The Reading Matrix
Vol. 5, No. 1, April 2005

INFERNECE GENERATION SKILL AND TEXT COMPREHENSION

Mohammad Davoudi

Abstract

One of the most common findings of recent reading research is that drawing inferences is an essential part of the comprehension process, even among young children (Anderson & Pearson, 1984). Dole et al (1991) argues that inference is at the heart of comprehension process. As they construct their own models of meaning for a given text, readers and listeners alike use inferencing extensively to fill in details omitted in text and to elaborate what they read. The important point is that even the simplest of texts require inferencing. Despite persistent, well-meaning positions that argue for delaying inferential activities until literal comprehension is mastered (e.g., you need to get the facts straight before you can reason beyond the text), both basic and applied reading research supports a strong emphasis on inferential strategies from the beginning of instruction. The present paper has explored the factors affecting the generation of inferences by readers as well as the reasons for their inference failure. Some instructional techniques and strategies for the development of inferential skill is provided.

1.1 Introduction

Text understanding is constructing a coherent representation of the information in a text. A text contains more information than what is explicitly expressed. The representation also contains information that is implied by the text: information that the writer supposes the reader will compute from the text and that the writer therefore leaves implicit. "The computation of the implicit information is referred to as inferencing (Vonk & Noordman, 1990: 447). In other words, the words and phrases chosen for any linguistic communication compose merely a rough sketch of the entire meaning conveyed. To understand written language, a reader must use more than the individual words on a page to understand the writer's intent. Most readers are capable of effortlessly integrating general knowledge in long-term memory with the written message to form a unified, coherent representation of the ideas the writer wished to impart. Remarkably, all of this work seems to be done so rapidly and spontaneously that readers are unaware of its occurrence. As a text is read, information that is relevant to the written message is activated in long-term memory. "When information that was not explicitly stated in the text is activated, an *inference* is made." (St. George, Mannes, & Hoffman, 1997: 776) This process of inference-making is a key component of fluent reading, and as such, several aspects of the process are of interest, including the kinds of inferences readers make and the factors that determine whether and when inferences are made.

It is widely accepted by reading theorists and researchers that the ability to make inferences is necessary for reading comprehension. At a general level, inference is a cognitive process used to construct meaning. Inference in reading comprehension is a constructive thinking process because the reader expands knowledge by proposing and

evaluating competing hypothesis about the meaning of the text in an attempt to progressively refine understanding. The importance of inference in understanding even the simplest text was pointed out by Thorndike (1917). Inference makes it possible for a reader to comprehend the information that the author presents (Goetz, 1977) and is an integral part of the comprehension of and memory for text (Anderson & Pearson, 1984; Bransford & McCarrell, 1974; Brewer, 1977; Harris & Monaco, 1978; Kintsch, 1986; Mason, 1984; Schank, 1975; Tierney & Spiro, 1979; van Dijk & Kintsch, 1983). Hence, as it is argued by Long, Oppy & Seely (1994), that if readers are unable to generate inferences that connect explicit information in a text to relevant world knowledge, they feel as though the do not comprehend the text and have difficulty remembering it.

A number of disciplines have shown an interest in the study of inference as a crucial contribution of the mind to language comprehension and production as well as thinking. The nature of the inferential processes in which one belief is formed on the basis of other beliefs "is a major question in the philosophy of mind and the psychology of cognition. The way those processes can extend justification and knowledge is a major question in epistemology" (Audi, 1998: 152). The importance of inference in knowledge acquisition is to the extent that philosophers who work on inference process have claimed that through the joint work of perception and our rational powers, particularly out inferential capacities, we acquire new beliefs, our justification is extended, and we gain new knowledge. Inference is not a basic source of knowledge, but rather transmits and thereby extends it, in appropriate circumstances, from one or more premises to the conclusion inferred from them.

Inference making is a part of children's everyday experiences, a central means of making sense of the world by inferring differences and similarities between new situations and what the children already understand and know how to do (Hansen & Pearson, 1983). Cain, Oakhill, Barnes, & Bryant (2001) investigated the relation between young children's comprehension skill and inference-making ability using a procedure that controlled individual differences in general knowledge. They found a strong relation between comprehension skill and inference-making ability even when knowledge was equally available to all participants. They suggest that poor comprehenders construct incomplete representations of the text: They are often able to integrate information at a local level but are unable to produce a coherent integrated model of the text as a whole. Poor comprehenders' difficulties with inference making are a likely cause of their text-level comprehension problems (Cain & Oakhill, 1999). The important point is that even the simplest of texts require inferencing. When narrative and expository texts' meanings are represented using Grasser's (1981) system of text analysis, there can be "as many as 12 to 15 implicit inferences for every expressly mentioned statement in the passage" (Waever & Kintsch, 1991:235). If we juxtapose this finding with the fact that "even the simplest type of literal comprehension requires that we engage in inferencing" (Samuels & Kamil, 1984:297), it becomes clear that ***the ability to draw inferences is the cornerstone of reading competence.***

The most important function of inferences is in the realm of language comprehension to the extent that the depth, breadth, and richness of text comprehension and the resultant

mental representation of the text in the form of a mental or situation model is attributed to the quantity and quality of inferences made by the reader in the course of comprehension. Some researchers have introduced the dichotomy of shallow versus deep comprehension. With reference to the three levels of mental representation introduced by Kintsch (1974) and taken up by researchers in the realm of text comprehension (i.e., the surface code, the textbase, and the situation model level), shallow comprehension refers to the act of processing a text in the first two levels. The surface code and the textbase provide a shallow representation of the explicit text but does not go the distance in capturing the deeper meanings of the text. Deeper meanings are achieved by computing a referential specification for each noun, by constructing causes and motives that explain why event and actions occurred, by inferring the global message or point of the text, and by relating the state of affairs or the situation described in the text to the state of affairs in the world which is, of course, located in the background knowledge structure of the reader of the text. Comprehension improves to the extent that the reader constructs more levels of representations and more inferences at each level. This, among others, means that the quantity of inferences made in the course of comprehending the text is one index in the richness of text comprehension attempted by the reader.

