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Higher-Order Comprehension Processes in Struggling Readers: A Perspective for Research and Intervention

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Many children struggle to learn to read, and these difficulties can persist well into adulthood. To address this problem, researchers have investigated the processes that underlie reading. An informative body of work has thus identified basic skills (e.g., decoding, vocabulary knowledge) as necessary for successful reading. Researchers also have begun to examine comprehension skills and their contributions to the reading process. In this article we describe research from the cognitive sciences on the processes that underlie higher-order, coherence-oriented comprehension to provide an empirically and theoretically driven perspective for investigating struggling readers' difficulties. We show that this perspective is particularly beneficial in the development and assessment of instructional approaches by relating it to existing, effective interventions. Finally, we demonstrate how our own research activities have derived from this perspective and how preliminary findings extend our understanding of readers' difficulties. This work seeks to address existing challenges in the field of reading comprehension while also suggesting new ways of investigating the plight of struggling readers.

The demand for literacy in our increasingly information-driven society has placed a premium on the effective and immediate application of reading skills in a variety of settings. Few would disagree that reading is essential for academic, economic,

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and social success. Yet many school-age children struggle to learn to read: Over one third of fourth graders and one fourth of eighth graders cannot read at a basic level (National Center for Education Statistics [NCES], 2005). Reading difficulties often persist into adulthood; approximately 23% of U.S. adults meet only basic reading proficiency levels (NCES, 2004; Pressley & Harris, 2006). These issues have led to public concern and policy initiatives that emphasize the need for effective approaches for teaching reading, particularly for struggling readers.

In response to these concerns and initiatives, reading experts have identified basic skills (e.g., phonological awareness, decoding, fluency, and vocabulary knowledge) that are important for successful reading (see National Reading Panel [NRP], 2000). Decades of reading research have informed our understanding of the role of these basic skills, which has led, in turn, to the development of interventions designed to help readers develop these skills in the service of successful reading comprehension. At the same time, it has become clear that higher-order reading skills—those involved in comprehension itself—are also essential to successful reading (e.g., NRP, 2000; Oakhill, Cain, & Bryant, 2003; Paris & Paris, 2003; Snow, 2002; van den Broek, Kendeou, et al., 2005).

In fact, the importance of including both basic and higher-order skills in reading instruction has been reflected in reviews of the literature that distinguish between "inside-out" (e.g., decoding) and "outside-in" (e.g., comprehension) skills (e.g., Bus & van Yzendoorn, 1999; Whitehurst & Lonigan, 1998). Authors of these reviews have concluded that basic and higher-order skills develop simultaneously and independently rather than sequentially (although development in one set of skills may enable development in the other; e.g., Tannenbaum, Torgesen, & Wagner, 2006). This conclusion has important educational implications, suggesting that instruction in higher-order reading comprehension is essential regardless of students' mastery of basic skills. This conclusion particularly applies to struggling readers, who often exhibit reading comprehension difficulties even when basic skills are taken into account (e.g., Alvermann, Fitzgerald, & Simpson, 2006; Englert & Thomas, 1987; Taylor & Williams, 1983).

The growing awareness of the contributions of comprehension skills for successful reading has led to strong calls for more thorough and systematic investigations of the nature of higher-order reading activities, and for the development of interventions that specifically target them (e.g., Gersten, Fuchs, Williams, & Baker, 2001; Mastropieri & Scruggs, 1997; Pressley, Graham, & Harris, 2006; Snow, 2002; Snow & Sweet, 2003). Federal initiatives, such as those spearheaded by the U.S. Department of Education, have been designed to further stimulate these investigations. To be clear, these calls and initiatives do not imply that research and instruction focusing on basic skills should be curtailed, but rather that the development of comprehension skills also requires investigation, and that comprehension instruction should be integrated into existing reading interventions and content domains (Pressley et al., 2006; Williams et al., in press).

Researchers have conducted extensive research on both mechanisms that underlie comprehension-oriented skills and strategies designed to target reading comprehension difficulties. The aforementioned calls and initiatives targeting students' higher-order reading comprehension, though, have suggested that there has been less interaction across theoretical and applied research areas than might be expected (Graesser, 2007; McNamara, 2006; Snow, 2002). Nonetheless, some of this work has converged on principles and findings appropriate for theoretical and applied settings. Consider, for example, that researchers who have focused on comprehension have taken care to differentiate between the processes and products of comprehension, whereas reading intervention researchers have also been concerned with this important distinction, although often less explicitly.

The *products* of comprehension are indicators of what the reader knows and understands after reading is completed, whereas the *processes* of comprehension are those cognitive activities by which the reader arrives at those products. Contemporary interventions are typically guided by the view that effective methods for helping struggling readers should be obtained by affecting the processes that occur *during* reading. Yet comprehension assessments and interventions are often grounded in product-based measures such as recall or question-based tasks that are collected *after* reading.

