Predictors of Reading Literacy

Cordula Artelt, Ulrich Schiefele & Wolfgang Schneider

Abstract Two reading literacy/text comprehension tests with different demands (on-line comprehension vs. memory-based comprehension) were administered to 6,104 15-year-old students from all German states and school types. The combined and specific effects of proximal and distal variables from small-scale psychological research as well as from large-scale educational studies on each text comprehension measure were investigated.

Metacognitive knowledge, decoding speed, and the number of books at home (as an indicator for family background) were found to have specific and large effects on on-line comprehension and accounted for 46 percent of the variance with the highest effects for metacognition. Metacognitive knowledge was also highly predictive when the effects of specific prior knowledge and thematic interest on memory-based text comprehension were estimated simultaneously.

In addition, students who showed relative strength in building up a coherent representation of specific texts (memory-based text comprehension) were characterised by high amounts of prior knowledge and thematic interest thereby underlining the important of these student characteristics for learning.

Keywords *Decoding speed Interest Metacognitive knowledge Reading literacy Text comprehension*

Research on *text comprehension* has a long tradition in different areas of psychological research. For instance, theories of memory development and cognitive representation rely heavily on research conducted with written material (e.g., Kintsch, 1998; for a review see Schneider & Bjorklund, 1998, in press). There is also a long tradition of research on individual predictors of discourse comprehension (for reviews see Britton & Graesser, 1996; van Oostendorp & Goldman, 1999). The findings of this research suggest, for example, the importance of prior knowledge, decoding speed, metacognitive knowledge (including strategic learning), and motivational variables (cf. Schiefele, 1996).

At the same time, the study of *reading literacy* has become an important topic in international large-scale assessment studies on school achievement. For instance, the International Association for the Evaluation of Educational Achievement (IEA) has conducted several international comparison studies on reading literacy (cf. Elley, 1992; Thorndike, 1973). Recently, programs such as PISA (Programme for International Student Assessment; funded by the OECD) and the American National Assessment of Educational Progress Program (NAEP) have also assessed individual differences in reading literacy. From a general point of view, reading skills have been always important; given that we now have to cope with an "information society," however, they seem particularly crucial today. Reading skills can be conceived of as effective instruments for acquiring, organising, and applying information in different domains. As such, the ability to read and comprehend written material is a "cross-curricular" competence and an important prerequisite for success in school. In educational settings, most information is transmitted through linear and non-linear texts. Therefore, it is not surprising that policy makers have developed an interest in international comparative research on reading literacy.

We believe that recent studies on reading literacy (such as PISA and IEA) can contribute to our understanding of reading comprehension because of two major strengths: (1) the international comparative perspective provides the opportunity to study similarities and differences in students' knowledge and thinking in reading literacy across the world, and (2) the test developed to measure reading literacy not only meet the standards of modern test development, but also provide a broad variety of items and texts.

However, the large-scale assessment of reading literacy can also profit from psychological research in multiple ways, by including psychological concepts that have proved to be important in small-scale and experimental studies. In the present study, the attempt was made to combine the findings and insights of psychological research with those of large-scale assessment studies. Specifically, the rich PISA database will be used to test psychological models of reading achievement, taking important predictor variables from previous IEA reading studies into account. In the following, we present a brief overview of the most significant findings from psychological research and from the IEA studies on text comprehension.

Psychological research on reading comprehension

Most psychological theories assume that reading comprehension is the result of an interaction between the reader and the text. The reader does not merely reconstruct the meaning of a text on the basis of certain text features. Rather, comprehension of a text is the result of an interactive process between the text, prior knowledge (content knowledge, world knowledge, knowledge about text features), the context in which the text is read, and the motives and goals of the reader. The resulting mental representation goes beyond the information given in the text, in that the reader integrates this information into his or her existing knowledge base.

Kintsch (1998) defines reading comprehension as a combination of text-driven construction processes and knowledge-driven integration processes. Idea units in the form of propositions as well as the reader's goals lead to the retrieval of associated elements from the reader's long-term memory (knowledge, experience) to form an interrelated network. This is to a large extent an automatic process. Deliberate control only becomes necessary when the text information interferes with the knowledge base and/or when not enough knowledge is available to form a coherent mental representation of the text.

According to Kintsch, it is possible to reproduce a text from memory without being able to use it for any other purpose. In this case, the information learned from the text remains inert knowledge. The most elaborated form of text learning, in contrast, is called a "situational" representation. Here, the contents of the text and the reader's current knowledge are interconnected. The situational representation also includes additional information generated through inferences. No general rules can be stated about when and how a situational representation is formed, because there are many ways to elaborate text information, and the extent to which elaborations occur may differ widely among readers and occasions. How much elaboration occurs depends both on the text – whether inferences are explicitly included or not – and on the readers, their goals, motivation, and abilities.

A major determinant of learning from text is background knowledge. For learning to be effective, background knowledge must be put to active use. Accordingly, it is important that learners take an active role in their learning by making inferences, filling gaps, and generating macrostructures and elaborations. Engaging in such strategic learning activities implies an awareness of text structure and how it facilitates comprehension. It also involves an understanding for the differential processing demands of different kinds of tasks. The success of various strategic learning activities is, of course, constrained by insufficient prior knowledge in the domain, working memory limitations, or a lack of interest or motivation (Goldman, 1997).

Text learning is the result of many factors. Besides more basic verbal skills (e.g., letter identification, word decoding, reading span), a large number of possible predictors has been discussed in the literature. From an applied perspective, we believe that the following factors are of particular importance: prior domain knowledge, metacognitive knowledge, learning strategies, and motivation or interest. These variables were all included in PISA. Prior findings regarding these effects on text learning will now be considered in more detail.

Metacognition and Learning Strategies

It is well established that readers often do not construct coherent propositional or situational representations of text information. One reason for failure to detect or generate the connections necessary for coherent representations is the unavailability of relevant information in the working memory. In the process of reading a long text, keeping relevant information active in the working memory often requires readers to monitor the coherence of the evolving representations. Furthermore, it is important to use discourse and topic knowledge in a strategic way in order to identify relevant information, selectively reinstate previous text information, retrieve or reinstate information from long-term memory, or both (e.g., Ericsson & Kintsch, 1995; Fletcher, 1986; Kintsch, 1998; Kintsch & van Dijk, 1978).

Memory or learning strategies have been defined as mental or behavioural activities that help the learner to achieve cognitive purposes, and that are effort-consuming, potentially conscious, and controllable (Flavell, Miller, & Miller, 1993). According to Flavell and Wellman (1977), knowledge about memory strategies constitutes part of the declarative metamemory or metacognitive knowledge. Declarative metacognitive knowledge reflects what learners factually know about their memory. This type of knowledge is explicit, can be verbalised, and includes knowledge about the importance of person variables (e.g., age or IQ), task characteristics (e.g., task difficulty), and learning strategies (e.g., rehearsal). In contrast, procedural metacognitive knowledge is mostly implicit (subconscious), and entails the self-monitoring and self-regulation activities that learners use when solving memory problems. Both categories of metacognitive knowledge refer to the control of and knowledge about cognition (Baker & Brown, 1984a, 1984b; Brown, Bransford, Ferrara, & Campione, 1983; Schneider & Pressley, 1997). In general, correlations between procedural metacognition and

memory performance tend to be higher than those between measures of declarative metacognition and memory performance, although both relations have been shown to be substantial (see Hasselhorn, 1995; Schneider & Pressley, 1997). The relation between declarative metacognitive knowledge and memory performance becomes very close only when task-specific components of metamemory are assessed (Larkin, 1989; Schneider, 1999; Wimmer & Tornquist, 1980).

