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**AN EXPANDED REVIEW OF THE RESEARCH ON VARIABILITY  
IN READING COMPREHENSION**

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This appendix contains an extended overview of the discussion in Chapter Three on variability in the three elements of reading comprehension—reader, text, and activity.

**VARIABILITY IN READERS**

In this section, we review research on the dimensions associated with variation in what readers bring to the activity of comprehending any particular text. We see variation among readers as being analyzable at four levels:

- *Sociocultural factors* help us understand differences among readers in the way they define comprehension, the nature of opportunities that readers have to learn to comprehend, and the texts and comprehension activities that they value. For example, learners from some social groups experience a lack of congruence between their own definitions of literacy and those they encounter at school, whereas those from other social groups find the school-based texts and literacy activities familiar.
- *Group membership* may have an effect on certain reader capabilities directly or on reader access to support for acquiring comprehension capabilities. For example, teachers may have varying expectations of literacy success for children from low- versus middle-income families. Second-language readers are likely in general to have less-extensive vocabulary knowledge than first-language readers, and recent immigrants are likely to be less familiar with presupposed background knowledge than long-term residents.
- *Individual differences* among readers go beyond those that correlate with sociocultural or group factors, reflecting the effect of biological, familial, or idiosyncratic factors. For example, the individual capacities that codetermine success in literacy acquisition, such as short-term memory, vocabu-

lary knowledge, or sensitivity to discourse markers, can show large differences among children from the same social group or family.

- *Intra-individual differences* encompass the same dimensions as individual differences but arise from the fact that readers' deployment of their capabilities varies as a function of setting, text, and purpose for reading.

We review what we know and what we need to know about the many sources of reader variability in comprehension, noting explicitly that the correlations found between certain sociocultural and group factors on the one hand and individual or intra-individual differences on the other cannot be taken to indicate causal relations.

It will be evident from our review that considerably less is known about cultural and social sources of variability, or about the specifics of group sources, than about the reader differences related to inter- and intra-individual cognitive and motivational capacities. The reading processes of readers from backgrounds other than European-American have been investigated, sometimes from a sociocultural and sometimes from a group-differences perspective (see García, Pearson, & Jiménez, 1994; García, 2000, for reviews). Studying these groups helps us understand variability in reading comprehension because it extends the range on many relevant variables beyond that available within the European-American community and because the effect of other sources of variability may well differ as a function of group membership.

In each of the following subsections documenting various sources of reader variability, we consider first the research dealing with younger children, typically preschool and primary-grade children, then discuss older learners. Under inter- and intra-individual differences, though, we make the break slightly later, between preadolescent and adolescent readers, to accommodate the most frequent groupings in the literature.

### **Social-Cultural Influences**

It is in some sense inappropriate to subordinate the discussion of social and cultural influences under reader variability, since in fact we are starting from an assumption that sociocultural influences infuse all reading and all learning. Nonetheless, it is clear that much research has conceptualized the challenge of universal high achievement as, in part, a problem of adapting schools to the degree of sociocultural diversity they now contain. Thus, we review in this section the research that attributes reader variability to sociocultural factors. As we will show in the next section, such group differences may significantly contribute to performance differences that may be observed in children from different backgrounds.

**Preschool Through Primary-Grade Readers.** Although all students have to learn how to adapt to school norms and mores (e.g., a student must raise his or her hand to be called on and ask permission to go to the bathroom), students who are not European-American and middle class are often at a disadvantage because they typically do not belong to their teacher's primary discourse community (see Cazden, 1988). Heath's research in the Piedmont region of the Carolinas showed that middle-class teachers expected their preschool children to respond to their literacy instruction in the same way that they expected their primary-grade students to respond (Heath, 1981, 1982). In contrast, children and parents from a working-class African-American community held beliefs about appropriate social interaction that conflicted with the teachers' beliefs. Because of such differences, the teachers viewed the African-American children as having deficits in their language and literacy abilities, for example, and were not able to engage them in effective literacy instruction. Valdés (1996) reported similar findings for immigrant Mexican children and their teachers. In their homes, the children were taught to respect others by not engaging in displays of knowledge, whereas the teachers expected the children to demonstrate what they knew. This discrepancy between home and school expectations often worked to the children's disadvantage because the teachers misperceived them as being less capable and placed them in lower reading groups.

Researchers (e.g., Juel, Griffith, & Gough, 1986) have compared the performance of African-American and Latino students with that of European-American students on a range of variables, such as word recognition, spelling, reading comprehension, and writing. Although the researchers took into account one or two sociocultural variables, such as ethnicity/race or socioeconomic status, they sometimes ignored other sociocultural variables, such as dialect or second-language status, that might have influenced their assessment of the students' performance or the interpretation of the data. For example, in a comparison of grades 1 and 2 European-American, African-American, and Latino students, Juel et al. reported that ethnicity and oral language strongly influenced the students' grade 1 year-end performance on phonemic awareness and to a lesser extent their grade 2 year-end performance. However, they did not take into account the variation in students' oral pronunciation of standard English that was due to dialect or second-language status.

Other researchers have focused on the reading performance and instruction of dialect speakers (e.g., Burke, Pflaum, & Knafle, 1982; Labov, 1982). They concluded that teachers' negative reactions to students' use of dialect adversely affected the type of instruction that the students received. Teachers' negative reactions were determined to have more of an effect on students' reading comprehension development than the students' use of dialect features.

These sociocultural factors produce readers who interact with text differently from the way European-American students do, since their preferred discourse forms may not appear in the most commonly used texts. They also receive access to a different set of reading activities because they are disproportionately placed in the lowest reading groups or lowest tracks where isolated-skill instruction dominates (e.g., Allington, 1983; Nystrand, 1990).

These examples clearly show that membership in different groups defined, in part, by factors that may appreciably affect proficiency in reading and reading comprehension per se—factors such as social class, ethnicity, and native language—can, indeed, have a significant effect on early reading development. Thus, research evaluating the relative contribution of such factors to early reading development as well as their interaction with other factors contributing to variability in such development (capacity differences) is an important area of inquiry in need of further study.

**Preadolescent and Adolescent Readers.** Social cultures offer a wealth of positions that readers can assume, and each position requires certain attributes. For example, to assume the position of “good reader,” an individual must possess certain abilities that are verifiable and recognizable to others who occupy that same position (McDermott & Varenne, 1995). But how students end up inhabiting some positions and not others in their classroom environments is sometimes a matter of their being placed into those positions because of differential instruction, teacher attitudes, and certain expectations. Researchers working within a sociocultural framework recognize the possibility that youth who are routinely described in school as resistant readers may actually be readers who use alternative literacy practices, such as predicting the next episode in the Japanese anime *Dragonball-Z* (Alvermann, 2001) and using football statistics to structure an essay about the economic connections between athletes and commercial enterprises. A productive research focus would highlight situational contexts that promote reading comprehension both in and out of school for all adolescents.

Researchers who investigated older students' reading comprehension from a sociocultural perspective focused primarily on cultural schemata (e.g., Reynolds, Taylor, Steffensen, Shirey, & Anderson, 1982) as a source of variability. They reported that when students read culturally familiar material, they read it faster, recalled it more accurately, and made fewer comprehension errors. However, the researchers did not develop profiles of expert and novice readers from various backgrounds. As a result, no information is available on how students from these backgrounds resolved dialect or language problems or varied in their strategy use or motivation.

## Group Differences

We include group differences as a focus of our interest, even though they are to some extent coterminous with sociocultural sources of variability, because a fairly large body of work has considered group membership (e.g., social class group, racial group, ethnic group, native language group) without relating the findings to cultural factors. Further, some identified groups (e.g., children growing up in poverty) or group-related factors (e.g., the more-limited English vocabulary associated with speakers of English as a second language) cannot be defined as cultural or culture-related, and some potentially influential factors (e.g., family income, attendance at good versus poor schools) are likely to be correlated with group membership. We are not concluding that membership in any of these groups can itself cause particular comprehension outcomes; rather, we are suggesting that documenting the differences may generate hypotheses about causal connections.

**Preschool and Primary Readers.** In research conducted with young children, Sonnenschein and colleagues (Sonnenschein, Baker, Serpell, Scher, Truitt, & Munsterman, 1997) found that children from lower-income brackets had fewer opportunities to interact with print and play with words than did children from higher-income brackets. Similarly, Whitehurst and Lonigan (1998) reported that children from low-income homes had less experience with books, writing, rhymes, and other literacy-promoting activities than did children from higher-income homes. In contrast, children from higher-income homes tended to enter kindergarten with more of such experience, as evidenced in greater alphabetic knowledge, greater ability to generate invented spellings, greater knowledge of print concepts, and so forth. Thus, in general, children from low-income families are less well prepared to engage in formal literacy learning than are those from higher-income families. However, as Goldenberg (2001) points out: “Family socioeconomic effects on achievement are in fact quite modest; and . . . effective school programs will help more children achieve, regardless of their economic class” (p. 216).

Another example of a group membership factor that significantly affects early literacy development is second-language learning. Tabors and Snow (2001) recently reviewed research on language and literacy development in second-language learners from birth to age 8. They generally concluded that second-language learning differentially affects literacy development depending on such factors as the age at which second-language learning is initiated, the language in which exposure to print and early literacy instruction is initiated, the child’s degree of proficiency in a first or second language, the child’s proficiency in the language in which print exposure and literacy instruction begins, and the degree of support for first- and second-language learning and literacy development in both the home and school environments (see also Snow et al., 1998).

For example, whereas learning to read a second language is impeded by a child's limited proficiency in that language, learning to read the native language may facilitate a child's ability to learn to read a second language. Similarly, disruption of first-language learning by virtue of total immersion in second-language learning may impede language and literacy development in both. Thus, variability in both language and literacy development is greatly affected by the second-language learner's home and school environments.

