Toward a Theory of Reading Comprehension Instruction

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IN THE LAST 10 YEARS the number of theories, models, and hypotheses explaining how people read and learn to read has rapidly expanded. The work of Gough (1972), Goodman (1976), LaBerge and Samuels (1974), and Smith (1978) deserves special mention for influencing the way reading researchers and practitioners think about the reading process as well as instructional practices in teaching reading. However, few ideas in reading have the potential impact of the emerging research on *schema theory.*

The word *emerging* is particularly appropriate in characterizing the growth of schema theory. Schema is a construct that gathered impetus gradually, partially from research studies and partially from rationalistic speculation about the nature of memory and comprehension. Third, although it has only recently become fash-

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ionable, the notion of schema has firmly established historical and philosophical antecedents (Bartlett, 1932; Kant, 1787).

Perhaps the most important reason to refer to schema theory as emerging, however, is the simple fact that it is not yet a well-developed theory. It should be kept in mind that what follows is a discussion of a theory in evolution, one that has already provided important lessons for reading instruction, but one that also requires considerable further development before it fulfills its abundant promise.

SCHEMATA: BUILDING BLOCKS OF COGNITION

The title for this section is taken directly from the title of a recent paper by Rumelhart (in press) to recognize his important contribution in elucidating schema theory (see also Anderson, 1977; Minsky, 1975; Rumelhart & Ortony, 1977; Schank & Abelson, 1977; Spiro, 1977). Schemata are constructs applicable to cognitive activity generally rather than reading phenomena specifically. Schema theory is first and foremost a theory of human information processing, and therefore applies equally as well to attention and memory as to comprehension.

What is a schema?

A schema is a hypothetical knowledge structure, an abstract entity to which human information processors bind their experiences with real world phenomena. The key words in this definition are *hypothetical* and *abstract*. *Hypothetical* is important because we can only hypothesize that schemata exist on the basis of observations of human behavior. The word *abstract* is also important because it captures the fact that schemata are used as entities to which people bind the variety of concrete experiences they have with specific instances of things. It makes sense to have a schema for chair, but it makes little sense to hypothesize a schema for every particular chair an individual experiences in the world. Researchers explaining schema theory often note the similarity of schemata to concepts because of the abstractness that both entities share. However, schemata differ in important ways from what researchers have traditionally labeled as concepts.

The term *schema* applies to a wide variety of objects, ideas, and phenomena. For example, an individual can have a schema for a particular type of object in the world, such as a schema for chair, a schema for boat, or a schema for seatback cushion on an aircraft. Presumably the schema for chair, for example, would correspond not to a particular experience with any particular chair but rather to that common set of features abstracted from experience with a variety of chairs. Alternatively, the schema for chair may be characterized not so much by that set of abstract features common to all chairs but to a prototypical notion of what a chair is. For example, the schema for chair might correspond roughly to a side chair commonly seen at tables. Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976) have conducted research to substantiate precisely that viewpoint for concrete concepts such as furniture, tools, and animals.

Schemata can also exist for ideas such as

love, hope, charity, and perseverance. These schemata might differ in nature from those for physical objects, but the generic notion of a schema as an abstraction of experience still holds.

People can have schemata for actions, such as buy, dive, run, and play. At the level of actions, schemata become increasingly complex because they now must contain subroutines. For example, within a schema for *dive* there must be subroutines for approaching the board, climbing onto the board, stepping off the board, floating through the air, and hitting the water. Schemata for events, such as attending a football game, going to a party, or going to a restaurant, become even more complex.

What are schemata like?

Schemata are like concepts. The relationship between concepts and schemata is best characterized as one of class inclusion. All concepts are schemata but not all schemata are concepts. In applying a notion of schemata to objects and ideas, the similarity between what researchers have traditionally called concepts and schemata is relatively straightforward. However, as one moves to actions, events, sequences, or aggregations of entities, the relationship between the two becomes diffuse. However, the beauty and power of the notion of schema lies in the fact that it can apply to a wide range of phenomena in the world, unlike the traditional notion of concepts.

Rumelhart (in press) has likened schemata to plays. Just as a play has a plot, cast of characters, and a set of actors, so schemata, especially schemata for actions, events, or sequences, have counterparts to these elements in plays (although the degree of specification is not as great as in plays). For example, anytime there is a *buy* schema there must be a buyer, a seller, an object to be purchased, a medium of exchange, and a place of purchase. These entities are comparable to the cast of characters in a play.