Comprehension improves to the extent that the reader constructs more levels of representations and more inferences at each level. To illustrate some multiple levels of representation, consider the following short text:

The truck driver saw the policeman hold up his hand.
The truck driver's vehicle stopped, but a car rear-ended the truck driver.

The textbase level of representation would include a propositional description of the explicit text (Kintsch, 1992; Kintsch & van Dijk, 1978). For example, the first sentence would have the following propositional representation:

PROPOSITION 1: saw (truck driver, PROPOSTITION 2)
PROPOSITION 2 : hold-up (policeman, hand)

Each proposition has a predicate and one or more arguments. The textbase level would also connect the explicit sentences by argument overlap. The first sentence would be connected to the second sentence by the overlapping argument "truck driver".

The textbase provides a shallow representation of the explicit text but does not go the distance in capturing the deeper meaning of the text. Deeper meaning is achieved by computing a *referential* specification for each noun. For example, the car would rear-end the vehicle of the truck driver rather than the body of the truck driver. Deeper comprehension is achieved when the reader constructs *causes and motives* that explain why events and actions occurred. Readers would infer that an abrupt stop of the truck caused the caused the car to rear-end the truck, even though the text never states that there was an abrupt stop. The reader would infer that the truck driver had the goal of stopping the truck and performed some intentional action to stop it, even though this was never explicitly stated. Deeper comprehension is achieved when the reader infers the

global message/point of the text, such as “accidents occur even when people follow society’s rules.” However, this level of representation may be difficult to construct without the pragmatic context of the text, such as who wrote the text, why it was written, who read the text, and why it was read. Nevertheless, according to our definition of our comprehension, readers attempt to construct representations at all of these levels.

Students rarely acquire a deep understanding of the material they are supposed to learn in their courses. This painful fact is widely acknowledged in the field of education. Students normally settle for shallow knowledge, such as a list of concepts, a handful of facts about each concept, and simple definitions of key terms. What is missing tare the deep coherent explanations that organize the shallow knowledge and that fortify the learner for generating inferences, solving problems, reasoning, and applying their knowledge to practical solutions. The acquisition of shallow knowledge is unfortunately reinforced by the normal classroom activities and testing formats. Classroom lectures typically are information delivery systems for shallow knowledge. The teachers' questions in the classroom typically are shallow short-answer questions that require only single words or short phrases in the student response. The format of most examinations consists of multiple choice, true-false, or fill-in-the-blank questions that, once again, tap primarily the shallow knowledge. Given this unfortunate state of affairs, many researchers and teachers have been exploring learning environments and pedagogical strategies (e.g., making inferences) that promote deep comprehension. The field of discourse processing offers some solutions to the challenge of promoting deep comprehension during learning. The present research sketches the salient components of discourse processing mechanisms and subsequently points out how such mechanisms can be used to improve deep comprehension.

For those unfamiliar with research on the basic ‘nuts and blots’ of inferences, a good illustration of their importance and pervasiveness is provided by Meehan’s *talespin* project (cited in Schank, 1984). Meehan programmed a computer with a certain amount of information about the world and then instructed it to tell a story. Since the computer had a lack of general knowledge the result was as follows:

One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe threatened to hit Irving if he didn’t tell him where some honey was.

Clearly, neither the computer nor Joe Bear is aware of the link between beehives and honey. When programmed with this information, however, the computer still misses the point:

> *One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe walked to the oak tree. He ate the beehive.*

In this case, the computer has gone to the opposite extreme and equated the beehive with the honey, rather than regarding it as a container for the food. Meehan shows here

that although common sense often suggests an easy solution to such problems, it is not so straightforward to specify a complete set of rules that work unambiguously in all circumstances. Meehan's work demonstrates what inferences are by showing what happen when 'taken for granted' information is not 'taken for granted'. Questions which seem ridiculously simple are by no means simple for artificial intelligence researchers trying to replicate the brain's ability to process texts. As Johnson-Laird (1983) points out: "that is the nature of many problems about the mind; we are so familiar with the outcome of its operations, which are for the most part highly successful, that we fail to see the mystery."

Assuming that inferences are time-consuming processes, what motivates a reader to make inferences? The reason for making inferences may be related to the nature of the inferences as well as to characteristics of the reader. Inferences may serve different functions and may have different properties which will result in different probabilities that inferencing occurs during reading.