**Preadolescent and Adolescent Readers.** Two indicators of the reading performance and academic engagement of older students (grades 4–12) in U.S. schools are data from NAEP, often termed “the nation's report card,” and data on the dropout rate. Ever since NAEP has kept statistics on the reading performance of various groups, national samples of African-American, Latino, and Native-American students have scored significantly lower than national samples of European-American students. In 1992, 1994, and 1998, high percentages of African-American, Latino, and Native-American students scored below the basic level, or the lowest achievement level, for grades 4, 8, and 12 (Campbell, Hombo, & Mazzeo, 2000). The performance of English language learners is difficult to ascertain because NAEP has not differentiated these students' scores from the national sample unless they have been in U.S. schools for less than two years and their teachers have judged them incapable of participating in the assessment because of their limited English proficiency. Students who fit in the latter category are required to participate in NAEP but with accommodations. Not surprisingly, their NAEP reading performance is significantly lower than that of their European-American counterparts and, on average, is below the basic level. According to the National Center for Education Statistics, dropout rates for African-American, Latino, and Native-American students are considerably higher than those of European-American students. Clearly, if we want to improve the literacy performance of all students, we must pay more attention to the literacy instruction and performance of those groups of students who have historically been poorly served by U.S. schools.

More research has focused on the reading processes of older English language learners (grades 3–7) than on younger children (García, 2000). English language learners, when compared with monolingual English speakers, typically have less background knowledge relevant to topics in English texts or tests, know less English vocabulary, and have some difficulty with questions that rely on background knowledge (e.g., García, 1991). Researchers who explored how English language learners were making sense of reading in both of their languages reported that it was important to differentiate students who were successful English readers from those who were less successful (e.g., Jiménez, García, & Pearson, 1996). The successful English readers had a unitary view of reading and used strategies and knowledge that they had acquired in one language to

approach reading in the other language. They also used bilingual strategies, such as cognates, paraphrased translating, code-mixing, and code-switching. The less-successful English readers did not use cross-linguistic transfer strategies and thought that they had to keep their two languages separate or they would become confused.

For younger children, various reading activities are differentially available. English language learners, regardless of the program in which they were enrolled, tended to receive passive, teacher-directed instruction of the sort that does not promote higher-order thinking or language development (Padrón, 1994; Ramirez, Yuen, & Ramey, 1991). Metacognitive and cognitive strategy instruction, such as reciprocal teaching and question-answer relationships, has shown promise with both English language learners and monolingual English speakers (see, e.g., Muniz-Swicegood, 1994).

We reiterate that when discussing group differences associated with race, second-language learning, and similar factors, research that emphasizes literacy processes at the level of the individual is not very illuminating unless we situate the individual's experience within the larger sociocultural and historical context (Buenning & Tollefson, 1987). Yet, the trend within literacy research has been to focus on the structural and formal properties of literacy, often seeing it as a technical problem that can be investigated without taking into account power relations and social practices (Wiley, 1996). When ethnic/racial and linguistic minorities are included in large-scale research, they often are part of a random sample, and specific information related to their actual literacy performance and improvement is not included in the data interpretation (García et al., 1994). At other times, projects have excluded these populations (Willis & Harris, 2000), erroneously generalizing to them the findings based on the experiences and instruction of European-American, middle-class, monolingual students. Given the discrepancy in literacy performance between the default monolingual European-American reader and readers from other ethnic/racial and linguistic groups, research efforts that specifically examine the literacy processes, performance, and engagement of students from diverse ethnic/racial and linguistic groups, and that take into account the larger sociocultural and historical contexts, are warranted.

### **Inter-Individual Differences**

Describing and attempting to explain inter-individual differences in reading outcomes have been by far the most common undertakings of reading researchers. Indeed, many of the advances in our understanding of early reading development have emerged from studies that took an individual differences perspective. A systematic analysis of individual differences in the capabilities

that relate to comprehension is a potential source of considerable insight about the process of comprehension.

**Preschool and Elementary School Readers.** Individual children vary in their reading comprehension abilities. Some of this variability, no doubt, reflects the procedures used to assess reading comprehension. However, variability in reader characteristics may also partially account for these differences. Thus, the differential development of a variety of capabilities and dispositions supporting reading comprehension may lead to patterns of relative strengths and weaknesses that are directly related to variations in reading comprehension abilities. Moreover, we have reason to believe that the relative contributions that different learner characteristics make to variability in reading comprehension ability change significantly during the course of reading development. For example, we know from research done over the past two decades that accurate and fluent (automatic) word recognition is a prerequisite for adequate reading comprehension and that language comprehension processes and higher-level processes affecting language comprehension (applying world knowledge, reasoning, etc.) do not become fully operative in comprehending text until the child has acquired such facility (Adams, 1990; Gough & Tunmer, 1986; Hoover & Gough, 1990; Perfetti, 1985; Stanovich, 1991; Sticht & James, 1984; Vellutino et al., 1991, 1994).

We also know that in learning to read in an orthography derived from an alphabet, the acquisition of facility in word recognition depends heavily on the acquisition of print concepts (printed words comprise letters, letters carry sound values, print proceeds from left to right, etc.), mastery of the alphabetic code, and oral language development, among other things, and that both word identification and alphabetic coding depend heavily on such phonological skills as phoneme awareness, name retrieval, and verbal memory. In fact, abundant evidence now shows that most children who have difficulty learning to read have deficient phoneme awareness and alphabetic coding skills and that such deficiencies are causally related to deficiencies in word recognition, spelling, and writing (Adams, 1990; Liberman, 1983; Snow et al., 1998; Vellutino, 1979, 1987).

There is also some reason to believe that deficiencies in vocabulary and oral language development can lead to deficiencies in the acquisition of word recognition and related phonological skills, especially in bilingual children and children from low-income families (Goldenberg, 2001; Dickinson & DeTemple, 1998; Snow, 1993; Snow, Barnes, Chandler, Goodman, & Hemphill, 1991; Strickland, 2001; Tabors & Snow, 2001; Vernon-Feagans, Hammer, Miccio, & Manlove, 2001; Whitehurst & Lonigan, 2001). However, recent observational and intervention studies have demonstrated that many such children are the victims of inadequate instruction, limitations in early literacy experience, or

both (see, e.g., Blachman, 1997; Dickinson & DeTemple, 1998; Dickinson & Sprague, 2001; Neuman, 1999; Neuman & Roskos, 1990, 1997; Roskos & Neuman, 2001; Snow et al., 1991; Torgesen, Wagner, & Rashotte, 1999; Vellutino et al., 1996).

At the same time, substantial evidence indicates that the reading problems of a very small percentage of beginning readers are due, in significant measure, to basic deficits in phonological skills not accounted for by limited experience or poor instruction (Torgesen et al., 1999; Torgesen, 2000; Vellutino et al., 1996). Finally, we know that phonological skills deficits can occur even in children who are intellectually capable and who are not generally impaired in learning. In fact, a great deal of convergent evidence now indicates that measured intelligence is not highly or reliably correlated with basic reading subskills, such as word identification and letter-sound decoding, although it is often found to be significantly and reliably correlated with measures of reading comprehension (Fletcher, Shaywitz, Shankweiler, Katz, Liberman, Steubing, Francis, Fowler, & Shaywitz, 1994; Siegel, 1988; Stanovich & Siegel, 1994; Vellutino, Scanlon, & Lyon, 2000). Thus, reader differences in the acquisition of word-level skills are the primary source of variability in reading comprehension in beginning and elementary school-age readers. And because long-standing reading difficulties inevitably lead to deficiencies in higher-level language skills and knowledge sources that depend heavily on proficient reading (Stanovich, 1986; Vellutino, Scanlon, & Tanzman, 1988; Vellutino, Scanlon, & Spearing, 1995), the importance of fluency in word recognition to reading comprehension cannot be underestimated.

However, we also know that fluent word recognition is a necessary but not sufficient condition for successful reading comprehension and that other variables that directly or indirectly influence language comprehension are also critically important determinants of variability in reading comprehension. These variables include (1) vocabulary and linguistic knowledge, including oral language skills and an awareness of language structures; (2) nonlinguistic abilities and processes (attention, visualization, inferencing, reasoning, critical analysis, working memory, etc.); (3) engagement and motivation; (4) an understanding of the purposes and goals of reading; (5) discourse knowledge; (6) domain knowledge; and (7) cognitive and metacognitive strategy development. The degree to which these components develop in an individual child or adult may well account, in part, for individual differences in the development of reading comprehension abilities. Thus, such variables may also be usefully targeted in research evaluating inter-individual differences in reading comprehension.

For example, evidence from research conducted with both children and adults indicates that individual differences in language comprehension and related skills, such as vocabulary knowledge and syntactic competence, account for

more of the variance in reading comprehension than do individual differences in word-level skills (i.e., word recognition and letter-sound decoding) in readers who have acquired enough facility in word recognition to comprehend in print what they would normally comprehend in spoken language (Bradley & Bryant, 1983; Curtis, 1980; Davis, 1944, 1968, 1972; Hoover & Gough, 1990; Neuman & Dickinson, 2001; Stanovitch, 1991; Sticht & James, 1984; Vellutino et al., 1991, 1994). There is also some evidence that individual differences in the awareness of linguistic structure (phonological awareness, syntactic awareness, pragmatic awareness, etc.) have an appreciable effect not only on the acquisition of word recognition skills but also on language and reading comprehension skills, especially in terms of the role that such awareness plays in comprehension monitoring (Tunmer, Herriman, & Nesdale, 1988). Thus, it is not surprising to find that individual differences in vocabulary knowledge, syntactic competence, and metalinguistic awareness, associated with neurodevelopmental and home background factors, are good predictors of literacy development and reading comprehension (Dickinson & DeTemple, 1998; Snow, 1993; Snow et al. 1991; Scarborough, 2001; Vellutino & Scanlon, 2001; Whitehurst & Lonigan, 2001). Moreover, deficiencies in one or more of these skills have been found to distinguish between good and poor comprehenders (Tunmer et al., 1988; Vellutino et al., 1991, 1994, 1996; Vellutino & Scanlon, 2001).