A focus on the cognitive processes that underlie reading comprehension may be useful for describing, explaining, and addressing the needs of struggling readers. Research in cognitive science has led to a greater understanding of the nature of comprehension processes as well as to an understanding of the reasons that such processes may fail across a variety of reading contexts and for a variety of readers (see Graesser, McNamara, & Louwerse, 2003). We, along with others, believe this work can prove informative for addressing the needs of struggling readers (e.g., Gersten et al., 2001; Graesser et al., 2003; Nesbit & Hadwin, 2006; Pressley, 2002; Pressley et al., 2006). In this article, we describe research in the field of cognitive science on reading comprehension processes. Further, we use this perspective as a means for examining the development and assessment of interventions designed to improve reading skills. In doing so, we attempt to integrate findings from cognitive science with work on reading interventions to develop effective methods of addressing readers' higher-order reading difficulties.

To elucidate this perspective, we first summarize current empirical findings on the cognitive mechanisms underlying higher-order, comprehension-oriented processes. We describe the role of these processes in reading and suggest how they influence understanding of texts. We then discuss several evidence-based interventions designed to influence reading comprehension activities and explore how such interventions remediate struggling readers' difficulties. These interventions, we contend, align nicely with the cognitive perspective described in this article. We conclude by describing our own current research on the role of comprehension-oriented skills for both successful and struggling readers. Our hope is that the

perspective outlined in this article further facilitates the incorporation of empirical research on higher-order processes into existing instructional programs. Our ultimate goal, of course, is to attain the most effective methods for helping students learn to read.

COGNITIVE PROCESSES IN TEXT COMPREHENSION: ESTABLISHING COHERENCE

Research in the cognitive sciences has provided important insights into the nature of the processes involved in reading comprehension (see Gernsbacher, 1990; Graesser, Gernsbacher, & Goldman, 2003; Graesser, Golding, & Long, 1991; van den Broek, 1994; Zwaan & Rapp, 2006, for reviews). In this section we briefly introduce some of this research to demonstrate how such findings are relevant to understanding the higher-order abilities that readers must possess, and to illustrate the challenges that readers face in their attempts to comprehend text.

Whereas basic reading skills concern the identification of letters and words in a text, higher-order skills concern the understanding of concepts and ideas conveyed by the text. In the context of learning, comprehension entails the identification of the meaning of the text as a connected whole rather than as a series of individual words and sentences. Indeed, one of the most consistent findings from cognitive psychological research on reading is that the construction of a coherent representation of text in memory is central to successful comprehension. A useful coherent mental representation contains the various pieces of information provided in the text, is integrated with the readers' prior knowledge, and is easily accessed and applied in a variety of situations. One can think of this mental representation as a network, with nodes that depict individual facts and events, and connections that depict the meaningful relations between them (e.g., Kintsch & van Dijk, 1978; Trabasso, Secco, & van den Broek, 1984). Coherence reflects the degree to which appropriate, meaningful connections are established between elements of text and the reader's prior knowledge.

Researchers have found referential and causal/logical relations to be particularly important in establishing coherence. Referential relations enable readers to keep track of objects, people, and events mentioned in a text (Gernsbacher, 1990; Graesser et al., 2003; Kintsch & van Dijk, 1978). Causal/logical relations enable readers to identify how different events or facts depend on or cause each other (e.g., Goldman & Varnhagen, 1986; Trabasso & van den Broek, 1985). In naturalistic texts, the referential and causal/logical relations readers must infer are not necessarily obvious. They can be numerous and complex, extending over long distances in the text, involving extensive background knowledge, and requiring coordination of multiple pieces of information. This complexity and the demands it

puts on readers' processing capacities is a major source of comprehension difficulty.

A large body of empirical evidence indicates that such referential and causal/logical network representations are key components in proficient adult readers' comprehension of texts. For example, when asked to recall what they have read, college-age readers more frequently and quickly recall information on the "causal chain" of the network (i.e., the causal structure provided by the plot or explanations in a text) than information not on the chain. Similarly, recall is a linear function of the number of connections an element of the text has to other information in the text: The more connections an element has, the more often and faster it is recalled (e.g., Graesser & Clark, 1985; Trabasso & van den Broek, 1985). Readers also judge information with many causal connections as central to the text and selectively include such information in their text summaries (Trabasso & Sperry, 1985).