1.2 A review of research on inference generation

1.2.1 The first generation of research (1970s)

Since the early 1970s, it has been recognized that inferences are a crucial aspect of language. Stevenson (1993: 16), in a review of models of language comprehension, indicated that "linguistic processes are insufficient to account for the way we comprehend and remember sentences. Thinking, the ability to make inferences, is needed." The inferences that are made during reading stimulate intriguing questions for research. Some inference processes seem to be automatic and effortless yet they yield quite complex kinds of information. Other inference processes seem to be dependent on the goals, strategies, and contextual situations of the readers. Some inferences are concerned with the relatively small units of reading represented by words; others are concerned with much larger units like event structures or story outlines. Since about 1970, all of these kinds of inferences have been the subject of investigation, and all of these investigations have shared a common problem: finding empirical measures that can be used to investigate the processes and the products of inference. It was in 1978 when Kintsch and van Dijk (1978) exclaimed that no general theory of inference processing was in sight and the alternative of restricting the model to a small but manageable base had many disadvantages. Of course, in the 1970s, the study of inferences and inference processes was still at its infancy and the theory of Kintsch and van Dijk illustrated one of the first bold attempts to propose a theory of text comprehension and production. However, things have changed a lot. In the past two decades there have been numerous attempts by discourse analysts, linguists, cognitive psychologists, computer scientists, educationalists and researchers from many other disciplines to discover the nature of inferencing and its relevance to the process of text comprehension. The result is the existence of a number of theories, models, and hypotheses concerning the nature of inferencing and the processes involved in making inferences.

1.2.2 The second generation of research

With the development of methodologies for measuring online activities and activations (eye-tracking techniques, probe techniques, etc.) in the mid-1980s, attention shifted from

the product of reading, the memory representation, to the actual process of reading itself. The purpose of this second generation of research was to describe and understand what readers do as they proceed through a text. Here, the focus was on the balancing act that the reader must perform: on the one hand the reader needs to make inferences in order to comprehend the text, on the other hand he or she has a limited attentional or working memory resources available to do so. Models in this generation describe the cognitive processes that take place online: what are the inferences that readers routinely make (and what are those they do not make), how do the confilicting constraints of limited attentional resources and the need for comprehension interact during reading, and so on. Examples of such models are ***Current State Strategy*** (Fletcher & Bloom, 1988), the ***Causal Inference Maker*** (van den Broke, 1990), the ***Construction-Integration Model*** (Kintsch, 1988), ***Minimalist Theories*** (McKoon & Ratcliff, 1992), ***Constructionist Theories*** (e.g., Graesser, Singer, & Trabasso, 1994; Singer, Graesser, & Trabasso, 1994), and the ***Structure Building Framework*** (Gernsbacher, 1990).

1.2.3 The third generation of research

Both generations of research continue to exist, yielding important new insights into reading comprehension and memory. However, in the mid-1990s, a third generation of research developed. The purpose of research in this generation is to integrate the online and offline aspects of reading (e.g., Goldman & Varma, 1995; Goldman, Varma, & Cote, 1996; van den Broek, et al., 1996). Thus, the focus is on comprehension processes *and* memory representation and, most importantly, on the relation between the two. This relation is complex and bidirectional because not only is the representation constantly modified as the reader encounters and comprehends new text, but the developing representation itself provides an important resource for the reader in understanding subsequent text. Thus, comprehension of new information updates the memory representation, which, in turn, influences subsequent comprehension. The Landscape Model attempts to capture the online processes and the offline representation as well as their dynamic interaction (van den Broek et al. 1999).

Thirty years ago there was very little scientific knowledge about inferences in text comprehension. Most research efforts concentrated on the representation of explicit text and the process of linking anaphoric expressions (e.g., noun-phrases, pronouns) to previous explicit text constituents. Time has changed in the world of discourse psychology. There have been serious efforts by discourse psychologists to dig deeper and understand how readers construct ‘situation models’, i.e., mental models of what the text is about. It is now established that inference generation is inextricably bound to the process of construction situation models. The research efforts in recent years have produced a wealth of theoretical positions in discourse psychology, each of which makes distinctive claims about situation model construction and inference generation: ***The constructionist theory*** (Graesser, Singer, & Trabasso, 1994), ***the construction-integration model*** (Kintsch, 1988), ***the structure building framework*** (Gernsbacher, 1997), ***the event indexing model*** (Zwaan, Langston, & Graesser, 1995; Zwaan & Radvansky, 1998), ***the resonance model*** (Myers & O’Brein, Albrecht, & Mason, 1994; O’Brein, Raney, Albrecht, & Rayner, 1997), ***the landscape model*** (Van den Broek, Young, Tzeng, & Linderholm, 1999), ***the schema copy plus tag model*** (Graesser, et al.,

1998), ***the 3CAPS model*** (Goldman, Varma, & Cote, 1996), and ***the minimalist hypothesis*** (McKoon & Ratcliff, 1992).

1.3 Factors affecting inference making

1.3.1 Reader's Background knowledge

Readers' background knowledge has also been shown to be an integral factor in the comprehension of text through inference. Fluency is increased by domain knowledge, which allows the reader to make rapid connections between new and previously learned content; this both eases and deepens comprehension. An expert in a subject can read a text about that subject much more fluently than she can read a text on an unfamiliar topic. Prior knowledge about the topic speeds up basic comprehension and leaves working memory free to make connections between the new material and previously learned information, to draw inferences, and to ponder implications. A big difference between an expert and a novice is the ability to take in basic features very fast, thereby leaving the mind free to concentrate on important features. Experiments have shown that when someone comprehends a text, background knowledge is typically integrated with the literal word meanings of the text to construct a coherent model of the whole situation implied by the text. An expert can quickly make multiple connections from the words to construct a situation model. But a novice will have less relevant knowledge and less well-structured knowledge, and will therefore take more time to construct a situation model. Pearson, Hansen, & Gordon (1979) found that background knowledge had a facilitating effect on inferential comprehension. They emphasized, moreover, that it is not sufficient to have the background knowledge because a reader must also have the ability to relate it to the text. Nicholson & Imlach (1981) cautioned that, although background knowledge is important, readers will learn more from texts by learning how to learn from the texts—by focusing on the 'right elements'. It seems, then, that a reader must rely on knowledge of the incoming text events and must impose some type of organization on these events if the text is to be understood. Furthermore, it seems that readers must not only be able to restructure , disambiguate, and abstract information in order to understand text, but they may also have the desire to carry out these tasks. Thus, there are many demand on a reader. [Phillips, 1988: 195]