Similarly, the consistent finding across a broad age span that measures of intelligence tend to be strongly correlated with measures of language and reading comprehension (see Vellutino et al., 2000, for a recent review) provides strong evidence that intellectual skills such as reasoning, critical analysis, and inferencing ability are important sources of individual differences in reading comprehension. Thus, it is not surprising to find that measures of intelligence tend to distinguish between children who are skilled and less-skilled comprehenders, despite the fact that such measures do not reliably distinguish between children who are more- or less-skilled in word recognition and related phonological skills (Vellutino et al., 1996, 2000).

In the same vein, abundant evidence is available to show that individual differences in working memory are highly correlated with individual differences in language and reading comprehension (Baddeley, 1986; Baddeley & Logie, 1999; Cantor, Engle, & Hamilton, 1991; Daneman & Carpenter, 1980; Engle, Cantor, & Carullo, 1992; Engle, Tuholski, Laughlin, & Conway, 1999; Ericsson & Kintsch, 1995; Just & Carpenter, 1992). And although most of this work has been done with adults, some work has recently been done with children (see Swanson & Siegel, in press, and Vellutino, in press, for a review of this work). In general, the evidence suggests that individuals with a low working-memory capacity process language less effectively and are less effective comprehenders than individuals with high working-memory spans. The research with children is seminal, how-

ever, especially in terms of its implications for instruction, and more work needs to be done in this area.

A closely related area of inquiry is the study of individual differences in controlled and focused attention as it relates to skill in reading. Some researchers suggest that individual differences in maintaining controlled and focused attention are the primary source of individual differences in working-memory spans and, therefore, of individual differences in reading comprehension (Cantor et al., 1991; Engle et al., 1992, 1999; Swanson & Siegel, in press). However, this assumption is arguable (Ericsson & Kintsch, 1995; Vellutino, in press). That deficiencies in maintaining controlled and focused attention would have a deleterious effect on reading comprehension (and on the acquisition of skill in reading in general) seems a reasonable and valid assumption on its face, however. Some evidence supports this assumption (Shaywitz, Fletcher, & Shaywitz, 1995), but the relative contribution of attention deficits to deficiencies in reading comprehension remains to be further explored.

Another cognitive ability that might be an important source of individual differences in reading comprehension is the ability to visualize, especially as it relates to the use of illustrations and pictorial material as an aid to comprehension. Gyselinck and Tardieu (1999) reviewed the evidence for this relationship and generally concluded that a positive and reasonably strong correlation exists between the use of pictorial aids and comprehension. They point out, however, that individuals may differ in their ability to profit from such aids and suggest that the ability to visualize may be one source of such individual differences. The use of visual imagery as an aid to verbal memory has been extensively studied in both adults and children (e.g., Begg & Clark, 1975; Begg, Upfold, & Wilton, 1978; Paivio, 1971, 1986; Paivio & Begg, 1971; Pressley, 1977; Pressley & Miller, 1987; Vellutino & Scanlon, 1985; Vellutino et al., 1995). However, the research concerned with individual differences in visual-spatial ability as a determinant of variability in reading and language comprehension is seminal (e.g., see Reichle, Carpenter & Just, 2000; Hegarty, Carpenter, & Just, 1991; Mayer & Sims, 1994), and this also seems to be a useful area of inquiry.

Research documenting that a knowledge of linguistic discourse is an important source of individual differences in reading comprehension has a long history (Just & Carpenter, 1987; Mandler & Johnson, 1977; Stein & Glenn, 1979; Stein & Trabasso, 1981; van Oostendorp & Goldman, 1999), but most of this research has studied reading comprehension processes in adult skilled readers. Considerable research has focused on children's understanding of narrative text (Mandler & Johnson, 1977; Stein & Glenn, 1979; Stein & Trabasso, 1981), and some, but much less, work has studied children's understanding of expository text (Armbruster & Anderson, 1984; Taylor, 1985; see Graves & Slater, 1996, for a review). The available evidence suggests, however, that good comprehen-

ders better appreciate discourse structure than do poor comprehenders, and they more effectively use such knowledge than do poor comprehenders.

Using cognitive and metacognitive strategies as an aid to reading comprehension also has a long history, and some research evidence indicates that good comprehenders are inclined to use such strategies more often and more effectively than poor comprehenders (e.g., Palincsar & Brown, 1984; Pearson & Fielding, 1991; Pressley, 2000; Tierney & Cunningham, 1984). This research also suggests that such strategies can be effectively taught and that their use will improve reading comprehension. In addition, there is some reason to believe that intervention that fosters the use of strategies—such as comprehension monitoring, use of linguistic context, and other meaning-based devices—to aid understanding (e.g., pictorial clues) will facilitate the acquisition of word recognition and phonological decoding skills as well as reading comprehension skills (Pinnell, Lyons, DeFord, & Bryk, 1994; Tunmer et al., 1988; Vellutino & Scanlon, *in press*). Thus, it seems that the role that cognitive and metacognitive strategies play in accounting for individual differences in acquiring both word-level and comprehension skills is worth additional study.

That engaged and intrinsically motivated children will become more proficient readers than less engaged and less intrinsically motivated children is a truism that generalizes across advantaged and disadvantaged populations and is supported by abundant evidence (e.g., Guthrie, Cox, Anderson, Harris, Mazzoni, & Rach, 1998; Guthrie, Van Meter, et al., 1998; Guthrie, Wigfield, & VonSecker, 2000; Snow et al., 1991; Strickland, 2001; Sweet, Guthrie, & Ng, 1998).

Motivated and engaged readers are also purposeful and goal-directed readers. The same research supports the generalization that purposeful and goal-directed readers become better comprehenders than less purposeful and less goal directed readers. Moreover, engaged, motivated, purposeful, and goal-directed readers also acquire more knowledge than those who are less engaged, less motivated, less purposeful, and less goal directed. Some of the most impressive research supporting this generalization comes from studies comparing individuals having high and low degrees of domain knowledge in given areas (knowledge of baseball, football, soccer, etc.). These groups were compared on measures evaluating comprehension of texts describing events in their area of expertise as well as on measures evaluating memory for factual information presented in these texts, while varying such relevant factors as verbal ability, reading ability, and IQ (e.g., Schneider, Koerkel, & Weinert, 1989; Recht & Leslie, 1988; Walker, 1987; Yekovich, Walker, Ogle, & Thompson, 1990). The common finding among these studies is that individuals having a high degree of knowledge in a given domain performed at a higher level on these measures than individuals having a low degree of knowledge in that domain, regardless of their aptitude in the other areas assessed. Such findings also underscore and support

the important role played by individual differences in acquired knowledge—both world knowledge and domain knowledge—in accounting for variability in reading comprehension.

However, much more remains to be learned about the relationship between and among these different capabilities and dispositions on the one hand and the acquisition of skill in reading on the other. For example, a child's motivation to engage beginning reading as an academic enterprise and his or her success in doing so seem to be related to the child's initial preparedness for reading in terms of home background and emergent literacy skills, as well as to reading-related cognitive capabilities that set constraints on success in beginning reading. Similarly, a child's motivation to engage beginning reading and to sustain efforts in the interest of becoming a proficient reader seems to be related, in no small way, to the quality of reading instruction to which the child is exposed during both the beginning and the advanced stages of reading development. Obviously, instruction that capitalizes on the child's inherent interest and surrounds him or her with high-interest and readable materials (i.e., materials at the child's level of proficiency) appears to be more effective than instruction that does less; evidence supports this assertion (e.g., Hiebert & Martin, 2001; Morrow & Gambrell, 2001). Thus, research evaluating the relative contributions made by individual capabilities and dispositions to variability in reading comprehension at different phases of reading development is greatly needed.

**Adolescent Readers.** As with younger children, the differences in adolescent readers' motivation to read and their engagement with subject matter texts, broadly defined—for example, social studies textbooks, geologic maps, Internet sites, videos, magazines, and photographs—depends on a number of factors. Chief among these is the adolescent's perception of how competent he or she is as a reader. In adolescence, as in earlier and later life, it is the belief in the self (or the lack of such belief) that makes a difference in how competent the individual feels (Pajares, 1996). Providing adolescents who are experiencing reading difficulties with clear goals for a comprehension task and then giving feedback on the progress they are making can lead to increased self-efficacy and a greater use of comprehension strategies (Dillon, 1989; Schunk & Rice, 1993). As well, creating technology environments that heighten students' motivation to become independent readers and writers can increase their sense of competency (Kamil, Intrator, & Kim, 2000). The research is less clear, however, on the shifts that occur in students' motivation to read over time. Although decreases in intrinsic reading motivation have been noted as children move from the elementary grades to middle school, explanations vary about the cause, with a number of researchers attributing the decline to differences in instructional practices (Eccles, Wigfield, & Schiefele, 1998; Oldfather & McLaughlin, 1993).

A second determining factor in how adolescents respond differently to different subject matter texts lies in their ability to comprehend information that is new or that conflicts with their prior knowledge. Not all adolescents enter their middle and high school years with effective strategies for comprehending large chunks of text over relatively short periods of time. Nor do they possess adequate background knowledge and technical vocabularies for comprehending their assignments, although the importance of vocabulary knowledge to subject matter comprehension has been recognized since the 1920s (Whipple, 1925).