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Likewise, within a *buy* schema, particular subsequences occur in order. First the buyer enters the store, encounters the seller, a transaction occurs, and finally the transaction is closed. These are comparable to the scenes in a play. A *buy* schema to be realized must also have a particular buyer, a particular seller, a particular object of exchange, and a particular medium of exchange. These elements are comparable to the set of actors that happen to be playing the roles identified in the cast of characters for the play.

What are schemata made of?

Perhaps the most important component of a schema is the idea of *variable slot*. All schemata have variable slots that are much like the roles or cast of characters in a play. These slots must be filled for schemata to be realized (*instantiated*, in schema theory terms), but they can be filled with many different things or

values. For example, the variable slot for buyer within a *buy* schema can be filled or realized with many different individuals when a particular instance of the *buy* schema is realized.

The entities that fill variable slots are called *values*. Particular variable slots are identified with a set of potential candidates (values) available to fill that slot. For example, for the variable slot of buyer within a *buy* schema, any human being is a potential candidate to fill that variable slot. The same is true for the variable slot, seller. For the variable slot object of exchange, again, a whole range of candidates is available to fill that variable slot. The variable slot for medium of exchange can be filled by many fewer values, for example, money, credit card, check, loan, and bank draft. The boundaries that apply to the range of things that can fill a variable slot are called *variable constraints*. Those familiar with classic semantic theory will recognize the similarity between selectional restrictions on verbs and nouns that can co-occur (see Katz & Postal, 1964), and the notion of variable constraints that applies within schema theory.

Now consider the interaction of variable constraints and the values that fill particular variable slots within the *buy* schema. Imagine the following scenario: John went into the drugstore and purchased a tube of toothpaste. If asked what John used to pay for the tube of toothpaste, most people would suggest that he probably used cash. The value that can fill a particular variable slot is constrained by the values that fill other variable slots. Now read the following sentence: John took 17 friends to a fancy restaurant and treated them all to dinner. If asked what John used to pay for the dinner for himself and his 17 friends, most people would probably suggest something like a credit card or perhaps a check. In general, cash becomes a less probable value to fill the medium of exchange slot the more expensive the object of exchange (for a detailed discussion of the variable binding and constraint satisfaction process, see Collins, Brown, & Larkin, in press).

Hierarchical and network relations

An important characteristic of schemata is their hierarchical organization. For example, most schema theorists hypothesize that the schema for *canary* is stored closely to and hierarchically embedded within the schema for *bird*. This hierarchical arrangement allows for considerable cognitive economy. It allows the attachment of all those variable constraints known to be true about birds to the schema for canaries by virtue of the fact that the schema for *canary* is embedded within the schema for *bird*. Considerable research has been devoted to verifying that such a semantic network of relations among various concepts or schemata exists (see Shoben, in press). Similarly, the schema for *birthday party* is embedded within the more general schema for *party*, and the schema for *attending a football game* is embedded within a more general schema for *attending sporting functions*, which is likely, in turn, embedded within the schema for *attending large social events* of any type (see Rumelhart & Ortony, 1977, on embedding).

Cross referencing occurs when variable slots within one schema are filled with values that themselves exist within other schemata. For example, the schema for *football teams* is likely organized independently from that for *attending a football game*. However, when a schema for attending a football game is selected, the variable slots for teams have to be filled, and presumably they are filled by values that themselves come from other parts of the semantic networks. This makes semantic processing complex, and any theory that allows less than such crossover seems doomed to failure in explaining how it is that we are able to fill various variable slots.

How do schemata work?

Selection

While reading, listening, or viewing something, an information processor picks up enough clues from the particular environment to recognize that a particular schema ought to be brought to bear to aid understanding. Concrete stimuli guide the selection of general schemata. For example, when a person walks into a drugstore to make a purchase, presumably a *buy* schema is instantiated and, as a consequence, certain aspects of the environment, such as persons in the store, become likely candidates to fill variable slots like seller and buyer.

Instantiation

Instantiation, from the word *instance*, occurs when particular values are bound to variable slots within a working schema. Recognizing a person behind a counter as the seller within a buy schema is an example.

Inference

Inferences may be involved in the process of deciding what schema among many should be called into focus. It is rarely the case when reading, listening, or viewing the world that one is told directly what schema to select. Subtle cues are usually picked up from the environment that allow schema selection. For example, to see or read about an individual entering a business establishment, such as a drugstore, may suggest a *buy* schema.