A similar pattern can be found in learning strategy research. Self-report measures of generalised deeper level learning strategies are often reported to be less highly correlated to achievement than learning strategy measures that are proximal to learning and domain-specific (Artelt, 2000; Lehtinen, 1992; O'Neil & Abedi, 1996). This can partly be attributed to the fact that the generalisation and aggregation levels of strategies and achievement measures are more comparable (cf. Asendorpf, 1990). However, it might also be a developmental problem. According to Borkowski, Milstead, and Hale (1988), *specific* strategy knowledge is acquired first. To the extent that specific strategy knowledge increases, relational and general strategy knowledge can develop.

Students' knowledge about their memory and task-specific strategies obviously influences their recall strategies. Furthermore, the use of strategic knowledge is dependent on task features and motivation (Folds, Foto, Guttentag, & Ornstein, 1990). In addition, motivational factors, such as attribution behaviour, seem to be beneficial for strategy generalisation. Kurtz and Borkowski (1984) found that attributions to controllable factors facilitated the subsequent use of memory strategies when working on transfer and generalisation tasks.

Prior Knowledge

The term "comprehension" usually implies the interaction of new information with existing knowledge. To say that one has comprehended a text is to say that one has found a mental "home" for the information in the text, or else that one has modified an existing mental "home" in order to accommodate that new information (Anderson & Pearson, 1984).

One of the major research findings from the expert-novice approach is the importance of prior knowledge (Reusser, 1994). The empirical evidence indicates that there is a monotonic relation between the recall of new information and prior domain-specific knowledge. Specifically, it has been found that experts and novices differ mainly with respect to the speed of access to relevant knowledge and the sophistication of knowledge-based strategies (see Schneider, in press).

The importance of the knowledge base for various aspects of memory performance has been shown repeatedly (for reviews see Bjorklund & Schneider, 1996; Chi & Ceci, 1987; Schneider, in press; Schneider & Pressley, 1997). Dochy (1996; Dochy & Alexander, 1995) found that about 90 percent of the studies he reviewed showed a positive effect of prior knowledge on memory behaviour, thus explaining a substantial amount of the variance in achievement measures. As emphasised by Schiefele (1996), prior knowledge helps learners to integrate new information into the knowledge system because it directs attention to relevant text information and thus helps to structure a given text. In addition, an elaborated knowledge base may enable the reader to compensate for any lack of coherence in the text.

According to many developmental psychologists, the knowledge base is one of the crucial sources of memory development in childhood and adolescence, probably outweighing other relevant factors such as capacity, strategies, or metamemory. Siegler (1990) and Pressley, Wood, and Woloshyn (1990) pointed out that there is a bi-directional influence of prior declarative knowledge and the use and knowledge of memory and learning strategies. Domain-specific prior knowledge can compensate for a lack of strategic knowledge and vice versa (Garner & Alexander, 1989; Minnaert & Janssen, 1995; Schneider & Weinert, 1990). The complex interrelationship among memory capacity, learning strategies, metacognitive knowledge, and domain-specific knowledge is addressed in the "good information processing model" developed by Pressley, Borkowski, and Schneider (1989). According to this model, good information processors benefit from high levels in all of these components.

Decoding Speed

Another important cognitive predictor of text comprehension is the student's decoding speed, the effects of which have been shown repeatedly (Thorndike, 1973; see Kintsch, 1998, for an overview). Good decoders recognise words almost twice as fast as poor readers (Graesser, Hoffman, & Clark, 1980). According to Perfetti (1985) rapid decoding is important because better word recognition frees up resources for higher-level processing. Better decoders should therefore be more likely to build accurate and complete representations of text content. It can be assumed (Kintsch, 1998) that slow decoders have to use the sentence context to speed up their word recognition. Good decoding skills make good readers less dependent on the context of the discourse in order to recognise a word.

Motivational Influences on Text Comprehension

In general, motivation refers to the processes involved in forming intentions that exert influence on the intensity, persistence, and direction of behaviour. In the field of expertise, the importance of motivational variables has been shown repeatedly (Czikszentmihalyi, 1988; Ericsson, 1996). Individual differences in the amount of deliberate practice and motivation are key variables for predicting individual differences in the level of expertise in a given domain among high-ability individuals (Schneider, in press).

Most studies investigating the effects of motivation on text comprehension have focussed on the construct of interest, which is closely related to – and sometimes seen as a prerequisite for – intrinsic motivation (Deci, 1998; Deci & Ryan, 1985). Usually, a distinction is made between personal and situational interest (Hidi, 1990; Krapp, Hidi, & Renninger, 1992; Schiefele, 1996, in press). Personal interest is conceived of as a more or less stable evaluative orientation toward certain domains or topics, whereas situational interest is a temporal emotional state (e.g., effortless concentration and enjoyment) aroused by specific features of an activity or task (e.g., personal relevance or novelty; see Hidi, 1990). In the following, we only refer to personal or topic interest. According to a definition proposed by Schiefele (1996, in press), personal (or topic) interest is a domain-specific motivational characteristic of the person that is characterised by *feeling-related* and *value-related valence beliefs*. Feeling-related valence beliefs refer to feelings that are elicited by an object (e.g., enjoyment, flow, activation). Value-related valence beliefs refer to the personal significance of an object (e.g., relevance of an object or topic for one's self-concept). Both types of valence beliefs are distinguished only for analytical purposes; so far, they are not distinguishable empirically.

Personal interest has also been suggested as a key influence on cognitive action and learning (Hidi, 1990). Personal interest in a topic or domain positively affects academic learning in that domain (Alexander, Kulikowich, & Jetton, 1994). Whether and to what extent interest actually causes achievement or whether perceived competence leads to higher interest is still an issue of debate (see Köller, Baumert, & Schnabel, 2000). Schiefele and Krapp (1996) found that topic interest is positively related to depth of learning, including recall of main ideas and coherence of recall (for a review see Schiefele, 1999). Similar effects were reported by Hidi (1990). Schiefele (1996) also tested the effect of personal interest on text comprehension and reported a correlation of $r = .27$ after controlling for cognitive factors. On the basis of longitudinal data, however, Köller, Baumert, and Schnabel (2000) found no significant effects of interest on achievement after controlling for prior knowledge. Further evidence supporting the assumption that there are reliable links between interest and reading performance can be found in Renninger (1992).

In addition, there is some evidence that interest leads to more frequent learning activities (time on task) and the use of deeper information processing strategies (Alexander, Murphy, Woods, Duhon, & Parker, 1997; Schiefele & Schreyer, 1994).

Large-Scale Assessment Studies of Reading Literacy

Most psychological research on reading comprehension has focussed on processes of constructing a mental representation of a text, as well as on individual factors that contribute to elaborated comprehension and good memory performance. These processes and individual factors can be conceived of as proximal variables. In contrast, large-scale studies on reading literacy have aimed to identify general and more distal factors that may affect performance on reading comprehension tasks. For instance, in the Fifteen Country Comparison IEA Study (Thorndike, 1973), students of three age levels (10- and 14-year-old students, and students at the end of secondary school) took part in reading tests in which multiple-choice items were used to measure different facets of reading comprehension (identifying the main idea of a paragraph, finding the answer to a question specifically answered in the passage, recognising information implied in the passage but not specifically stated, identifying the writer's purpose).

To account for differences in the overall measure of reading literacy, different factors related to the school (e.g., tracking), class (class size, teaching practice), and family (SES, cultural capital) were taken into account. In addition, individual difference variables such as reading speed and word knowledge were assessed. A major finding of the Fifteen Country Comparison were the high percentages of illiterates identified in the developing countries, and the relatively small effect of selected school variables on reading literacy. School variables were at best minimally related to reading achievement, and relations found in one country did not generalise to others.

> "As one views the results on school factors related to reading achievement, it is hard not to feel somewhat disappointed and let down. There is so little that provides a basis for any positive or constructive action on part of teachers or administrators. There is so little consistent identification of school factors that make a difference." (Thorndike, 1973, p. 121)

In contrast, family background variables seemed to be of overwhelming importance.