Research on vocabulary knowledge is best interpreted conditionally. It seems likely, for example, that for readers with reasonably well-developed background knowledge who are reading text with a large number of unfamiliar words, knowledge of words *per se* may be the most significant problem. If these same readers read a text with only a few unknown words, their ability to make inferences about word meanings might be a more important factor than their word knowledge. If, however, this same text involved culturally unfamiliar material or a topic of little interest to the reader, comprehension might again be difficult. We therefore believe that research is called for that examines how the relationship between vocabulary knowledge and reading comprehension depends on specific conditions, including the type of reader, type of text, proportion of unfamiliar words, their role in the text, and the purpose for reading or the outcome being considered. Because the relationship between word knowledge and conceptual knowledge is more variable among second-language readers, it is especially important to examine the contributions and interactions of these two types of knowledge for such readers.

Adolescents who fall behind in their course work are typically described as being “at-risk” of dropping out of school or, more recently, as “struggling readers” (Moore, Alvermann, & Hinchman, 2000). The struggling reader label is a contested term and one that means different things to different people. It sometimes refers to youth with clinically diagnosed reading disabilities as well as to those who are English language learners, underachieving, unmotivated, disenchanted, or generally unsuccessful in school literacy tasks that involve print-based texts. As such, these labels tell very little about the reader, although they do suggest ways of thinking about culture and adolescents who, for whatever reason, are thought to be achieving below their full potential as readers.

The research on struggling readers covers a broad spectrum and varies in specificity according to the perceived reasons for the struggle. For example, reviews of research that take into account individuals with clinically diagnosed reading disabilities (Shaywitz, Pugh, Jenner, Fulbright, Fletcher, Gore, & Shaywitz, 2000) focus on the cognitive basis for the struggle. Reviews of second-language reading, in contrast, encompass a much wider view of the reasons behind the struggle. In fact, the difficulties that English language learners expe-

rience are often spread over a vast array of sociocultural, motivational, and linguistic factors that vary with the population being studied (Bernhardt, 2000). These same factors are often manifested in the difficulties that monolingual adolescents experience when a reading problem is present. In their critique of culture as a disabling agent, McDermott and Varenne (1995) argue that society (for the problem does not lie solely with schools) *makes* struggling readers out of some adolescents who for any number of reasons have turned their backs on a version of literacy called school literacy.

A third factor contributing to inter-individual differences among adolescent readers has to do with their access to (and ability to use) new information communication technologies. The Internet figures prominently in the lives of American youth, particularly suburban youth (Barton, Hamilton, & Ivanic, 2000; Beach & Lundell, 1998). According to a phone survey of 754 teenagers and 754 of their parents reported by the Pew Internet and American Life Project in conjunction with a weeklong online discussion-group study conducted by the research firm Greenfield Online (Lenhart, Rainie, & Lewis, 2001), 17 million youths between the ages of 12 and 17 use the Internet. This number represents 73 percent of the young people in that age bracket. Moreover, close to 13 million adolescents use instant messaging (with one-quarter of that number saying that they pretend to be different people when online).

That literacy is reinventing itself through new digital technologies (Luke & Elkins, 1998; Moje, Young, Readence, & Moore, 2000) has enormous implications for how we view inter-individual differences among adolescents at the middle and high school levels (de Castell, 1996). Researchers working within a qualitative paradigm have found patterns in their data to suggest that adolescents who appear most at risk of failure in the academic literacy arena are sometimes the most adept at (and interested in) understanding how media texts work—in particular, how meaning gets produced and consumed. For example, O'Brien (1998, 2001) found in a four-year study of working-class adolescents deemed at risk of dropping out of high school that students were quite successful in producing their own electronic texts, such as multimedia documentaries, and critiquing media violence by using multiple forms of visual texts. Working alongside the students and their teachers in what came to be called the Literacy Lab, O'Brien observed that by not privileging print over other forms of literacy, the students appeared capable and literate. This finding is similar to one that Alvermann and her colleagues (Alvermann, Hagood, Heron, Hughes, Williams, & Jun, 2000) reported for their after-school study of 30 adolescents who participated in a 15-week Media Club project. Although the participants had scored in the lowest quartile on a standardized reading achievement test, they capably demonstrated their critical awareness of how a variety of popular media texts represented people, ideas, and events. They also engaged

in literacy practices of their own choosing (what they called their “freedom activities”), which included searching the Internet for song lyrics, producing hair and fashion magazines, e-mailing knowledgeable others to obtain information on favorite rap groups, and so on. Activities such as these, along with numerous other examples in *Intermediality: The Teachers’ Handbook of Critical Media Literacy* (Semali & Pailliotet, 1999), point to young people’s interest in working with diverse symbol systems and their ability to be critical consumers, as well as producers, of multiple forms of text.

When multimedia texts offer text with visual and verbal information, the extant research on multimedia processing offers some guidelines for how information can be presented more effectively. According to a dual code theory of information processing (Paivio, 1986), visual information and verbal information are processed in separate codes. Thus, multimedia information that is processed both verbally and visually is hypothesized to be more memorable because there are two memory traces instead of one. In fact, some empirical research supports a dual coding hypothesis with multimedia information (Mayer, 1997; Mayer & Moreno, 1998; Plass, Chun, Mayer, & Leutner, 1998).

How prior knowledge influences learning with multimedia information is an important variable that has significant implications for evaluating and selecting appropriate texts for children. Balcytiene (1999) found that low-prior-knowledge students benefit from hypermedia more than high-prior-knowledge students in his research with college students’ improvement in recognition task scores. Correspondingly, in a review of six studies with multimedia instruction, Mayer (1997) also found that learners with low prior knowledge performed better with multimedia. In contrast, Lawless and Kulikowich (1996) found that students who did not have enough relevant domain knowledge had difficulties with hypertext comprehension; they also found significant relationships among domain knowledge, strategy knowledge, and measures of recall.

Given the conflicting findings, it appears that the interaction of prior knowledge and subsequent learning from hypertext is also influenced by other task and learner variables. In a study with grade 2 children, Shin, Schallert, and Savenye (1994) found a significant interaction with learner control and the degree of prior knowledge the learner had, suggesting that low-prior-knowledge students would be more successful within a more limited learner-control environment.

This preliminary study holds important ramifications for the selection of multimedia documents for children, suggesting that children who have low subject matter expertise should have multimedia text with fewer user-controlled options for hypertext navigation and browsing. It also points out the importance of having a developmental perspective when considering the influence of dimensions of individual differences. Collectively, these studies underscore the

importance of considering the learner's domain knowledge when selecting multimedia documents for a particular student. For example, in comparing multimedia with traditional text, Kozma (1991) notes how the transient nature of multimedia information versus the stability of regular text could pose more of a problem for novice and low-domain-knowledge students.

With respect to the special case of reading texts with hyperlinks, students may need additional strategies for proficient reading and navigation. Hypertexts, or electronic texts that include links to additional information or content, demand special skills for monitoring comprehension—the timing and navigation of links to prevent problems such as disorientation or distraction. In addition, children who are accustomed to reading linear documents may become confused or distracted by following links incorporated within the text of documents. Preliminary research has identified the potential role of strategy use in accounting for differential reading outcomes. The use of specific strategies—such as being able to identify important text nodes and read them longer (Gillingham, Garner, Guthrie, & Sawyer, 1989), being a self-regulated reader (Balcytiene, 1999), and using a variety of learning strategies (Davidson-Shivers, Rasmussen, & Bratton-Jeffery, 1997)—helped students' performance on various tasks.

### **Intra-Individual Differences**

The topic of intra-individual differences has been somewhat underemphasized in research on reading, although practitioners are well aware of the degree to which a child's apparent reading proficiency can be influenced by the nature of the text being read or the activity being engaged in. We explore variability within readers in part because this topic offers insights for designing instruction.

**Preschool, Primary, and Elementary Grades.** Students differ from one another in how diverse their reading competencies and interests are. For example, some students read stories frequently and are expert in story comprehension, whereas they rarely read electronic text and are not highly competent with computers. However, other students may be competent with computer and Internet reading, whereas they are not proficient in interpreting written stories. These intra-individual differences are not well represented on current measures of reading comprehension and are seldom used productively in instruction. Moreover, intra-individual variability in the acquisition of reading competencies can be observed during each phase of reading development and is sometimes manifested in the uneven development of important skills and subskills that underlie proficient reading.

To illustrate, during the beginning phases of reading development, when children are acquiring basic word recognition, phonological (letter-sound) decoding, and text-processing skills, it is not uncommon to find significant imbalance in the acquisition of one or another of these skills in a given child, to the detriment of that child's progress in becoming a proficient, independent, and motivated reader (Vellutino et al., 1995; Vellutino & Scanlon, in press). This type of imbalance is, in most cases, a by-product of such important influences as home literacy experiences, the child's instructional program, or the particular way the child conceptualizes reading. Thus, one child may have a strong and growing sight word vocabulary and strong text-processing skills (comprehension monitoring, use of context, knowledge of story grammar, etc.), but little or no ability to use phonological decoding skills to help identify unfamiliar words encountered in text. Another child may have strong phonological decoding skills but a limited sight vocabulary and weak text-processing skills; as a result, this child is destined to become a letter-by-letter, word-by-word reader with a limited ability to comprehend what he or she reads. And still another child may have a strong sight vocabulary and strong phonological decoding skills but weak text-processing skills, as manifested in a limited sense of story structure; a limited sense of the pragmatic relations embedded in the text; little or no tendency to monitor understanding; and little or no use of semantic, syntactic, or pictorial clues to aid word identification and text comprehension. Such a child is also destined to become a word-by-word reader with little ability to comprehend what he or she reads. Thus, despite strengths in one or another aspect of reading, a child with weaknesses in one or more of the aforementioned reading sub-skills will have difficulty becoming a fluent and proficient reader. The goal of the practitioner must, therefore, be to assess and correct such weaknesses, while capitalizing on the child's strengths to facilitate growth in reading.