Likewise, network representations based on causal/logical and referential relations are an important component of comprehension by children—as young as preschoolers—as evidenced when their memory and comprehension is tested using nontext materials (e.g., Casteel, 1993; Trabasso & Nickels, 1992; van den Broek, Lorch, & Thurlow, 1996). There are, of course, constraints on children's propensities for establishing such relations. Because of differences or limitations in prior knowledge, attentional capacities, or strategies for establishing relations, and so on, younger children may not recognize certain relations as readily as older children (van den Broek, 1997). For example, relations that span large distances in a text often remain unidentified by young children, whereas older children show a stronger proclivity for establishing causal connections across story episodes and longer text distances (van den Broek, 1989). Relations that require the coordination of multiple causes may initially be lacking from young children's representations, with a stronger influence of multiple connections on the probability of story recall for 10-year-olds as compared to 6-year-olds (Trabasso et al., 1984). Younger children also tend to place importance on the concrete actions of characters in their causal models of stories, more so than on the mental states of characters or more abstract event features. In contrast, these internal, abstract causal factors exert a considerable influence on older readers' comprehension. In addition, older children seem to show a stronger propensity for establishing causal connections across story episodes and longer text distances than younger children (van den Broek, 1989). Overall, causal relations are critical to establishing coherence for readers, with more sophistication and elaborative activity emerging with age and experience.[1]

[1]These same constrained patterns occur in older children or adults when they are lacking essential processing skills, capacities, adequate strategies, or prior knowledge. Indeed, even otherwise proficient readers may suffer in similar fashions when rushed through their reading of a text, when lacking knowledge necessary for understanding a text, and so on.

By understanding the processes through which these relation-based representations are constructed we can better appreciate how some readers succeed but others do not. Such an understanding may provide a basis for further development and enhancement of reading comprehension interventions. For example, when readers are asked to think aloud while proceeding through a text, they often give responses that explicitly reflect attempts to establish coherence (Kendeou & van den Broek, 2005; Pressley & Afflerbach, 1995; Trabasso & Suh, 1993). Moreover, proficient readers adjust the exact nature of these coherence-building processes as a function of their reading goal, constructing different types of coherence for different goals (Magliano, Trabasso, & Graesser, 1999). Thus, proficient individuals reading with a study goal in mind tend to produce explanatory statements and predictive inferences that are useful for understanding why and how events happen; proficient individuals reading for entertainment tend to produce more evaluative and associative comments associated with general descriptions of text events (van den Broek, Lorch, Linderholm, & Gustafson, 2001). As a second example, coherence building also has been shown in tasks involving naming or lexical decisions, with readers reactivating information from the prior text at points for which such information helps establish causal or referential coherence (e.g., Rapp & Taylor, 2004; Sundermeier, van den Broek, & Zwaan, 2005). Likewise, measures of reading latencies reveal evidence of readers' activities in the service of coherence building: Participants' reading times for story sentences increase when causal antecedents and consequences are not readily available in the current text (Bloom, Fletcher, van den Broek, Reitz, & Shapiro, 1990). In such cases readers must rely on prior knowledge to derive adequate explanations or logical outcomes for story events as they attempt to build coherence, and these processes influence moment-by-moment reading patterns.

Although existing research suggests that successful readers place a premium on establishing coherence during reading, constructing a coherent representation requires a delicate balancing act. Readers must engage in extensive inferential processing to meet their standards of coherence (based on task or learning goals, motivation, prior experience, and other situational determinants) but must do so while working within the inherent limitations of their attentional and working memory resources (e.g., Rayner & Pollatsek, 1989; van den Broek, Rapp, & Kendeou, 2005). Proficient readers engage in the complex, dynamic allocation and reallocation of attention as they read, continuously shifting attention to focus on incoming text information; selectively letting go of extraneous information; and, when necessary to establish coherence, activating background knowledge and reactivating information from the prior text (e.g., Fletcher & Bloom, 1988; Kintsch, 1988; Rapp & van den Broek, 2005). These fluctuations in focus allow the reader to identify meaningful connections between text elements and between those elements and background knowledge. Computational models and simulations of human performance have been quite successful at both predicting and replicating the

performance of real readers by implementing such fluctuations as a design feature (e.g., Goldman & Varma, 1995; van den Broek, Young, Tzeng, & Linderholm, 1999). The processes underlying these fluctuations, for both the models and actual readers, depend on reader properties including reading skill and knowledge, textual properties such as structure and difficulty level, and the standards of coherence that the reader has for reading that particular text (e.g., van den Broek & Kremer, 1999; van den Broek, Risden, & Husebye-Hartman, 1995).

It is worth noting that these processes need not solely be under conscious control of the reader. For example, reading about particular concepts triggers a spontaneous spread of activation to other concepts that are, in the mind of the reader, associated with what is being read. These associations may have come about during reading of earlier parts of the text or may preexist in the reader's prior semantic knowledge. Either way, reading a piece of text will, without any effort, evoke activation of related information (e.g., O'Brien, Rizzella, Albrecht, & Halleran, 1998). Other processes, in contrast, are more strategic and under reader control. For example, readers may reinstate prior text information by looking back or by accessing their memory representation of the prior text, or they may search their background knowledge in an attempt to create coherence. Other examples of strategic processes include summarization or integration activities aimed at thematic understanding, predictive inferences, and so on. Together, all of these processes constitute a type of "toolkit" available to readers. Readers differ in the extent to which each type of process is available, well practiced, and usable (indeed, an individual reader may vary in the tools available from one reading situation to the next) and, hence, in the exact nature of the fluctuations in their focus during reading. The balance achieved by proficient reading, then, is characterized by the appropriate selection and use of comprehension processes in a particular reading situation.