Favourable home and environmental backgrounds provided strong differentiation between countries, and – within countries – between students. Thus, SES and cultural capital variables (such as father's occupation and the number of books in the home) turned out to be the best predictors of reading literacy across various countries.

In a more recent IEA study, the reading literacy of 9- and 14-year-old students was assessed in 35 different educational systems (Elley, 1992). In Germany, school and class context variables (such as class size, quality of teacher-student relationship, school climate, and homework frequency) again failed to show overall effects (Lehmann, Peek, Pieper, & von Stritzky, 1995). Similar to the Fifteen Country Comparison (Thorndike, 1973), the number of books in the home turned out to be the best predictor of reading achievement. Indeed, this family background variable was a key factor in reading literacy for each of the 35 educational systems included in the IEA study. Additionally, those countries with the highest scores in the reading literacy tests typically provide their students with excellent access to books in community libraries and book stores, and in school (Elley, 1992, 1994). Moreover, the frequency of voluntary reading and reading in class also varied across countries: In high scoring countries, students borrowed books more regularly, did more silent reading in class, and had more lesson hours scheduled for the mother tongue.

Implications for the Present Study

Obviously, the main predictor of reading literacy identified in the IEA reading literacy studies (i.e., the number of books) is a distal measure, and does not explain the cognitive processes that are responsible for varying reading achievement. Instead, the results of the IEA studies cited above suggest a very simple and almost trivial explanation for reading competence: The more you read, the better your reading performance. On the other hand, the number of books at home, as an indicator of family background, can be interpreted as an omnibus variable for many of the often reported competence differences that can be found in different social milieus.

We would like to argue that a more profound insight into possible interactions among proximal (process) and distal (status) variables can be gained by including both types of variables in the same study. It is assumed that variables that are more proximal to the actual reading process will yield more information as to possible interventions and educational implications. From the perspective of educational psychology, it is important to test whether process variables (such as knowledge about learning strategies and domain- and subject-specific interest) have significant effects on reading achievement when the "number of books" is controlled for.

We will thus analyse the combined effects of cognitive, motivational, and socio-cultural variables on different facets of text comprehension. In addition to learning strategies, metacognition, prior knowledge, interest, and socio-cultural variables (e.g., the number of books in the home) we will analyse the effect of decoding speed. This variable indicates both processing speed and prior world knowledge, and has emerged to be an important predictor of reading achievement in several previous studies (van Kraayenoord & Schneider, 1999).

Moreover, a distinction is made between the context of working with a text (i.e., being able to refer back to a text when answering questions about it) and that of learning or memorising from a text (i.e., not being able to consult a text when answering questions about it). It is assumed that not having access to the text in the question answering stage triggers the construction of a mental representation, whereas being able to consult the text calls for fewer memory processes. The differences between these two text comprehension measures will be analysed by dimensional analyses, by comparing predictor models, and by analysing relative strengths and weaknesses of students.

Method

Sample

A total of 6,104 students from all 16 German states and school types participated in the PISA field trial in Germany. The main purpose of the field trial was to develop optimal and culturally fair tests of reading, mathematics, and science literacy, in accordance with an international framework developed for all 32 participating countries. In addition to the international testing program, which was administered on the first day of testing, the German National Consortium developed additional tests to capture different aspects of text comprehension and several proximal antecedents of reading comprehension, all administered on the second day of testing. Because of the multi-matrix design (booklet rotation) of the tests and questionnaires, the number of subjects in each of the presented analyses varies considerably.

Measures

International test of text comprehension (on-line comprehension). The international framework for the assessment of reading literacy is largely based on a structural model developed by Kirsch and Mosenthal (1994; Kirsch, Jungeblut, & Mosenthal, 1998). This model has strongly influenced most large-scale assessment studies involving reading

literacy (i.e., the IEA studies, NAEP, and OECD's International Adult Literacy Survey, IALS). At a general level, this model distinguishes primarily between the text-based and the knowledge-based aspect of text comprehension. Whereas the former relies almost exclusively on information provided in the text, the latter also draws on prior knowledge. These two aspects are further broken down into five levels of comprehension: retrieving information, developing a broad understanding, and developing an interpretation (text-based comprehension), and reflecting on the content and on the form of the text (knowledge-based comprehension). Moreover, for text-based comprehension the model distinguishes whether the reader is asked to consider the text as a whole (developing a broad understanding) or whether he or she is asked to focus on specific pieces of information[1] (retrieving information and developing an interpretation) contained within the text. For knowledge-based comprehension, it distinguishes whether the reader is asked to focus on structure or content (reflecting on the content of a test, reflecting on the form of a text). Text comprehension was measured based on a broad variety of text types (including charts, graphs, and diagrams) and reading situations (e.g., reading for private or public use, reading for work or for education). Each of the nine different test booklets contained reading items. Depending on the test booklet, students spent between 30 minutes (minimum) and two hours (maximum) reading texts and answering questions.

The international approach examines reading comprehension in the context of working with texts (on-line comprehension). Thus, students were allowed to look back at the text while answering questions about it. Items were presented either in a multiple-choice format or – to a large extent – in an open format (45% of all items). Open-ended items were coded by trained coders who used the German version of the international coding system. The scores for retrieving information and for developing an interpretation (as well as the total score for the international reading test) were calculated by standardising scores for each of the relevant dimensions in each of the nine booklets before aggregating them to a total score.

National test of text comprehension (memory-based comprehension). One major incentive for the construction of a national test on text comprehension was the idea that reading literacy also encompasses the ability to generate mental representations of texts. This ability enables the reader to use text information at a later point of time without having to consult the text again. This aspect that can be described as learning or memorising from texts was assessed on a second day of testing, using a set of six different narrative and expository texts and a variety of learning tests.

Prior knowledge and interest in the topic of the text were assessed for only three of the six texts. These texts were expository texts related to the (natural) sciences. The first text dealt with the origin of the earth (628 words). The presentation of results will focus mainly on this text. The two other texts, which will be mentioned only if their results differ from those of the earth text, were about water and its chemical and biological properties (451 words), and the origin of the moon (552 words). Students were asked to read each text with the aim of being able to remember it, and were given 10 minutes to read and re-read it after instruction. Directly after reading each text, students were asked to answer questions about the text without being able to look back at it. The test items were either multiple-choice or open-ended. In addition, the earth text included a recognition and verification test based on Kintsch and van Dyk's (1978) model of text comprehension (see Schiefele, 1996). Students had to decide whether or not the sentences presented had been included in the text verbatim (recognition). In the case of a negative answer, the students had to rate whether or not the content of the sentence corresponded with the information presented in the text (verification). A total score based on the number of correctly answered items was used as an indicator of text comprehension for each of the three texts separately. The different texts were rotated over nine different test booklets. The total number of students per text ranges from 1,390 to 2,196. The number of students for which the text comprehension measures for different texts can be compared is even lower (314 to 320).

Assessment of knowledge about learning strategies for reading (metacognition). Metacognitive knowledge of reading strategies was assessed using a questionnaire developed by Schlagmüller and Schneider (1999). This instrument tapped knowledge of strategies that are relevant during reading and for the comprehension and recall of text information. Six different scenarios were provided. For each scenario, students had to evaluate the quality and usefulness of five different methods (strategies) for reaching the intended learning or memory goal. The rank order of methods for each scenario was compared with an optimal rank order developed by experts in the field of text processing (teachers and educational psychologists). The correspondence between the two rankings is expressed in a metacognition score indicating the degree to which students are aware of the best ways of storing text information and understanding memory goals. In order to achieve high scores on the metacognition test, students had to activate knowledge about cognitive resources, the nature of

[1] The focus on specific parts of the text is further subdivided into a focus on independent pieces of information on the one hand and understanding of relationships on the other.

the memory task, and strategies that facilitate remembering and recalling information.