Of course, intra-individual differences in capabilities other than word recognition and rudimentary text-processing skills may also set limits on the child's growth in reading. They may also affect appreciably the child's ability to acquire knowledge in areas that depend, to some extent, on reading. For example, despite having adequately developed word recognition and phonological decoding skills, the child with limited vocabulary knowledge or limited world knowledge will have difficulty comprehending texts that presuppose such knowledge. Similarly, given the important role played by extensive and diverse reading in acquiring vocabulary knowledge, in encountering and representing the more abstract and more complex syntactic structures, and in acquiring a broad-based knowledge of discourse structure (Olson, 1977, 1994; Watson & Olson, 1987; Watson, 2001), the child who does little independent reading, and who is not motivated to read extensively and diversely, will be ill equipped to engage and profit from the broad array of expository and technical texts encountered in school learning, even if he or she has no basic intellectual deficits or basic

deficits in reading or oral language development. Further, the child who has not acquired the cognitive and metacognitive strategies and study skills necessary to use reading as an instrument of learning will undoubtedly profit less from reading in a given domain than the child who has acquired these skills, along with the disposition and tenacity to use them, even if the two children have comparable reading and oral language skills (Palincsar & Brown, 1984; Pearson & Fielding, 1991; Pressley, 2000; Tierney & Cunningham, 1984). The child who is not motivated to acquire knowledge in a given domain or to engage the school curriculum and school learning at large, will not acquire much knowledge in any given domain and will not profit much from school learning in general.

These influences, either separately or in some combination, may be partly responsible for Venezky's (1998) finding, in a recent analysis of Slavin's Success for All intervention program (Slavin, Madden, Karweit, Dolan, & Wasik, 1992), that the reading comprehension scores of disadvantaged children who were graduates of this program were substantially below national normative standards, despite the fact that their scores on measures of word-level skills (word recognition, letter-sound decoding) were comparable to national standards. They may also be responsible, to some extent, for the well-known fourth-grade slump so often observed in the educational community, although alternative explanations, such as inadequacy of vocabulary knowledge, have also been proposed (Meichenbaum & Biemiller, 1998).

On the positive side, the tenacious and inquisitive child with basically strong intellectual skills, a high degree of intrinsic motivation to become a good student, strong study skills, and a positive and goal-directed attitude toward reading and school learning may acquire a level of proficiency in reading and writing that will allow him or her to become a good student, despite inherent limitations in reading-related linguistic abilities that make it difficult for that child to acquire the full range of literacy skills. Similarly, the child with a high degree of interest in gaining knowledge and expertise in a given domain (e.g., sports, wildlife, theater, computers) may acquire through reading and other vehicles a higher degree of knowledge and expertise in that domain than the child who has little interest in the domain, even if the former child has less intellectual, oral language, or reading ability than the latter child (Schneider et al., 1989; Recht & Leslie, 1988; Walker, 1987; Yekovich et al., 1990). Conversely, the child who has wide ranging and diverse interests, but little motivation and tenaciousness for acquiring a high degree of expertise in a given domain, is likely to acquire a substantial amount of world knowledge and perhaps a large number of facts (the proverbial "master of trivia"), but is unlikely to become an expert performer in any given domain.

Finally, the child who has strong capabilities and dispositions in most or all of the areas that contribute to variability in reading comprehension has the po-

tential to become a proficient reader and successful achiever, provided that other important factors influencing achievement are favorable.

The challenge for researchers and practitioners alike is to acquire the means for assessing these intra-individual differences—that is, patterns of strengths and weaknesses—of the child. They must also develop instructional techniques and formats to help the child correct or compensate for weaknesses or limited interests in given domains, while using strengths and high-interest domains as the springboard for acquiring proficiency in reading and becoming an engaged, motivated, and successful student in the later grades.

**Adolescent Readers.** All the various issues we raised about the sources of inter-individual variability in adolescent readers could be recapitulated under the heading of intra-individual differences. Thus, domains of particular interest associated with varying degrees of engagement can lead adolescent readers to perform with much greater comprehension when reading about some topics than others. Further, patterns of strength or weakness in the domains of word-reading accuracy, fluency, comprehension strategies, vocabulary, domain knowledge, and so on can lead to performances that vary as a function of the characteristics of the text and of the task being engaged in. Little research directly addresses the issue of intra-individual differences in the adolescent reader; this clearly is a topic that needs more attention.

## VARIABILITY IN TEXT

Understanding variability in the text dimension requires paying attention to several components and levels of the text being read and to what it affords to the reader trying to construct a representation of that text. The processes of reading and post-reading presumably have some connections to elements and features of the text. Vocabulary and syntax have traditionally been recognized as text attributes that have a strong effect on comprehension. However, researchers in discourse have identified text features that are linked to the content, mental models, pragmatic communication, discourse structure, and genre of the text. All of these levels are construed from the perspective of the sociocultural context of the readers and participants in the learning environment. Further, it is important to realize that particular features of the text create difficulty for particular readers engaged in particular activities; texts are not difficult or easy in and of themselves, but they become difficult or easy at the interface with readers and the purpose of the activity (see Figure 2.1 in Chapter Two).

Language and discourse researchers have identified the following general levels of text representation (Graesser, Millis, & Zwaan, 1997; Kintsch, 1998): the surface code (vocabulary and syntax), the propositional text base (explicit meaning of the content), the mental model (deeper referential content), pragmatic

communication, and discourse structure and genre. The *surface code* consists of the exact wording and syntax of the sentences. The *propositional text base* contains explicit propositions in the text (i.e., statements, idea units) in a stripped-down form that preserves the meaning, but not the verbatim surface code. The *mental model* (or what is sometimes called the situation model) is the referential microworld of what the text is about; it contains the people, setting, states, actions, and events that are either explicitly mentioned or inferentially suggested by the text. The *pragmatic communication* level refers to the exchange between the speech participants, between the reader and the writer, or between the narrator and the audience. Sometimes this level is not manifested directly in the text, but at other times it is explicit (e.g., “The purpose of this article is to persuade you to . . .” or “This manual will show you how to assemble your bookshelves”). *Discourse structure and genre* are the rhetorical structure of the discourse as well as the category of discourse, such as narration, exposition, persuasion, and so on. Each level is discussed below.

### Surface Code: Vocabulary

The vocabulary load of a text has repeatedly been demonstrated to be a powerful predictor of the comprehensibility of the text (Freebody & Anderson, 1983). Readability research has consistently identified two factors, one representing vocabulary load or difficulty and one representing syntactic complexity, with the first having the greater loading (Klare, 1974–75, 1976). The data linking vocabulary and text difficulty are predominantly correlational, and readability formulas have been rightly criticized as being inadequate either as causal explanations of text difficulty or as guidelines for text revision (e.g., Davison & Kantor, 1982). Nevertheless, as we discuss elsewhere in this report, under some circumstances, vocabulary per se can be a source of comprehension difficulty.

### Surface Code: Syntax

Sentences are segmented into phrases that are structurally related systematically. The effect of syntax on sentence processing has a long history in psycholinguistics (Fodor, Bever, & Garrett, 1974; Mitchell, 1994). Sentences with complex syntax may present comprehension problems or a high load on working memory. This occurs when a sentence is embedded, dense, ambiguous, or ungrammatical. Some of the problematic syntactic constructions are highlighted below.

1. *Left-embedded syntax instead of right-branching syntax.* Sentences with left-embedded syntax occur when many clauses, prepositional phrases, and qualifiers are encountered before the main verb of the main clause: “The processing of left-branching utterances which are characterized, for exam-

ple, by relative clauses modifying the subject can, especially for young or unpracticed readers, pose great difficulty.” Such sentences are difficult because the respondent needs to hold a large amount of partially interpreted code in memory before he or she receives the main proposition.

2. *Dense clauses.* Sentences with a syntactically dense clause pack too many higher-level constituents or idea units (i.e., propositions) within a single clause. Readers need to have a high analytical ability to unpack the various idea units. An example is the following question on a U.S. Census questionnaire: “Approximately how many miles was it one way to the place you hunted small game most often in this state?” It may facilitate comprehension to break up the single clause into multiple independent clauses. A dense clause, sentence, or question has a high ratio of propositions or higher-level syntactic constituents per word. Oral language has a simpler syntax than printed text (Chafe & Tannen, 1987), typically with only one new idea per intonation unit (roughly a clause). In contrast, the language of print packs many new idea units into a clause and thereby overloads working memory. Thus, it can simplify comprehension challenges if writers write the way they talk.
3. *Dense noun-phrases.* A dense noun-phrase has too many adjectives and adverbs modifying the head noun: “The regular monthly or quarterly mortgage payment.”
4. *Structural ambiguity.* Ambiguous syntactic structures occur when two or more syntactic structures can be assigned to a sentence. For example, the following question from a U.S. Census survey is structurally ambiguous in a number of ways: “Is this house or apartment owned by you or someone in this household with a mortgage or loan?”
5. *Garden path sentences.* In “garden path” sentences, the respondent starts out assigning one syntactic structure to a sentence, but eventually realizes that the structure is wrong and has to reinterpret the syntactic structure. The following is an example of a garden path question: “Did you know the owner of the apartment sold the property?” This garden path question can be disambiguated with the word *that* to signal the existence of a complement clause: “Did you know that the owner of the apartment sold the property?”
6. *Complex Boolean expressions.* These sentences have a high density of logical operators: *or*, *and*, *not*, or *if-then*. Disjunctions (expressions with *or*) quickly impose a load on working memory because the respondent needs to keep track of different options and possibilities. The following question illustrates this: “At the time of the incident, were you covered by any medical insurance, or were you eligible for benefits from any other type of health benefits program, such as Medicaid, Veterans Administration, or Public Welfare?”