Inference is also involved in the process of instantiating variable slots within a selected schema. This occurs in two ways. First, one may use inference processes to decide that a particular value mentioned in a story is intended to fill a particular variable slot. Consider the following: "I went to buy a new car yesterday. Boy, was that agency ever crowded." In this case, one might infer that, if the new car was purchased, it was purchased at the agency mentioned in the story. Note that there is nothing in the text to indicate this. However, because agencies are likely candidates for places to purchase new cars, it is reasonable for a reader or listener to believe that the agency mentioned is intended to fill the place slot in the *buy* schema. The reader has made a text-connecting inference in recognizing the relationship between elements in two different text segments and acting accordingly in filling slots.

A second, common way in which inference is implicated in filling slots is by the assignment of default values to variable

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slots in the absence of any substantiating information in the text. In the example, suppose that the story did not mention the agency, but the reader is nevertheless asked where the new car was purchased. The reader is likely to respond "at a new car agency" or even with the name of a specific new car agency if the scenario occurred within a given locale. In such a case the reader has made a slot-filling inference. It should be noted that such slot filling by default does not occur only when questions are asked about some information missing from initial understanding; rather, it is a routine aspect of the ongoing process of comprehension. Speakers or writers know that there is a considerable amount of knowledge that they share with their audience. When it can be assumed that their audience will be able to accurately infer what shared knowledge has been omitted, speakers and writers will usually omit it (Clark & Haviland, 1977; Grice, 1975).

A default value is simply a particular individual's "best guess" as to what value is likely to fill a variable slot in the absence of any determining information. The earlier discussion of the interaction between variable constraints and variable slot assignment had examples of the use of default values to fill variable slots. Recall the difference in the "most likely candidate" to fill the medium of exchange slot when toothpaste or a dinner for friends was being purchased. In each of those examples a particular type of medium of exchange was assigned to that variable slot through default values.

Learning

Schema theory has been shown in many experiments to be an effective framework for explaining much of what goes on in text comprehension. Fewer experiments have illustrated the role of schema theory in learning. However, the operations involved in learning are as important and relevant as those involved in comprehension.

The first and most common kind of learning within a schema theory point of view is what Rumelhart (in press) calls *accretion*. The notion of accretion is similar to Piaget's (1936) notion of assimilation and Smith's (1975) notion of comprehension. Accretion occurs each time an individual experiences an example of a schema and records in long-term memory its particular instantiation. Accretion is what allows a person to recall the specific circumstances involved, for example, a particular trip to a restaurant. Unlike other forms of learning, accretion does not alter the structure of the schema.

A second kind of learning within schema theory is called *fine tuning*. While fine tuning has no exact counterparts in Piaget's or Smith's views of information processing, it would be included in what Piaget calls accommodation and what Smith calls learning. Within fine tuning the components of schemata are modified in important ways. New variable slots are added, variable slots are

changed, default values are altered, or the constraints that apply to various variable slots are modified. A person who has experienced only male recreational vehicle salespersons might have a variable constraint that such salespersons must be male. When a female recreational vehicle salesperson is encountered, the constraint for that variable slot must be modified to include females.

The third kind of learning in schema theory, *restructuring*, occurs when old schemata must be discarded and new schemata built to accommodate existing and incoming data. Restructuring is what occurs when old theories or paradigms are shown to be incorrect and new ones arise to replace them. The Copernican revolution, the advent of Newtonian physics, and Einstein's notions of relativity represent this ultimate stage of restructuring (see Kuhn, 1962).

Restructuring occurs continually at a more modest level in daily life. Examples include the 4-year-old child who discovers that not all four-legged creatures are dogs and who is forced to develop specialized schemata for horses, cats, cows, and goats; the teacher who learns that different teaching routines are optimally suited to children of differing aptitudes; and the student who discovers that the laws of commutativity generalize from addition to multiplication but not to subtraction or division.

There are two general thrusts to restructuring. Schema *specialization* is often involved; several schemata are needed where one previously existed. At other times, schema *generalization* occurs; several subschemata are seen to share some common variable slots, and the learner realizes that they can be seen as variations on the same theme.