Indeed, proficient readers adjust their reading strategies and their use of processes as a function of the text and task; these adjustments affect the types of fluctuations previously described. For instance, readers process expository materials quite differently from narrative texts. As one example, surface features of texts receive more focus when individuals read literary materials than during their readings of newspaper articles, with corresponding memory effects on the information people recall after reading articles and novels (Zwaan, 1994). Even within a genre, readers make adjustments as a function of the difficulty of the text content, their familiarity with the material, and the structure of the information (Meyer & Freedle, 1984; Meyer & Poon, 2001). As mentioned earlier, particular goals likewise can influence the types of relations readers attempt to develop, such as when they read for study or entertainment (van den Broek, Lorch, et al., 2001), or are asked to carefully evaluate or generally comprehend a text (Rapp & Kendeou, in press). Thus, the role of attention allocation in reading is not restricted to how much attention the reader designates overall to the task, but also involves the dynamic shifting of attention to particular processes and text elements while proceeding through the

text. This shifting is in the service of constructing a coherent representation that fits with the reader's goals for reading.

POSSIBLE SOURCES OF COMPREHENSION DIFFICULTIES

The depiction just presented suggests various potential sources of failure. For example, reading will fail when a reader is unable to adjust and allocate attention. This may happen because of attentional capacity or executive control problems, but it may also happen if the reader has access to appropriate comprehension processes but is unable to use them properly (see Gersten et al., 2001). For example, the reader may be capable of searching through memory to reinstate information from earlier in the text but may perseverate on less-than-useful information or may incorrectly select inappropriate information as necessary for establishing coherence. Even skilled readers may fail if they do not invoke processes when they would be helpful or appropriate. For instance, readers may rely solely on the text for comprehension when accessing background knowledge would be useful or, conversely, search their background knowledge for information that is readily available in the text. Other individual differences, such as quantity and quality of relevant background knowledge, knowledge of genre, and so on, all further affect the processes in which a reader is able to engage during reading and, hence, the final outcome of those processes in terms of the coherence of the mental representation.

We invoke these various situations to suggest that struggling readers can struggle for a variety of process-related reasons. An important implication is that the different processes in which readers engage, or fail to engage, as they read can provide a unique profile of their reading activity. Distinct subgroups of struggling readers may emerge from such profile analyses. These profiles, in turn, may help us understand when and how readers fail to establish coherence as they read and allow us to develop specific assessment and intervention strategies for struggling readers.

ADDRESSING COMPREHENSION DIFFICULTIES OF STRUGGLING READERS: EXISTING INTERVENTIONS

Many educational researchers have recognized the importance of the reading process as critical in the design and implementation of interventions. For the last several decades, numerous researchers have worked to understand comprehension problems and to find ways to develop comprehension skills in struggling readers (see Block & Pressley, 2002; Dole, Duffy, Roehler, & Pearson, 1991; Gersten

et al., 2001; Mastropieri & Scruggs, 1997; Mastropieri, Scruggs, Bakken, & Whedon, 1996; Pearson & Hamm, 2005; Pressley, 1991, 1998; Swanson, 1999; Talbott, Lloyd, & Tankersley, 1994, for reviews). This work has led to an improved understanding of factors that affect some readers' failure to comprehend text as well as to a variety of instructional approaches designed to address those difficulties. In this section, we briefly review aspects of this research. These approaches each address some of the processes we have described, with the aim of remediating struggling readers' difficulties.

We rely on the perspective offered by cognitive science to organize our review, as it provides a potential framework for coordinating research on reading intervention (e.g., Pressley, 2000). Recall that the processes readers apply during comprehension are determined by properties of the reader, the text, and the goals or instructions of the reading task. Van den Broek and Kremer (1999) described a model of reading comprehension that relies on interactions among these three sets of properties (and which we implicitly invoked in our earlier discussion of factors that influence readers' processing of texts). This model is also reflected in the framework proposed by the RAND Reading Study Group (Snow, 2002; see also Snow & Sweet, 2003) to promote an agenda to advance reading comprehension research. Our description here aligns with that model, allowing us to focus on factors that influence reading processes by relating them specifically to particular instructional strategies.