## Propositional Text Base

The text base captures the meaning of the explicit propositions and includes the necessary bridging inferences that the respondent needs to connect the explicit propositions (van Dijk & Kintsch, 1983; Kintsch, 1998). The text base is a propositional code that preserves the arguments (nouns, pronouns, embedded propositions) and the predicates (main verbs, adjectives, connectives), but not the more subtle details about verb tense and aspect and about deictic references (*here, there, now, then, this, that*). Examples of propositions follow: The cam is between the cylinder and the spring [*between* (cam, cylinder, spring)]; the singer repaired the computer [*repair* (singer, computer)]; and if the cam rotates, the spring contracts [*if* (rotate [cam]), (contract [spring])]. The most common method of scoring text-recall protocols is to segment the text into proposition units and to score the proportion of these units that are recalled correctly.

## Mental Model

The mental model (or situation model) is a deeper conceptual depiction of what the text is about (Graesser et al., 1997; Johnson-Laird, 1983; Mayer, 1992; van Oostendorp & Goldman, 1999). Researchers have analyzed the contents of the mental models in expository texts in great detail. Some of the common types of referential content follow:

- *Class inclusion.* One concept is a subtype or subclass of another concept. For example, a Pentium is a computer (is a device).
- *Spatial layout.* Spatial relations exist among regions and entities in regions. For example, a pin is in a cylinder (is in a lock). A spring surrounds a rod.
- *Compositional structure.* Components have subparts and subcomponents. For example, a computer has (as parts) a monitor, a keyboard, a central processing unit, and memory.
- *Procedures and plans.* A sequence of steps or actions in a procedure accomplishes a goal. An example would be the steps in removing the hard drive in a computer.
- *Causal chains and networks.* An event is caused by a sequence of events and enabling states. An example is the sequence of events that lead to a polluted lake.
- *Agents.* These are organized sets, such as people, organizations, countries, and complex software units. Examples are organizational charts and client-server networks.

- *Others*. These include property descriptions, quantitative specifications, and rules.

We note, once again, that some aspects of the mental model are directly captured by elements and features in the text, whereas other aspects are inferred by the reader during comprehension.

A mental model may also include a more formal representation of the problem (Nathan, Kintsch, & Young, 1992), a level that takes into account the formal (mathematical) relations that exist between the elements described in the statement of a problem. In addition to everyday general world knowledge, there needs to be scientific and mathematical knowledge on the relations between the variables in the problem. Thus, a student may create an appropriate mental model of the entities and events in the text, but still be incapable of translating this into scientific concepts and principles.

Regarding coherence *between* levels, there needs to be a mapping between the elements of the representation at one level and the elements at another level. For example, the surface code has words and syntactic patterns that signal content features at the level of the situation model. Comprehension suffers when the surface code and the mental model clash. If the text stated that “the key is turned after the cylinder rotates,” there would be a discrepancy between the order of events in the situation model (the key is turned *before* the cylinder rotates) and the surface code (clause X *after* clause Y).

### Pragmatic Communication

The communication level captures the pragmatic context that frames the messages in the text (Beck, McKeown, Hamilton, & Kucan, 1997; Graesser, Bowers, Olde, & Pomeroy, 1999; Nystrand, 1986; Rosenblatt, 1978/1994; Schraw & Bruning, 1996). Simply put, who is communicating to whom? What author is talking to what reader? Is there a narrator communicating to an addressee? For example, the text about a dishwasher would be composed quite differently for readers trying to repair a dishwasher, those trying to assemble a new dishwasher, and for those deciding which dishwasher to purchase. A good technical writer anticipates whether the reader will be a repairman, an assembler, or a potential customer. The writer crafts the texts for these different purposes, and these differences are reflected in the textual features.

### Discourse Structure and Genre

Discourse analysts have proposed several classification schemes, called genres, that are organized in a multilevel hierarchical taxonomy or in a multidimen-

sional space (Biber, 1988). Some examples of text genres at a basic level of classification are science textbooks, literary novels, repair manuals, comic books, and science fiction novels. The traditional general categories are narration, exposition, persuasion, and description (Brooks & Warren, 1972). We can imagine a detailed fine-grained typology of text genre. A rich literature on the composition and comprehension of narrative texts includes research on story grammars (Mandler, 1984) and on the construction of the point/moral/themes of stories (Williams, 1993). We currently have very little understanding about students' awareness of discourse genre for expository texts. Meyer & Freedle (1984) and Chambliss (in press) have investigated the rhetorical composition of several subclasses of expository texts, such as problem+solution, claim+evidence, compare-contrast, definition+example, and so on.

Discourse structure is the rhetorical organization of a text that coherently connects text elements and constituents and that relates the content to the messages of the author. Discourse structure includes text genre, the distinction between given (old) and new information in the discourse context, the points (main messages) that the author intends to convey, the topic structure, the pragmatic goals or plans of the communicative exchange, and the function of the speech acts (e.g., assertion, question, directive, evaluation). Discourse knowledge builds on linguistic knowledge but is distinct from it.

## VARIABILITY IN ACTIVITY

In this section, the three types of variability in the reading comprehension activity—variability in purpose, variability in operations, and variability in consequences—are examined in depth.

### Purpose

When most adults read, the purpose organizing the activity is the reader's purpose. In instructional activities, there are imposed purposes that may or may not penetrate to the consciousness of the learner. Indeed, some teacher-imposed purposes may conflict with the purposes that some children, in particular those from certain social and cultural groups, bring to the reading activity. Further, teacher-imposed purposes may be relatively limited (read this text to answer this question) or more dynamic (read this text to learn something novel from it) or even long term (read this text to apply and practice a newly learned strategy). Teachers can also construct authentic purposes for reading that students enthusiastically adopt, such as reading for writing (Horowitz, in press), reading for presentation (Schank, 1999; Bransford, Goldman, & Vye, 1991; Bransford, Brown, & Cocking, 1999), and reading to support long-distance

communication (Leu, 1994). Various teacher-defined purposes relate to the organization of instructional contexts for reading.

Although this is not an exhaustive list, the dimensions of variability in instructional contexts that may be relevant for the activity of reading include the following:

- *Unit focus.* Instruction that focuses on reading individual words or brief sentences obviously provides less scope for comprehension instruction than activities that take longer texts as the unit of relevance.
- *Teacher-defined task.* During comprehension instruction, teachers may define the task for the student as one of recovering specific information (read this passage and then answer detailed questions), one of constructing the main idea, one of analyzing, and so on. These various imposed purposes create varying opportunities to learn from the specific text and to learn about comprehending texts more broadly.
- *Teacher goals, expectations and epistemological beliefs.* It is well known from studies of grouping that teachers define different goals for different groups of students. When the varying goals come from assessment-based data about students' greatest instructional needs, of course they are highly appropriate. When they are based on depressed expectations about the capacities of groups of children, however, they can generate instruction in which very simple purposes for reading are defined, such as finding particular words or answering low-level questions.
- *Curriculum.* Curricula define to a large extent the reading purposes, by virtue of structuring activities for teachers.
- *Grouping.* Purposeful and flexible grouping, such as that used in Success for All (Slavin et al., 1992), creates different short- and long-term purposes for readers in different groups. Such grouping strategies work well if the instruction indeed becomes more efficient so that all readers move into the higher-level groups where more challenging purposes can be formulated.
- *Pacing.* Setting the pace for reading instruction is an important ingredient in priming students for success in reading. To some extent, pacing depends on the fluency of individual students. Striking a balance between keeping students challenged by teaching advanced reading skills and ensuring that all students have the appropriate level of fluency to handle the demands of new lessons is a routine part of skillful teaching.
- *Coverage.* Especially when teaching reading in the content areas, teachers should carefully plan how much material to cover on a particular topic. Factors they should consider when making judgments about the scope of

coverage include concept complexity, specialized vocabulary, and the depth of understanding they expect students to achieve. They should teach comprehension strategies that foster deep understanding of relevant content matter and give students ample opportunities to employ them.

- *Setting.* Common differences between the purposes of electronic and paper texts emerge. Much reading on the Internet, for example, involves scanning in search of specific sorts of information. It would be inefficient to use the same deep comprehension strategies during that phase of electronic text reading as during the reading of an assigned content area text.

Of course, these dimensions of variability in purpose and related organizational factors are in themselves determined by other factors, many of which are known to relate to reading comprehension outcomes as well. For example, we know that reading instruction in schools serving poor children is likely to be more exclusively skill focused and to incorporate less focus on text interpretation (Allington & McGill-Franzen, 1989; Nystrand, 1990). Schools serving poor children are much less likely to have lengthy texts widely available in classrooms, and instruction in such schools is more likely to require students to read and write single words and brief texts than longer units (Duke, 2000). High-stakes assessments that are limited to low-level competencies, low-inference items, and forced-choice questions may influence teachers to de-emphasize higher levels of comprehension in their instruction. Some schools and school systems have extremely rich electronic environments for reading activities, whereas others either have no computers available or have computers but only low-level practice-oriented software.

Comprehension instruction varies with the age and the reading level of the learner. Children just starting to learn the alphabetic principle benefit from activities that elicit and model the comprehension of texts read aloud (Beck & McKeown, 2001), whereas for more advanced readers, instruction in strategies for comprehending texts they themselves read can be helpful (NRP, 2000). Instruction focused on capacities related to comprehension, such as vocabulary and oral language production, is also rare in preschool and primary grades and is largely ineffective in the later grades (Meichenbaum & Biemiller, 1998; Morrison, Jacobs, & Swinyard, 1999; Stahl & Fairbanks, 1986). Many have argued that explicit attention to oral language development and vocabulary in the preschool and primary grades constitutes a crucial aspect of comprehension instruction (Whitehurst & Lonigan, 2001); although we know that older readers also benefit from aural exposure to rich text (Stahl, Richek, & Vandevier, 1991), it is unclear whether there are advantages to aural versus literate exposure for children who themselves can read the text.

