# INFERENTIAL COMPREHENSION
# BY LANGUAGE-LEARNING DISABLED CHILDREN

By

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B.A., Simon Fraser University, 1988

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
in

THE FACULTY OF GRADUATE STUDIES
The School of Audiology and Speech Sciences

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
January 1991

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Date Jan 7, 1991

# ABSTRACT

This study evaluated the comprehension of inference statements by language-learning disabled (LLD) children and children with normal language development (NL) under two conditions: uncontextualized and contextualized. The contextualized condition was designed to encourage retrieval of information from the subject's general knowledge -- a procedure proposed to encourage elaborative inference-making. Two text passages were analyzed according to a model developed by Trabasso and presented by Trabasso, van den Broek & Suh (1989), which yielded a set of bridging causal connections across clause units. Sets of three true and three false causal inference statements were developed to represent bridging inferences for each story. In addition, three true and three premise statements were obtained directly from each story, yielding a total of twelve statements for each text. Subjects were ten language-learning disabled students (7 boys, 3 girls) and ten children with normal language development (5 boys, 5 girls) aged 9 to 11 years old. Mean age for children in both groups was 10 years, 4 months.

Children were selected for the LLD group on the basis of the following criteria: (1) enrollment in a learning assistance or learning resource program for learning-disabled students, preferably for remediation of Language Arts; (2) history of speech-language intervention in preschool or early primary grades; (3) normal nonverbal cognitive skills; (4) lexical and syntactic comprehension within normal abilities (as determined by standardized language tests for the LLD group); (5) native English speaker and (6) normal hearing ability.

Every subject received both stories and conditions. Story presentation and condition were counterbalanced across 8 of the 10 subjects in each group; condition only was counterbalanced across the remaining two subjects in each group. Inference and premise statements were randomized; each random set was randomly presented to each subject. Items were scored correct or incorrect. Subjects were also asked to answer open-ended wh-questions. Responses were compared and analyzed using a nonparametric statistical method appropriate for small sample sizes.

Results indicated significant differences between the LLD and the NL groups on the number of correct responses to inference and premise items. Both groups scored significantly worse on inference than premise items. Analysis did not indicate that the LLD group scored significantly worse on inference items than the NL group did. Results also suggested that a contextualization effect operated for both groups, which affected the retention of premise items but acted to improve scores on inference items. This effect was seen most notably for the LLD group.

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# ACKNOWLEDGEMENTS

Sincere thanks to the students, teachers and parents who participated in this study.

Great thanks and love to my mother, Johanna, for her unending encouragement.

# CHAPTER ONE

## REVIEW OF THE LITERATURE

### Introduction

Clinical observations of children with language-based learning disabilities have indicated that there exists a population of students for whom particular classroom material poses difficulty. Tasks within the classroom often require children to understand units of written or verbal texts, such as expository or descriptive passages and stories, where information is sometimes not explicit in the language of the material. Implicit writing style may be very common in children's textbooks (see Irwin, 1988). In fact, implicational style is commonly found in most linguistic exchanges in general (Brown & Yule, 1983). From textbooks, students are required to somehow bridge the material provided to acquire its informational content. The process of bridging, or "reading between the lines," is known as making inferences. Speech-language clinicians are frequently referred students who demonstrate problems comprehending such classroom text material. However, such children are difficult to diagnose because traditional assessment of language based on the comprehension of lexical forms and syntactic structures proves to be limited in explaining the problem. Often such children display normal comprehension of language at this level. However, upon investigation, a significant population within this group of children indeed demonstrates not only lack of comprehension of textbook material, but also lack of ability to apply the content to such tasks as answering questions about it,

or solving problems related to the content. Brown & Yule describe the task many readers must face (not least of which include school-aged children):

> it is typically the case that the texts which a reader will normally encounter will show a minimal amount of formal cohesion[1], assume massive amounts of background knowledge, and normally require the reader to make whatever inferences he feels willing to work for in order to reach an understanding of what is being conveyed. (1983: 269-270)

Research results, which will be presented later, suggest that successful inference-making is a complex process that involves understanding how content in a text interrelates and relates to information in the real world. This procedure requires actively determining how text and real world knowledge can plausibly relate. Thus, inference-making requires retrieval of information from a store of background knowledge. Clinicians faced with diagnosing and providing instruction to children who fail to comprehend material at this level frequently assume an inference-making process deficit exists. A common assumption is that inference-making is a simple unitary phenomenon, whereas in fact this process is quite complex.

Important questions should query who the children who exhibit these difficulties are; why certain material contributes to these problems being manifested; and how intervention should proceed to remediate the deficits displayed. The hypothesis presented in the following study will be that children who display difficulty understanding text-level material in which information is implicit in fact have difficulty retrieving appropriate real world knowledge to understand the text completely, and not just in integrating sentences within a text (Kintsch & van Dijk, 1978; Bransford & Johnson, 1973), as is often assumed.

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[1] Connection on the basis of linguistic forms.

Language-Learning Disabled Children

Language-disabled students form a heterogeneous group; they are those children who demonstrate a discrepancy between their potential for academic success and their actual achievement. Within this group, a subgroup of children may display particular difficulties with language-based material. In fact, language-impaired students are said to comprise a large percentage of the learning disabled population (McKinney, 1984). These children are often termed "language-learning disabled" (or LLD), a concise label which encompasses a large field of disorders. Some recent studies have shown that children included in the LLD category have more difficulty than normal children making inferences when listening to short stories (e.g. Ellis Weismer, 1981; 1985) and to longer more elaborated stories (Crais & Chapman, 1987). Waller (1976, cited by Kail, Chi, Ingram & Danner, 1977) presented sentences such as "The airplane flew over the city" and "The city was Chicago" to children identified as poor readers and to their normal reading peers. The children from the disordered group were less likely than those from the normal group to say they had heard a sentence, one that could possibly be inferable, derived from the two sentence set, such as "The airplane flew over Chicago."

Normal language developers are said to acquire subtle and important language skills beyond the age when major structures and the rules of the language have been acquired (e.g. Johnston, 1982; Trabasso, 1986). The most notable developmental changes occur at levels beyond the sentence, at the discourse level. These changes include improved proficiency at producing and understanding story structure and content, improved conversational adequacy, and continued "register" development, i.e. improved knowledge that different language tasks require different language structures. Thus, it follows that language-impaired children may

eventually experience deficits within these discourse domains. A clearer understanding of the locus of the comprehension breakdown is required by the speech-language pathologist for the diagnosis and remediation of these children.

The children of interest in the following study are those who demonstrate difficulty comprehending text-based material, such as textbook passages or stories, and who have in their younger years demonstrated comprehension problems with other language constructs, such as vocabulary and sentence-level elements. These children are receiving learning-assistance or have been identified as being learning disabled, however that label is applied within their particular school or instructional program, indicating that academic success is weak.

## Development of Inference-Making Abilities

Early studies in the area of inference-making processes by school-age children showed that these abilities improve with age (Paris & Lindauer, 1976; Paris, Lindauer & Cox, 1977; Paris & Upton, 1976). Some other studies have shown no developmental changes in these processes (e.g. Kail, Chi, Ingram & Danner, 1977). Studies by Paris and his colleagues attempted to investigate children's comprehension of sentences and sentence pairs where the subjects were required to construct additional meanings to perform a variety of tasks. They found that children eventually developed the ability to infer various semantic components such as instruments, agents or action consequences given sentences containing implicational gaps. Hilyard (1979) explained that the process of within-text inference-making, or constructing new meanings by, say, integrating two sentences to formulate a third proposition, develops by the time a child is about 7 years old. The ability to make constructed

meanings that require accessing lexical knowledge (as in Paris, Lindauer & Cox, 1977) develops by about 10 years. Trabasso claimed that by 11 years, children should be able to actively apply their knowledge about the world to construct inferences that help to integrate stories, in order to comprehend them.

Statements about the general developmental course of inference-making abilities by children should be made with caution, however. As will be shown, there is little concensus in the available literature regarding the definition of inference or inference-making operations. Studies have centred on the comprehension of short texts requiring relatively "simple" inferences (e.g. Paris & Lindauer, 1976) to the construction of elaborated inferences that incorporate text material and prior knowledge during text comprehension (e.g. Crais & Chapman, 1987). In summary, despite studies that differ in methodology, materials, operational definition etc., there appears to be evidence that a certain population of children experience difficulty comprehending textual material requiring the generation of a certain type of inference. These children, often receiving academic assistance from speech-language pathologists or other resource professionals, are those who display difficulty comprehending certain oral language texts but for whom traditional diagnostic tools are limited. It is the aim of this study to show that complex inference-making requiring access, retrieval and active application of real world knowledge for text comprehension, poses particular difficulty for these children. Finally, it is suggested that when these children are aided in the retrieval of their own prior knowledge, comprehension of implicit material is facilitated.

## Theoretical Framework for Studying Inferential Processing

Language comprehension traditionally was viewed as the process of deriving meaning from the sentence unit. Most recently comprehension of sentence sequences in units, such as texts or discourse entities have been considered. This thesis will approach the process of inference-making within the larger framework of text comprehension. In this approach, the process by which a listener or reader forms a "conceptual representation" of a set of sentences will be investigated. This issue addressed is how the comprehender not only utilizes the linguistic information provided by the lexical and syntactic elements of individual sentences, but also infers information from other sources, such as real world knowledge and environmental context, in developing a concept of the textual meaning. In capturing the idea that inference-making is "reading between the lines" of sentences, Rickheit, Schnotz & Strohner (1985) stated that this process is "the generation of new semantic information from old semantic information in a given context" (p. 8). Termed "constructive comprehension," the inference-making process is applied whereby ambiguities or gaps found in the text, or implied meanings, are resolved by accessing knowledge from memory (Johnson-Laird, 1973).[2]

The building of a text framework provides a representation of not only specific text features, but also of what the text is about (Speelman & Kirschner, 1990). Text comprehension is accomplished when a functional and meaningful representation is formed. The representation is composed of representations of surface structure elements and any and all causal, instrumental, agentive and consequence connections (to name a few) that

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[2] Both within-sentence and across-sentence gaps can be resolved by this procedure (Johnson-Laird, 1983). Only across-sentence processes will be addressed in this study.

can plausibly relate to text meaning. Again, inferences are required to help build such a representation.

Thus, inferences provide the binding links necessary to help integrate individual sentences in a text, and allow the listener or reader to interpret a speaker's or writer's intention. Inferences are, in particular, "gap fillers" that serve to accomplish text coherence (Kintsch & van Dijk, 1978; Whitney, 1987).

Consider, for example, the following set of sentences:

(1) a. One spring day the wind was blowing.

b. All the ice piled up on a rock in the middle of the lake.

c. Big spaces of blue appeared in the water.

d. The next day, the Indian men from the reserve were able to go beaver trapping.

This text is generally understandable, even though the connecting relationships between the propositions are not explicit. The reader must comprehend the overt text elements and recognize that some connections between them are implicit. In relating the meaning of each proposition to the following and to the previous proposition, a set of conditions -- a context -- that provides the integrating concepts is established. The nature of this invoked context can be explained several ways.

Two major viewpoints have arisen from research in the area of constructive comprehension. Some researchers have attempted to incorporate the process of inference-making during text comprehension into larger frameworks of knowledge or memory representation, which still satisfy the autonomous or modular requirements of a language comprehension system (Johnson-Laird, 1973). This is justified because it is necessary to appeal to a theory that encompasses linguistic competence (i.e. knowledge of lexical and structural elements and rules) as well as

cognitive processes (i.e. those involved in the interpretation of text units). Thus, these theories attempt to explain the nature of the organized structure that the listener or reader derives from the text. The two approaches have investigated text comprehension, and therefore inferential processing, from theories of general knowledge structures.

Text-based Theories

The first approach, exemplified by a text comprehension model developed by Kintsch & van Dijk (1978), suggests that discourse comprehension involves forming a representation of the propositional structure inherent in the discourse. In other words, comprehension involves development of a discourse "schema."[3] During reading or listening, comprehension involves matching incoming information with that of the particular discourse structure thus invoked.

Inferences are provided to this structure when information from the text is missing; the inferences provide the intervening details which have not been satisfied by the text material. Inferences have also been considered the "default values" of the stereotyped text structure. Kintsch & van Dijk (1978) state "an attempt will be made to fill in the missing information by applying available *knowledge frames* to the information presented directly" (1978: 373, italics added). Unfortunately, it is not clear from the model delineated by the researchers what the nature of this background knowledge is. From the terminology, it is assumed that larger stereotyped knowledge structures are appealed to, such as those described by Minsky (1975) or Schank & Abelson (1977).[4]

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[3] Kintsch & van Dijk (1978) take their notion of discourse schematic structure from Minsky (1975) and Shank & Abelson (1977) among others.
[4] Brown & Yule (1983, Chapter 7) present a review of this topic.