Control mechanisms

All of the operations involved in processes like attention, perception, comprehension, and memory storage and retrieval are subject to the influences of certain control mechanisms. There are times when information processing is largely controlled by the data at hand (e.g., the print on the page, the sounds in the stream of speech, the phenomena in the field of vision) and the information processor assumes a passive, receptive role, waiting for data to clearly suggest the selection of a schema. In such a control mode the information processor is said to be operating in a *bottom-up* fashion (Smith, 1975, calls this outside-in processing). Others have labeled such a mode as data-driven processing or, in the case of reading, text-based processing.

Alternatively, there are times when the processor assumes a more active role. The processor, using his or her existing store of schemata, generates hypotheses about the probable nature of the about-to-be-observed data (e.g., upcoming text). Such hypotheses can be generated on the basis of a variety of cues from the environment: schematic knowledge about the general topic under discussion in a book or a conversation, the type of literary discourse expected from a given author, the compelling syntax of a particular sentence, or expectations about what to expect in certain places or social situations. Regardless of the source of the hypotheses, once they are set, they guide the processor's operation. In such cases the processor is said to be operating in a

top-down mode (Smith, 1975, calls this inside-out). Others have labeled this mode as conceptually driven, schema-driven, or in the case of reading, reader-based processing.

Some models of the reading process, such as that proposed by Gough (1972), contend that all processing in reading is bottom-up in the sense that all decisions about visual units such as letters or words must be made before the data are transformed into the kind of meaning code necessary to allow instantiation into long-term semantic memory. The schemata in a reader's memory never serve to direct hypotheses about what a particular word or letter might be. Others, such as those proposed by Goodman (1976) or Smith (1978), allow for some bottom-up processing but have a definite procedural preference for top-down processing. In these models, bottom-up processing is necessary only in the most dire of contextually impoverished circumstances.

Still other models, most notably Rumelhart's (1977) interactive model, argue for a constant and simultaneous generation of hypotheses about both visual information and meaning from both data-driven (bottom-up) and conceptually driven (top-down) sources. In Rumelhart's model, the domination of one mode over another depends on the strength and credence given to various hypotheses by the mind's executive processor. Strength and credence are at least partially determined by factors like background knowledge, text difficulty, and purpose for reading.

Within the present framework, something like Rumelhart's interactive model is proposed. A reader is constantly shifting between one mode of processing and another depending on his or her familiarity with the global topic, the syntax, and the lexical elements of the text, as well as purpose for reading (e.g., understanding versus copy editing). These modes of processing are synergistic; they support and feed on one another. For example, consider Rumelhart's (in press) short text:

1. Business had been slow since the oil crisis.

In the absence of any topical information the reader begins the sentence in a bottom-up mode. However, the reader cannot process the sentence without generating a default value to fill the business slot, such as service station, automobile sales, recreation—top-down processing at work. Observe the difference in fulfillment of hypotheses when sentence 2a instead of 2b follows sentence 1.

2a. Nobody seemed to want anything elegant anymore.

2b. Nobody seemed to want to travel very far anymore.

If a reader's hypothesis is fulfilled, he or she is likely to maintain the hypothesis and continue in a top-down mode. If it is disconfirmed, the reader is likely to suspend judgment, waiting for more data.

Notice one other aspect of top-down processing and hypothesis generation: A hypothesis is nothing more or less than an inference of the type discussed earlier. Inference is pervasive in reading. Authors rarely explicate all aspects of a scenario; they assume readers will fill in important gaps. Even when authors eventually offer explications, readers often anticipate (rightly or wrongly) the explication long before the author gets to it.

SCHEMA THEORY AS A METAPHOR FOR INSTRUCTION PROBLEMS

The background provided by the previous discussion is intended to serve as a framework in which to view the diagnosis and correction of particular roadblocks that stand in the way of comprehension. Note that many of the instructional suggestions offered are based on our judgment that they follow from the theory and on favorable experience in applying them, rather than on formal empirical testing.

Schema availability

There are many occasions in schools when students fail to understand a particular passage, selection, chapter, or book because they lack the background knowledge necessary to make sense of the text; they do not have the appropriate schemata available for comprehension. Sometimes students not only do not have schemata appropriate for understanding the new vocabulary in the text, they do not even possess background knowledge (schemata) for the terms in which the new vocabulary is defined or explained.

The problem becomes more acute as children advance through school. The conventional wisdom in elementary school reading lessons begins the reading of a selection with vocabulary instruction and discussions to build background. Conversely, in secondary school, students are usually asked to read a chapter *before* a class discussion of the topic occurs.