These dimensions of variability can to some extent be seen as the product of higher-level factors influencing the organization of schools and of instruction, such as the following:

- *Age of child.* Reading instruction for primary school children tends to focus on word-reading skills. As children get older, those who have mastered word reading may well enter instructional contexts where a greater focus on comprehension instruction is possible, but all do not have access to such contexts.
- *Stakes.* The nature of the accountability system in place, and of the specific assessment instruments used, can affect contexts for instruction by narrowing or broadening the curriculum and by directing instructional attention to particular purposes, consequences, and response formats.
- *Information about children.* Teachers vary enormously in the degree to which they have access to and make sensible use of information about children's reading abilities. Such differences can influence how much they can individualize instruction to address particular children's areas of strength and weakness.
- *Demographics.* Lower-level and more exclusively skill-focused instruction is more likely to take place in schools serving low-income children (Allington, 1983; Nystrand, 1990). Further, English language learners, regardless of the type of program in which they are enrolled, tend to receive passive, teacher-directed instruction of the type that does not promote higher-order thinking or language development (Padrón, 1994; Ramirez et al., 1991).
- *Environment.* The environments in U.S. classrooms vary enormously in the availability of resources that might promote comprehension activities. Aspects of those environmental differences that might particularly influence comprehension include the availability of a wide variety of texts, access to electronic media, and the availability of intervention for children who fail to make adequate progress.
- *Curriculum.* Although the curriculum in some schools is under the control of the teacher, in others it is largely dictated by the principal or the superintendent. Reading curricula, but also mathematics, science, and social studies curricula, provide varying levels of opportunity for teachers to engage in instruction that promotes comprehension and the acquisition of comprehension skills.

## Operations

The operations engaged in during reading activity consist of cognitive processes and procedures that extract information from the text and construct meaningful representations. These processes reflect the constraints of the text, the context, and the reader. Some of these operations become automatic through extensive learning and practice, so they consume very few attentional resources and little consciousness. For example, the operations of written-word decoding, lexical access, and syntactic parsing become automatic in proficient readers. Other operations are more deliberate processes that demand attention and consciousness, such as constructing a mental model and generating some classes of inference. This section identifies operations during reading that are needed for comprehension to be successful.

**Attention.** As with any cognitive task, adequate reading comprehension implies sufficient ability to attend to and concentrate on material being read in a controlled and focused manner. Research in the study of attentional processes has made it clear that information pickup in any knowledge domain is virtually impossible if attentional processes are fractionated and inefficiently deployed, although we do not fully understand the means by which an individual filters irrelevant from relevant information (e.g., Broadbent, 1958; Posner & Snyder, 1975; Norman & Bobrow, 1975; Gernsbacher, 1997). However, we do know something about some of the factors that may affect the ability to read for meaning in an efficient and focused manner. As we indicated earlier, attention to the meaning of a text is compromised by a lack of fluency in word identification because of the inefficient deployment of cognitive resources occasioned by word identification problems (LaBerge & Samuels, 1974; Perfetti, 1985). Similarly, the difficulty level or the structural characteristics of the text (e.g., Graesser & Bertus, 1998; Hiebert & Martin, 2001) are other factors that may compromise a reader's ability to attend to the meaning of a text. The reader's ability to negotiate these text features may be appreciably affected by such variables as his or her level of oral language development (e.g., Dickinson & Snow, 1987; Snow et al., 1991), background knowledge (Kintsch, 1998; van Oostendorp & Goldman, 1999), familiarity with text genre (Lorch & van den Broek, 1997), and interest in the content of the text (Alexander & Murphy, 1998; Morrow & Gambrell, 2001), in addition to his or her fluency in word identification. Finally, the ability to attend to and pick up information from a text may be appreciably affected by inherent differences in the ability to deploy attentional resources in a controlled and focused manner (Barkley, 1990). Thus, it is clear that how attentional processes affect reading comprehension is a multidimensional question in need of further study.

**Written Word Decoding.** Adequate facility in reading comprehension implies adequate facility in decoding written words. Readers who have difficulties in ac-

quiring word-decoding skills will have trouble progressing to the deeper levels of language analysis; therefore, their comprehension will suffer (Perfetti, 1994; Stanovich, 1986). Readers with a slow or an inadequate mastery of word decoding may attempt to compensate by relying on meaning and context to drive comprehension, but at the cost of glossing over important details in the text. When readers read at the normal rate of 250 to 400 words per minute, a large amount of the reading time variance is explained by features of the surface code (Carver, 1992; Haberlandt & Graesser, 1985; Perfetti, 1994), such as the number of letters, the number of syllables, and the word frequency. These features are less predictive of reading time when the students study the text for a longer time.

**Fluency.** Fluent reading is the performance of a complex skill. Fluent reading is reading that is fast and accurate. It reflects the ability to decode without effort, to read aloud smoothly with expression that indicates the text's prosodic features (i.e., appropriate pacing and phrasing), and to comprehend easily what is read. A fluent reader achieves comprehension without consciousness or awareness of the many component tasks involved. With practice, low-level word recognition becomes automatic, which reduces the need for allocating attention to visual coding processes during reading and allows more attentional resources to be allocated to comprehension (LaBerge & Samuels, 1974; Perfetti, 1985). As readers become fluent, they also gradually begin to recognize the syntactic structures or segments in printed text and thereby compensate for its lack of prosodic information (punctuation does provide some assistance; Schreiber, 1987).

The complex set of processes that underlie fluency can be broken down in several ways (Meyer & Felton, 1999), for example, in the lower-level processes of phonological or orthographic processing (Breznitz, in press); in making connections between semantic and phonological processes (Wolf, Bowers, & Biddle, 2000); and in syntactic processing, which may be observable in oral language at early ages (Schreiber, 1980).

There is evidence that fluency is an index of comprehension, although the evidence is only correlational. Oral reading fluency (ORF) measures fluency simply as the number of words read aloud correctly per minute (Fuchs, Fuchs, Hosp, & Jenkins, 2001). There is a substantial correlation between ORF and standardized reading comprehension performance. This correlation is sometimes higher than the correlation between the standardized test and other direct measures of reading comprehension (Fuchs et al., 2001). These findings are based on samples of both learning-disabled and non-learning-disabled students at varying reading levels, who were assessed with a variety of criterion measures of reading comprehension and whose oral reading fluency was assessed on both instructional-level texts and fixed-level texts, (e.g., Jenkins, Fuchs, Espin, van den

Broek, & Deno, 2000; Levy, Abello, & Lysynchuk, 1997; Torgesen, Rashotte, & Alexander, in press).

Many informal procedures have been devised to assess fluency, although no standardized tests of reading fluency exist. Miscue analysis and running records have been used. Informal reading inventories assess the reading of grade-level passages both aloud and silently. Although most measures evaluate both speed and accuracy, NAEP (Pinnell, Pikulski, Wixson, Campbell, Gough, & Beatty, 1995) added a measure of pausing efficiency, which assessed sensitivity to prosodic cues.

**Syntactic Parsing.** Parsing is the process of segmenting words into constituents, assigning the constituents to syntactic categories, and interrelating the constituents structurally. The effect of syntax on sentence processing has a long history in psycholinguistics (Fodor et al., 1974; Mitchell, 1994). Sentences with complex syntax may present comprehension problems or a high load on working memory when a sentence is left-embedded, dense, ambiguous, garden-path, ungrammatical, or replete with logical expressions (*or, and, not, or if-then*), as we discussed earlier in this appendix.

The fields of psycholinguistics and discourse psychology have investigated how syntactically complex constructions influence reading time, working memory load, and comprehension (Fodor et al., 1974; Mitchell, 1994; Carpenter, Miyake, & Just, 1994). Unfortunately, much of the psycholinguistics work has focused on sentences in isolation, out of a discourse context, so it is unclear how problematic these constructions are when students read naturalistic print. We do know that the syntax is comparatively complex in expository text (Chafe & Tannen, 1987) and that syntactic complexity has a robust effect on elderly readers of expository text (Kemper, Jackson, Cheung, & Anagnopoulos, 1993), so the obvious prediction is that syntactic complexity will be a robust predictor of reading performance when expository text is read in virtually all subject populations. A more detailed analysis of syntactic processing in children is needed.

Readability indexes normally include word frequency and number of words in the sentence in the formulas, but not specific aspects of syntactic processing. The tests of syntax that are available present sentences in isolation, not in a discourse context. One direction for future research is to investigate the role of syntax in the comprehension of expository text in different subject populations, with a research team that includes experts in linguistics, psycholinguistics, discourse psychology, discourse processing, psychometrics, and education. The training of students on syntax will require computer technologies and improved teaching methods.

**Constructing the Propositional Text Base.** The reader segments the text into proposition units, interrelates the propositions structurally, and builds the nec-

essary bridging inferences that are needed to connect the explicit propositions (van Dijk & Kintsch, 1983; Kintsch, 1998). The text base is retained in memory for hours, much longer than the surface code is (Kintsch, 1998). Empirical evidence suggests that a measurable amount of time is needed to construct the propositional text base. Reading times increase linearly as a function of the number of propositions in a text, even after controlling for extraneous variables (Kintsch, 1974; Haberlandt & Graesser, 1985). The slopes of the linear functions vary from 100 milliseconds to 1,500 milliseconds per proposition, depending on the reading task and the text.

**Constructing Mental Models.** The reader constructs the referential mental model at various levels of content, such as class-inclusion, temporality, spatiality, causality, goals, and so on. When comprehension is successful, there is coherence both *within* and *between* the levels of the mental model. Stated differently, there are no serious coherence gaps *within* a particular level and there is harmony *between* the levels of representation.