Knowledge-based Theories

The second major approach to text comprehension emphasizes that representations of text material should reflect the real world situations described by the discourse. Here interpretations of the text are made in light of the text itself, the nonlinguistic and pragmatic context, and previous real world knowledge of the listener. In contrast to text-based theories of comprehension, textual sentences are related to each other not merely on the basis of their overt propositions, but on the basis of their underlying conceptual relations (Garnham, 1987; Johnson-Laird, 1973)

Inference-making from this perspective may or may not involve accessing generalized knowledge structures. Further, text-based processes may or may not be active, generative ones. Much research in this area has analogized inference-making procedures to automatic "information processing" systems. No active or conscious comprehension abilities are appealed to. Later evidence shows that inference-making within text comprehension from a knowledge-based perspective can be and is an active, generative and dynamic procedure. Some researchers have begun to develop comprehensive explanations of the process. The most desirable theories account for ways in which systems of knowledge and environmental context interact during these inference-making processes.

Automatic Bridging Inferences

Returning to the notion that inferences serve to integrate text propositions, the following discussion will show that methodological considerations bias how inferential processes are interpreted. A sudden wave of research in the 1970s showed that the time needed by subjects to indicate comprehension of a sentence related to a previous sentence

increased with the decreasing relatedness between the sentences.[5] Paradigms were set up to show that during this lag, inferences were being drawn. An assumption was made that inference-making involves time-consuming elaborative processes. Haviland & Clark (1974), working in the area of presuppositional comprehension, postulated that some sentences require lengthy processing times to accomplish the integration of new information in memory. The crux of their argument was that information from a sentence should be quickly integrated with previous information if there is a match of semantic information between the text and memory. Hence comprehension should be effectively accomplished. When a match is not made immediately, the system effects a lengthy search for one. Kintsch & van Dijk (1978) incorporated this notion into their text comprehension theory, and called it inferencing.

This trend of research included studies in which the presentation of short, two- or three-sentence stimulus sets was employed in recognition or reaction time paradigms. Among the earliest researchers, Bransford & Johnson (1973) demonstrated the existence of logical (i.e. transitive) inferences, using a sentence recognition task. For example, given a two-sentence set such as:

(2) a. Three frogs sat on a lily pad.

b. A minnow swam under it.

adult subjects often confused sentence (b) with a sentence such as:

c. A minnow swam under them.

implying that spatial inferences were constructed during comprehension.

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5 Many studies from this time examined the time taken to process a sentence whose meaning was directly, indirectly or remotely related to a previous sentence. The issue of sentence-pair relatedness will be discussed in a later section.

Sanford & Garrod (1980), in a review of their previous studies, noted that inferences could be determined using a reading time paradigm. In sentence pairs like the following (adapted from Sanford & Garrod, 1980) the researchers found that items like (4b) required longer processing times than for those like (3b):

(3) a. Gordon packed a sandwich in his knapsack.

b. The sandwich had three layers.

(4) a. Gordon packed a lunch in his knapsack.

b. The sandwich had three layers.

Readers of (4)-type items, in order to understand the referent marked by the definite article, may have constructed a bridge between the two sentences, perhaps something like:

(4) c. Gordon's lunch had a sandwich.

Sanford & Garrod (1980) described several studies designed to further determine the nature of the mapping procedure between new and extant memory structures. Whereas Haviland & Clark (1974) suggested direct mapping may proceed automatically when a direct match exists on the surface structure content of the "new" and "given" propositions, such as in examples (2a-b), Sanford & Garrod predicted that general knowledge structures, such as schemata or scripts, include other elements by which direct mapping can occur. In other words, implicit connections can be made on the basis of such structures. An interesting result from their study showed no significant difference in processing times between seemingly indirectly related versus directly related sentences. Consider the following pairs:

(5) a. Meg fed her grandmother.

b. The food was mashed to a puree.

(6) a. Meg gave food to her grandmother.

b. The food was mashed to a puree.

Sanford & Garrod (1980) reported how they correctly predicted that no difference in reading times would exist between (5b) and (6b) after subjects had read (5a) and (6a), respectively. The researchers attributed this result to the fact that the verb (e.g. feed) activates a schematic knowledge structure that necessarily includes the elements found in the second sentence (e.g. food); food is included as part of the explicit meaning of feed.[6] Furthermore, no additional processing involving a search in memory to find a match of information is required when sentence (5b) is encountered, since the meaning has already been activated via the invoked knowledge structure (Sanford & Garrod, 1980; Brown & Yule, 1983). Hence, because the latter term in (5) is part of the lexical decomposed meaning of the former term, such a search is considered automatic, focused and not requiring extensive searches of memory. It will be argued that such focused and limited bridges occur frequently in texts, but are perhaps not to be considered as demanding in terms of cognitive resources as the more elaborative forms of connecting links, or inferences.

Findings by Paris and his colleagues, studying children's comprehension and memory, substantiated the conclusion that some elements are automatically invoked. Again, single sentences or two-sentence texts were presented with recognition task paradigms employed. The results often gave evidence that agents, instruments or objects could be instantiated (invoked automatically). This lent credence to the notion that verb entailments are activated during comprehension (Paris & Lindauer, 1976; Paris, Lindauer & Cox, 1977). In one study, older children

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6 Linguists would predict this result on the basis of the nature of lexical entries for verbs, each of which includes the verb's arguments.

(11 years old) were required to memorize lists of sentences containing, for example:

(7) The workman dug a hole with a shovel.

(8) Doris cut her finger instead of the bread.

Sentence (7) contains an explicit instrument (shovel) where sentence (8) contains an implicit instrument (knife). Older children were able to recall the sentences equally well when given an implicit or explicit instrument as a cue (Paris & Lindauer, 1976). The instruments of the actions had been "inferred," or rather were automatically entailed. Further studies have indicated that, like instruments, agents (Just & Carpenter, 1980) and actions (Paris, Lindauer & Cox, 1977) can be instantiated during text comprehension.

Dynamic View of Inferential Processing

Out of schema-based research, a theoretical framework of inference-making was developed, with some problematic implications. For example, the idea of schema instantiation precludes the notion that "inference" be defined as an elaborative cognitive procedure, since evidence shows instantiation requires no additional processing time at all. Collins, Brown & Larkin (1980) suggested, therefore, that inferences are probably based on more dynamic, generative operations, and do not merely act to fill slots in schematic structures. Inferences do aid in constructing some frame of the ongoing discourse by recourse to general world knowledge, by acting to fill gaps in the listener's or reader's interpretation of the text (Brown & Yule, 1983). How this is done is unclear. For this reason, and because each person's knowledge base is unique, Brown & Yule claim that inferences are not predictable nor strictly classifiable.

Retreating from a purely organizational point of view, Whitney (1987) reviewed the issue of the function of inference-making. He stated that recall and recognition methods of testing inferencing are problematic; it is often equivocal whether inferences are made during discourse comprehension, on-line, or as a result of the testing procedure itself. Rickheit et al. (1985) query whether verb-related subcategorized terms are instantiated at the time of encoding or at the time of retrieval.

This can be elucidated by an example. A sentence such as:

(9) The fish attacked the swimmer.

can be easily retrieved from memory using a cue such as shark (Anderson, Pichert, Goetz, Schallert, Stevens & Trollip, 1976; cited by Brown & Yule, 1983). This raises the question of when the inference is encoded: during or after hearing the stimulus sentence. Again, often the one or two-sentence text is a poor context in which to distinguish these factors, since the context is very limited.

On the other hand, a functional explanation of inference construction helps to demonstrate that the goals of the reader or listener determine whether inferences are constructed during comprehension (Frederick, 1981; Graesser & Clark, 1985; Rickheit et al., 1985; Whitney, 1987). That is, more elaborative processes may be employed while listening to a text during a question-answering task than during a memory task (Graesser & Clark, 1985). Here, there is a valid reason for the listener to try to understand.

In support of this idea, Frederick (1981) and Graesser & Clark (1985) suggest that inferences, while they may be automatically invoked, more importantly have necessary functions for comprehension. They address several questions, such as:

What types of inferences do language users make?

In what contexts do language users make inferences?

What functions do inferences accomplish?

In response to the first question, it is difficult to establish a clear taxonomy of the types of inferences that will or can be made by a listener (Brown & Yule, 1983). Depending on the nature of the relationship between text propositions, it was seen above that inferences, or bridging connections, link propositions on the bases of lexical subcategorization frames (Paris & Lindauer, 1976; Paris, Lindauer & Cox, 1977); propositional structure (Kintsch & van Dijk, 1978); or text structure (Kintsch & van Dijk, 1978).

Furthermore, the types of inferences associated with relationships among propositions are often predictable and based on stereotyped knowledge schemas. On the other hand, those inferences that do require a language user to actively make sense of the presented discourse are often based on indeterminable beliefs and knowledge of the listener (Brown & Yule, 1983).

Needless to say, certain discourse contexts may invite inference-making, and may frame and delimit the constructed inferences. Thus, indirectly related utterances, as in example (4), or in presupposing sentences such as:

(10) a. Billy got his hair cut , too.

indicate that an inference may be made, but not necessarily what it should be. In (10) the inferences may be somewhat unlimited, depending on the reader's expectations. One could infer:

b. Billy has hair.

c. Another person got her hair cut as well.

d. Billy had some other procedure performed.

As will be emphasized later, the knowledge a listener or reader brings when interpreting a text constrains (or fuels) the interpretive inferences that are to be made (Hayes & Tierney, 1982; Steffensen, 1985).

To summarize, the process of inference generation may occur at different levels, and to various degrees, depending on the degree of explicit information the text provides, the comprehension task the listener is required to perform, the length of the text, the nature of the text, the amount of cohesion expressed in the text, and individual subject variables such as language proficiency or memory capabilities (e.g. Graesser & Clark, 1985; Potts, Keenan & Golding, 1988, among others).

However, the importance of inference function helps to consolidate this complex issue. In terms of organization, inferences operate internally on a text and, as such, are considered bridges between text propositions and structures. The argument has been that these bridging inferences establish a conceptual connection between passage statements. These connective inferences include some gap-filling and instantiation types, as well as more complex causal inferences. Some researchers have shown that such inferences are important for on-line comprehension during discourse (e.g. Keenan et al., 1984). Bridging inference is one relation between presuming and presumed elements, thus establishing cohesion in a text (Kintsch & van Dijk, 1978). Other types of inference are generated merely to serve a task-specific function, such as recall, summarization, question-answering or story-retell (Paris, Lindauer & Cox, 1977). Others are activated when a specific discourse structure, such as a story narrative, is presented and help to organize the text to fit the schema.

True Inferences

Brown & Yule (1983) have extensively reviewed the inference literature and have questioned whether bridging inferences are "true inferences." They state that while it may be impossible to predict the actual inferences a reader will make in interpreting a text, one may predict aspects of text that need to be interpreted on the basis of inference. Frederick (1981) claimed that aspects of discourse comprehension which call for increased interpretation on the part of the reader/listener are those which:

> involve extending a text's meaning by relating it to other knowledge and (are) particularly important in situations in which texts are used as sources of new information or learning and situations of use of language for communication in social settings. (1981: 320)

During these situations, inferences not only require recourse to prior knowledge but also satisfy the criterion that they operate within text organization. In this light, some bridging inferences do require more elaborative cognitive processing than others and can therefore be considered "true inferences" (Keenan et al., 1984; Myers, Shinjo & Duffy, 1987; Whitney, 1987). Of particular interest are those which establish connections between conditional relations, especially causal relations, for it is this type of relationship that requires the comprehender to use the information from the text to access general knowledge and experience (i.e. not just specific and limited schemata). The listener or reader must integrate and incorporate knowledge or exemplars from experience with the explicit information provided by the text to actively form a coherent structure of the text. Additionally, the language user must recognize that the content provided by a text is representative of or analogous to knowledge already possessed, and that this knowledge can be used to

construct the bridging causal inferences necessary to connect the seemingly disparate propositions of the text (Steffensen, 1985).