Reader Characteristics

Readers' basic skills play an important role in successful comprehension. These skills include phonological awareness, decoding (e.g., Gough & Tunmer, 1986; Perfetti, 1988; White, 2005), fluency (e.g., LaBerge & Samuels, 1974), and vocabulary knowledge (e.g., Beck, Perfetti, & McKeown, 1982; Stanovich, 1986). Several interventions focus on the development of these skills, with the rationale that their improvement should facilitate translation of the written text into the correct meaning as well as free up attentional resources for higher-order processing (Cunningham & Stanovich, 1998; LaBerge & Samuels, 1974; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). Indeed, basic skills interventions including word training (e.g., Tan & Nicholson, 1997), repeated reading (e.g., LaBerge & Samuels, 1974; Rashotte & Torgesen, 1985; Sindelar, Monda, & O'Shea, 1990), and vocabulary instruction (e.g., Beck et al., 1982; Pany, Jenkins, & Schreck, 1982), can lead to improved comprehension (e.g., Mastropieri et al., 1996, reported a mean effect size of .62 in an examination of the impact of such skill-building approaches on the reading comprehension of students with learning disabilities). However, some readers continue to struggle with comprehension despite such interventions (e.g., Englert & Thomas, 1987; Taylor & Williams, 1983), and

skill transfer to novel texts is not guaranteed (Pany et al., 1982; Rashotte & Torgesen, 1985).

Again, in addition to basic skills, readers' higher-order processes have become critical in conceptualizing effective reading interventions. For example, as mentioned in our earlier discussion, a lack of background knowledge, or failure to activate background knowledge when appropriate, constitutes a potential source of difficulty for struggling readers (e.g., Bos & Anders, 1990; Williams, 1993). As described, background knowledge can be activated both automatically and strategically (e.g., Guéraud & O'Brien, 2005; Kendeou, Rapp, & van den Broek, 2003; van den Broek, Rapp, & Kendeou, 2005). This is reflected in many interventions that address the task- and reader-driven activities that facilitate the retrieval of potentially relevant knowledge for understanding text.

Whereas activating background knowledge may be useful for comprehending text, some researchers caution that struggling readers often overrely on their background knowledge—which is often faulty or incomplete—causing them to move further from, rather than closer to, the intended meaning of texts (e.g., McCormick, 1992; Trabasso & Suh, 1993; Williams, 1993). Interventions that have promoted the effective use of background knowledge have been specifically structured and relevant to the text at hand. The interventions, which include text previews (e.g., Idol-Maestas, 1985; Sachs, 1983), the introduction of vocabulary or text-relevant facts prior to reading (e.g., Snider, 1989), advance organizers (e.g., Lenz, Alley, & Schumaker, 1987), or question-and-answer-generation tasks (e.g., Billingsley & Wildman, 1988; Darch & Gersten, 1986) have been demonstrated to facilitate recall and comprehension of text.

Another process critical to reading success is the construction of inferences (e.g., Cain & Oakhill, 1999; Graesser, Singer, & Trabasso, 1994; van den Broek, 1997). Improving readers' inference-making skills may lead to substantial reading benefits. For example, teaching readers to recognize and answer different types of comprehension questions can help them learn to build particular types of inferences. Strategy-based interventions such as Question–Answer Relationships teach students to categorize information as stated in the text, implied by the text, or requiring background knowledge (Simmonds, 1992). The use of such strategies has resulted in improved comprehension for students with learning disabilities (LD). Similarly, questions specifically designed to elicit coherence-based inferences have demonstrated improvements in regular students' comprehension and memory for texts (van den Broek et al., 2001). It is important to note that these results were obtained only if the questions were presented during the actual inference-making process, *during* reading, but not if the questions were presented *after* reading was completed. It is interesting that fourth graders performed best without questions during reading—for these students the questions may actually have interfered with their moment-by-moment reading. This result highlights the fact that interventions may be effective for students with some cognitive profiles but not for students with

different profiles. Similarly, think-aloud activities also promote inference making and thereby improve comprehension (Trabasso & Magliano, 1996), although poor readers generate fewer inferences than average readers during these tasks (e.g., Laing & Kamhi, 2002). Again, inference-based approaches may not be equally effective for readers of all skill levels.

Limits on readers' attention-allocation skills also have been implicated as potential sources of failure. Many struggling readers process information inefficiently, with breakdowns occurring when they fail to implement particular reading strategies (Gersten et al., 2001). To address failures to repair such breakdowns, researchers have developed a variety of interventions in which students are explicitly taught to use metacognitive strategies, through tasks such as self-questioning or explanations (e.g., Jenkins, Heliotis, Stein, & Haynes, 1987, McNamara, 2004; Wong & Jones, 1982), summarization (e.g., Gajria & Salvia, 1992; Malone & Mastropieri, 1992), and explicit self-monitoring of comprehension (e.g., Borkowski, Weyhing, & Carr, 1988). These strategies lead to improvements in struggling readers' comprehension, at least for the materials used in the interventions. What remains unclear is whether students will more generally apply these learned strategies to texts beyond those used in the interventions or whether specific types of strategies are best suited for specific texts, tasks, and reader groups (Gersten et al., 2001).

