions,* which include *inhibition, shifting*, and *updating* (Miyaki et al., 2000). These generally concern the individual's ability to effectively *allocate attention,* thereby influencing the content of working memory. Although these have received less attention from researchers than working memory, they too have been found to affect comprehension of text (e.g., Sesma, Mahone, Levine, Eason, & Cutting, 2009).

2.3.2 General comprehension skills

Individual differences occur in the execution of comprehension processes that occur in all modalities including, but not limited to, reading. One important individual difference pertains to one's *standards of coherence*. Individuals may differ systematically in the type and degree of coherence they maintain while reading texts or processing information in other modalities (van den Broek, White, Kendeou, & Carlson, 2009). They may also differ in their ability to adjust their standards to fit the particular (reading) situation. For example, readers with weak comprehension adjust their reading processes less effectively to variations in reading goals than do good comprehenders (Cain & Oakhill, 2007; Linderholm & van den Broek, 2002).

A second important source of individual differences in comprehension skills concerns the degree to which individuals allocate attention to information that is important for the semantic structure of the text. Differences in this *sensitivity to structural centrality* result in differences in what information is selected from new text input for further processing.

A third source of individual differences in comprehension concerns *inferential skills*. The information that is available to the reader at a particular point in reading needs to be connected by the reader by constructing, actively or passively, a particular semantic relation. Differences in the ability to do so also have been studied mostly in the context of children. We discuss these in the context of text processing in the following subsection.

2.3.3 Text-specific skills

The processes described in the preceding section apply to all comprehension contexts, whether in reading, listening, or another medium. There also are cognitive factors that are particular to the reading context. One concerns the reader's knowledge about *text genres*. Different genres are structured around different types of coherence relations. The reader's

ability to adjust his or her reading to the genre of a text influences the depth of knowledge gained from reading (Oakhill & Cain, 2011).

A second source of individual differences pertains to a reader's knowledge of and ability to process *textual cues*. Texts contains 'instructions for processing' such as headers for (sub)sections and connectives that promote the reader to engage in particular semantic processing (Lemarié, Lorch, Eyrolle, & Virbel, 2008). Through experience and instruction developing readers acquire knowledge of these and other semantic cues. Together these cues also contribute to a reader's skill in recognizing the broader structure within a text. For example, in expository texts headers that signal (sub)sections may create a hierarchical organization to parts of the text (Lorch, 1989; Lorch, Lemarié, & Grant, 2011; Surber & Schroeder, 2007). Likewise, connectives (e.g., *and*, *so*, *because*, *however*, *meanwhile*) provide the reader with processing instructions, guiding and helping the reader to connect different parts of the text, inducing inferential processing (Sanders, Land, & Mulder, 2007; Van Silfhout, Evers-Vermeul, & Sanders, 2015).

A third source of individual differences in text-specific factors concerns *inference-making* skills. Although these skills apply to any comprehension situation, their implementation may be partially specific to the reading context. For example, evidence from eye-tracking and think-aloud studies show that poorly comprehending readers often engage in suboptimal inferential processing during reading (Rapp, van den Broek, McMaster, Kendeou, & Espin, 2007; see also Oakhill & Cain, 2011). Interestingly, it appears that these poorly comprehending readers fall into at least two distinct subgroups (McMaster et al., 2012): those who generate relatively few inferences that connect text elements and those who *do* generate such inferences but often to irrelevant information. A second example of individual differences in inference-making skills concerns differences in reading-specific strategies that a reader may have available to establish coherence when reading a text, such as knowledge about when and how to reread, how to interpret a table of contents, and so on.

A fourth source of individual differences concerns variation in *motivation for reading*. The amount of motivation that a reader brings to a reading situation determines how much mental energy he or she is willing to expend, his or her standards of coherence, and so on. Motivation can be intrinsic (Clinton & van den Broek, 2012; Guthrie & Wigfield, 2000; Wang & Guthrie, 2004) or extrinsic (dependent on incentives; e.g., Konheim-Kalkstein & van den Broek, 2008). Intrinsic motivation for reading revolves around reading for enjoyment and for interest

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(Guthrie & Wigfield, 2000). It has been found to lead to both higher exposure (more frequent reading) and higher reading performance (Baker & Wigfield, 1999). With regard to processing, it leads to more frequent use of (adequate) strategies and deeper level learning (Schiefele, 1999).The role of extrinsic motivation for reading has been investigated less extensively. The results are mixed. For example, presenting student readers with incentives to read a text has been found to improve comprehension, at least in immediate tests (Konheim-Kalkstein & van den Broek, 2008). But the effect of external reinforcement may be detrimental in the long run: Becker, McElvany, and Kortenbruck (2010) observed that, over time, providing extrinsic reading motivation may have a negative effect on performance, even when they controlled for children's frequency of reading and previous reading performance.