Prior knowledge. Before reading the text material, students' prior knowledge was assessed for the three science-related texts in the national study. After the title of each text was presented (e.g., "The Origin of the Earth"), students were asked to answer six different questions about the topic of the text, resulting in a prior knowledge score for the specific text. Items were either multiple-choice (e.g., "What was the state of the material that the Earth and our solar system are made of before the origin of our solar system? A: solid, B: liquid, C: gaseous") or open-ended (e.g., "What is the Milky Way?").

Thematic interest. Students' interest in the text topics was assessed before and after working on the respective text. Students were asked to indicate their general interest after reading the title and a short description of the text on a 5-point rating scale (from 1 = very uninteresting to 5 = very interesting). After reading the text, students were again asked to rate their interest in the particular text.

Decoding speed. As another addition to the international PISA design, the German Consortium decided to administer a test of decoding speed. This test involves a narrative text consisting of 1,847 words. Every third or fourth sentence includes a blank that the students had to fill in by deciding which of three different words presented in brackets was appropriate. The number of correctly chosen words per student was taken as an indicator of student's *quality of decoding,* whereas the total number of words read within the time interval of four minutes serves as an indicator of *decoding speed*.

Number of books (SES). Furthermore, in the student questionnaire students were asked to indicate the number of books in the home (none, 1–10, 11–50, 51–100, 101–250, 251–500, more than 500 books). As a frame of reference, students were told that there are usually 40 books per metre of shelving. The number of books is used as an indicator variable for socio-economic status and family background. Given that there are more elaborated forms of measuring SES, however, we prefer to use the orignal label which is closer to its operationalisation.

Results

Predicting Text Comprehension

Predictors of text comprehension will be considered separately for the two different text comprehension measures (on-line text comprehension vs. memory-based comprehension) because they measure distinct aspects of text comprehension (see below) and because not all predictor variables were available for both tests.

For the prediction of text comprehension in the international test (on-line comprehension) decoding speed, metacognition, and the number of books in the home are available as predictors. As can be seen in Table 1, both the total on-line reading comprehension score and the subscores are correlated (moderately or substantially) with all three variables. The zero-order correlations of the three predictor variables indicate that the number of books in the home has a considerable effect, but that the effect of metacognitive knowledge is stronger.

We estimated a model with decoding speed, metacognition, and number of books as predictors and on-line text comprehension as a latent dependent variable. The results of this model are presented in Figure 1. Although it was intended to have all five subscales as indicator variables for the latent variable "on-line text comprehension", the model fit statistics produced by AMOS indicated that a five-indicator model does not fit the data. Instead a two-indicator model was preferred, with the subscales *retrieving information* and *developing an interpretation* as indicators. According to theory, both aspects measure text-immanent reading comprehension and focus on specific parts of the text. A manifest model with the total on-line text comprehension score (ceteris paribus) yields the same results (coefficients differ between .01 and .03). The two-indicator model is presented here because the manifest model has no degrees of freedom, and therefore no overall model test is possible.

Table 1: Zero-Order Correlations Between the Predictor Variables and Text Comprehension in the International Test (On-Line Comprehension)

	Number of books[1]	Decoding speed[2]	Metacognition[3]
Text comprehension (total score)	.44**	.36**	.51**
Developing a broad understanding	.30**	.21**	.39**
Retrieving information	.37**	.32**	.43**
Developing an interpretation	.39**	.31**	.42**
Reflecting on the content of a text	.30**	.23**	.36**
Reflecting on the form of a text	.28**	.23**	.31**

Note: [1] Number of cases varies from n = 2,899 to n = 3,372.
[2] Number of cases varies from n = 639 to n = 745.
[3] Number of cases varies from n = 623 to n = 717.
** $p \leq .01$.

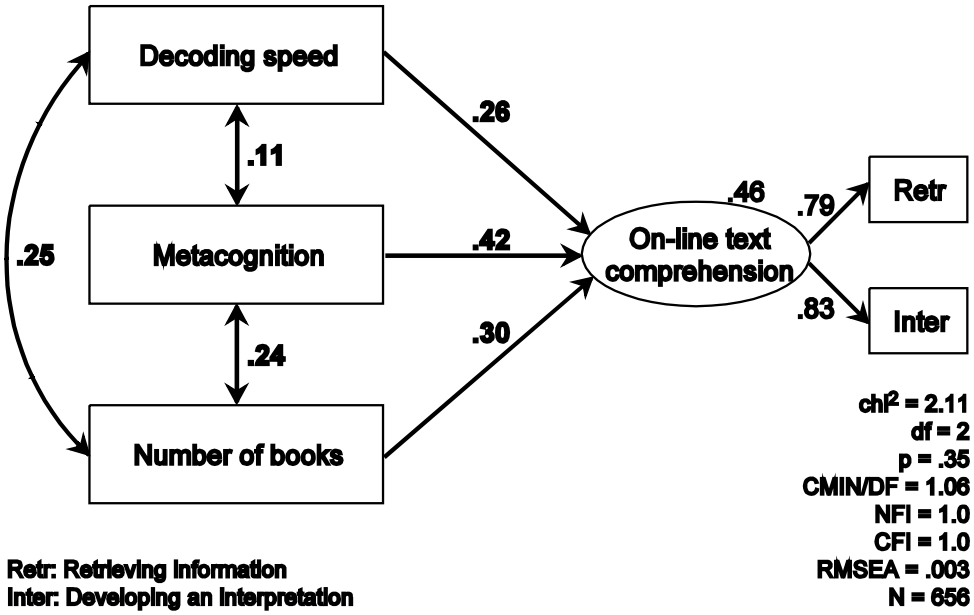


Figure 1. Prediction of on-line text comprehension (international test).

The model presented in Figure 1 explained about 46 percent of the variance in text comprehension. In contrast to the findings of the IEA reading literacy studies, the number of books in the home was not the best predictor of text comprehension when all three predictor variables were taken into account simultaneously. Furthermore, metacognition (knowledge about learning strategies) and decoding speed had separate and substantial effects on the measures of text comprehension. The high correlations between the three predictor variables indicate that a considerable degree of criterion variance might be explained by these commonalities. An additional commonality analysis showed that 14 percent of the variance in text comprehension was explained by first- and second-order commonalities, while another 32 percent of the variance was explained by specific effects of the three predictors.

Further consideration of proximal predictor variables is possible using the results of the national reading test (memory-based comprehension), in which prior knowledge and thematic interest were assessed additionally. Given the domain- and topic-specificity of interest and prior knowledge, we did not compute an overall text learning score, but analysed each text individually (here: 'The Origin of the Earth'). Prior knowledge and interest are content-specific, and their effects should be described in relation to the specific content represented in a text. The following results are based on memory-based text comprehension, interest, and prior knowledge with reference to a specific text (Earth). The results for the other two texts will be mentioned in the text.

As shown in Table 2, the zero-order correlations between metacognition, decoding speed, number of books, and memory-based text comprehension (Earth text) were generally lower than those referring to the on-line comprehension measure. Still, the relation between metacognition and text comprehension was fairly high. In addition, prior knowledge and thematic interest had a considerable effect on text learning. The results for the two other texts are not significantly different.

Table 2 Zero-Order Correlations Between the Predictor Variables and Memory-Based Text Comprehension

	Number of books	Decoding speed	Metacognition	Prior knowledge	Thematic interest
Memory-based text comprehension: Earth text	.33** (n = 1,260)	.16** (n = 633)	.36** (n = 628)	.41** (n = 1,390)	.25** (n = 1,387)

Note: ** $p \leq .01$.

To estimate the combined effects of the five predictor variables, a structural-equation-model was specified (see Figure 2). Predictor variables for memory-based text comprehension (Earth text) included prior knowledge about the origin of the earth and interest in this domain. In addition to these proximal measures, decoding speed, metacognition, and number of books were also used as predictors.