1.3.2 Working memory capacity

Singer et al. (1992) investigated how individual differences affect inference-making. They presented paragraphs that required bridging inferences and found that subjects displayed near-ceiling accuracy on inference generation, regardless of their reading span. This is not surprising considering that bridging inferences are assumed to be automatic and necessary for comprehension and, therefore, to occur during reading for most people. However, they found a significant correlation between reading span and accuracy; the higher the reading span, the more accurate the readers were at making the inferences when three sentences intervened between the pieces of information that had to be connected. Using the Reading Span Test, Daneman & Carpenter (1980) and Daneman (1981) observed that individual differences in working memory capacity are associated with individual differences in inference generation and text integration. Daneman & Carpenter found that low-span readers were unlikely to identify the referent to a pronoun sufficiently when six or seven sentences intervened between the two. By contrast, high-

span readers could always identify the referent o the pronoun, regardless of the number of intervening sentences. These studies suggest that working memory capacity is a major determinant of the efficiency of various comprehension processes that are important in reading. It could therefore play a central role in determining what information is readily available, and in turn, whether optional inferences are drawn. [St. George, Mannes, & Hoffman, 1997]

1.3.3 Reading ability

Competent readers have certain characteristics. They have the basic decoding skills that are needed for letter and character identification and word recognition and for understanding sentences. They also have general world knowledge relevant to the topic and content of the text. More important, they are able to make connections between ideas in the text, and between the text and their general knowledge, to construct a coherent representation of the text (Black & Bower, 1980; Graesser, 1981; Just & Carpenter, 1992; Kintsch, 1998; Myers & Duffy, 1990; van den Broek, 1990). To assess the contribution of inferential processing to reading skill, researchers have examined whether skilled and less skilled readers differ in the extent to which they generate inferences during reading. Although studies have shown that less skilled readers perform poorly on tasks that require inference generation (Garnham, Oakhill, & Johnson-Laird, 1982; Long & Golding, 1993; Oakhill, 1983, 1984; Oakhill, Yuill, & Donaldson, 1990; Singer et al. 1992; Whitney, Ritchie, & Clark, 1991; Yuill, Oakhill, & Parkin, 1989), it is difficult to know whether their poor performance is due to deficits in inferential abilities or failure to encode an accurate propositional representation of the text. For example, Long & Golding (1993) found that readers who failed to generate inferences that specified the goals of characters in script-based stories also exhibited poor recall of the explicit information in the texts. These readers may have performed poorly on the memory test because they (a) failed to establish an accurate propositional representation or (b) failed to generate inferences to elaborate their representation.

Several researchers have attempted to distinguish between the two possibilities above by matching subjects on certain reading abilities and then assessing the contribution of inferential processing to comprehension performance. For example, Oakhill and her colleagues conducted several studies in which they selected subjects who were matched on tests of word recognition accuracy and reading vocabulary but differed on a test of reading comprehension (Garnham et al. 1982; Oakhill, 1983, 1984). They found that less skilled readers , compared with skilled readers, (a) were poorer at answering questions that required an inference even when the text was available during questioning (Oakhill, 1984), (b) made less use of context in the interpretation of a text (Oakhill, 1983), and benefited less from referential continuity in stories (Garnham et al. 1982). Although these studies suggest that inference problems can occur independently if deficits in word recognition accuracy, the extent to which failure to generate inferences may be secondary to deficits in other reading abilities has not been fully assessed. For example, less skilled readers may have accurate word recognition skills but have deficiencies in syntactic or semantic processes. Alternatively, less skilled readers may have accurate but very slow word recognition processes, which limit the rate at which higher sentence-level processes can be executed (Perfetti & Roth, 1981). It is unlikely that groups of skilled and less

skilled readers can be identified who differ in comprehension performance but do not differ on a range of component reading abilities. Less skilled readers typically show deficits in multiple component processes (Perfetti, 1985, 1989).

1.3.4 Reader's goal

The control of inferences depends to a considerable extent on the reader's purpose and the reader's knowledge. Inferences are made online if they are related to information that is relevant to the reader's purpose, and inferences are more likely to be made if they deal with familiar topics. This is because reading is a process in which a balance between costs and benefits is achieved. The benefits consist of the information extracted from the text; the costs are related to the extra mental processes that this requires. The reader seems to be rather parsimonious in processing. Apparently, readers have a tendency to satisfy themselves with rather shallow processing. This is indicated by the absence of the inferences in normal reading expository text. “The control of inferences depends to a considerable extent on the reader’s purpose and the reader’s knowledge” (Vonk & Noodman, 1990: 462). Readers are motivated by one or more comprehension goals when reading a text. The goals are either idiosyncratic to the reader or are appropriate for the text genre. Good readers allocate their mental effort to explicit information and inferences that address the reader's comprehension goals. There are certain conditions that prevent the reader from constructing a meaning representation. If the reader fails to devote any effort, then these inferences are not drawn. (Graesser, Singer, & Trabasso, 1994). Apparently, readers have a tendency to satisfy themselves with ***shallow processing***. The control of inference depends to a considerable extent on the reader’s purpose and the reader’s knowledge. Inferences are made online if they are related to information that is relevant to the reader’s purpose, and inferences are more likely to be made if they deal with familiar topics. Reading is a process in which a balance between costs and benefits is achieved. The benefit consists of information extracted from the text; the costs are related to the extra mental processes that this requires. The reader seems to be rather parsimonious in processing (Vonk & Noordman (1990). It is somehow pointless to make inferences that are not central (or relevant) to the discourse. Inferential activity could be constrained by processes oriented toward certain key activities that are usually required for comprehension. Examples include anaphora and causality. “Inferential activity could be constrained by processes oriented toward certain key activities that are usually required for comprehension, e.g., anaphora and causality” (Sanford, 1990: 525).