Text Properties

The content and format of texts also influence struggling readers' comprehension. Struggling readers often have little knowledge of narrative or expository text structures and as a result do not rely on structure to guide their reading (Meyer, Brandt, & Bluth, 1980; Taylor & Williams, 1983; Williams, 2006). Accordingly, text structure interventions provide readers with strategies for reading particular types of texts (Gersten et al., 2001; Linderholm et al., 2000). These interventions have included using charts, graphs, and diagrams to provide visual aids for understanding text (e.g., Winn, 1987); teaching students to identify common organizational structures (e.g., Smith & Friend, 1986); teaching the use of story grammar and semantic mapping (e.g., Bos, Anders, Filip, & Jaffe, 1989; Gurney, Gersten, Dimino, & Carnine, 1990; Idol & Croll, 1987; Williams, 1993); helping students identify the main ideas or themes in texts (e.g., Taylor & Williams, 1983; Wilder & Williams, 2001); and providing explicit instruction on text structure, such as cause-and-effect relationships (Williams et al., 2007). These interventions have obtained moderate to strong, positive effects (e.g., Mastropieri et al., 1996, reported an overall effect size of .92 for text enhancements for students with LD), even on transfer tasks (e.g., Williams, Hall, & Lauer, 2004). Williams (2006) cautioned, however, that these studies often include both careful instruction and well-structured texts but that in reality texts are not necessarily well structured. Thus, it is important to

identify the conditions under which positive effects are obtained for a variety of texts, and whether transfer effects exist.

Instructional Contexts

In conjunction with reader characteristics and text properties, researchers have investigated the role of instructional contexts in the remediation of comprehension difficulties. Some of this work has focused on the type of instructional delivery system rather than on the actual content of instruction. For example, one aspect of instructional delivery that has been explored is the explicitness of comprehension instruction. Researchers have examined the efficacy of direct instruction for students with LD (e.g., Jitendra, Cole, Hoppes, & Wilson, 1998; Lloyd, Cullinan, Heins, & Epstein, 1980; Polloway, Epstein, Polloway, Patton, & Ball, 1986), which involves explicit, teacher-directed instruction that incorporates structure, repetition, careful task sequencing, and immediate corrective feedback. Direct instruction approaches have improved the comprehension of struggling readers and appear more effective than less explicit instruction (e.g., Stein & Goldman, 1980; Talbott et al., 1994; Talbott et al. reported a mean effect size for direct instruction of .67 for students with LD).

Researchers have also investigated multicomponent interventions that combine specialized instructional delivery systems with instructional content designed to improve the comprehension of struggling readers. For example, Palincsar and Brown (1984) developed Reciprocal Teaching, which involves students' use of specific comprehension strategies in a peer-mediated instructional format. In Reciprocal Teaching, teachers model summarizing, predicting, questioning, and clarifying strategies with small groups of students to promote the use of a metacognitive dialogue during reading. Students gradually assume the role of teacher, using the dialogue to guide their peers in applying the strategies.

Other multicomponent programs also have incorporated peer-mediated instruction with additional strategy instruction. For example, "POSSE" (Englert & Mariage, 1991) combines a Reciprocal Teaching format with activities that help students predict, organize, search, summarize, and evaluate what they are reading. POSSE has improved poor readers' (including those with mild cognitive disabilities) recall of ideas from expository text. Peer-assisted Learning Strategies (PALS; Fuchs, Fuchs, Mathes, & Simmons, 1997) is another peer-mediated approach to building comprehension skills. PALS involves pairing higher performing readers with lower performing readers to complete structured reading activities. Students read and retell what they have read, summarize paragraphs using questioning strategies similar to those developed by Jenkins et al. (1987), and make predictions about what will happen next in texts. PALS has been demonstrated to improve reading fluency and comprehension for average- and low-performing readers, as well as for some students with disabilities (Fuchs et al., 1997). There are many

other examples of multicomponent interventions that incorporate specific comprehension strategies with specialized instructional delivery systems, and several have shown promise for struggling readers and students with disabilities.

The extant literature provides an array of interventions that address reader characteristics, text properties, and instructional contexts, and that attend to both basic and higher-order comprehension skills. Meta-analyses of reading comprehension intervention research indicate that many of the aforementioned instructional approaches have been successful with struggling readers and students with LD, with large positive mean effect sizes (e.g., .98, as reported by Mastropieri et al., 1996; .72, as reported by Swanson, 1999; 1.13, as reported by Talbott et al., 1994). The consensus among reviewers of this work (e.g., Gersten et al., 2001; Mastropieri & Scruggs, 1997; Pressley et al., 2006), however, is that more research is needed to ensure that comprehension interventions are effective for the most severely struggling readers and that any obtained skills generalize to a variety of texts (Gersten et al., 2001). Further, researchers have called for a better understanding of the interactions among readers, texts, and instructional contexts (e.g., McGill-Franzen, 2005; Snow, 2002; Snow & Sweet, 2003) and have suggested multilevel reading studies that examine and account for the complex interactions among readers and their instructional environments (Sloane, 2005).