Causal Inferences. Recent approaches to the study of narrative comprehension by Trabasso and his associates have emphasized the centrality of causal relationships within the representation of narrative texts (Trabasso, 1986; Trabasso & van den Broek, 1985; Trabasso, van den Broek & Suh, 1989; Trabasso & Sperry, 1985). Story grammar research (e.g. Stein & Glenn, 1979) suggests that developmental changes are evident in the story structures that children produce. Trabasso (1986) claimed that these changes, as well as changes in story comprehension, reflect children's growing knowledge and appreciation of the world around them, particularly of the physical and social world; animate beings; goals, plans and motivations such beings encounter; actions and their consequences; and knowledge about internal states, beliefs and feelings. As a consequence, children are able to more fully understand stories and how these relationships interact to make stories coherent. Extending this idea further, Trabasso (1986) claimed that conditional relationships are integral to the formal representation of story events and categories. Thus, local coherence between two propositions results when a comprehender infers how these story events must relate in terms of conditional and causal situations. In turn, events are organized into higher units of structure, such as the story episode and the story structure proper, also by virtue of the conditional relations between the intervening levels. Trabasso (1986) went on to suggest that causal inferences help organize story events into episodes, and help define settings, goals, attempts and so on.[7]

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[7] Definitions are adapted from story grammar theory (e.g. Stein & Glenn, 1979).

An example may help to illustrate. Coherent understanding of the short episodic story in example (1) involves a meaningful interpretation of the stated events; because the reader recognizes that the initiating and motivating causal relations in the story are, for the most part, implicit, he or she begins to infer them. For example, examining the relationship between "the wind blowing" and "ice piling up on a rock," one may infer that the blowing wind physically caused the ice to move about the lake, thus establishing an initiating event. In order to relate the final sentence (d) to the rest of the structure, again the reader may make a causal connection, perhaps that open spaces on the lake physically enabled the men to go beaver trapping, providing the reader with goal information.

Several studies have shown how causal connections are important organizational entities in stories. Keenan et al. (1984) and Trabasso et al. (1989) suggest defining "cause" in terms of a necessity criterion; this includes strict causal relations between one concept and another, in which concept A is said to be temporally prior to and necessary for B. The necessity criterion also stipulates that the consequence is dependent on the cause, or the cause determines the consequence. Trabasso et al. (1989) found that the judgments of causality were best made within the circumstances of the story, that is when story context was available.

Trabasso et al. (1989) constructed a causal network representation of narrative structure, from which pairs of causally related events were obtained. Sentence pairs varied in the degree of causal relatedness, depending on the causal distance between events, or the number of intervening causal interactions. The researchers found that judgments of sentence pair "relatedness" correlated with causal distance (i.e. number of intervening causes in the story), independent of referential distance (number of shared referents between pairs) or temporal distance (number

of intervening statements). The representation of a narrative according to its causal relationships proved to be valid. A more thorough outline of this model will be presented in the next chapter.

Other studies have indicated that degree of causal relatedness predicts memory for stories (Trabasso & van den Broek, 1985) and sentence pairs (Myers et al., 1987); comprehension time (Keenan et al., 1984); answers to why-questions (Trabasso, Secco & van den Broek, 1984, as cited by Trabasso & Sperry, 1984) and importance of story events (Trabasso & Sperry, 1985). Trabasso & Sperry (1984) explain that importance judgments are based on the apprehension of "conceptual dependencies" that the statement has to other parts of the text. One takes into account the antecedents, consequences and implications of an event when making an importance judgment, and thus importance depends upon the number of direct connections (i.e. causal connections) a statement has to other statements.

Causal events are deemed more central to a story's event chain than are other events. In fact, causal events gain increased prominence by virtue of their causal connectedness; that is, each causal event (by definition) should have at least two connections, an antecedent and a consequent event (Trabasso & van den Broek, 1985; Trabasso & Sperry, 1985). Trabasso (1986) claimed that it is not necessarily a category's status (i.e. goal, outcome, etc.) that determines its importance in a story, but rather its causal relatedness to other events. The causal model of story representation suggests how story categories are best connected to form episodic and story structures (Trabasso et al., 1989).

Inference-making as a Complex Process

As was mentioned previously, causal inference-making is considered an elaborative process, which requires accessing and retrieving previous knowledge. However, few studies have empirically addressed the nature of the procedure of constructing a text representation, beyond suggesting that naive theories of psychological and physical causality are applied. Most authors only go so far as to claim that, when the story calls for it, "the comprehender invokes a context that provides the circumstances for making a causal inference" (Trabasso et al., 1989). Others have vaguely suggested that a backdrop from real world knowledge, or a "schematic scaffold," is set up from memory, providing the "necessary and sufficient" conditions from which the intervening details between stated facts can be obtained (Garnham, 1987; Graesser & Clark, 1985; Steffensen, 1985; Trabasso & Sperry, 1985). Any adequate explanation of inference-making should more thoroughly account for the accessing process.

In response to suggestions that the application of world knowledge may potentially be unlimited (e.g. Brown & Yule, 1983), the body of researchers involved in causal inference theory suggest that only that information which is necessary and sufficient to account for the story context will be activated (Trabasso & Sperry, 1985). A two-step process occurs: (1) single events in the story activate general knowledge (or combinations of knowledge schemata, as is sometimes claimed); (2) the nature of the activated knowledge in turn constrains what relations are to be inferred between story events (Trabasso, 1986).

Some authors have attempted to describe the nature of prior knowledge effects on comprehension more specifically. Hayes & Tierney (1982), using a reading comprehension task, determined that those subjects who had prior knowledge of a certain topic (e.g. baseball) were

able to transfer their knowledge to an analogous situation (e.g. cricket) and hence were better able to understand the new content material. Steffensen (1985) suggested that culture determines one's experiences and shapes one's viewpoint and knowledge of the world. A text which is highly culture-specific and includes many cultural anecdotes and rituals would be more poorly understood by a reader from outside the culture in question. Relationships among events expressed in the text could not be inferred, due to lack of "undergirding schemata" from which specific facts, motivation, consequences and so on could be drawn. Using a recall task, Steffensen (1985) showed that American subjects, who read a text which described an Indian custom and another about an American custom, recalled fewer correct cohesive elements from the Indian text than the American text. These studies merely confirm that the level of background knowledge affects the comprehension text material.

In summary, inference-making is a complex process. Furthermore, the process can be analyzed from the perspective of discourse comprehension. On encountering a discourse situation, which by nature can be highly implicational, a listener or reader forms a conceptual representation of the set of spoken or written discourse elements. From this representation, implicational gaps within the text are resolved and thus overall comprehension of the discourse exchange is achieved. Specifically, according to theories of text-based mental models, text representations are composed of several elements: text features, such as explicit surface structure linguistic elements, context features and information which has been retrieved from general knowledge. Claims are that those connections in the representation which are derived from prior knowledge storage are inferences. A listener or reader often makes automatic "bridging" connections during the comprehension process, but

such connections are not generally considered inferences (e.g. Brown & Yule, 1983). Inferences which are formed actively as a result of recourse to integrated knowledge structures are most often constructed when discourse comprehension serves a specific function, for example during learning situations. "Elaborative" inferences, or those which are based on applied elements of prior knowledge, include the subgroup of causal inference types. These are seen to be important in the structure of narrative representations.

## Developmental Studies

Insofar as causal inference-making requires the application of developing knowledge structures, it follows that there may be an ordered development of this ability. Early studies by Paris and his colleagues (Paris & Lindauer, 1976; Paris, Lindauer & Cox, 1977; Paris & Upton, 1976) began to demonstrate a relationship between age and inference-making ability. The conclusions in general confirmed their developmental expectations. Paris & Lindauer (1976), using a recall task, studied children between the ages of 6 and 12 years. The children were asked to memorize lists of sentences with explicit and implicit instruments, such as those in examples (7) and (8), and were then required to recall the sentences when the instruments were used as retrieval cues. Six- to 8-year-olds retrieved more sentences in which instruments were explicitly mentioned than with implicit cues. The researchers concluded a developmental course, although it should be kept in mind that this study actually investigated inferences of the automatic, or instantiated, variety, which have been seen to be related to lexical or semantic knowledge rather than general knowledge (e.g. Sanford & Garrod, 1980).

Paris, Lindauer & Cox (1977) investigated recall by children, 6 to 11 years old, of sentences which contained explicit and implicit consequences to actions, such as the following (Paris et al., 1977):

(11) My brother fell down at the playground and skinned his knee.

(12) Mary dropped the vase of flowers.

Sentence (11) contains an explicit consequence, whereas sentence (12) contains an implicit consequence (i.e. the vase broke). The inferences of interest in this study tended to be of the causal or conditional type. Again, subjects were asked to recall sentences with implicit or explicit cues. Younger children (7 years old) recalled fewer sentences with implicit cues that with explicit cues, and recalled fewer implicit sentences than the older children did. However, when they were asked to generate stories based on the sentences prior to the recall task, younger children (6 years old) performed similarly to older children (11 years old) on the recall of both implicit and explicit sentences.

These findings supported previous results suggesting that inference ability, particularly the construction of elaborative causal inferences, can be facilitated at an early age. Of course, because the inferences tapped by this study were presented in a decontextualized condition, and were supposedly invoked by single sentence stimuli alone, generalizations regarding the facilitation of elaborative integrative inferences within larger pieces of text cannot be made. However, Paris et al. (1977) claimed that, when serving a nonintegrative or connective function, inferences that require accessing prior knowledge in a decontextualized context tend to display a developmental course.

Kail et al. (1977) investigated the construction of transitive and "contextual" inferences by children aged 7 and 12 years, but used a question-answering rather than a recall task. An example of a contextual

inference type, which appeared to be characterized by automatic bridging-type inference, is as follows (from Kail et al., 1977):

(13) a. Jack was playing in a game.

b. He was hit by a bat.

c. Jack cried out in pain.

Inference: Jack was playing baseball.

True and false inference and premise questions were constructed for each paragraph. Kail et al. found no changes across age in the ability to construct transitive or "contextual" inferences, suggesting that this ability develops early, and may be facilitated by task.

Danner & Matthews (1980) studied the inferencing skills during a reading task of children 7 and 11 years old. Using reading latency times, they concluded that children at both ages were able to make inferences during reading. This finding was indicated by analyzing the time taken for children to verify whether an inference statement was true or not, given a set of premise (content) statements. These researchers suggested that the findings of Kail et al., (1977), which differed from those of Paris and his associates, could be explained in terms of the function that inference-making plays. Those that help form a cohesive text meaning are more likely to be constructed than those that serve to improve recall of a sentence.

Hilyard (1979) suggested that 6-year-old children are more capable of constructing elaborative inferences requiring knowledge retrieval than constructing inferences involving strict manipulation and integration of premise sentences. Again, inference-making can be facilitated and improved when the inferences are based on text content and context, rather than form. She showed, using a question-answering design, that when children were provided with familiar information that could be

related to prior knowledge, their ability to integrate text propositions was better than when they were required to answer inference questions from arbitrary propositions that were not related by inherent logical relationships. For example, an arbitrary sentence set (from Hilyard, 1979) is:

(14) a. The policeman is in front of the clown.

b. The garbageman is behind the clown.

Arbitrary Inference:

c. The policeman is in front of the garbageman.

An example of a contextualized sentence pair is as follows:

(15) a. The policeman, on his horse, was in front of the clowns, clearing the way for the parade.

b. The garbageman was behind the clowns, collecting the candy wrappers from the candies the clowns gave to the kids on the sidewalk.

Meaningful Inference:

c. The policeman was in front of the garbageman.

The latter pair offers causal information, providing a meaningful basis from which to interpret the text.

Hilyard used lengthy stories containing utterances like (14) or (15) above. The results of her study showed that 10-year-old children were better at constructing arbitrary inferences than 6- or 8-year-old children. Children in all ages, however, were equally capable of deriving implicit inferences in meaningful contexts, including causal inferences. A second experiment by Hilyard (1979) substantiated this finding and extended it. Children in all age groups were asked to answer forced choice, yes/no and open-ended questions targeting bridging (spatial, temporal or comparative) and causal inferences. Scores on causal inference questions

were similar across age groups, but scores for noncausal bridging inferences improved with age.

Trabasso (1986) described how the ability to construct causal inferences for the purpose of text comprehension develops early. He suggested that the development of inference-making ability is dependent upon the development of causal knowledge, together with the development of the ability to utilize this knowledge to infer causes between story states and actions. Within the realm of story comprehension, inference-making is further dependent on the ability to organize the outcomes of the inferences into the hierarchical structures of stories. However, Hilyard (1979) earlier pointed out that although integration of story categories into particular stereotyped and universal structures may reflect children's developing conceptual knowledge, it is still not clear how these operations interact, or upon what continuum they can be differentiated (e.g. see Ellis Weismer, 1981; 1985).

As was seen in early studies, the ability to manipulate linguistic forms to derive new meanings (or inferences) independent of context or experience changes with age and perhaps does not reach mature levels until beyond 10 years (Hilyard, 1979; Kail et al., 1977; Trabasso, 1986). On the other hand, the ability to construct inferences when it is clear that prior experience and knowledge of the physical world are applicable is an early skill when it serves to facilitate text comprehension. Therefore the mental ability to utilize real world knowledge for text comprehension is acquired relatively early.