That background knowledge influences a student's ability to understand a text seems intuitively obvious. There is much support for the generalization (Anderson, Spiro, & Anderson, 1978; Bransford & Johnson, 1972; Bransford & McCarrell, 1974; Steffensen, Anderson, & Joag-Dev, 1979). Yet our own observations of classroom practices suggest that the problem is often ignored. Students are often asked to read texts they are incapable of understanding or remembering.

A study by Pearson, Hansen, and Gordon (1979) suggests that, at least for younger children, the problem is more acute for inferential than for literal comprehension. They found that second-grade students who were divided into two groups on the basis of the strength of their background knowledge about spiders (but equated on intelligence, reading achievement, and socioeconomic status) exhibited differing patterns of behavior when responding to postreading literal and inferential probes. The strong schema group was somewhat superior to the weak schema group on literal probes (based on information explicitly stated in the text), and they were far superior on probes that required students to generate an answer implied and invited by the text but not explicitly stated (inferential probes). In the language of schema theory, background knowledge assists instantiation to a moderate degree, but it assists default value assignment even more so.

The following techniques may serve as more precise diagnostic procedures to identify students with a schema availability problem:

1. Carry out a simple pretest, asking students to define or explain key

concepts in the text or key prerequisite concepts.

2. Preferably, conduct a group assessment of the associations students have with key concepts. List the words on the chalkboard and ask what comes to mind when they hear words such as photosynthesis or transpiration. Write down their associations next to the key words. Teachers can quickly learn which concepts will present problems, and this technique paves the way for an appropriate remedial strategy.
3. As a variation of technique 2, list the topic of the selection to be read in the middle of the chalkboard and ask students what they think of in association with this word. As the students offer associations, group them into appropriate categories. Later on the categories can be labeled.

We prefer techniques 2 and 3 to 1 because we find students are usually more willing to offer associations than answers or definitions because there is less risk involved. Associations also provide a starting point for helping students in *fine tuning* or *restructuring* their existing schemata.

In providing corrective action, teachers should offer both general and content-specific instructional programs. Every school and every teacher should have a general program of concept and vocabulary development independent of any particular subject matter or text that students may be reading. Such a program would include field trips, museum visits, movies, and film strips to expand children's language experiences. One note of caution on providing children with such experiences: experience, even direct experience, needs guidance if any fine tuning or restructuring of existing schemata is to occur. Turning a group of eighth-grade students loose in a museum without any guidance about what to look for or how various items relate to one another does little to help students expand their schematic frameworks in a meaningful way.

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In the area of vocabulary and concept development specifically tied to texts within a content area or reading curriculum, educators have typically misled themselves by asking the wrong question about how to build schemata where none exist. Given the constraints that exist in schools, teachers can hardly expect to provide direct experiences for all the concepts that students need to understand the texts they must read. Instead of asking the question "What *does* the student *not know* that I have to help him or her learn?" educators should be asking "What is it that the student *does know* that I can use as an anchor point—a bridge—to help develop the concepts that he or she needs?"

When a teacher asks the latter question, the informal diagnostic procedures (the group association tasks discussed earlier) can help students. For example, certain students may not have a schema for jaguar (the cat), but the associations car,

fast, wolf, sleek, cat, and leopard offered by other students can provide an appropriate set of known "bridging" concepts to access the new unknown concept.

The basic point is that the appropriate corrective instruction is not conventional reading instruction. It is instead simply good *instruction*, the socratic give and take admired in expert teachers at work. Such instruction is characterized by several distinguishing features, including the following:

1. There is always an attempt to begin with a positive attitude (what the student does know) rather than a negative posture (what the student does not know).
2. Analogies, comparisons, and sometimes even metaphorical comparisons will be used to build bridges between the known and the new. People do this naturally in everyday discourse with peers. When explaining to friends that they have not witnessed, people often use a structure like "Well, it's sort of like an *x*, but it's different in that. . . . "
3. Whenever possible, numerous examples of the new concept will be offered so that students get a fix on "what it is." Appropriate nonexamples will be offered to help students discover the parameters of the new concept, "what it isn't."

Corrective instruction is neither quick nor easy. It takes time, thought, patience, and considerable care and preparation by teachers. Those devoted to the "coverage syndrome"—I must get through a certain number of pages this week—may as well not even consider this alternative. The number of analogies or examples needed can be determined only in practice. However, letting students plow their way through an incomprehensible text has little, no, or possibly a negative effect on existing schemata.