1.3. 5 Reader's Interest

While the vast majority of previous studies on text processing have focused on the structural importance of the text, the *affective variables*, such as interest, have been ignored for several decades. However, in recent years the concept of interest has received increasing attention not only in the area of text processing, but also of learning and memory in general.. Nevertheless, there is no theoretical model of interest due to the lack of empirical study on the cause of interest. Most research on interest has focused on two different types of interest: individual interest and situational interest (Hidi & Baird, 1988). Individual interest, which are specific to the individual predisposition, are relatively stable but develop slowly. On the other hand, situational interests elicited by stimulus characteristics or the environment are generated immediately and shared among

individuals. Kintsch (1980) suggested that interestingness is determined by *unexpectedness* and *personal relatedness*. Schank also postulated that certain themes such as death, danger, power, sex, etc., are inherently interesting although it is not clear why. Kintsch (1980) proposed a more elaborative explanation of interest than Schank's. He distinguished two types of text-based interest, *emotional interest* and *cognitive interest*. Emotional interest is created by events that have an arousal function, such as violence, sex, etc. Cognitive interest, on the other hand, is produced by the relationships of incoming information to background knowledge and is determined by three factors: (a) how much background knowledge a reader possesses on the topic; the degree of uncertainty (unexpectedness or surprise) of the information; and (c) the postdictability of the information, meaning how well the information can be meaningfully related to other sections of the text. According to Kintsch (1980), cognitive interest is assumed to be an inverted U-shaped function of the knowledge and uncertainty. That is, if a situation is highly familiar or highly unfamiliar, or if a situation is easily expected or not expected at all, the interstingness decreases.

1.4 Inference training

Some evidence suggests that making inferences per se is not an inherently difficult task (Markman, 1981). Children routinely use inferencing during nonschool activities, for example, when deducing similarities and differences between new and familiar events, but classroom activity does not often provide opportunities for the use of such skills (Chouhare & Pulliam, 1980). Instead of being taught to learn textual information by relating it to something they already know, children are often taught to learn new information by simply remembering it. Sundbye (1987) found that asking inference questions about relationships between characters in a text, for example, their goals and motivations for action, enhanced third grade children's story comprehension as effectively as modifying the text so that the information was explicitly stated. This indicates that inference training may represent a powerful tool for children in their text-related activities. (McGee & Johnson, 2003). Instead of being taught to learn textual information by relating it to something they already know, children are often taught to learn new information by simply remembering it. Teachers frequently hear students lament the answer is not in the book; in actuality, students do not know how to construct the answer from prior knowledge and textual content. Moreover, some poor readers do not understand how the process of answering inferential questions differs from answering literal ones (Raphael, Winograd, & Pearson, 1980; Carr, Dewitz, & Patber, 1989).

Without explicit training it is more difficult for children to answer ***inferential questions*** about a text than literal questions (Hansen & Pearson, 1983; Pearson, Hansen & Gordon, 1979). It is important for educators to understand whether this gap between the ability to answer inferential and literal questions reflects a natural variation in task difficulty, in instructional history, or a combination of both. Some evidence suggests that making inferences per se is not an inherently difficult task (Markman, 1981). Children routinely use inference during nonschool activities, for example when deducing similarities and differences between new and familiar events, but classroom activity does not often provide opportunities for the use of such skills. (Chouhare & Pulliam, 1980). Instead of being taught to learn textual information by relating it to something they already know,

children are often taught to learn new information by simply remembering it. Sundbye (1987) found that asking inference questions about relationships between characters in a text, for example their goals and motivations for action, enhanced third grade children's story comprehension as effectively as modifying the text so that the information was stated explicitly. This indicates that inference training may represent a powerful tool for children in their text-related activities.

Sundbye (1987) found that asking inference questions about relationships between characters in a text, for example, their goals and motivations for action, enhanced third grade children's story comprehension as effectively as modifying the text so that the information was explicitly stated. This indicates that inference training may represent a powerful tool for children in their text-related activities. (McGee & Johnson, 2003). Yuill & Joscelyne (1998) examined the effect of short term inference instruction on skilled and less-skilled comprehenders. Their results showed that once trained, less-skilled comprehenders showed significantly enhanced performance on comprehension questions than control subjects given no training. Skilled comprehenders did not show a similar improvement but Yuill & Joscelyne argue that this may be because they are already using the strategy spontaneously and so have little scope for further improvement. Yuill & Oakhill (1988) suggested that poor comprehenders are often not aware of their comprehension difficulties but are generally less satisfied with reading as a potentially enjoyable activity. They combined explicit training in question generation with inference instruction to alert such children to the type of inferences they might make from a text and to provide a technique for them to do so effectively.

One of the most effective instruction techniques investigated in recent years is *inference awareness training*. This technique represents a way of thinking about stories that may be less familiar to children because they have fewer opportunities to analyze stories in a standard classroom setting. Working with remedial and other elementary students, Carr, Dewitz, & Patberg (1989) developed the Inferential Training Technique (ITT), which helps students to infer information while improving general comprehension and comprehension monitoring. The strategy has been used successfully with 5^{th} and 6^{th} grade classes including remedial leaners (Dewitz, Carr, & Patberg, 1987). They claim that the technique can be readily integrated into classroom instruction in nearly all curricular areas. Its components include a modified cloze procedure and a self monitoring checklist for transfer the strategy to new situations.