## Inference-making by Disordered Children

Given the complexity of inferential relationships, some issues have unfortunately not been consistently consolidated in developmental studies

of normal inference-making ability; these factors include cognitive level, type or degree of inference required, type or length of text material, or methodological factors, among others. Nevertheless, some studies have indicated that language ability may play a significant role in enabling a language user to make knowledge-based inferences from texts. For example Irwin & Pulver (1984) found that students identified as poor readers in Grade 5 and Grade 8 had more difficulty than their better-reading peers in constructing causal inferences from textbook material[8].

One study attempted to demonstrate that learning-disabled students can be helped to use their own knowledge to make inferences. Wong (1980) replicated the Paris et al. (1977) study with learning-disabled students aged 7 and 11 years and compared them to successful students in the same grade levels. As predicted, the poor students recalled fewer single sentences with implicit consequence cues than the normal group. Then Wong (1980) used a question prompt procedure in which subjects were requested to state their expectations of consequences to the actions, prior to the recall task.[9] The prompting procedure significantly improved the recall of implied consequence information by the learning-disabled children. Wong claimed that the memory skills of this population can be facilitated by helping them to access their own prior knowledge repertoires. Limitations of the original study hold, however, in terms of generalizations that can be appropriately applied to the disabled students.

Only a handful of studies have attempted to clarify how proficiency at understanding verbal material affects the ability to make intersentential inferences within texts. There is a paucity of research that even analyzes

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8 Unfortunately no age ranges were provided by Irwin & Pulver (1984). Grade 5 children are about 10 years old, grade 8 children about 13.

9 "Predicting" is becoming a standard part of teaching reading comprehension.

inference-making by language-disordered children within a framework of text comprehension theory. However, a few recent studies have attempted to determine bridging inference-making abilities by this particular group of children. Although they have limitations, these studies have generally shown that even when language-impaired school aged children are matched to normal children according to nonverbal cognitive abilities, the former group do demonstrate difficulty constructing spatial and causal inferences.

Studies by Ellis Weismer (1981; 1985) and Crais & Chapman (1987) are among this body of research. Ellis Weismer (1981) examined responses to true and false premise and inference questions by twelve normal and twelve language-learning disabled children, aged 7 and 8 years. A younger group of twelve children matched to the LLD children on the basis of the their vocabulary comprehension was also included. The children were presented with short (three-sentence) stories and were asked to answer four sets of questions: in each set two questions were associated with explicit information from the story (premise questions); two questions pertained to implicit, unstated information (inference questions). One of each question pair was true, one false. The stories were constructed in such a way as to invite the listener to make spatial or causal inferences. An example of a story designed to invite a causal inference follows (from Ellis Weismer, 1985):

(16) a. The baby drinks some milk.

b. He throws the glass down.

c. The glass hits the table.

The subjects were then asked questions such as:

True Premise: Did the baby drink some milk?

False Premise: Did the baby throw the spoon?

True Inference: Did the glass break?

False Inference: Did the table break?

Ellis Weismer (1981) also included a nonverbal condition (Picture task) in which each story was represented by a set of three pictures. They were designed to also invoke causal or spatial inferences, equivalent to the sentences in the Verbal task. In order to solicit responses in this condition, the experimenter presented a multiple-choice array of four pictures, each depicting "correct" or acceptable and "incorrect" premise and inference information. Across-subject analysis showed that in both conditions (Picture and Verbal tasks), the language-disordered group responded correctly to significantly fewer inference items than the normal age-matched group; but they responded similarly in each condition to the language-matched, younger group. A conditional analysis of the data showed that even when performance on premise questions was considered, language-disordered children constructed fewer acceptable inferences than peers matched according to cognitive level, but scored similarly to younger children. Although the LLD group scored significantly lower than the age-matched control group on inference and premise items, the strength of the conclusion that an inferencing deficit existed was based on the fact that the disordered group performed worse on inferences than their recall of premise statements would indicate. Ellis Weismer noted that because the disabled group performed relatively poorly on inference questions in the verbal and nonverbal conditions, a cognitive processing deficit, rather than just a linguistic deficit, was indicated.

This conclusion in part substantiated conclusions by Paris et al. (1977), Hilyard (1979) and Wong (1980). However, these researchers did conclude that children with weak language proficiency have difficulty making inferences from verbal material. Deficits in constructive

comprehension skills by language-impaired children could involve linguistic material alone, or could possibly extend to those skills which depend on constructive processing skills or relating text information to stored knowledge. Although the language-disordered children performed similarly to language matched peers on both verbal and nonverbal inference-making tasks, they also performed more poorly on nonverbal inference questions than normal peers matched on nonverbal intelligence. Therefore, Ellis Weismer concluded that language-disordered children with normal nonverbal intelligence who may even adequately understand individual words and sentences, appear to have "pockets of deficits" that make inference-making from verbal and nonverbal material difficult. She suggested that:

> in terms of language comprehension, this would mean that even when language-disordered children understand individual words or sentences, they tend not to 'read between the lines' as readily as their age mates to arrive at a full understanding of the message (1985:183).

In her study, Ellis Weismer (1981) did not distinguish between inference-making as a sentence integrative process in the formation of a representation, or as an invocation of real world knowledge to arrive at a meaningful text interpretation, although she implies the former. To substantiate the claim that poor inferencing performance by language-impaired children is not due to constructive processing skills alone (i.e. manipulating information to construct new meanings) Ellis Weismer (1981) provides a discussion in which she presents data indicating that all subjects performed more poorly on spatial inference-type stories than causal inference-types. However, she did not compare the disordered group to the younger group on correct causal inference performance. Poorer performance on causal inferences by the LD group might have

indicated a true elaborative inference-making deficit, even beyond a language deficit component, since it is predicted that younger children should perform well on causal inferences (e.g. Hilyard, 1979).

Crais & Chapman (1987) also attempted to show that language-impaired children perform more poorly on inference tasks than nondisabled children. In this study language-learning disabled (LLD) children aged 9 and 10 years were matched to normal language peers according to age, and to younger children, 6 and 7 years of age, according to vocabulary comprehension level. The subgroups listened to short stories, seven to eleven sentences in length, which were followed by eight true and false inference and premise questions. In a second experimental condition, for half the stories the children were required to retell the story prior to answering the questions. This task was included to determine if story retell facilitated inference construction, as purported by Paris et al. (1977). Similar to Ellis Weismer's findings (1981; 1985) LLD children demonstrated more difficulty on inference questions than normal age peers did, but performed as well as younger children. Story retell did not yield an improvement for any of the subgroups. Crais & Chapman (1987) offered two explanations for this: (a) question-answering may have facilitated inferencing to a degree that was not surpassed by story retell, or (b) story retell does not induce inferencing. A third possibility was not addressed: inferencing may have been facilitated by story structure, in which story cohesion necessitated inference-making. The authors concluded that LLD performance was attributable to a weak lexical semantic system. Inference questions were constructed most often with synonymous, but different, lexical items than those presented in the stories; they were not often drawn from the integrative connections

between story statements. For example, one story presented in this experiment contained the sentence:

(17) a. The farmer said that the duck who got in the water first was always the male duck.

The following false inference item was constructed from this premise:

b. Did the farmer show the boy which duck was the male duck?

Inference-making ability was tested using items semantically analogous to premise statements which differed only in terms of individual vocabulary. Thus, in contrast to Ellis Weismer (1981; 1985), Crais & Chapman (1987) concluded that language level, rather than nonverbal cognitive level, determined story comprehension, hence, implicitly, inference-making ability.

A clearer picture of the text integrative aspects again may have been elucidated if an analysis of within-group performance of inference type had been included. A second considerable omission regarded how inferences were derived from the stories, or on what theoretical grounds decisions for their inclusion were made. Crais & Chapman (1987) themselves admitted that performance on true and false inference questions by the LLD group differed from that found by Ellis Weismer (1981), in that true inferences were harder than false inferences in the Ellis Weismer study. Crais & Chapman (1987) suggested that responses to true inference questions in Ellis Weismer's study required the integration of information across statements (where all subgroups performed more poorly in both conditions). On final analysis, those inferences requiring information integration across statements were deemed more difficult for LLD children than within statement inferences. An attempt was not made to differentiate semantically instantiated versus elaborative integrating (bridging) inferences in this regard. An additional problem concerns a

"plausibility" factor in judgement of inference truth value. Ellis Weismer (1985) suggested that a response bias to reject false statements, (hence respond correctly) may have been operating; false inferences contained information from outside the story and were perhaps identified as false more readily. Crais & Chapman (1987) did not include false inference statements containing information independent of the stories in their study.

## Statement of the Problem

Children referred to school-based speech-language pathologists by those concerned about language-based learning difficulties, often tend to evidence normal performance on instruments which measure lexical and sentence level abilities. A common assumption among teachers and clinicians alike is that these older language users have "pragmatic problems,' which include rather nebulous concerns regarding problem-solving, abstract reasoning and inferential thinking. These problems tend to straddle the boundary between language and thought. Without theoretically valid or reliable means of measurement or intervention, clinicians intuitively assume that weak inference-making ability reflects a weak cognitive base. Namely, often a lack of previous knowledge about the topic or a lacking repertoire of strategies to implement knowledge are said to be the cause. Intervention goals aimed at improving such deficits may or may not be misguided.

Attempts to analyze the inference-making abilities by normal and language-learning disabled children have generally been problematic. Granted, the very nature of text comprehension is complex, but it is for this reason that investigation should be specific. Many studies have not yielded comparable results, due to a lack of concensus as to the type of

2. Do LLD children correctly respond to significantly more causal inference statements in a contextualized condition than in an uncontextualized condition?

3. Do LLD children respond to more premise than inference statements in an uncontextualized condition as compared to normal language children?

4. Do LLD and normal language subjects respond similarly to causal inference statements in a contextualization condition as in an uncontextualization condition? That is, if both groups respond differentially to contextualization and uncontextualization conditions, is this differential greater for LLD children?

5. Do LLD children respond correctly to fewer false versus true inference statements than normal children?

6. Does contextualization condition influence the differential between responses to true versus false inference statements, if one exists?

Null Hypotheses Statements

The study attempted to disconfirm the following null hypotheses:

1. There will be no difference between language-learning disabled and normal children in the number of correct responses to causal inference statements in an uncontextualization condition.

2. There will be no difference between language-learning disabled and normal children in the number of correct responses to premise statements in an uncontextualized condition.

3. There will be no difference in the number of correct responses to causal inference statements by LLD children in a contextualization condition versus an uncontextualization condition.

4. There will be no difference between LLD and normal children in the number of correct responses to true versus false causal inference statements.

5. There will be no difference in the differential score between correct responses to causal inference statements in the contextualization and the uncontextualization conditions by the LLD group versus he normal group.

6. There will be no difference in the differential score between correct responses to causal inference statements by the LLD group and the normal group in the uncontextualization condition versus the contextualization condition.

7. There will be no difference between language-learning disabled and normal children in the differential score obtained between the number of correct responses to causal inference and premise statements in an uncontextualized condition.

# CHAPTER TWO

## RESEARCH METHODOLOGY

### Design

This study evaluated the comprehension of inference statements by language-learning disabled (LLD) children and children with normal language development (NL) under two conditions: uncontextualized and contextualized. The contextualized condition was designed to encourage retrieval of information from the subject's general knowledge -- a procedure proposed to encourage elaborative inference-making. Each of two text passages was analyzed according to a model developed by Trabasso and presented by Trabasso, van den Broek & Suh (1989), which yielded a set of bridging causal connections across clause units. Sets of three true and three false causal inference statements were developed to represent bridging inferences for each story. In addition, three true and three premise statements were obtained directly from each story, yielding twelve statements for each text. Subjects were ten language-learning disabled students (7 boys, 3 girls) and ten children with normal language development (5 boys, 5 girls) aged 9 to 11 years old. Mean age for children in both groups was 10 years, 4 months.

Children were selected for the LLD group on the basis of the following criteria: (1) enrollment in a learning assistance or learning resource program for learning-disabled students, preferably for remediation of Language Arts; and (2) history of speech-language intervention in preschool or early primary grades. Each subjects was

selected under the following criteria: (1) normal nonverbal cognitive skills; (2) lexical and syntactic comprehension within normal abilities (as determined by standardized language tests for the LLD group); (3) native English speaker and (4) normal hearing ability.

One condition was assigned to one story during the presentation. Every subject received both stories and conditions. Story presentation and condition were counterbalanced across 8 of the 10 subjects in each group; condition only was counterbalanced across the remaining two subjects in each group. Inference and premise statements were randomized; each random set was randomly presented to each subject.