SCHEMA SELECTION

A related but somewhat different problem occurs when a student possesses the appropriate background knowledge but fails to bring it into focus for purposes of comprehending a particular passage. This is a problem of schema selection rather than schema availability.

This problem has several manifestations. A common one is for children to be unaware that they possess relevant schemata, relying instead on bottom-up processing. Diagnostic and remedial strategies for this problem are similar to those for schema availability. For the most part, the two association techniques discussed as diagnostic procedures for schema availability serve even better here. The very act of organizing a group's prior knowledge about a topic or set of concepts prior to reading often serves as a prima facie demonstration of the fact that they are not starting from ground zero.

In addition, there are several other prediction and previewing strategies that serve to allay student anxieties about a perceived lack of background knowledge. The whole tradition of the directed reading-thinking activity (DRTA) popularized by Stauffer (1969) carries with it this active attitude of predict-read-verify. The previewing strategies suggested by Pearson and Johnson (1978) begin by saying "Let's write down what we know about

x." In addition, a teacher can find many activities that promote this same attitude in the work of Herber (1970) and Thomas and Robinson (1972). One of the best-developed strategies in this tradition has been offered by Hanf (1971).

One technique that captures the essence of this active attitude begins by constructing an informal semantic map of a group's collective knowledge about a topic. Then students read the selection with the semantic map as an implicit guide for directing attention to particular parts of a text. After reading, the group meets again, this time to modify, amend, and correct the prereading map. Now the students have a clear and vivid demonstration of what they knew before reading, what they learned from the reading that they did not know before, and how these ideas relate to one another.

Other manifestations of the schema selection problem are more difficult to remediate but should be recognized. One occurs when children focus on an inappropriate schema, perhaps one suggested by a peripheral part of the text. A related problem is the selection of schemata at a nonoptimal level of generality (e.g., using a specific schema for the child's home city when a general schema for cities is required). Often schemata must be combined in novel ways that may prove difficult for some children. Finally, since even recombinations of schemata cannot produce sufficient background knowledge for all situations that may be encountered, it is sometimes necessary to construct new schemata in an ongoing fashion. Needless to say, such creative processes remain mysterious to psychologists.

SCHEMA MAINTENANCE

Because readers have available and select a certain schema does not guarantee that they will continue to use it or maintain it throughout the passage (at least for as long as it remains appropriate). Some students begin appropriately but somewhere along the way forget what they are reading about. This is the problem of schema maintenance.

There are several possible reasons for this problem. First, students may be operating at such a low level of textual analysis that they are directing all their attention and capacity to the visual analysis of letters, syllables, or words. They have little or no cognitive capacity left to direct to the kind of synthesis and integrative thinking necessary to create a coherent whole for the text.

Second, sometimes this is as much a problem of the writer as it is the reader. Spiro, Boggs, and Brummer (in preparation) found, for example, that good readers spontaneously integrate two pieces of information whether they are presented in a single cohesive sentence or in two separate sentences. Poor readers, on the other hand, spontaneously integrated the information only when it appeared in the same sentence. This tendency of poor readers not to maintain the earlier information when processing the related information in a subsequent sentence was not due to the former information being forgotten. Marshall and Glock (1978–1979) and Irwin (1980) found that poor readers had more difficulty understanding or remembering the relationship between two ideas when they appeared in

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separate sentences than when they were linked together in a single sentence by cue words such as *because*, *since*, *after*, or *therefore*. Good readers seemed better able to supply these links when they were missing in the text. Contrary to what might be inferred from readability formulas, shorter and simpler is not always more comprehensible.

Problems of schema maintenance are difficult to handle instructionally because they are more a processing than a knowledge-base deficit. But these guidelines, even though they have not undergone full-scale empirical testing, seem a useful starting point.

1. Ask students to read a selection quickly for the basic idea of a text. Because they tend to be slowed by detail and bit-by-bit processing, encourage the creation of a consistent framework to keep in mind while reading the entire text.
2. Provide them with partially completed visual representations of the major points of the passage (at least for expository passages). In their second reading of the text, have them complete the visual representation.

When creating a visual representation, do not limit it to outlines, although outlines can be useful. Semantic maps, flow charts (especially for sets of directions or descriptions of how something works), and various realizations of a matrix, such as a table or a graph, are also successful.