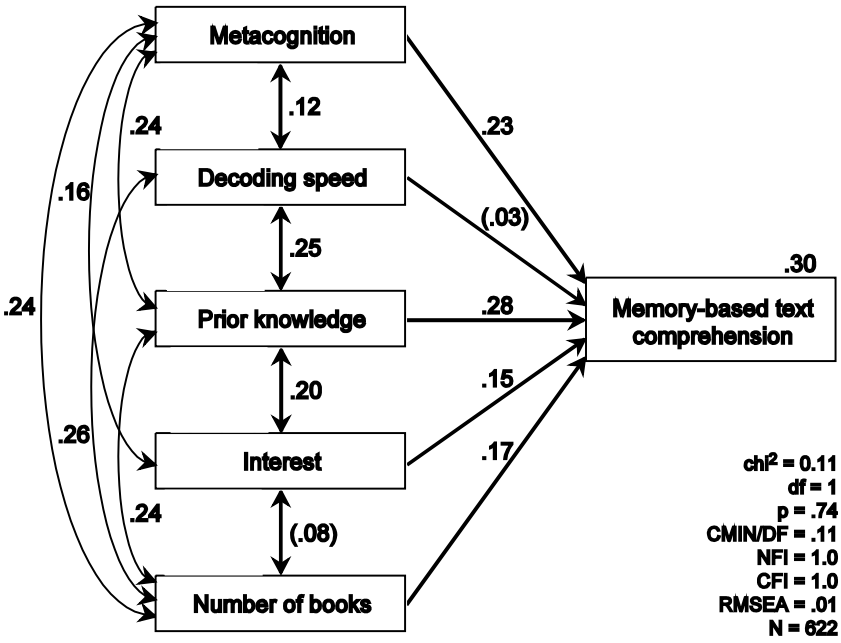


Figure 2. Prediction of memory-based text comprehension (Earth text).

When taking all five predictor variables into account, 30 percent of the variance in memory-based text comprehension could be explained (Figure 2). Even after statistically controlling for decoding speed, prior knowledge, and the number of books, there were significant specific effects of metacognition and thematic interest on memory-based text comprehension. Compared to the zero-order correlations (see Table 2), the effect of the number of books decreased considerably, thus indicating that a substantial proportion of criterion variance (13%) can be explained by commonalities, whereas only 17 percent can be attributed to specific effects of the predictors. The same rank order, a comparable level of β-coefficients, and a similar model fit was found for the "Water" text. Because of systematic missing data, no such model could be estimated for the text on the origin of the moon.

Text Comprehension while Reading a Text (On-Line Comprehension) Versus Text Comprehension after Reading a Text (Memory-Based Comprehension)

In a subsequent step, we analysed whether the two measures of text comprehension represent qualitatively different facets of text comprehension and how these can be described.

Whereas the international test consists entirely of items to be answered while having the text available: (on-line comprehension) the national test measured text comprehension after reading the text and without the possibility of referring back to the text. Thus, the national test involved not only on-line comprehension but also the storage and retrieval of the text information in and from memory (memory-based comprehension). These two facets of reading literacy were highly correlated, with correlations ranging from .60 to .66 ($p < .01$) depending on the text (Earth, Moon, or Water) used in the national test. However, comparison of a two- and a one-dimensional IRT model (item response theory, calculated using ConQuest) indicated that a two-dimensional model fit the data better (Wu, Adams, & Wilson, 1998).

Moreover, a substantial proportion of students showed relative strengths in either on-line comprehension or memory-based comprehension. Relative strengths of students were analysed by dividing students' overall performance in each comprehension test into three categories (either low, average, or high) on the basis of the distribution of test scores (33% criterion). The results of the cross tabulation of these data are presented in Table 3.

Table 3 Students with Low, Average, and High Memory-Based Text Comprehension Relative to Their On-line Comprehension Performance

		Memory-based text comprehension					
	% students	Low		Average		High	
On-line text comprehension	Low	20.2 %[1]		9.6 %		2.1 %	
		21.7 %[2]	**21.1 %**[4]	7.1 %	**8.3 %**	2.7 %	**2.2 %**
		21.4 %[3]		8.3 %		1.9 %	
	Average	8.2 %		16.5 %		10.0 %	
		10.2 %	**9.2 %**	12.5 %	**14.7 %**	11.9 %	**10.4 %**
		9.2 %		15.1 %		9.3 %	
	High	1.7 %		9.7 %		22.0 %	
		3.8 %	**2.6 %**	9.3 %	**9.6 %**	20.9 %	**21.7 %**
		2.4 %		9.8 %		22.4 %	

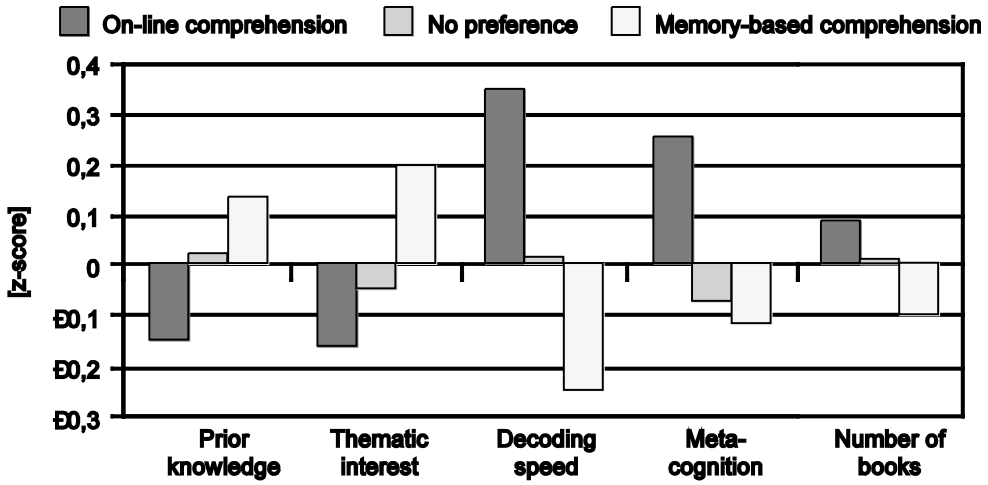
Note: [1]Text # 1: Moon; [2]Text # 2: Earth; [3]Text # 3: Water; [4]Total.

As can be seen in Table 3, 21.7 percent of the students were good on both tests, 14.7 percent showed average text comprehension on both tests, and 21.1 percent performed poorly on both tests. In addition to this group of students (57.6%) that belonged to the same text comprehension group (either low, average, or high) in each test, there were two more groups. The first group (20.9%) is characterised by low on-line text comprehension and moderate or high memory-based text comprehension, or average on-line comprehension and high memory-based comprehension. This group of students obviously learned the texts better. The other group of students (21.4%) is characterised by low memory-based comprehension but average or high on-line comprehension, or average memory-based comprehension and high on-line comprehension. The group of students that did better in the memory-based comprehension tests than in the on-line comprehension test was labelled "memory-based comprehension" on the basis of their relative advantage. The group of students that showed the opposite pattern, and displayed a relatively low memory performance was labelled "on-line comprehension" on the basis of their relative advantage in applying information from the text.

As noted above, the number of students is rather low for a direct comparison of text comprehension measures with all three national texts. Nevertheless, a cross tabulation of high, middle, and low memory-based text comprehension measures for two of the texts at a time indicated that there was some variation between memory-based comprehension measures in the different texts. Even

though this is the case, the assumption that there is a systematic difference between on-line and memory-based comprehension again proved to be plausible, as the variation between memory-based texts was low when comparisons with the on-line comprehension measure were taken into account. To further elaborate the idea of relative strengths of students in either on-line or memory-based comprehension we analysed if students' relative strengths were paralleled by differences in decoding speed, thematic interest, prior knowledge, metacognition, and number of books.