In the uncontextualized condition, subjects listened to the first story two times and responded to true/false inference/premise statement. Response mode was verbal. During the contextualization condition, subjects heard one presentation of the story, and then engaged in a discussion with the experimenter in which the subject was encouraged to relate his or her own experiences to the story and to make predictions about unstated events or situation. The subjects heard the story again following the condition. Items were scored correct or incorrect. Subjects were also asked to answer open-ended wh-questions. Responses were compared and analyzed using a nonparametric statistical method appropriate for small sample sizes.

## Subjects

Twenty elementary school children from three suburban school districts within the Greater Vancouver area participated in this study: 9- to 11-year-old language-learning disabled children (LLD group, M= 10 years, 4 months; 123.8 months) and 9- to 11-year-old children with normal language development (NL group, M= 10 years, 4 months; 124 months).

The LLD group contained seven boys and three girls; the NL group five boys and five girls. All children had normal hearing and vision, and came from English speaking homes, according to classroom teacher report. The NL children were reported by classroom teachers to have normal speech, language and intellectual abilities. They were reportedly average in academic achievement.

Selection of LLD group

Students were selected for inclusion in the experimental group if they were receiving learning assistance from a learning assistance teacher, or were enrolled in a learning resource program at their particular schools. All LLD students from the first school district were enrolled at the time of testing in a skill-based Diagnostic-Prescriptive Centre. Placement of students into the Centre is based on identification of a learning disability. This is described as a discrepancy between learning potential and actual achievement not attributable to sensory deficits. Nonverbal cognitive skills should be average or better. Students in the program received individualized instruction in Arithmetic and/or Language Arts, which included the specific areas of reading comprehension, vocabulary, spelling and written expression activities.

Two subjects from the third school district were selected to participate in the study because they were receiving learning assistance for Language Arts. Students from the third school district were included into the study if they were receiving learning assistance for Language Arts, such as reading comprehension, or expository and narrative writing skills. Other subjects were included if they were placed in a learning resource program. This program is described as a school-based program for

severely learning disabled students. Learning disability within this school district is defined as:

> a processing disorder resulting in a significant discrepancy between estimated learning potential and actual performance. This discrepancy should not be primarily due to other factors such as: sensory impairment, mental handicaps, behaviour disorder, environmental or cultural disadvantage or E.S.L. [English as a Second Language].[10]

On the basis of a psychoeducational assessment for placement into these programs, a learning disabled subject demonstrated average or better intellectual ability, a discrepancy of more than one standard deviation on a standardized academic achievement test as compared to cognitive skills, and he or she displayed a specific learning problem with classroom-based material. Finally, all subjects in the experimental group had received language intervention for the remediation of oral language deficits. Table I summarizes the profiles of the experimental subjects in terms of age, grade, the most recent cognitive assessment, and the language scores received from the administration of two standardized tests during the present study. Table II summarizes school program placement and speech-language intervention history for those subjects for whom this information was available.

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10 From School District No. 43 (Coquitlam) Student Services Resource Book (1990-90: 29).

Table I. *Language-learning disabled subjects' test scores on WISC-R, CELF-R, and PPVT-R tests.*

| SUBJECTS | WISC-R Scores (SS) | | CELF-R Scores (percentile) | | | PPVT-R (Form M) |
|---|---|---|---|---|---|---|
| LD GROUP | Verbal Score | Performance Score | Linguistic Concepts | Semantic Relations | Formulated Sentences | (percentile) |
| S1 | 79 *(a)* | 118 | 16 | 16 | 91 | 37 (Form L) |
| S2 | 100 | 96 | 16 | NA | 37 | 34 (Form L) |
| S3 | 98 | 91 | 37 | 25 | 16 | 47 (Form L) |
| S4 | 97 | 97 | 37 | 9 *(c)* | 84 | 23 |
| S5 | WNL *(b)* | WNL *(b)* | 2 *(c)* | NA | NA | 16 |
| S6 | WNL *(b)* | WNL *(b)* | 50 | NA | 25 | 30 |
| S7 | WNL *(b)* | WNL *(b)* | NA | 9 *(c)* | 16 | 19 |
| S8 | 30 | 73 | 50 | NA | NA | 45 |
| S9 | NA | NA | NA | 37 | 16 | 32 |
| S10 | 92 | 111 | 6 *(c)* | NA | NA | 12 *(c)* |

*(a)* Standard scores (X=100 ± 15).
*(b)* Within normal limits. No scores available; documentation provides interpretation only.
*(c)* Below average score.

Table II. *Subject description data for language-learning disabled group of school program placement and speech-language intervention history; subje*

| Subject | Sex | CA | Program/Grade Placement | Speech-Language Intervention History | Subject | Sex | CA |
|---|---|---|---|---|---|---|---|
| LD Group | | | | | NL group | | |
| S1 | M | 8;10 | Elementary resource class (ERC) (full day) for learning-disabled (LD class) Grade 4 | Direct SLP during Grade 1 and 2 for "semantic expressive weakness" | C1 | F | 9;0 |
| S2 | M | 10;11 | Receiving learning assistance; enrolled in ERC in primary grades. Grade 5 | Direct SLP as preschooler. SLP during primary grades for weak "auditory processing," "word finding" and use of language skills | C2 | M | 10;2 |
| | | | | | C3 | F | 11;2 |
| S3 | M | 10;3 | Diagnostic Prescriptive Centre full day (LD class); Learning assistance at home school | Consultative SLP therapy for "verbal reasoning" skills | C4 | M | 10;0 |
| | | | | | C5 | M | 10;11 |
| S4 | M | 10;10 | Diagnostic Prescriptive Centre full day | Direct SLP early primary for "weak oral language" skills | C6 | F | 9;4 |
| | | | | | C7 | M | 9;8 |
| S5 | F | 9;4 | Learning assistance for language arts. Grade 4 | SLP therapy during early primary; poor auditory comprehension | C8 | F | 10;8 |
| | | | | | C9 | M | 9;10 |
| S6 | M | 11;2 | DPC; received learning assistance at home school | Consultative SLP at home school for poor reading/ spelling | C10 | F | 11;5 |

Table II,
continued

| | | | | |
|---|---|---|---|---|
| S7 | F | 10;7 | Resource room (part time LD assistance); integrated with learning assistance for language arts. Grade 5 | Direct SLP therapy early primary; consultative at present. Weak auditory comprehension and poor verbal production skills |
| S8 | F | 9;11 | Resource room last year; learning assistance for language arts; Grade 4 | Direct SLP in grade 3 for functional language production skills |
| S9 | M | 9;8 | Learning assistance for poor reading comprehension | Direct SLP in grades 1-3 for poor "auditory memory", language comprehension and production skills |
| S10 | M | 11;8 | Learning assistance; skill development program (full day LD class) in Grade 3. Grade 6 | Direct SLP in early primary for weak syntax production; word finding difficulty. |

## Materials

### Stories

Two textbook passages were presented in this experiment, each incorporating similar content material. They each contained ten independent clause units.[11] The stories were analyzed according to the recursive transition network model of Trabasso, van den Broek & Suh (1989). The complete texts of the stories are shown in Appendices A and B. The stories, referred to as Text 1 and Text 2, were adapted from curriculum material utilized at present by school districts within the Lower Mainland. Text 1 was adapted from a story A Boy of Tache (Blades, 1973); this story was developed for children at a grade 2 level, according to British Columbia Ministry of Education (1987) guidelines. Text 2 was adapted from a short excerpt from The Haida and the Inuit: People of the Seasons (Siska, 1984), at present the suggested textbook for grade 4 socials studies instruction according to B.C. curriculum guidelines.

The stories were modified in such a way as to eliminate anaphoric ambiguity and to eliminate as many linguistic cohesive devices as possible. Clauses were further modified in order to render the interpropositional causal relations implicit. Rationale for this procedure was so that comprehension of the text as a whole was based strictly on construction of causal connections between clauses, and so that comprehension was not facilitated by coreference and other types of cohesion. The modified text clauses maintained the lexical and syntactic structures of the original texts as much as possible. Vocabulary was assumed to be interpretable at a grade 4 (9-year-old) level.

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11 The independent clause unit will be defined in a later section.

The stories were analyzed before their presentation using a procedure developed by Trabasso et al. (1989), which determined the causal relationships between the clause units of the stories. From this analysis procedure, a recursive transition network model representing each story's structure in terms of their causal relationships was obtained. The necessary inferences were derived from these models. The following section will describe the network model and explain its application to the two experimental stories.

## Description of the Recursive Network Transition Model

As a result of intensive study of the comprehension of narratives by young children, Trabasso and his associates developed a representational model for stories, based on the causal connections required between story elements. The model arises from the perspective of mental model theory, in that text-based and knowledge-based information are necessarily integrated in the formation of this representation. The model takes the format of a recursive network, the elements of which include categorized clauses and labelled causal relations (also see Trabasso & van den Broek, 1985). The model also includes an algorithm for identifying causal relations and a taxonomy for labelling them.

Causal relationships are the basic functional unit within this network model; they serve to link clausal elements with respect to their underlying content and they act to help assemble the clause units into a network. The authors state that the causal connections between pairs are constrained by the clause categories in the pair. Figure 1 shows a general template of the model (from Trabasso et al., 1989: 3). The figure generalizes one story episode.

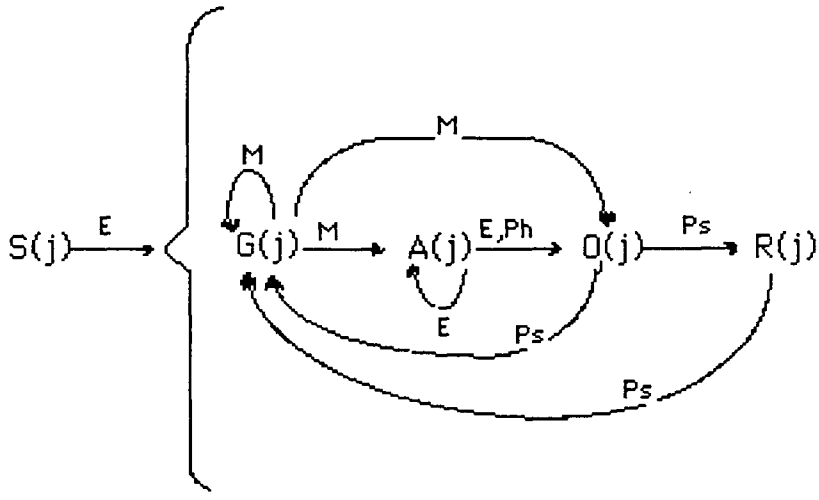


Figure 1. *Causal network transition model (from Trabasso, van den Broek & Suh, 1989).*

A node labelled by a letter characterizes the underlying concept or semantic category of a story clause. The adjoining arc between a category pair represents the causal relationship that exists between two story concepts. According to Trabasso et al. (1989), it is these causal connections which are inferred by the comprehender in developing a representation of the narrative discourse.

Definition of content categories: Category labels in Figure 1 stand for the following: S (Setting); G (Goal); A (Attempt); O (Outcome); and R (Reaction). Categories were assigned to clause units on the basis of their surface structure semantic content and corresponded generally to categories discussed in story grammar theory (e.g. Stein & Glenn, 1979). Category definitions from Trabasso et al. (1989) are shown in Table III.

TABLE III. *Definition of story content categories. From Trabasso, van den Broek & Suh, 1989.*

| Category | Definition |
|---|---|
| Settings | introduce characters, time and place of events, and states that provide background conditions in which actions or states may be enabled. |
| Outcomes or Complications | describe events which initiate the story; represent changes in state or action that are the outcome of unstated causal events. |
| Reactions | represent internal or emotional states or changes that are psychologically caused by outcomes or other reactions. |
| Goals | desired or undesired states, actions or objects that causally motivate attempts or other goals. |
| Attempts | motivated by goals; actions that are performed to achieve goal success; physically enable other attempts or physically cause outcomes. |

Differences are evident in the representations described by Trabasso as compared to those of other researchers. By analyzing folktales and children's narrative, Stein & Glenn (1979) and other researchers of narrative structure (e.g. Mandler & Johnson, 1977; Rumelhart, 1975) developed the principles seen to underlie the production of stories. Trabasso and associates attempt to describe a formal representation as it relates to the comprehension of stories. Thus the latter researchers assume that such a representation underlies both narrative structure production and comprehension. Further, the story statements as viewed from the perspectives of the former group may be connected in various

ways -- causally, temporally or additively; Trabasso et al. (1989) propose that their categories are connected only causally.[12]

It is important to note that Trabasso's definition of "causal" includes one type (elaborative) of necessary but not sufficient condition, which means that it includes relations other researchers have defined as "temporal." Another difference between the two approaches of Stein & Glenn (1979) versus Trabasso et al. (1989) concerns the basic clause unit itself: the former group, among others, suggests that story categories do not correspond to sentences, but to sets of sentences which together comprise an information unit; or they may correspond to a single word or to a phrase. The latter group stipulates that content categories for the most part are assigned to clause units containing action or states of agents and/or state changes of patients.