The visual representation serves two functions. First, because teachers have already provided between 30% and 50% of the information, the visual representation provides strong cues about what is important. Second, the visual representation makes relatively explicit relations among ideas that may be only implicit in the text.

Another possibility is to call attention to information that must be related across sentences by manipulating the text's graphic presentation. For example, related information might be presented in the same color or underlined. Once a child begins to see the relevance of schema maintenance, such external support can be gradually withdrawn.

PATTERNS OF CONTROL MODE OVERRELIANCE

In the preceding discussions we have been discussing some of the prerequisites for knowledge-based processing: the availability of necessary background knowledge and various skills in applying that knowledge. We now discuss what happens for some readers when they fail to meet these prerequisites. One possibility is that the child who meets difficulty with top-down processing will avoid it, compensating by an overreliance on text-based processes. Another possibility is that the child will persevere in top-down processing despite his or her deficiencies and thus use so much attention that too

little is left for bottom-up processing—they think so much about how the text relates to what they already know that they cannot think enough about the text itself. The result is an overreliance on top-down processes.

Before proceeding, it is important to note that we do not believe that deficiencies in background knowledge or top-down processing skills are the only causes of overreliance on either control mode. Just as such deficiencies can result in a bias toward either top-down or bottom-up processing, lack of skill in bottom-up processes can lead to either type of bias (depending on whether the child perseveres and distracts attention from top-down processes or escapes by overrelying on top-down processes). Furthermore, skill deficiencies are not the only cause of these styles of overreliance. For example, a bottom-up bias could just as well be the product of a misconception about the need to employ top-down processes—some children may mistakenly think it inappropriate when reading to consider anything but the explicit text itself (see Spiro, 1979, for a discussion of the causes of text-processing styles). The following discussion concerns problems of overreliance that may result from a variety of causes.

Overreliance on bottom-up processing

Of all the comprehension problems children could have, overreliance on bottom-up processing is among the most serious, for the students who exhibit the symptoms indicative of the problem have lost their sense of language as it applies to reading.

The symptoms take several forms. There are children who laboriously proceed through a text word by word or even letter by letter, so intent on getting things right that they fail to process any meaning. There are other students who exhibit little flexibility in their reading rate; they read all parts of a chapter as if they had the same level of background knowledge for each. They do not "read to update their knowledge" (Spiro, 1977). If they did, they would recognize places where their background knowledge was weak or strong and vary their pace accordingly. Such readers assume a passive role while reading even when the situation would allow them to read more actively and aggressively, at least for certain segments of a text.

Most serious are the students who have given up on meaning altogether. Their strategy for oral reading is to say anything that has some visual similarity to the first part of the word they are attempting to decode, a practice that results in reading errors like "The dover souping the car" for "The driver stopped the car." The seriousness of error patterns such as this stems from students' total disregard for *language sense* while reading. One of the goals of good oral reading instruction should be to help children use their knowledge of oral language to monitor their oral reading output. Children who exhibit an error pattern like the one illustrated have somehow learned that oral reading does not need to make sense in the same way that speech does.

How does such an attitude become established? First, if children are exposed to content that is foreign to their oral language repertoire, they may never see

the relationship between speech and print (note, for example, the peculiar patterns in early linguistic readers and traditional basal readers). Second, the oral reading atmosphere may be so anxiety provoking that they learn that it is better to suffer a little embarrassment by saying dumb things than it is to endure a lot of anxiety by trying to read what is on the page. Third, no one may have ever pointed out to them that oral and written language, although differing in form and precision, stem from a common source, their experiences. For example, some students, when given a question-answering assignment, cannot provide an answer that is not explicitly stated in the text. They seem to think that all the answers are in the text, even when the question begins "What do you think. . . ." Such an attitude may stem from an overdose of literal questions from the teacher, the text, or the workbook. Students may learn not to trust themselves and their knowledge base even when the task invites such recourse, preferring instead to take the safer course of laboriously searching the text and grabbing at the first word or phrase adjacent to some words that form part of the question.

Children who grab at the first word or phrase adjacent to some words that form part of the question have learned that reading need not make sense (in the same way that oral language does), that they should not trust themselves, and that reading occurs out there on the page rather than inside one's head. Remedially it is as important to overcome these attitudes as it is to provide any specific kind of practice. Following are some techniques that educators have found helpful in reorienting students to reading as a sense-making process.