A coherence gap within the situation model occurs when a reader cannot link an incoming clause in the text to the previous content on any conceptual dimension, such as causality, temporality, spatiality, or the goals of characters (Gernsbacher, 1997; Zwaan & Radvansky, 1998). In essence, the incoming event seems to be mentioned out of the blue, so the reader needs to construct a new conceptual structure from scratch. Zwaan, Magliano and Graesser (1995) reported that reading times for clauses in text increased as a function of the number of coherence gaps along these conceptual dimensions. That is, clause-reading times were an additive function of the number of conceptual dimensions that had a coherence break (e.g., a break or discontinuity in time, space, causality, goals, agents). The extent to which clauses in text are conceptually related is an inverse function of the number of conceptual dimensions with coherence breaks (Zwaan & Radvansky, 1998; Zwaan, Langston, & Graesser, 1995).

Regarding coherence *between* levels, there needs to be a mapping between the elements of the representation at one level and the elements at another level. For example, the surface code has words and syntactic patterns that signal content features at the level of the situation model. Comprehension suffers when the surface code and mental model clash. If the text stated that “the key is turned after the cylinder rotates,” there would be a discrepancy between the order of events in the situation model (the key is turned *before* the cylinder rotates) and the surface code (clause X *after* clause Y).

The comprehender obviously needs an adequate repertoire of world knowledge, domain knowledge, and cognitive skills to construct coherent representations. Comprehension breaks down when there are deficits in relevant knowledge or processing skills at particular levels of representation. When all

background knowledge and skills are intact, the comprehender constructs a meaningful representation that is coherent at both local and global levels. However, when there is a deficit at a particular level of representation, the problems either propagate to other levels or, in some cases, other levels can compensate. For example, nonnative speakers of English may have trouble processing the words and syntax of English, which makes it difficult for them to process the deeper levels of representation. They might try to compensate by using their knowledge of the situation model, pragmatics, and the discourse genre to reconstruct what was being said. As another example, readers have trouble comprehending technical texts on arcane topics because they lack world knowledge about the topic. This deficit at the situation model confines their processing to the surface code and text base levels. So they might parrot back explicit information in a textbook, but have no understanding at a deeper level—a routine occurrence in our school systems. The challenge is to design the text and the testing format to encourage deeper levels of processing.

Researchers have documented some counterintuitive interactions among the text, the task, the test, and the reader's world knowledge. For example, MacNamara, Kintsch, Songer, and Kintsch (1996) investigated an interaction among (1) the readers' knowledge about a topic, (2) the coherence of the text base, and (3) the level of representation that was being tapped in a test. The readers varied in the amount of prior knowledge they had about the topic covered in the text (the topic was the functioning of the heart). Half of the readers read a text with a coherent text base; clauses were linked by appropriate connectives (*therefore, so, and*), and the topic sentences, headings, and subheadings were inserted at appropriate locations. The other half of the texts had low coherence because of violations in the insertion of connectives, topic sentences, headers and subheaders. The tests tapped either the text base level of representation (which included recall tests) or the mental-model level (which included tests of inferences and answers to deep-reasoning questions). The results of the study were not particularly surprising for the low-knowledge readers. For these readers, texts with high coherence consistently produced higher performance scores than texts with low coherence. The results were more complex for the readers with a high amount of prior knowledge about how the heart functions. A coherent text base slightly enhanced recall, but actually lowered performance on tests that tapped the mental model. The gaps in text coherence forced the high-knowledge reader to draw inferences, construct rich elaborations, and compensate by allocating more processing effort to the mental model. In essence, deep comprehension was a positive compensatory result of coherence gaps at the shallow levels of representation. Similar complex interactions among text, task, test, and knowledge have been reported in other studies (Cote, Goldman, & Saul, 1998; Graesser, Kessler, Kreuz, & Mclain-Allen, 1998; Mannes & Kintsch, 1987).

**Generating Inferences.** Students need to construct inferences when they construct the text base and the mental models that go beyond the information directly articulated in the text. Available research on inference generation supports the claim that many classes of inferences are routinely generated during reading when the material taps world knowledge that is familiar to the reader (Graesser, Singer, & Trabasso, 1994). In contrast, inferences are a challenge to generate when the text consists of unfamiliar scientific mechanisms (Cote et al., 1998; Graesser & Bertus, 1998; Singer, Harkness, & Moore, in press).

Table A.1 lists and defines different classes of inferences that are frequently relevant to expository texts. The inferences in Table A.2 do not exhaust the classes of inferences that comprehension researchers have investigated, but they do cover the inferences investigated frequently by researchers in discourse psychology and discourse processing. Some of the inferences are more difficult to construct than others (see the references above). For example, anaphoric and bridging inferences are made most reliably, whereas predictive inferences are very difficult to make. Explanation-based and goal inferences are prevalent in good readers, whereas poor comprehenders have a higher density of elaborative associations that are often irrelevant to the text.

**Comprehension Monitoring.** Good readers monitor whether they are comprehending text effectively. One counterintuitive result of comprehension research

Table A.1

Classes of Inferences That Are Relevant to Expository Texts

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**Anaphoric references.** A pronoun or noun-phrase that refers to a previous text constituent or to an entity already introduced in the mental model.

**Bridging inferences.** These are any inferences that a reader needs to semantically or conceptually relate the sentence being read with the previous content. These are sometimes called *backward* inferences.

**Explanation-based inferences.** The event being read about is explained by a causal chain or network of previous events and states. These are sometimes called *causal antecedent* inferences.

**Predictive inferences.** The reader forecasts what events will causally unfold after the current event that is being read. These are sometimes called *causal consequence* or *forward* inferences.

**Goal inferences.** The reader infers that an agent has a motive that explains an intentional action.

**Elaborative inferences.** These are properties of entities, facts, and other associations that are not explained by causal mechanisms.

**Process inferences.** These inferences specify the detailed steps, manner, or dynamic characteristics of an event as it unfolds.

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is that most child and adult readers have a poor ability to calibrate the success of their comprehension (Glenberg, Wilkinson, & Epstein, 1982; Hacker, Dunlosky, & Graesser, 1998). Comprehension calibration can be measured by asking readers to rate how well they comprehend a text and correlating such ratings with their comprehension scores on an objective test. These ratings are either low or modest ( $r = .2$  to  $.4$ ), which suggests that college students have disappointing comprehension calibration. Another way to calibrate comprehension is to plant contradictions in a text and to observe whether the reader detects them. Such contradictions are not detected by a surprising number of adult readers. Readers show a strong tendency to have an “illusion of comprehension” by pitching their expectations at handling the surface code, explicit text base, and other shallow levels of representation. They need to be trained to adjust their metacognitive expectations and strategies to focus on the deeper levels. This has important implications for teacher training and textbook design. There need to be adjunct aids or activities that challenge the students’ misconceptions about comprehension.

**Deeper-Level Comprehension Operations.** It is widely acknowledged that students rarely acquire a deep understanding of the technical, expository material they are supposed to read in their courses. Students normally settle for shallow

**Table A.2**  
**Levels of Cognitive Processing and Mastery**

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1. **Recognition.** The process of verbatim identification of specific content (e.g., terms, facts, rules, methods, principles, procedures, objects) that was explicitly mentioned in the text
  2. **Recall.** The process of actively retrieving from memory and producing content that was explicitly mentioned in the text
  3. **Comprehension.** The process of demonstrating an understanding of the text at the mental-model level by generating inferences, interpreting, paraphrasing, translating, explaining, or summarizing information
  4. **Application.** The process of applying knowledge extracted from text to a problem, situation, or case (fictitious or real-world) that was not explicitly mentioned in the text
  5. **Analysis.** The process of decomposing elements and linking relationships between elements
  6. **Synthesis.** The process of assembling new patterns and structures, such as constructing a novel solution to a problem or composing a novel message to an audience
  7. **Evaluation.** The process of judging the value or effectiveness of a process, procedure, or entity, according to some criteria and standards
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NOTE: Based on Bloom, 1956; Otero, Leon, & Graesser, in press.

knowledge, such as a list of concepts, a handful of facts about each concept, and simple definitions of key terms. It takes more effort and thought to acquire the difficult conceptualizations and the deep coherent explanations that would organize such shallow knowledge. The deeper knowledge is needed to fortify learners for generating inferences, solving problems, reasoning, and applying their knowledge to practical situations. The deeper levels of Bloom's (1956) taxonomy of cognitive mastery are not adequately taught, achieved, and tested in most curricula.

Table A.2 lists the major types of cognitive processes that Bloom (1956) and others proposed nearly 50 years ago. According to Bloom's taxonomy of cognitive objectives, the cognitive processes with higher numbers are more difficult and require greater depth of thinking. Recognition and recall are the easiest processes, comprehension falls in the middle, and processes 4–7 are the most difficult. It is debatable whether there are differences in difficulty among categories 4–7, so most applications of this taxonomy collapse them into one category.

**Navigation.** Particularly for electronic texts, an additional skill that we call *navigation* becomes important. This skill consists of knowing how to access hyperlinks as well as knowing how to move forward and backward in electronic text.

## CONSEQUENCES

The consequences of reading, or comprehension outcomes, are, of course, the aspect of the reading instruction activity of greatest interest to members of the RRSB, and the aspect in which variability is the most puzzling and the most distressing. A difficulty in discussing consequences in any great detail is that only very limited assessments of reading comprehension are available. The assessments that exist tend to operationalize comprehension in an impoverished way, focusing on knowledge outcomes over application and engagement outcomes. They also tend to reflect consequences associated with reading particular texts rather than consequences more broadly defined, such as learning some new vocabulary items or new meanings for previously known words, bringing a previously held viewpoint into question, enhancing the reader's understanding of how to present a convincing argument, or drawing conclusions about the writer's political biases. Until comprehension measures expand to reflect an underlying theory that acknowledges a variety of possible consequences, both immediate and long term, we will be severely hampered in our capacities to engage in excellent research on this topic.