There are many ways to foster student awareness of inferences and assumptions. For one thing, all disciplined subject-matter thinking requires that students learn to make accurate assumptions about the content they are studying and become practiced in making justifiable inferences within that content. As a matter of daily practice, we can help students begin to notice the inferences they are making within the content we teach. We can help them identify inferences made by authors of a textbook or of an article we give them. Once they have identified these inferences we can ask them to figure out the assumptions that led to those inferences. When we give them routine practice in identifying inferences and assumptions, they begin to see that inferences will be logical when the

assumptions that lead to them are not justifiable. They begin to see that whenever they make an inference, there are other (perhaps more logical) inferences they could have made. They begin to see high quality inferences as coming from good reasoning. We can also help students think about the inferences they make in daily situations and the assumptions that lead to those inferences. As they become skilled in identifying their inferences and assumptions, they are in a better position to question the extent to which any of their assumptions are justified (Elder & Paul, 2002)

Many basal reading series direct teachers to use valuable teaching time to instruct students in 'inferencing skills". But a simple example illustrates that inferencing itself is a fairly basic skill that most children already have: If somebody says to a child, "Hey, shut up. I'm trying to read," most children can infer the connection between the first statement and the second. They have prior knowledge of the fact that hearing somebody talk can be distracting and make reading difficult. So they are able to construct a mental model that meaningfully connects the sentence "Hey shut up" with the sentence "I'm trying to read."

Collins, Brown & Larkin (1980) identified eight strategies used by skilled adult readers making inferences to understand text. They argued that, in creating an understanding of text, readers progressively refine models of the text until they converge on a model that seems to be the most plausible. This refinement process makes use of several problem-solving strategies. Their work on strategies used by readers as they attempt to make inferences was extended by Phillips (1988) who identified the following ten strategies utilized by young readers in the course of text comprehension:

1. Rebinding is used when a reader suggests or hypothesizes a possible interpretation, *immediately* realizes that this interpretation conflicts with previous information, and then substitutes another interpretation. In essence, the reader binds (connects) all the information up to a point but then changes the interpretation (rebinds) to make it a better or more plausible fit.

2. Questioning a default interpretation is employed when a reader's initial interpretation triggers a knowledge schema that the reader may or may not continue to maintain. The reader may have misinterpreted certain data and/or may have made incorrect assumptions based on the available data. Strategy 2 is used when subsequent information is in conflict and, rather than questioning the current interpretation, the reader questions a previous interpretation and/or accompanying assumptions.

3. Shifting of focus is used when the immediate information cannot be readily resolved within a reader's interpretation and the reader addresses related questions that have not yet been considered.

4. Analyzing alternatives is used when a reader does not settle on any interpretation of the data but raises more than one possibility and remains tentative until more information is available. Words indicating tentativeness and the recognition of alternatives such as *probably, maybe, or, might,* and *I think* are often used with this strategy.

5. Assigning an alternative case is employed when information cannot be interpreted to fit an existing interpretation, subsequent information does not provide a solution, and the reader temporarily digresses from the ongoing interpretation.

6. Confirming an immediate prior interpretation is used when a reader confirms an interpretation on the basis of information immediately following it.

7. Confirming a nonimmediate prior interpretation is used when a reader considers interpretations different from the one already made but, on the basis of subsequent information, reverts to the earlier interpretation, confirming it as the choice and thus taking on a new interpretation.

8. Assuming a default interpretation and transforming information is used when a reader makes an interpretation and then, in an attempt to confirm the interpretation despite inconsistencies, microstructures new data presented.

9. Withholding or reiterating information is used when a reader either is silent in response to requests for information or rephrases a previously made interpretation without the addition of any new information.

10. Emphasizing with the experiences of others is used when a reader, through personal identification with the story, projects himself or herself into the situation and experiences another's condition. This emphasizing becomes part of the readers' interpretation, without a loss of story focus or the introduction of inconsistencies with either the text or with the reader's interpretation.

References

Anderson, R. c., & Pearson, P. (1984). Research methodology on the use of verbal reports in reading research. *Journal of Reading Behavior, 16,* 307-322.

Audi, R. (1998). *Epistemology: A contemporary introduction to the theory of language.* London: Routledge.

Black, J. B., & Bower, G. H. (1980). Story understanding as problem solving. *Poetics, 9,* 223-250.

Bransford, J. D., & McCarrell, N. S. (1974). A sketch of a cognitive approach to comprehension: Some thoughts about understanding what it means to comprehend. In W. G. Weimer & D. S. Palermo (Eds.), *Cognition and the symbolic processes* (pp. 189-229). Hillsdale, NJ: Lawrence Erlbaum Associates.

Brewer, F. W. (1977). Memory for the pragmatic implications of sentences. *Memory and Cognition, 5,* 673-678.

Cain, K. Oakhill, J. V., Barnes, M. A., & Bryant, P. E. (2001). Comprehension skill, inference-making ability, and their relation to knowledge. *Memory & Cognition, 29(6),* 850-859.

Cain, K., & Oakhill, J. V. (1999). Inference making ability and its relation to comprehension failure in young children. *Reading & Writing: An Interdisciplinary Journal, 11,* 489-503.

Carr, E., Dewitz, P., & Patberg, J. (1989). Using cloze for inference training with expository text. *The Reading Teacher, 42(6),* 38-385.

Chouhare, V., & Pulliam, C.A. (1980). Teacher questioning: A verification and an extension. *Journal of Reading Behavior, 12,* 69-72.