As illustrated in Figure 3, for all variables significant mean differences between students with relative strengths in on-line comprehension and students with relative strengths in memory-based comprehension could be found. Students with strengths in on-line comprehension showed higher decoding speed, higher levels of metacognitive knowledge, and had more books at home, whereas students with strengths in memory-based comprehension were characterised by higher interest and a high degree of prior knowledge.



* All differences between „on-line comprehension" and „memory-based comprehension" are significant.

Figure 3. Mean scores with respect to prior knowledge, thematic interest, decoding speed, metacognition, and number of books for students with relative strengths in on-line comprehension, memory-based comprehension, or with no preference.

The analysis of relative strengths based on the "Water" and the "Moon" text yielded similar results for decoding speed, number of books, and thematic interest. However, in contrast to the results referring to the "Earth" text there were no significant differences between the memory-based comprehension and the on-line comprehension group for prior knowledge and metacognition.

Discussion

The major purpose of this article was to evaluate and describe antecedents of reading literacy, taking into account relevant variables from large-scale assessment studies on reading literacy (Elley, 1992, 1994; Lehmann et al., 1995; Thorndike, 1973) as well as variables from psychological research on text processing. The combination of more proximal (process) and distal (status) variables yielded interesting results concerning the prediction of on-line text comprehension and memory-based text comprehension. In line with prior large-scale studies, the number of books available in the home was highly correlated with text comprehension. The number of books at home may be seen as an indicator of socio-economic status and family background. In addition, this variable also captures competence differences between different social and cultural milieus. This may explain the size of its effect. Nevertheless, even after controlling for the number of books as well as for decoding speed, metacognition proved to be the best predictor of on-line text comprehension (international test). This result indicates that the ability to decode in combination with strategy awareness and the availability of books in the home distinguishes between good and poor readers. A number of relevant predictors, however, were not available in

the international test. These variables were included in the national test. The resulting prediction model, which included decoding speed, metacognition, number of books in the home as well as thematic interest and prior knowledge as predictors, partially supported the international findings. Again, the effect of metacognition proved to be substantial, though prior knowledge turned out to be a better predictor. Knowledge of learning strategies seemed to be an important prerequisite for both on-line and memory-based text comprehension. In addition, thematic interest had specific and substantial effects on memory-based comprehension. The reduction of the effects of the number of books at home is in line with the assumption that proximal competence variables are more important than family background variables.

The relatively strong relation between metacognition and text comprehension has rarely been reported in previous studies. More general measures of metamemory or metacognition have often been found to be less closely related to memory behaviour (see Borkowski et al., 1988, for a review). *Task-specific* assessment of components of metamemory seems to be a more appropriate measure because it makes less demanding assumptions about the generality of metamemory. Moreover, instead of directing students to use a peripheral context such as "in the course", a task-specific assessment poses questions that are easier for students to answer, because algorithms for making judgements about importance or frequency refer to fewer and concrete situations.[2] Besides, as mentioned above, task-specific measures are better predictors of actual memory behaviour (Larkin, 1989; Schneider, 1989; Wimmer & Tornquist, 1980).

The results concerning the predictive value of decoding speed for text comprehension are consistent with the effects reported in the literature. Van Kraayenoord and Schneider (1999) presented evidence showing that the ability to decode distinguishes between good and poor readers (see also Kintsch, 1998). The advantage of good decoders was interpreted in terms of resource availability for higher level processing (Perfetti, 1985). In line with our findings, word decoding skills have also been shown to be a strong predictor of reading comprehension (Juel, 1988).

The strong effects of prior knowledge on text comprehension are also consistent with the research literature. A rich knowledge base is an important prerequisite for building a structured mental representation of the text in that it enables better integration of the presented information, and helps to focus the reader's attention on relevant parts of the text. Moreover, the role of prior knowledge in the process of text processing and forming a coherent mental representation is more complex than our findings suggest (Pressley et al., 1989). On the one hand, prior knowledge may compensate for low metacognitive knowledge because deliberate and active processing of the text may no longer be necessary (Bjorklund, 1987). Metacognitive competence, on the other hand, may compensate for a lack of prior knowledge (Garner & Alexander, 1989). According to many researchers, the relation between prior knowledge and strategies is bi-directional (Pressley et al., 1990; Siegler, 1990). Prior knowledge and strategy awareness in text processing seem to interact, and the concrete quality of text processing is also dependent on the motivational characteristics of the learner.

The effects of thematic interest on text comprehension were substantial even after controlling for prior knowledge, metacognition, number of books, and decoding speed. Thus, interest has a separate effect that may be explained by deeper levels of learning (e.g., the use of deeper information processing strategies; Schiefele, 1996).

The results of the prediction models suggest possibilities for intervention. Whereas family background is not a characteristic that can easily be changed, it is possible to exert an effect on knowledge about the value of learning strategies. Potential ways of fostering strategy awareness can be inferred from models of strategy development. Students can be taught to become more aware of those strategies that can be used for remembering and reading. Programs aimed at fostering metacognition (e.g., Jacobs & Paris, 1987; Kurtz & Borkowski, 1984; Palincsar & Brown, 1984; Pressley, Harris, & Marks, 1992) usually involve explicit strategy instructions and techniques, such as thinking aloud, and the discussion of strategies and their use. In addition, decoding skills and thematic interest might also be changed by educational interventions (e.g., Bergin, 1999).

Whereas the first part of this investigation focussed on predictors of reading literacy, analysing the specific and combined effects of relevant predictor variables on different measures of text comprehension, the second part aimed at describing different facets of text comprehension and describing differences between them. The two text comprehension measures compared in our study differed with regard to the learning activities

[2] According to Winne and Perry (2000), we as yet know very little about the algorithms studnts use when making judgements about general learning behaviour (frequency, importance, etc.), and there are almost no empirical works on matters such as these that substantiate assumptions about how measurement interventions give rise to responses.

students need to engage in to be able to answer text-related questions. They also differed in the number and thematic focus of the texts the students had to work on. Because the students were not allowed to refer back to the texts, the national test is more demanding with respect to students' memory skills: Good performance in the national learning test is based on a mental representation of the text. This is not necessarily the case for the on-line text comprehension measure of the international test because students were allowed to refer back to the text while answering questions. As could be shown by a comparison of IRT models, the two text comprehension measures capture different aspects of text comprehension, referred to as memory-based comprehension (national test) and on-line comprehension (international test). A substantial proportion of students was found to do equally well in both tests. Nevertheless, almost half of the students were better in one test than in the other. Whereas students with relative strengths in on-line-comprehension were found to have better decoding skills, more books at home, and more metacognitive knowledge, students with relative strengths in learning had higher levels of prior knowledge and thematic interest. The effects of decoding speed, number of books, and thematic interest proved to be consistent across all three texts.

For the interpretation of these findings one needs to keep in mind that no thematic interest and prior knowledge measure were available for the on-line comprehension test because of the lacking thematic focus of the test. Thus, it cannot be concluded that interest and prior knowledge do not contribute to on-line comprehension. Nevertheless, the higher amounts of prior knowledge and thematic interest for students with strengths in the memory-based comprehension text are in line with existing theory and empirical evidence because both variables foster the construction of a coherent text representation. However, the high values for decoding speed and metacognition in the on-line comprehension group were unexpected. We suggest that these findings are due to the difference in length between the national and international tests. The international test was based on a broad variety of texts and items and testing time varied between 30 minutes and 2 hours. Students with better decoding ability probably do better in this test because they have more time left to answer the items. By contrast, the memory-based comprehension texts were shorter and capacity deficits with respect to word decoding were probably not as important. This post-hoc explanation is supported by the finding that more items at the end of the on-line comprehension test were missing than items at the end of the memory-based comprehension test. Whether this explanation also holds for metacognition is debatable. Furthermore, whereas most results concerning the prediction of relative strengths were consistent across the three memory-based comprehension texts, the finding concerning metacognition was only observed for one of the tests. This inconsistency has to be taken into account when interpreting the results. Nevertheless, more fine-grained research is needed to evaluate why knowledge about learning strategies (metacognition) is more pronounced in the group of students showing relative strengths in on-line comprehension. The finding that students with relative strengths in on-line comprehension reported having more books in the home might be a result of the lacking thematic focus of the on-line comprehension test. For more general ("cross-curricular") measures of reading competence (reading literacy), general indicators of reading frequency and family background (e.g., number of books in the home) are of particular importance.