Finally, whereas evaluations of reading interventions have often focused on the end products of reading, the constituent activities of the interventions reflect assumptions about the processes involved during reading. Indeed, close inspections of effective interventions (Cain & Oakhill, 1999; Gersten et al., 2001; Mastropieri & Scruggs, 1997; Vaughn, Gersten, & Chard, 2000) indicate that they often are comprised of various activities designed to help students allocate attention selectively to particular aspects of the text. Future iterations of existing interventions and the development of new ones would benefit from making explicit connections to research on reading processes (Graesser, 2007).

CHALLENGES FOR INTERVENTION RESEARCH

The perspective offered by building interventions that are directly informed by cognitive research has the potential to address other challenges for the field. Next, we describe three such challenges (Pressley et al., 2006). First, many successful comprehension interventions are based on what *good* readers do as they read (e.g., Pressley et al., 2006; Snowling & Hulme, 2005). Indeed this observation holds true for many of the interventions just described. For example, interventions designed to teach struggling readers to use metacognitive strategies would seem consistent with the higher-order processes identified as essential to proficient reading. To be sure, thorough knowledge of what good readers do may be useful for designing interventions. But simply assuming that struggling readers' difficulties can be

rectified by teaching them to "do what good readers do" is problematic; there may be structural reasons for the relative absence of those processes in struggling readers. Therefore, one challenge facing intervention researchers is to better understand the processes in which struggling readers engage—whether they are the same as or different from those employed by good readers—and under what circumstances those processes break down. The resulting profiles of struggling readers' characteristics would be useful in developing interventions that directly influence their comprehension processes, rather than training "good reader" strategies that may not always address struggling readers' underlying difficulties.

Second, Pressley et al. (2006) and Pearson and Hamm (2005) emphasized the importance of gaining a better understanding not only of *whether* an intervention works but also *how* it works. Assessments that provide insight into students' online reading processes would be particularly effective at developing such an understanding. Think-aloud and eye-tracking methodologies (Ericsson & Simon, 1984; Rayner, 1986; Rayner, Chace, Slattery, & Ashby, 2006) have the potential to provide insight into the moment-by-moment processes readers engage in as they read and respond to interventions applied during reading. These methodologies can be used in concert with more conventional product-oriented measures such as recall, summarization, question answering, and other reading outcomes. This would afford a more integrated and informative understanding of the comprehension processes of struggling readers as well as their responses to different types of interventions.

Third, Pressley et al. (2006) emphasized the importance of understanding and developing interventions in the context of diverse theories of reading. As an example, they discussed how models of direct instruction (which rely on behavioral theories of learning) and more naturalistic instructional approaches (which rely on constructivist theories of learning) could be integrated to provide students with more comprehensive instruction, the components of which may be relevant at different points in learning (e.g., acquisition of a new skill may be best taught with direct instruction, whereas the application of that skill might develop best under more naturalistic conditions). In other words, the instructional *content* to be taught may drive the most effective instructional *delivery system* to be used. This suggests the need to combine well-worn theories and approaches from diverse areas studying similar topics. To a large degree, this suggestion has driven the interdisciplinary approach we have adopted in our investigations of reading and reading interventions.

CURRENT DIRECTIONS

In this section, we illustrate the aforementioned approach to connecting cognitive science with educational practice by briefly describing some of our recent

research based on the concepts outlined in this article. This research has three aims: First, we apply cognitive research on reading comprehension to identify unique properties of the processes in which struggling readers engage as they proceed through a text. Second, we seek to generate insights into the sources of struggling readers' difficulties as suggested by these processing profiles. Third, we use these profiles to develop interventions focused specifically on the sources of those difficulties. Our work focuses on readers at various age and skill levels; to date, we have identified struggling, average, and good readers in fourth, seventh, and ninth grades, using multiple assessments to test both basic-level and higher-order skills. To develop processing profiles, we relied on methodologies from the cognitive sciences.

First, we have used eye-tracking methodologies to reveal where readers fixated as they proceeded through texts as well as how long they fixated at each point. Eye fixation records provide a dynamic account of the time course of eye movements both within and across sentences. This record includes both the pattern and duration of eye movements. It allows one to deduce the processes in which readers engage as they read. These data can reveal whether readers draw particular inferences (e.g., backward inferences) or encounter particular difficulties (e.g., slow down or look back as a function of specific text segments) at different points in the texts (Rayner, 1998; Rayner et al., 2006).