1. Begin with a purely listening task. Use a sensible text on a topic familiar to the students. Into the text embed anomalous words, phrases, or sentences. Read the text to the students, asking them to stop you whenever they hear something that does not make sense. When they stop you, ask them to tell why something did not fit.

2. Move into a combination listening and reading mode. Create similar kinds of anomalous texts. Provide the students with copies of the text written correctly. As you read orally, ask them to follow along, putting a checkmark near anything that does not make sense and does not match what is on the page they have. Afterward, discuss the anomalies and why they did not make sense.

3. Move into an independent activity in which students are provided with texts that actually contain the anomalies. Ask them to underline the anomalies and to substitute a word, phrase, or sentence that would make sense.

4. Three things help students who cannot come up with a nontextual answer. First, try the same technique as suggested for the top-down problem in the following section in which students must distinguish between two reasonable answers, one from the text, one not. Second, a recent

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study (Hansen & Pearson, 1980) found that simply giving students greater opportunity to answer inference questions increased their ability to do so. Third, that same study found that helping children acquire a specific strategy for drawing inferences (based on a text-to-head metaphor) helped them, in some cases, even more than simply providing them with extra practice.

Overreliance on top-down processing

Sometimes students who exhibit overreliance on top-down processing might not be considered problems. They are, by definition, approaching reading as a meaning-based process. In mild cases, overreliance on top-down processing is not a serious matter. However, in more extreme cases, such as one might encounter in a clinical setting, a student who exhibits this syndrome can have serious reading problems. It is easy to recognize such students. Their oral reading errors tend to preserve the idea of the selection and often even the sentence in which they were made. They tend to make what Goodman (1976) refers to as quality miscues. Furthermore the preservation of meaning is often accomplished at the expense of the preservation of visual form (letters or syllables). Hence such children might utter donkey for burro, alligator for crocodile, ran for pranced, or orange for apple. As suggested elsewhere (Kamil & Pearson, 1978), these students will often understand a passage, but do not send them to the grocery store with a list!

A second symptom of overreliance on top-down processing is a tendency to give answers to questions that come from prior knowledge even when there is an answer available from and invited by the text. Such students often complete a question-answering assignment in a fraction of the time it takes their peers, sometimes because they have not even bothered to consult the text. Furthermore, their answers tend to be fairly sensible and sometimes clever.

This problem cannot be ignored in its more severe forms. There are times when it is essential to get the message straight, for example, in chemistry. When reading literature or poetry, it makes a difference whether you think the author said stride rather than walk. The problem with close semantic approximations is that any two words that are denotatively similar at one level of understanding are connotatively distinct at a deeper level. Students may miss certain subtleties and nuances of meaning. Furthermore, texts usually contain new *general* information that cannot be supplied from prior knowledge. Such information is important for building or restructuring schemata.

There are several strategies one can use to convince such students of the importance of a greater regard for the text.

1. To force the students to see the importance of precise versus simply approximate meaning, ask them to complete fill-in-the-blank exercises in which the choices are all semantically appropriate but only one gives a precise semantic fit.

   Susan was so happy that she _____ through the park.

   ___walked ___skipped ___trudged

2. As a group activity, do a variation on 1 in which two blanks are used. One word is systematically changed, and students are asked to select a word for the second blank that denotes walking but fits the sense of the word.

   Susan felt so _____that she _____through the park.

   Keep replacing the first blank with words like happy, sad, proud, frightened, excited, dismal. In each case ask students to generate a word to fit the second blank.
3. Make sure students have many opportunities to read directions for making things. This encourages them to read carefully rather than to get the gist or the flavor of the piece.
4. Give students multiple-choice questions to accompany a text. Provide three choices: One that is obviously wrong, one that is reasonable *and* comes from the text, and one that is reasonable *but* does not come from the text. Tell them to pick the two reasonable answers. Then ask them to determine which answer comes from the text and which does not. This procedure encourages students to regard the text as an important source of information without making them slaves to the text.

A FINAL WORD

We have not nearly exhausted the range of problems or solutions that can be conceptualized within a schema-theoretic framework. Instead we have chosen to select a few key problems that seem to us to be important and prevalent among students, particularly among those for whom reading is a chore. We hope we have convinced you that schema theory provides a consistent and wide-ranging metaphor for explaining a host of problems and suggesting some sensible, if tentative, solutions. The theory (and its implications), as we suggested at the outset, is still emerging.

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