Identification algorithm for causal relations: Labelled arrows on Figure 1 denote the causal relations between the story categories. They are defined as: E (Enabling); Ps (Psychological); M (Motivating); and Ph (Physical). The researchers claim that the story events and states constrain what causal relationship obtains between them.

Trabasso et al. (1989) have suggested the following test which, when applied to the story events, can identify the types of causal connections that serve to link the story categories. Utilizing a logical heuristic principle -- a counterfactual test -- one can determine that, given two temporally ordered events, A and B, a causal relationship exists between them within the context of the story in the case where, if event A had not occurred,

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12 Lahey (1988) claimed that additive chains provide little structure for narratives; she agreed that causal connections provide more complex story structure.

then event B also would not have occurred. A judgment is made by considering the necessity of one event to another.[13] The model also assumes that a set of circumstances are created which allow necessary (and, for three of four types, sufficient) relationships to be connected. Thus, a set of necessary circumstances is invoked within which causal connections between two events depicted in a story can be made.

The above mentioned heuristic provides the basic format for the following algorithm: here causal relations can be easily identified. The causal relation will be identified as:

a) Motivational

if A is temporally prior to B and A is necessary and sufficient for B; and if A contains goal information,

b) Psychological

if there is no goal information in A, if A is necessary and sufficient for B and if B contains an internal state or cognitive or emotional reaction,

c) Physical

if there is no goal information in A, nor is there an internal state or reaction in B, but if A is necessary and sufficient in the circumstances for B to occur (that is, B will occur if A is placed in the circumstances),

d) Enabling

if A is not sufficient but is necessary for B to occur.

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13 The authors also suggest that by considering the criterion of necessity only, rather than the criteria of necessity and sufficiency, of one event to another, enabling causal relations are also identified.

Transitivity: A final procedure for the construction of the network involves chaining related events. Here, antecedent and consequent categories are connected with respect to their causal threads, independent of temporally or additively sequenced events. That is, the strength of a relationship of two categories varies with causal distance in the representation. Two categories may be directly causally related (i.e. share a transitive relationship and have no intervening causal categories), but in actuality, several clauses may intervene between these categories. Many researchers have shown that causal distance is a strong predictor of the strength of the causal relationship (e.g. Myers, Shinjo & Duffy, 1987).

Application of the Model

The analysis procedure described above was applied to the experimental stories, Text 1 and Text 2. A point of departure from the original model exists in this study with respect to the means of clause unit derivation. Trabasso et al. (1989) adapted a parsing method in which each clause unit contained one verb predicate. By this, each clause could stand alone as a grammatical structure, and include stative information such as "is" or "will be," for example:

(1) a. The long winter is over at last

b. and... the time for trapping beaver is here.

The researchers maintained this procedure, stating that inclusion of a verb within each clause provided information about agent action, state or state change (important for identifying causal relationships).

However, Trabasso et al. (1989) also suggested equivalent or alternative means for defining clause units. A decision was made in the present study to check the analysis procedure against a method defined by Ruthven (1989) adapted from Martin (1983). In this method, independent

clause units were categorized with respect to propositional mood, which was also seen to be maintained by verb predicate. Each clause unit includes subordinate (e.g. relative, verb complement) clauses gramatically related to it and conjoined clauses with subject ellipsis.

Establishment of causal networks: Figures 2 and 3 below represent the recursive causal networks developed for Texts 1 and 2 respectively. As per the model, each clause unit was classified into its semantic category, depending on its content. Application of the counterfactual heuristic and identification algorithm described previously yielded labelled causal relations among clause units for each story. Classification of clause units and causal categories was judged for reliability by a second evaluator. Discrepancies in judgements were discussed and a consensus was met regarding appropriate classifications for these items.

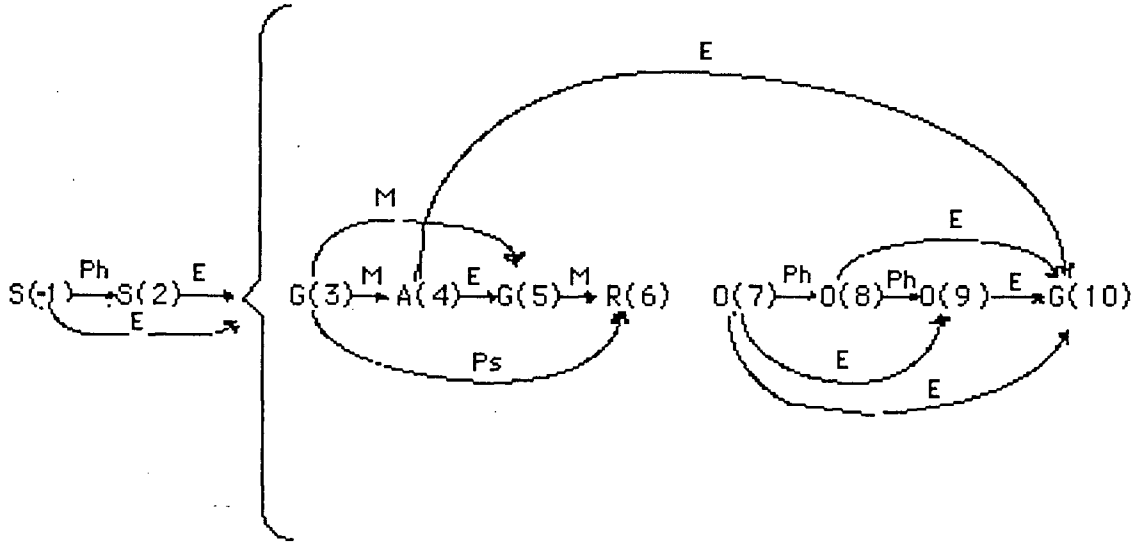


Figure 2. *Causal network transition model for Text 1.*

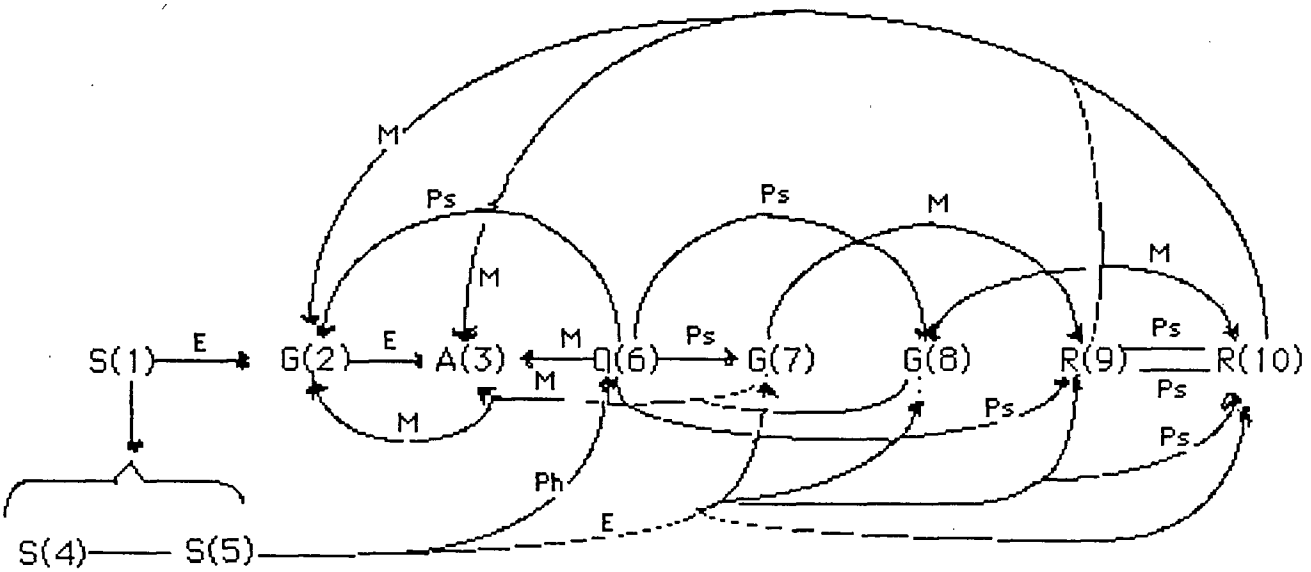


Figure 3. *Causal network transition model for Text 2.*

Causal inference matrices: A final procedure not been in the original model was devised for the purpose of the present study. Simple 10X10 (clause unit by clause unit) matrices were formed for for each representation with A clause units numbered down one axis and B clause units along the other. Corresponding causal inference types were entered into the cells which were at the intersection representing two causally related propositions. The purpose was to more clearly illustrate the distribution of causal inferences required within the stories. From these matrices the experimental inference statements were obtained. These matrices are shown in Appendices C and D.

Generation of Inference and Premise Statements

This section will describe the methods by which inference and premise statements used in the experiment were generated.

Inference statements: The analysis procedure outlined in the previous section yielded a causal inference matrix for each text analyzed. From them, inferences between propositions were obtained. These inferences are assumed to be psychologically real, and that the Trabasso et al. model is assumed to be a valid tool with which to determine causal inferences.[14]

Using the model and the matrices as a departure point, declarative statements were constructed to represent selected bridging connections within each text. Some inference statements on further analysis were determined to be composed of complex bridging connections; but it was proposed that for correct performance on these items the appropriate bridging inferences were necessary. Again, a second judge rated each inference statement as representing an appropriate implicit causal bridge within the context of the stories. According to the methods set by Crais & Chapman (1987) and Ellis Weismer (1981, 1985) half of these selected inferences were stated as true propositions and half were stated as false. An attempt was made in the present study to construct true and false inference statements that require integration of information across clause units as well as with subject's prior knowledge. Inferences that were interpretable based only on prior general knowledge, or that required manipulation of within-story relations (e.g. Hilyard, 1979) were not included.

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[14] Refer to Brown & Yule (1983) for a discussion of this topic.

Premise Statements: True and false premise statements were obtained directly from the texts themselves. These served as memory check controls, and were extracted from clause units representing all parts of the story, that is, from the beginning, middle and end of each story. An attempt was made to avoid, as thoroughly as possible, adding new semantic information for the construction of false premise statements. In these cases, the added or new information may be considered plausibly acceptable. A prediction is that if a bias were to operate, subjects may potentially err by accepting false statements (i.e. by responding incorrectly) rather than otherwise.

Wh-questions: A final qualitative procedure involved the construction of open-ended wh-questions. During this condition, subjects were allowed to elaborate on the inferences that they actually did construct during story comprehension. As Graesser (1985) has pointed out, "why" questions are particularly robust in encouraging inference-making, although it is equivocal whether this method taps knowledge consolidated during story comprehension, or in fact during the question-answering task. A decision was made to interpret the responses to wh-questions as an indication of prior knowledge content, and to interpret the responses to true-false statements as an indication of "on-line" inference construction.

Equipment

The stories were read aloud by the investigator and recorded on high fidelity cassettes using a Marantz PMD 220 professional audiocassette recorder with an AKG D-300 microphone. Text 1 was read at a speaking rate of 126 words per minute; Text 2 at a rate of 147 words per minute. Total duration of Text 1 was 40 seconds and of Text 2, 49 seconds. Each

passage was audiotaped on a separate audiocassette, and then dubbed once on the same tape, to yield an original and a dubbed version of each story per audiocassette. Therefore, each subject received the same version of both stories. The inference and premise statements were also read aloud by the investigator and audiotaped on the same recorder. The statements were audiotaped onto master tapes, one for each set of text statements. From the master tapes, individual statements were randomized and dubbed onto three separate tapes to yield three sets of randomly presented statements. Two Yamaha KX-550U audiocassette players were used for dubbing. Subjects heard one set of the randomized statements per story. Statements were presented at a rate of about 130 words per minute. Ten-second pauses were inserted between the statements on the dubbed versions to allow for response time. Recording volume, speaking rate, intonation, pause length and overall intelligibility of the recordings were checked for reliability by a second judge.

The audiocassettes were played to the subjects from a Marantz PMD 220 professional audiocassette player. Playback level was maintained for all subjects. Both subject and experimenter listened to the stories and statements using Sennheiser HD 420 SL headphones.