These eye-tracking data are complemented by protocols obtained using a think-aloud methodology. Think-aloud methods have a rich history in psychological research as a valuable means of assessing what individuals are thinking about as they read texts (Ericsson & Simon, 1984). With this method, readers are asked to state out loud (throughout or at selected points during reading) what they are thinking. Readers' utterances provide an account of the activities or processes they are implementing as they read. For example, readers may produce statements that reiterate what they are reading (i.e., paraphrases or text repetitions), invoke background knowledge to fill in missing information in the text (i.e., explanatory inferences), express expectations about what might happen next in the text (i.e., predictive inferences), relate what they are reading to things they are thinking about (e.g., associations), or reflect other types of processes.

Both the eye-tracking and think-aloud methodologies have their limitations. Eye tracking gives a precise time sequence of processing without interfering with the normal reading process but provides only indirect insight into the actual processes that occur at each time point and their specific content. In other words, one can obtain data on the shifting patterns of attention during reading but not on what processing occurs during each component of these patterns. Think-aloud data are rich in content, but the think-aloud task itself may alter processing in substantial ways; besides, a think-aloud task by its very nature can only reveal processes of which the reader is aware. The strengths and weaknesses of the two methodologies complement each other. Thus, they have the potential of providing convergent

evidence for a robust picture of moment-by-moment reading activity (Walczyk, Marsiglia, Johns, & Bryan, 2004).

Using these methods, we have observed systematic patterns among struggling, average, and good readers at all three grade levels. Some processes appear to be used similarly by these groups. For example, all readers generated text-based and knowledge-based inferences, associations, paraphrases, and metacognitive comments. Other processes were unique to different types of readers. For example, good readers appear to be more reliable than struggling readers in their use of particular processes, such as slowing down at inconsistencies in texts or looking back in the text to resolve ambiguities or identify main ideas (Kendeou et al., 2006; McMaster, Kendeou, Rapp, & van den Broek, 2006). It is interesting to note that two distinct subgroups of struggling readers emerged from our eye-tracking and think-aloud data. One subgroup appeared to restrict processing mostly to the current text; these readers refrained from constructing inferences that went beyond the specific information they had just read and instead reread or paraphrased the current text. In contrast, a second subgroup of readers appeared to engage in activities that went beyond what they had read, much as good readers did. Unlike good readers, however, these activities were frequently unsuccessful or invoked inappropriate background knowledge. Of interest, these same two subgroups of struggling readers appeared at each of the grade levels we examined. Moreover, these subgroups of struggling readers were indistinguishable in their performance on *product* measures (i.e., recall, standardized reading comprehension scores, oral reading fluency, etc.). It was only when we assessed *process* that the two subgroups emerged.

This latter finding has important implications. From a theoretical perspective it suggests that the same product may result from different patterns of processes. Perhaps the different patterns of processes result only in substantially different outcomes under particular circumstances—for example, when the task challenges a reader's knowledge or capacities. From a practical perspective these results may prove to have implications for assessment and diagnosis. It is possible that some behavioral measures of reading simply are not sensitive enough or not sufficiently reflective of comprehension. It is also possible, though, that these measures of reading products *are* sensitive and there truly are no differences in reading products between the subgroups. If this second possibility turns out to be the case, it would suggest there are multiple pathways to the same level of comprehension, each path built on a different set of processes. In this case interventions aimed at particular processes may assist some readers yet appear ineffectual when all readers are considered as a single group. Again, the importance of identifying the unique profile of processes that characterizes different readers is clear.

This brief illustration shows how one can adapt the theoretical framework and empirical methods from the field of cognitive science to investigate reading processes and obtain profiles of different subgroups of readers. The resulting profiles

may assist in the identification and development of reading interventions. Indeed we are currently using the profiles we have identified for just that purpose. The previous illustration also suggests that consideration of both process and product can provide insight that cannot be gleaned from either aspect alone. Although individuals may perform similarly, their performance need not derive from the same underlying processes. Finally, the profiles that emerge from such analyses may be useful for suggesting the types of interventions that are most appropriate for specific groups of readers. Targeted interventions may be necessary to adequately address different types of reading difficulties. In fact, such interventions may be a function not only of subgroup performance differences but also of other factors (e.g., grade, age; NRP, 2000; Snow, 2002; van den Broek, Tzeng, Risden, Trabasso, & Basche, 2001). In this sense, the ultimate test of the utility of these profiles will be the degree to which they help guide the development and application of interventions to remediate subgroup difficulties. This would raise an important question, namely, whether subgroups would benefit from different types of instruction and, if so, whether such differentiated instruction should focus on further developing the processes in which a subgroup already engages or on stimulating the use of the processes in which that subgroup is relatively underengaged.

CONCLUSIONS

In this article we have described a theoretical perspective for framing reading and intervention-based work that is derived from research in the cognitive sciences. We also have indicated how this perspective has been and can continue to be applied to educational issues such as the identification of profiles of struggling and good readers. This perspective provides a basis for both understanding existing, effective interventions—and for understanding for which readers they may be effective—as well as for suggesting potential new directions in the design and application of reading interventions.

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