2.3.4 Individual differences in the representation of texts

These and other potential factors that influence the processes that occur *during* reading result in differences in the mental representation of a text in a reader's memory and, hence, in differences in higher levels of comprehension that take this representation as input. Thus, problems in comprehension processes at the representational level likely reverberate in a reader's ability to engage in other comprehension activities such as reflecting on and evaluating the text, and integrating it with information from other texts or media.

With respect to the *product* of comprehension, there are considerable individual differences in the quality of representation and the sensitivity to structural centrality, in adults and in children. For example, strong comprehenders consistently recall or judge as important events from a text that have many connections to other elements of the text, but struggling or less-experienced (younger) readers show a much weaker tendency to do so (Bourg, Bauer, & van den Broek, 1997). This difference in sensitivity to structural centrality suggests that the latter group identifies and represents fewer (or different) connections than good comprehenders. Likewise, differences in background knowledge that the reader has recruited during reading result in differences in the richness and /or accuracy of the information that is included in the representation (Kendeou, Rapp, & van den Broek, 2004). Thus, considerable individual differences in both the quality and content of the representation of texts exist.

2.4 Acquiring reading comprehension skills

Children gradually develop the skills and strategies involved in reading comprehension, through experience, instruction, and maturation of the underlying cognitive functions. For some cognitive factors described above the developmental trajectories are fairly well mapped out. This is the case, for example, for working-memory capacity and other executive functions such as suppression of irrelevant information and attention shifting (Demetriou, Christiou, Spanoudis, & Platsidou, 2002; Gathercole, Pickering, Ambridge, & Wearing, 2004).

With respect to the development of reading-specific skills, several patterns have been clearly established. With age and schooling children's inference-making processes improve and their repertoire of strategies (e.g., for repairing inconsistencies, for searching texts for relevant information) expands dramatically. As a result, they become increasingly able to identify semantic relations between text elements that are distal in the text as well as relations that are abstract (e.g., about characters' emotional and motivational states, about themes) rather than concrete and physical (Diergarten & Niedling, 2015; Lynch & van den Broek, 2007; van den Broek, Lynch, Naslund, Ievers-Landis, & Verduin, 2003; Williams, 1993). In addition, relations can become more complex, involving crossing episodic boundaries, or depending on integration of multiple pieces of information (Linderholm, Therriault, & Kwon, 2014).

As these skills and processes develop, individual differences remain fairly stable. The results of several longitudinal investigations indicate that comprehension and inference-making skills as described above already form a stable cluster of skills at an early age –as young as 4 years- and that this cluster predicts comprehension many years later, when the children are well into elementary school (e.g., Kendeou, van den Broek, White, & Lynch, 2009; Oakhill & Cain, 2011; van den Broek et al., 2009). Thus, children that comprehend well at a young age are likely to remain good comprehenders as they grow older, whereas children who struggle with comprehension when young are at risk to struggle and have continued difficulties later in their lives. Importantly, this cluster of skills develops relatively independently from a second cluster of skills, those concerning letter and word identification. The longitudinal results show that these two clusters come together once the child starts to read for comprehension, with each cluster contributing uniquely to reading comprehension performance (e.g. Gough & Tunmer, 1986; Kendeou et al., 2009).

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2.5 Concluding remarks

Individuals differ in their ability to comprehend the texts they read. Even among those who arrive at a solid understanding, there are differences in the profiles of processes they recruit to achieve that goal. Similarly, struggling readers who arrive at inadequate understanding may do so because of problems in different processes, leading to distinct subgroups of struggling readers. In this chapter, we have attempted to provide an overview of the automatic and strategic processes that are involved in the comprehension of a text, and of the gradual emergence of a coherent, meaningful representation of the text in the reader's mind. This representation is the basis for other comprehension processes, such as analyzing and evaluating the text, comparing its content to that of other texts or non-texts, and so on. The content, quality, and form of the final representation are determined by the processes during reading of the text.