## Procedure

Each subject was tested individually in a quiet room by the experimenter. Each session lasted about 45-60 minutes for the control group subjects and about 75 minutes for the experimental group. For all subjects in the experimental group, the last part of the session involved administration of two standardized language assessment tools: (1) the Peabody Picture Vocabulary Test-Revised (Forms M and L) (Dunn & Dunn, 1981). This instrument was designed to evaluate comprehension of single

lexical elements, specifically nouns, verbs and adverbs. The experimental group also received administration of three subtests from the Clinical Evaluation of Language Fundamentals - Revised (Semel, Wiig & Secord, 1987), a standardized test designed to evaluate comprehension and production of syntactic forms and structures and of semantic relationships. The subtests administered were chosen to broadly determine comprehension of sentences using a variety of syntactic forms and semantic relational terms, and also to elicit production of sentences. The subtests administered from the CELF-R were the "Linguistic Concepts," "Formulated Sentences," and "Semantic Relationships" subtests. Subject scores are shown in Table I.

The purpose of the administration of these tests was to rule out subjects who may have had persisting lexical comprehension or syntactic deficits. This decision was made to allow interpretation of performance on the inference task: if a child performs poorly on inference items, it is necessary to demonstrate that this is not due to inability to understand lexical items or sentence structure. Note that this methodological decision contrasts the present study with Ellis Weismer's study. All experimental subjects scored within normal performance limits.[15] Procedures of the experiment before this point were similar for both the control and the experimental groups.

The subjects were instructed by the experimenter about the test equipment, such as the cassette recorder and the headphones. They were then instructed about the task. The subjects were told that they were going to hear two stories, one at the beginning and one near the middle of the

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15 Exceptions were Subject 4 who scored below average on the "Linguistic Concepts" subtest and Subjects 6 and 7 who scored below average on the "Semantic Relations" subtest.

session. The subjects were told they would hear each story two times and then were to answer some questions about the stories. They were instructed to listen to the stories very carefully in order to make judgements about the truth value of some following statements.

In order to make the experimental task more communicatively real, and also to ensure that the task elicited purposeful inference-making (e.g. Graesser, 1985) the following procedure was devised. The subjects were instructed to pretend that they were spies who had received a story and some mysterious messages on audiotapes. The subjects were instructed that some of the messages on the tapes were correct, and some were incorrect and that only they ("the spies") knew which were which. They were instructed to respond "Yes" if they judged a "message" (i.e. a True/False Statement) correct, and "No" if judged incorrect. The subjects were reminded of this task before presentation of the second passage.

The subjects were told they were to hear each story a total of two times before they would hear the statements, and were told they could listen to the stories as many times as they required after that. (Three subjects in the LLD group requested Text 2 to be repeated once, one subject asked for 2 repetitions; one LLD subject asked for Text 1 to be repeated. One normal control subject asked for one repetition of Text 2). The subjects again heard each story one time before presentation of the wh-questions. After the subjects were instructed on the task, they were asked to repeat the instructions, and then they were asked if they had any questions about the task. Before presentation of each story, subjects were given a brief preamble about the content of each passage, including a review of the necessary locative information contained in the stories. This information was not tested by the task. Subjects in each group were counterbalanced and randomly assigned to one of four conditions, in order

to eliminate order effects of text presentation and condition. The conditions are shown in Table IV .

TABLE IV . *Experimental Conditions.*

| Condition | Order of Presentation | |
|---|---|---|
| Condition A | Text 1 | Contextualized |
| | Text 2 | Uncontextualized |
| Condition B | Text 1 | Uncontextualized |
| | Text 2 | Contextualized |
| Condition C | Text 2 | Contextualized |
| | Text 1 | Uncontextualized |
| Condition D | Text 2 | Uncontextualized |
| | Text 1 | Contextualized |

Each subject was presented both uncontextualized and contextualized conditions, one for each story. A description of each condition follows.

Uncontextualized Condition

Subjects heard the story two times consecutively and were asked if they required another presentation of the story (Two LLD subjects requested repetition.) This was followed by presentation of one of the randomized sets of True/False statements. Subjects were reminded of the task to answer yes or no. The experimenter marked down the responses during the procedure manually.

Contextualized Condition

Subjects heard the story one time only, and were then told that they would be discussing some events from their own lives to help them understand the stories. The duration of the condition was on average about 15 minutes. The discussions were not taperecorded. See the following section for a discussion regarding this procedure. The subjects heard the story again once, and were asked if they required another presentation of the story (Two LLD subjects and one NL subject requested repetition). Presentation of one of the randomized sets of True/False statements for the story followed. Scoring procedure was as above.

All subjects in both conditions heard the stories again one time before presentation of the wh-questions. The subjects were then asked the wh-questions by the experimenter in person. Responses were recorded manually.

The procedure that was applied during the contextualization condition of the experiment was developed from studies which have indicated that access to prior or real world knowledge improves the comprehension of text material in which causal inferences must be made (Hayes & Tierney, 1982; Steffensen, 1985; Trabasso et al., 1989). Devine (1986), Irwin (1986) and Pulver (1986) reviewed specific instructional methods based on certain basic text-representational theories which help students use their existing knowledge to facilitate comprehension. These ideas were incorporated into the experimental condition. Main content areas from the experimental texts were selected as the basis for the discussions, depending on whether the content area contained a large proportion of causally related events. As Devine (1986) suggested, the children were asked to directly express what they knew about the particular topic. They were encouraged to "brainstorm" or describe as

much detail as possible about the selected topics. Personal information about experiences related to these content topics were solicited by the experimenter. In accordance with Devine's suggestions, the experimenter attempted to 1) determine the subject's prior knowledge by asking prompting questions; 2) activate prior knowledge by encouraging the subject to express information about the content and 3) relate old information to new information by encouraging the subject to generate ideas and make predictions about the story content as compared to personal experience. The above steps comprised the contextualization treatment. Story comprehension was facilitated through direct questioning, not necessarily of story content material, but of analogous material that the subject had personally experienced. The subjects were not taught what the direct relationships between their generated knowledge and text material were to avoid direct training of the desired causal inferences. They were encouraged to seek relationships through questions which were thought to elicit construction of complex knowledge frames important for inference-making (Devine, 1986).

## Analysis

All items were scored as correct or incorrect and were analyzed on the basis of the experimental questions. A nonparametric statistical method, Wilcoxon's Matched-Pairs Signed Ranks Test, was used to analyze data obtained across and within groups and conditions. Across group analysis required that a subject from one group was matched to a compatible subject from the second group on the basis of condition presented, age and sex, if possible.

Wilcoxon's test, is effectively used for small sample sizes (particularly for those smaller than 25). It provides for analysis of

significance at a level of 0.05, which was used for the present study. A more powerful method or significance level was not desired as the present investigation was designed primarily as an exploratory study.

# CHAPTER THREE

# RESULTS

## Presentation of the Data

The raw data, composed of the number of correct responses to yes/no inference and premise items in the contextualized and uncontextualized conditions, are presented in Appendix E. The data were analyzed according to the main questions proposed in Chapter One, in order to ascertain whether significant differences between language-learning disabled and normal children existed on task and item type. Data were analyzed using a nonparametric sign test -- the Wilcoxon Matched-Pairs Signed Ranks Test.

Table V. *Matched-pairs of language-learning disabled and normal language subjects on the basis of condition and chronological age (C.A.).*

| Pair number | LLD group | CA | NL group | CA | Condition |
|---|---|---|---|---|---|
| 1 | S1 | 8;10 | C1 | 9;0 | A |
| 2 | S2 | 10;11 | C6 | 11;2 | B |
| 3 | S3 | 10;3 | C3 | 11;2 | C |
| 4 | S4 | 10;10 | C4 | 10;0 | D |
| 5 | S5 | 9;4 | C9 | 9;10 | A |
| 6 | S6 | 11;2 | C8 | 10;8 | D |
| 7 | S7 | 10;7 | C2 | 10;2 | B |
| 8 | S8 | 9;11 | C5 | 10;11 | A |
| 9 | S9 | 9;8 | C7 | 9;8 | C |
| 10 | S10 | 11;8 | C10 | 11;5 | C |

Subjects from each group were assigned to pairs on the basis of the condition presented to the them and age. Subject pairs are shown in Table V. The scores from the two stories were collapsed and were not analyzed independently.

Group Differences on Inference-Making

Scores were analyzed to reject or accept the first null hypothesis which stated that there would be no difference between language-learning disabled and normal language children in the number of correct responses to causal inference statements in the uncontextualized condition. On general inspection of the data in Appendix E, the LLD group responded correctly to 39 out of 60 inference statements; the normal group responded correctly to 47 out of 60 items. Table VI demonstrates the matched-pairs analysis of these scores. T scores indicated that the normal

Table VI. *Matched pairs analysis of language-learning disabled group versus normal language group on correct responses to causal inference statements in the noncontextualized condition.*

| Pair No. | NL | LLD | Difference | Absolute Rank | R (+) | R (-) |
|---|---|---|---|---|---|---|
| 1 | 5 | 3 | 2 | 4 | 4 | |
| 2 | 4 | 1 | 3 | 6.5 | 6.5 | |
| 3 | 6 | 3 | 3 | 6.5 | 6.5 | |
| 4 | 2 | 5 | -3 | 6.5 | | 6.5 |
| 5 | 5 | 4 | 1 | 2 | 2 | |
| 6 | 6 | 6 | 0 | | | |
| 7 | 5 | 4 | 1 | 2 | 2 | |
| 8 | 4 | 5 | 1 | 2 | 2 | |
| 9 | 5 | 5 | 0 | | | |
| 10 | 6 | 3 | 3 | 6.5 | 6.5 | |
| T= 6.5 | | | | | R(+)=29.5 | R(-)=6.5 |
| N= 10 | | | | | | |

group responded correctly to significantly more inference items than the LD group (T=6.5, N=10, $p<0.05$). Therefore, the first null hypothesis was rejected.

Group Differences on Response to Premise Items

Scores were analyzed to test the second null hypothesis, which stated that there would not be a difference between the two groups in the number of correct responses to premise items in the uncontextualized condition. Table VII presents the matched-pairs analysis of scores. In general, the LLD group responded correctly to 46 out of 60 premise items in the uncontextualized condition; the normal group responded to 57 out of 60 premise items. T scores indicated that the normal group responded correctly to significantly more premise items than the LLD group in this condition (T=3, N=10, $p< 0.05$). Therefore the null hypothesis was rejected.

Table VII. *Matched-pairs analysis of language-learning disabled group versus normal group on correct responses to premise statements in the uncontextualized condition.*

| Pair No. | NL | LLD | Difference | Absolute Rank | R(+) | R(-) |
|---|---|---|---|---|---|---|
| 1 | 6 | 4 | 2 | 6.5 | 6.5 | |
| 2 | 5 | 6 | -1 | 3 | | 3 |
| 3 | 6 | 5 | 1 | 3 | 3 | |
| 4 | 5 | 5 | 0 | | | |
| 5 | 6 | 3 | 3 | 8 | 8 | |
| 6 | 6 | 5 | 1 | 3 | 3 | |
| 7 | 6 | 4 | 2 | 6.5 | 6.5 | |
| 8 | 6 | 5 | 1 | 3 | 3 | |
| 9 | 6 | 5 | 1 | 3 | 3 | |
| 10 | 6 | 6 | 0 | | | |
| T=3 | | | | | R(+)=30 | R(-)=3 |
| N=10 | | | | | | |

Effects of Condition on Inference-Making

The matched pairs analysis was applied to the data obtained from the LLD group to test the third null hypothesis. This null hypothesis stated that there would be no difference in the number of correct responses to causal inference statements by the LLD group in both the uncontextualized and the contextualized conditions. Overall, the LLD group responded correctly to 39 out of 60 inference items in the uncontextualized condition; in the contextualized condition they responded correctly to 44 out of 60 inference items. Table VIII presents the analysis of this data. Results indicate that there was no significant difference in scores obtained by the LLD group across the conditions (T=14, N=10, p> 0.05). Therefore the null hypothesis was not rejected.

Table VIII. *Matched-pairs analysis of number of correct inference items by LLD group across uncontextualized and contextualized conditions.*

| Subject No. | +Context Condition | -Context Condition | Difference | Absolute Rank | R (+) | R (-) |
|---|---|---|---|---|---|---|
| S1 | 4 | 3 | 1 | 2 | 2 | |
| S2 | 6 | 1 | 5 | 8 | 8 | |
| S3 | 6 | 3 | 3 | 7 | 7 | |
| S4 | 3 | 5 | -2 | 5 | | 5 |
| S5 | 4 | 4 | 0 | | | |
| S6 | 5 | 6 | -1 | 2 | | 2 |
| S7 | 2 | 4 | -2 | 5 | | 5 |
| S8 | 4 | 5 | -1 | 2 | | 2 |
| S9 | 5 | 5 | 0 | | | |
| S10 | 5 | 3 | 2 | 5 | 3 | |
| T=14 N=10 | | | | | R(+)=22 | R(-)=14 |

Conditional Analysis

A final analysis was made to compare premise versus inference scores by the two groups in the uncontextualized condition to test the seventh null hypothesis. That is, a differential score analysis was of interest to determine whether a significant difference existed between the groups in their scores on premise over inference items. Table X presents the matched-pairs analysis of the data. First, Table Xa reveals that the LLD group responded to significantly more premise than inference items in the uncontextualized condition ($T=7.5$, $N=10$, $p< 0.05$). Table Xb reveals that the NL group also responded to significantly more premise than inference items ($T=4$, $N=10$, $p< 0.05$). Finally, Table Xc reveals no significant difference between the groups in the differential scores on premise versus inference items. Therefore the null hypothesis was not rejected.