Collins, A., Brown, J. S., & Larkin, K. M. (1980). Inference in text understanding. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension* (pp. 385-407). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Daneman, M. (1981). *Individual differences in working memory and text integration.* Pittsburg. PA: Carnegie-Mellon University.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior, 19,* 450-466.

Dewitz, P., Carr, E. M., & Patberg. J. P. (1987). Effects of inference training on comprehension and comprehension monitoring. *Reading Research Quarterly, 22,* 99-119.

Dole, J. A., Duffy, G. G., Roehler, L. R., & Person, P. D. (1991). Moving from the old to the new: Research on reading comprehension instruction. *Review of Educational Research, 61,* 239-264.

Elder, L., & Paul, R. (2002). Critical thinking: distinguishing between inferences and assumptions. *Journal of Developmental Education, 25(3),* 34-37.

Fletcher, C. R., & Bloom, C. P. (1988). Causal reasoning in the comprehension of simple narrative texts. *Journal of Memory and Language, 27,* 235-244.

Garnham, A., Oakhill, J., & Johnson-Laird, P. N. (1982). Referential continuity and the coherence of discourse. *Cognition, 11,* 29-46.

Gernsbacher, M. A. (1990). *Language comprehension as structure building.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gernsbacher, M. A. (1997). Two decades of structure building. *Discourse processes, 23,* 265-304.

Goetz, E. T. (1977). *Inferences in the comprehension of and memory for text* (Tech. Rep. No. 49). Urbana-Campaign: University of Illinois, Center for the Study of Reading.

Goldman, S. R., & Varma, S. (1995). CAPing the construction-integration model of discourse comprehension. In C. Weaver, S. Mannes, & C. Fletcher (Eds.), *Discourse comprehension: Models of processing revisited* (pp. 337-358). Hillsdale, NJ: Erlbaum.

Goldman, S. R., Varma, S., & Cote, N. (1996). Extending capacity-constrained construction integration: Toward "smarter" and flexible models of text comprehension. In B. K. Britton & A. C. Graesser (Eds.), *Models of understanding text.* (pp. 73-113). Mahvah, NJ: Erlbaum.

Goodman, K. S. (1973). Miscues: Windows on the reading process. In K. S. Goodman (Ed.), *Miscue analysis: Applications to reading* (pp. 3-14). Urbana-Champaign, IL: National Council of Teachers of English.

Graesser, A. C. (1981). *Prose comprehension beyond the word.* New York: Springer-Verlag.

Graesser, A. C., Kassler, M. A., Kreuz, R. J., & McLain-Allen, B. (1998). Verification of statements about story worlds that deviate from normal conceptions of time: What is true about Einstein's dreams? *Cognitive Psychology, 35,* 246-301.

Graesser, A. C., Singer, M., & Trabasso, T. (1994). Constructing inferences during narrative text comprehension. *Psychological Review, 101,* 371-395.

Hansen, J., & Pearson, P. D. (1983). An instructional study: Improving the inferential comprehension of good and poor fourth-grade readers. *Journal of Educational Psychology, 75,* 821-829.

Harris, R. J., & Monaco, G. E. (1978). The psychology of pragmatic implication: Information processing between the lines. *Journal of Experimental Psychology: General, 107,* 1022.

Hidi, S., & Baird, W. (1988). Strategies for increasing text-based interest and students' recall of expository texts. *Reading Research Quarterly, 23,* 465-483.

Johnson-Laird, P. N. (1983). *Mental models.* Cambridge, MA: Harvard University Press.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 99,* 122-149.

Kintsch, W. (1974). *The representation of meaning in memory.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Kintsch, W. (1980). Semantic memory: a tutorial In R. S. Nikerson (Ed.), *Attention and Performance. (Vol, VIII).* Hillsdale, NJ: Erlbaum.

Kintsch, W. (1986). On modeling comprehension. In S. de Castell, A, Luke, & K. Egan (Eds.), *Literacy, society, and schooling* (pp. 175-195). New York: Cambridge University Press.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A constructive-integration model. *Psychological Review, 95,* 163-182.

Kintsch, W. (1992). How readers construct situation models for stories: The role of syntactic cues and causal inferences. In A. F. Healy, S. M., Kosslyn, & R. M., Shiffrin (Eds.), *From learning processes to cognitive processes. Essays in honor of William, K. Estes* (Vol. 2, pp. 261-278). Hillsdale, NJ: Erlbaum.

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

Long, D. L., & Golding, J. M. (1993). Superordinate goal inferences : Are they automatically generated during comprehension? *Discourse Processes, 16,* 55-74.

Long, D. L., Oppy, B. J., & Seely, M R. (1994). Individual differences in the time course of inferential processing. *Journal of Experimental Psychology: Learning, Memory, and Cogntion, 20(6),* 1456-1470).

Markman, E. M. (1981). Comprehension monitoring. In J. Dickson (ed.), *Children's oral communication skills* (pp. 137-145). New York: Academic Press.

Mason, J. (1984). A schema-theoretic view of the reading process as a basis for comprehension instruction. In G. Duffy, L. Roehler, & J. Mason (Eds.), *Comprehension instruction* (pp. 26-38). New York: Longman.

Mcgee, A., & Johnson, H. (2003). The effects of inference training on skilled and less-skilled comprehension. *Educational Psychology, 23 (1),* 49-59.

McKoon, G., & Ratcliff, R. (1992). Inference during reading. *Psychological Review, 99,* 440-466.