The comparison of the two text comprehension measures indicates that the distinction between memory-based and on-line comprehension cannot account for all the reported findings and that other differences (e.g., lenght, thematic focus) between the tests are relevant here.

In general, the results reported in this article can be interpreted in light of psychological and educational theories of the construction of mental representations. Prior knowledge and thematic interest are necessary prerequisites for the construction of coherent mental representations. This, in turn, is a prerequisite for high levels of text comprehension in the national memory-based test. Together with the finding of substantial prediction effects of task-specific metacognition and number of books in the home, the present results indicate that text comprehension is highly dependent on proximal (process) variables. However, distal (status) variables, such as family background (number of books) have additional effects on text comprehension. Nevertheless, the more proximal process and competence measures are available, the smaller the effect of family background.

References

Alexander, P. A., Kulikowich, J. M, & Jetton, T. L. (1994). The role of subject-matter knowledge and interest in the processing of linear and nonlinear texts. *Review of Educational Research, 64* (2), 201–252.

Alexander, P. A., Murphy, P. K., Woods, B. S., Duhon, K. E., & Parker, D. (1997). College instruction and concomitant changes in students' knowledge, interest, and strategy use: A study of domain learning. *Contemporary Educational Psychology*, *22*, 125–146.

Anderson, R. C., & Pearson, P. D. (1984). A schema-theoretic view of basic processes in reading comprehension. In P. D. Pearson (Ed.), *Handbook of reading research* (pp. 255–293) New York: Longman.

Artelt, C. (2000). *Strategisches Lernen*. Münster: Waxmann.

Asendorpf, J. (1990). *Die differentielle Sichtweise in der Psychologie*. Göttingen: Hogrefe.

Baker, L., & Brown, A. L. (1984a). Cognitive monitoring in reading. In J. Flood (Ed.), *Understanding reading comprehension: Cognition, language and the structure of prose* (pp. 21–44). Newark, DE: International Reading Association.

Baker, L., & Brown, A. L. (1984b). Metacognitive skills and reading. In P. D. Pearson, M. Kamil, R. Barr, & P. Mosenthal (Eds.), *Handbook of reading research* (pp. 353–394). New York: Longman.

Bergin, D. A. (1999). Influences on classroom interest. *Educational Psychologist, 34* (2), 87–98.

Bjorklund, D. F. (1987). How age changes in the knowledge base contribute to the development of children's memory: An interpretive review. *Developmental Review, 7,* 93–130.

Bjorklund, D. F., & Schneider, W. (1996). The interaction of knowledge, aptitudes, and strategies in children's memory performance. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 26, pp. 59–89). San Diego, CA: Academic Press.

Borkowski, J. G., Milstead, M., & Hale, C. (1988). Components of children's metamemory: Implications for strategy generalization. In F. E. Weinert & M. Perlmutter (Eds.), *Memory development: Universal changes and individual differences* (pp. 73–100). Hillsdale, NJ: Erlbaum.

Britton, B. K., & Graesser, A. C. (1996). *Models of understanding text*. Mahwah, NJ: Erlbaum.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering, and understanding. In J. H. Flavell & E. M. Markman (Eds.), *Handbook of child psychology: Cognitive development* (pp. 77–166). New York: Wiley.

Chi, M. T. H., & Ceci, S. J. (1987). Content knowledge: Its role, representation, and restructuring in memory development. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 20, pp. 91–142). Orlando, FL: Academic Press.

Czikszentmihalyi, M. (1988). Motivation and creativity: Towards a synthesis of structural and energistic approaches to cognition. *New Ideas in Psychology, 6,* 159–176.

Deci, E. L. (1998). The relation of interest to motivation and human needs – the self-determination theory viewpoint. In L. Hoffmann, A. Krapp, K. A. Renninger, & J. Baumert (Eds.), *Interest and learning* (pp. 146–162). Kiel: Institute for Science Education, University of Kiel.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum Press.

Dochy, F. J. R. C. (1996). Assessment of domain-specific and domain-transcending prior knowledge: Entry assessment and the use of profile analysis. In M. Birenbaum & F. J. R. C. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 227–264). Boston, MA: Kluwer.

Dochy, F. J. R. C., & Alexander, P. A. (1995). Mapping prior knowledge: A framework for discussion among researchers. *European Journal of Psychology of Education*, *10*, 225–242.

Elley, W. B. (1992). *How in the world do students read? IEA Study of reading literacy*. Amsterdam: The International Association for the Evaluation of Educational Achievement.

Elley, W. B. (1994). *The IEA study of reading literacy: Achievement and instruction in thirty-two school systems*. Oxford, UK: Elsevier Science.

Ericsson, K. A. (Ed.). (1996). *The road to excellence: The acquisition of expert performance in the arts and science, sports and games.* Mahwah, NJ: Erlbaum.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102* (2), 211–245.

Flavell, J. H., Miller, P. H., & Miller, S. A. (1993). Cognitive development (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Flavell, J. H., & Wellman, H. M. (1977). Metamemory. In R. V. Kail Jr. & W. Hagen (Eds.), *Perspectives on development of memory and cognition* (pp. 3–31). Hillsdale, NJ: Erlbaum.

Fletcher, C. R. (1986). Strategies for the allocation of short-term memory during comprehension. *Journal of Memory & Language, 25* (1), 43–58.

Folds, T. F., Footo, M. M., Guttentag, R. E., & Ornstein, P. A. (1990). When children mean to remember: Issues of context specificity, strategy effectiveness, and intentionality in the development of memory. In D. F. Bjorklund (Ed.), *Children's strategies: Contemporary views of cognitive development* (pp. 67–91). Hillsdale, NJ: Erlbaum.

Garner, R., & Alexander, P. A. (1989). Metacognition: Answered and unanswered questions. *Educational Psychologist*, *24,* 143–158.

Goldman, S. (1997). Learning from text: Reflections on the past and suggestions for the future. *Discourse Processes, 23,* 357–398.

Graesser, A. C., Hoffman, N. L., & Clark, L. F. (1980). Structural components of reading times. *Journal of Verbal Learning and Verbal Behavior, 19,* 131–151.

Hasselhorn, M. (1995). Beyond production deficiency and utilization inefficiency: Mechanisms of the emergence of strategic categorization in episodic memory tasks. In F. E. Weinert & W. Schneider (Eds.), *Utilization deficiencies in the development of memory strategies* (pp. 141–159). Mahwah, NJ: Erlbaum.

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. *Review of Educational Research, 60,* 549–571.

Jacobs, J. E., & Paris, S. G. (1987). Children's metacognition about reading: Issues in definition, measurement and instruction. *Educational Psychologist, 22,* 225–178.

Juel, C. (1988). Learning to read and write: A longitudinal study of fifty-four children from first through fourth grades. *Journal of Educational Psychology, 80,* 437–447.

Kintsch, W. (1998). *Comprehension: A Paradigm for cognition.* Cambridge, UK: Cambridge University Press.

Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological Review, 85,* 363–394.