Myers, J. L., & Duffy, S. A. (1990). Causal inferences and text memory. In A. C. Graesser, & G. H. Bower (Eds.), *Psychology of learning and motivation: Inferences and text comprehension.* (Vol. 25, pp. 35-52). San Diego, CA: Academic.

Myers, J. L., O'Brien, E. J., Albrecht, J. E., & Mason, R. A. (1994). Maintaining global coherence during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 876-886.

Oakhill, J. (1983). Instantiation in skilled and less skilled comprehenders. *Quarterly Journal of Experimental Psychology, 35,* 441-450.

Oakhill, J. (1984). Inferential and memory skills in children's comprehension of stories. *British Journal of Educational Psychology, 54,* 31-39.

Oakhill, J., Yuill, N., & Donaldson, M. L. (1990). Understanding of causal expressions in skilled and less skilled text comprehenders. *British Journal of Developmental Psychology, 8,* 401-410.

O'Brien, a. G., Raney, G. E., Albrecht, J. E., & Rayner, K. (1997). Processes involved in the resolution of explicit anaphors. *Discourse Processes, 23,* 1-24.

Pearson, P. D., Hansen, J., & Gordon, C. (1979). The effect of background knowledge on young children's comprehension of explicit and implicit information. *Journal of Reading Behavior, 11,* 201-210.

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

Perfetti, C. A. (1989). There are generalized abilities and one of them is reading. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 307-335). Hillsdale, NJ: Erlbaum.

Perfetti, C. A., & Roth, S. F. (1981). Some of the interactive processes in reading and their role in reading skill. In A. M. Lesgold & C. A. Perfetti (Eds.), *Interactive processes in reading* (pp. 269-297). Hillsdale, NJ: Erlbaum.

Phillips, L. M. (1988). Young readers' inference strategies in reading comprehension. *Cognition & Instruction, 5(3),* 193-222.

Reder, L. M. (1980). The role of elaboration in the comprehension and retention of prose: A critical review. *Review of Educational Research, 50,* 5-53.

Samuels, S. J., & Kamil, M. L. (1984). Models of the reading process. In P. D. Pearson (Eds.), *Handbook of Reading Research* (pp. 185-224). New York: Longman.

Schank, R. C. (1975). The structure of episodes in memory. In D. LaBerge & S. J.

Samuels (Eds.), *Basic processes in reading, perception, and comprehension* (pp. 237-272). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Singer, M., Andrusiak, P., Reisdorf, P., & Black, N. L. (1992). Individual differences in bridging inference processes. *Memory & Cognition, 20*, 539-548.

St. George, M., Mannes, S., & Hoffman, J. E. (1997). Individual differences in inference generation: An ERP analysis. *Journal of Cognitive Neuroscience, 9(6)*, 776-787.

Stevenson, R. J. (1993). *Language, thought, and representation*. New York: John Wiley & Sons.

Sundby, N. (1987). Text explicitness and inferential questioning: Effects of story understanding and recall. *Reading Research Quarterly, 22*, 82-98.

Thorndike, E. L. (1917). Reading as reasoning: A study of mistakes in paragraph reading. *Journal of Educational Psychology, 8*, 323-332.

Tierney, R. J., & Spiro, R. J. (1979). Some basic notions about reading comprehension: Implications for teachers. In J. Harste & R. Carey (Eds.), *New perspectives in comprehension* (pp. 132-137). Bloomington: Indiana University Monographs on Language and Thinking.

Tierney, R. J., & Spiro, R. J. (1979). Some basic notions about reading

Van den Broek, P. (1990). The causal inference maker: Towards a process model of inference generation in text comprehension. In D. A. Balota, G. B. Flores D'Arcais, & K. Rayner (Eds.), *Comprehension processes in reading* (pp. 423-435). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Van den Broek, P. Young, M., & Linderholm, Y. T. T. (1999). The landscape model of reading: Inferences and the online construction of a memory representation. In S. R. Goldman, H. V. Ooostendorp (Eds.), *The construction of mental representations during reading* (pp. 71-98). Mahvah, NJ: Erlbaum.

Van den Broek, P., Risden, K., Fletcher, C. R., & Thrulow, R. (1996). A landscape view of reading: Fluctuating patterns of activation and the construction of a stable memory representation. In B. K. Britton, & A. C. Graesser (Eds.), *Models of understanding text* (pp. 165-187). Mahvah, NJ: Erlbaum.

Van Dijk, T., & Kintsch, W. (1983). *Strategies of discourse comprehension.* New York: Academic.

Vonk, W., & Noordman, L. G. M. (1990). On the control of inferences in text understanding. In D. A., Balota, G. B. Flores D'Arcais, & K. Rayner (Eds.), *Comprehension processes in reading.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Weaver, C. A., & Kintsch, W. (1991). Expository text. In R. Barr, *Handbook of Reading Research* (pp. 230-245). Mahvan, NJ: Lawrence Erlbaum Associates.

Whitney, P., Ritchie, B. G., & Clark, M. B. (1991). Working memory capacity and the use of elaborative inferences in text comprehension. *Discourse Processes, 14*, 133-145.

Wilson, M. M. (1979). The processing strategies of average and below average readers answering factual and inferential questions of three equivalent passages. *Journal of Reading Behavior, 11*, 235-245.

Yuill, N., Oakhill, J., & Parkin, A. (1989). Working memory, comprehension ability and the resolution of text anomaly. *British Journal of Psychology, 80*, 351-361.

Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin, 123,* 162-185.

Zwaan, R. A., Langston, M. C., & Graesser, A. C. (1995). The construction of situation models in narrative comprehension: An event-indexing model. *Psychology Science, 6,* 292-297.