Kirsch, I. S., Jungblut, A., & Mosenthal, P. B. (1998). The measurement of adult literacy. In T. S. Murray, I. S. Kirsch, & L. Jenkins (Eds.), *Adult literacy in OECD countries: Technical report on the first International Adult Literacy Survey*. Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Kirsch, I. S., & Mosenthal, P. B. (1994). Interpreting the IEA reading literacy scales. In M. Binkley, K. Rust, & M. Winglee (Eds.), *Methodological issues in comparative educational studies: The case of the IEA reading literacy study.* Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Köller, O., Baumert, J., & Schnabel, K. (2000). Zum Zusammenspiel von schulischem Interesse und Lernen im Fach Mathematik: Längsschnittanalysen in den Sekundarstufen I und II. In U. Schiefele & W.-P. Wild (Eds.), *Interesse und Lernmotivation. Untersuchungen zur Entwicklung, Förderung und Wirkung* (pp 163–181). Münster: Waxmann.

Krapp, A., Hidi, S., & Renninger, K. A. (1992). Interest, learning and development. In K. A. Renninger, S. Hidi, & A. Krapp

(Eds.), *The role of interest in learning and development* (pp. 3–25). Hillsdale, NJ: Erlbaum.

Kurtz, B. E., & Borkowski, J. G. (1984). Children's metacognition: Exploring relations among knowledge, process, and motivational variables. *Journal of Experimental Child Psychology, 37,* 335–354.

Larkin, J. H. (1989). What kind of knowledge transfer? In L. B. Resnick (Ed.), *Knowing, learning and instruction: Essays in honor of Robert Glaser* (pp. 283–305). Hillsdale, NJ: Erlbaum.

Lehmann, R. H., Peek, R., Pieper, I., & Stritzky, R. von (1995). *Leseverständnis und Lesegewohnheiten deutscher Schüler und Schülerinnen.* Weinheim: Beltz.

Lehtinen, E. (1992). Lern- und Bewältigungsstrategien im Unterricht. In H. Mandl & H. F. Friedrich (Eds.), *Lern- und Denkstrategien* (pp. 125–149). Göttingen: Hogrefe.

Minnaert, A., & Janssen, P. J. (1995). How general are the effects of domain-specific prior knowledge on study expertise as compared to general thinking skills? In M. Birenbaum & F. J. R. C. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 265–281). Boston, MA: Kluwer.

O'Neil, H. J., & Abedi, J. (1996). Reliability and validity of a state metacognitive inventory: Potential for alternative assessment. *Journal of Educational Research, 89,* 234–245.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction*, *1,* 117–175.

Perfetti, C. A. (1985). *Reading ability.* New York: Oxford University Press.

Pressley, M., Borkowski, J. G., & Schneider, W. (1989). Good information processing: What it is and how education can promote it. *International Journal of Educational Research, 13,* 857–867.

Pressley, M., Harris, K. R., & Marks, M. B. (1992). But good strategy instructors are constructivists. *Educational Psychology Review, 4,* 3–21.

Pressley, M., Wood, E., & Woloshyn, V. (1990). Elaborative interrogation and facilitation of fact learning: Why having a knowledge base is one thing and using it is quite another. In W. Schneider & F. E. Weinert (Eds.), *Interactions among aptitudes, strategies, and knowledge in cognitive performance* (pp. 200–221). New York: Springer.

Renninger, K. A. (1992). Individual interest and development: Implications for theory and practice. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), *The role of interest in learning and development* (pp. 361–196). Hillsdale, NJ: Erlbaum.

Reusser, K. (1994). Die Rolle von Lehrerinnen und Lehrern neu denken. *Beiträge zur Lehrerbildung, 1,* 19–37.

Schiefele, U. (1996). *Motivation und Lernen mit Texten*. Göttingen: Hogrefe.

Schiefele, U. (1999). Interest and learning from text. *Scientific Studies of Reading, 3,* 257–280.

Schiefele, U. (in press). The role of interest in motivation and learning. In S. Messick & J. M. Collis (Eds.), *Intelligence and personality: Bridging the gap in theory and measurement.* Hillsdale, NJ: Erlbaum.

Schiefele, U., & Krapp, A. (1996). Topic interest and free recall of expository text. *Learning and Individual Differences, 8* (2), 141–160.

Schiefele, U., & Schreyer, I. (1994). Intrinsische Lernmotivation und Lernen. *Zeitschrift für Pädagogische Psychologie*, *8* (1), 1–13.

Schlagmüller, M., & Schneider, W. (1999). *Metacognitive knolwedge about text processing: A questionnaire.* Unpublished manuscript, University of Würzburg.

Schneider, W. (1989). *Zur Entwicklung des Meta-Gedächtnisses bei Kindern.* Bern: Huber.

Schneider, W. (1999). The development of metamemory in children. In D. Gopher, A. Koriat et al. (Eds.), *Attention and performance XVII: Cognitive regulation of performance: Interaction of theory and application. Attention and performance* (pp. 487–514). Cambridge, MA: MIT Press.

Schneider, W. (in press). Giftedness, expertise, and (exceptional) performance: A developmental perspective. In K. A. Heller, F. J. Mönks, R. J. Sternberg, & R. F. Subotnik (Eds.), *International handbook of research and development of giftedness and talent.* London: Elsevier Science.

Schneider, W., & Bjorklund, D. F. (1998). Memory. In W. Damon,

D. Kuhn, & R. Siegler (Eds.), Handbook of child psychology: Vol. 2. Cognition, perception, and language (5th ed., pp. 467–521). New York: Wiley.

Schneider, W., & Bjorklund, D. F. (in press). Memory and knowledge development. In J. Valsiner & K. Connolly (Eds.), *Handbook of developmental psychology*. London: Sage.

Schneider, W., & Pressley, M. (1997). *Memory development between two and twenty*. Mahwah, NJ: Erlbaum.

Schneider, W., & Weinert, F. E. (1990). The role of knowledge, strategies, and aptitudes in cognitive performance: Concluding comments. In W. Schneider & F. E. Weinert (Eds.), *Interactions among aptitudes, strategies, and knowledge in cognitive performance* (pp. 286–302). New York: Springer.

Siegler, R. S. (1990). How content knowledge, strategies, and individual differences interact to produce strategy choices. In W. Schneider & F. E. Weinert (Eds.), *Interactions among aptitudes, strategies, and knowledge in cognitive performance* (pp. 73–89). New York: Springer.

Thorndike, R. L. (1973). *Reading comprehension education in fifteen countries*. Stockholm: Almqvist & Wiksell.

van Kraayenoord, C. E., & Schneider, W. E. (1999). Reading achievement, metacognition, reading self-concept and interest: A study of German students in grades 3 and 4. *European Journal of Psychology of Education, 14,* 305–324.

van Oostendorp, H., & Goldman, S. R. (Eds.). (1999). *The construction of mental representations during reading.* Mahwah, NJ: Erlbaum.

Wimmer, H., & Tornquist, K. (1980). The role of metamemory and metamemory activation in the development of mnemonic performance. *International Journal of Behavioral Development, 3,* 71–81.

Winne, P. H., & Perry, N. E. (2000). Measuring self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self regulation* (pp 531–566). San Diego, CA: Academic Press.

Wu, M. L., Adams, R. J., & Wilson M. R. (1998). *ACER ConQuest: Generalized item response modeling software manual*. Melbourne: The Australian Council for Educational Research.

This article was published in:

European Journal of Psychology of Education 2001, Vol. XVI; No. 3, 363-383.

Authors

Cordula Artelt, Max Planck Institute for Human Development, Lentzeallee 94, D-14195 Berlin, Germany

Ulrich Schiefele (Fakultät Psychologie und Sportwissenschaft, Universität Bielefeld), Postfach 10 01 31, D-33501 Bielefeld

Wolfgang Schneider (Institut für Psychologie, Universität Würzburg), Röntgenring 10, D-97070 Würzburg