Table X. *Matched-pairs analysis of the number of correct responses to premise versus inference items by LLD and NL groups in uncontextualized condition.*

*a. Premise versus inference items by LLD group.*

| Subject No | Premise | Inference | Difference | Absolute Rank | R (+) | R (-) |
|---|---|---|---|---|---|---|
| S1 | 4 | 3 | 1 | 2.5 | 2.5 | |
| S2 | 6 | 1 | 5 | 7 | 7 | |
| S3 | 5 | 2 | 3 | 6 | 6 | |
| S4 | 5 | 5 | 0 | | | |
| S5 | 3 | 4 | -1 | 2.5 | | 2.5 |
| S6 | 5 | 6 | -1 | 2.5 | | 2.5 |
| S7 | 4 | 4 | 0 | | | |
| S8 | 5 | 5 | 0 | | | |
| S9 | 4 | 5 | -1 | 2.5 | | 2.5 |
| S10 | 5 | 3 | 2 | 5 | 5 | |
| T= 7.5 | | | | | R(+)= 20.5 | R(-)=7.5 |
| N=10 | | | | | | |

Table X, continued

*b. Premise versus inference items by NL group.*

| Subject No | Premise | Inference | Difference | Absolute Rank | R(+) | R(-) |
|---|---|---|---|---|---|---|
| C1 | 6 | 5 | 1 | 4 | 4 | |
| C2 | 6 | 5 | 1 | 4 | 4 | |
| C3 | 6 | 5 | 1 | 4 | 4 | |
| C4 | 5 | 2 | 3 | 6 | 6 | |
| C5 | 6 | 4 | 2 | 5 | 5 | |
| C6 | 5 | 4 | 1 | 4 | 4 | |
| C7 | 6 | 5 | 1 | 4 | 4 | |
| C8 | 6 | 6 | 0 | | | |
| C9 | 6 | 5 | 1 | 4 | 4 | |
| C10 | 5 | 6 | -1 | 4 | | 4 |
| T=4 | | | | | R(+)=35 | R(-)=4 |
| N=10 | | | | | | |

*c. Comparison of difference of premise and inference scores by LLD and NL groups.*

| Pair No, | LLD Group Difference | NL Group Difference | Difference | Absolute Rank | R (+) | R (-) |
|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | | | |
| 2 | 5 | 1 | 4 | 9 | 9 | |
| 3 | 3 | 1 | 2 | 4.5 | 4.5 | |
| 4 | 0 | 3 | -3 | 7.5 | | 7.5 |
| 5 | -1 | 1 | -2 | 4.5 | | 4.5 |
| 6 | -1 | 0 | -1 | 1.5 | | 1.5 |
| 7 | 0 | 1 | -1 | 1.5 | | 1.5 |
| 8 | 0 | 2 | -2 | 4.5 | | 4.5 |
| 9 | -1 | 1 | -2 | 4.5 | | 4.5 |
| 10 | 2 | -1 | 3 | 7.5 | 7.5 | |
| T=21 | | | | | R(+)=21 | R(-)=24 |
| N=10 | | | | | | |

## Summary

The above results were obtained from the data and can be summarized in view of the original questions as follows:

1. Normal language children correctly responded to significantly more causal inference statements than LLD children did in an uncontextualized condition.

2. Normal language children correctly responded to significantly more premise statements than LLD children did in an uncontextualized condition.

3. Both LLD and NL children correctly responded to significantly more premise than inference statements in an uncontextualized condition, but there was no difference between the groups in the obtained "premise advantage."

4. There was no significant difference in the scores obtained by the LLD group on causal inference statements in the uncontextualized versus contextualized conditions.

5. There was no significant difference in the scores obtained on true and false inference statements by the LLD group. There did appear to be an effect of story on scores obtained on true inference items for the LLD group.

# CHAPTER FOUR

# DISCUSSION

## Review of the Results

### Comparison of Findings to Previous Research

The major results of this investigation suggest that language-learning disabled children may not have difficulty constructing causal inferences. This finding contradicts those from other research; others have reported inference-making deficits by language-impaired subjects (Ellis Weismer, 1981) and language-learning disabled children (Crais & Chapman, 1987; Wong, 1980). Although language-learning disabled children performed significantly worse than normal language children on inference items, this result is viewed in light of other findings of this investigation, which indicated that LLD children also performed significantly worse on premise items than normal control subjects. This finding is consistent with Ellis Weismer's (1981), although she found that LLD subjects responded significantly worse on inference items beyond their memory capacities. Although each group responded correctly to significantly more premise than inference items in the uncontextualized condition, there was no significant difference between groups in the differential score between the two types of items. That is, both groups performed as poorly on inference items. In fact, general observation of the mean scores obtained by the groups in this condition revealed that normal children exhibited a greater discrepancy between inference and premise items than language impaired

subjects. (See Table XI below.) This result may be explained further, however, in consideration of methodology and subject response bias. It is suggested that a response bias was operating for the normal subject group in terms of rejecting certain inference items. This point shall be discussed in more detail later.

Several findings from this investigation suggest that inference-making may be facilitated in a contextualization condition. Wong (1980) directly demonstrated that learning-disabled students recalled more implicit-cued sentences following a question prompt procedure than prior to such a condition. Results from the present study did not show a significant difference in inference scores across conditions for the LLD group. However, several trends may indicate that such a condition may nevertheless be facilitative for this group. First, general inspection of the analysis of data presented in Table VIII in Chapter Three indicates that while differences in scores between conditions are not significant, it is clear that more inference items were correctly answered in the contextualized than uncontextualized condition (as demonstrated by the total sum of ranked differences in the positive direction). Thus, an increased sample size may provide data adequate for this interpretation.

Second, a difference in scores obtained on premise and inference items across conditions was additionally noted. Means on these items for each group were computed to determine the relative change in scores across conditions. Table XI summarizes these scores. As is evident in Table XI, both groups performed worse on premise items in the contextualized condition than in the uncontextualized condition; however both groups performed better on inference items in the contextualized condition.

Table XI. *Mean scores of inference and premise items by LLD and NL groups in the uncontextualized and contextualized conditions.*

| | Condition | | | |
|---|---|---|---|---|
| | Uncontextualized | | Contextualized | |
| Group | Inference | Premise | Inference | Premise |
| LLD Group | 3.8 | 4.6 | 4.4 | 4.5 |
| NL Group | 4.7 | 5.7 | 5.0 | 5.1 |

Table XI also shows that the relative increase in inference scores across conditions was greater for the LLD group than for the normal group. Thus it can be suggested that there are differing context effects on premise and inference items. For LLD children, contextualization does appear to facilitate inference-making.

Methodological Considerations

Observations during experimentation suggested some methodological implications. For both groups, contextualization acted as an interfering condition. Recall of premise items was deleteriously affected due to this condition. Furthermore, often retrieval of prior information contradicted that which was presented in the stories. For example:

I: Tell me what you know about winter in places like the North Pole.
C9: You can go beaver trapping, but you can trap it in the winter though. We trapped them in Prince George.
I: How?
C9: You use a canoe to get to them and then trap them. You dig a hole in the ice and set the traps around it. Lots of animals lay on the ice waiting for the beaver, like coyotes.

I: What do you think the Indians might have used to travel around in in the Queen Charlottes?
S2: Kayaks. The Haidas didn't use canoes.

Finally, due to the conversational nature of the contextualization condition, topic shifts often occurred so that information not pertinent to story comprehension was retrieved. As a result, memory for story content was weakened through this procedure. These factors may have contributed to the lower scores on premise (memory) items after this condition. On the other hand, in general, retrieval of related information tended to enhance inference-making, especially for learning-disabled subjects. Again, increased sample-size may provide adequate data for any significant context effects to be noticed. It appears that even with an interfering condition that affects the recall of literal story premises, implicational gaps can still be resolved through the relating of story content to general knowledge (e.g Devine, 1986).

Several other methodological issues must be discussed to account for the obtained data, and to allow for possible interpretations. As mentioned above, the contextualization task effect tended to impede recall of story premise items, but did tend to enhance comprehension of implicit causal connections. However, a note of caution is made in concluding that inherent processing differences between inference and premise statements exist. Another possible factor may have contributed to the present findings. There appeared to be a potential subject bias operating during the response task, especially for the normal subjects. As is shown in Table X in the Results chapter, a significant difference existed between the number of correct responses to inference and premise statements for both groups. Observations during experimentation with young children and adult subjects indicated that often inference statements were rejected as "not being heard," "not given," or were "not specified." Subjects who responded "I don't know," during the task applied this response only to inference items; they were then encouraged to guess. A guessing strategy,

i.e. a random application of a yes or no response, may have also automatically operated with some subjects. As described in the Methodology chapter, instructions requested subjects to attend to the story premises, then to attend to test items to make judgements as to whether they related to the preceding story. Subjects may have been biased to respond accurately only to those items which were literally related to the stories, that is , the premise items, and not as accurately to inference items. Results indicated that since no significant difference between true and false inference items existed, this trend may have operated over both types of inference items. Therefore, experimental instructions alone may have created a propensity to attend only to premise items, and a propensity to guess at inference items.

One additional item in Text 2 tended to confound responses by normal language subjects: namely the true inference statement "Cedar does not rot quickly." Here, subjects were required to process a negative statement and confirm or deny its truth value. A correct response required a "yes" answer. However, due to the nature of the response mode (forced choice yes/no), a bias tended to operate in which subjects may have in fact responded to emphasize the negative aspect of the statement, i.e. in effect responding "No, cedar does not rot quickly." Several subjects recanted their responses to item 2 or required longer response times.

Open-ended Inference Questions

As described previously, a quantitative analysis did not unequivocally show whether LLD children exhibit poorer inference-making abilities than their memory for story premise items would allow. However, the present study also included an open-ended question answering task which was purported to elicit causal inference-making (e.g.

Graesser & Clark, 1985). Often responses to these questions proved to reveal application of real world knowledge on the part of the LLD subjects as the basis of integrating text propositions. Qualitative analysis of responses to open-ended causal inference questions for Text 1 indicated that LLD subjects, normal language school-aged subjects and adult subjects responded by either (1) utilizing inferences that served to integrate text content or (2) retrieving prior content that did not relate to story material.

The questions were designed to access inferences of different types and complexity (according to the causal network model of Trabasso et al., 1989), but for an appropriate response, text and inference integration was necessary.[16] Information retrieved that indicated general knowledge but which was not integrated with story information was not considered appropriate inference construction. Each question will be be discussed in turn. (Text 1 is presented in Appendix A. Also see Figure 2 for outline of the causal network representation and bridging inferences of this story).

*How do you think the men get their boats ready?*

An enabling inference was required that bridged an attempt with the final goal in the story. Here, necessary, but not sufficient, information may be retrieved (e.g. Trabasso & van den Broek, 1985). All LLD subjects expressed that preparing boats for the goal of trapping beaver requires equipping boats with traps, gear and/or food. Two LLD subjects mentioned the necessary action of bringing boats down to the water from a winter storage place. No LLD subject retrieved general information that did not relate to story content. However, several NL and adult subjects did express "extra-story" material. Two NL children described a traditional

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[16] Wh questions from Text 1 will be discussed so as to compare responses with those by adult subjects.

method for making canoes, yet this information was not judged as being strictly necessary for the causal connection between text propositions. Three nondisordered subjects claimed that they did not know the answer, or that content was not given.

*Why will the men leave tomorrow?*

An appropriate response to this wh-question required construction of a complex of causal inferences, including enabling and physical types bridging the final goal to the previous physical outcome sequence (see Figure 2). Here, all but one LLD subject inferred that the melted and broken ice enabled the boats to travel through the lake. This one LLD subject and several NL and adult subjects retrieved other information that was not considered necessary and sufficient to connect the propositions. Information such as that the Indian men "might be tired," "are not ready to leave," or "leave to hunt beaver" did not form the necessary desired enabling and physical causal inferences.

*Why do the Tache men go beaver hunting in the spring?*

The third wh-question exemplifies the limitations and difficulties described by Graesser & Clark (1985) and Frederick (1981) in utilizing open-ended questions to determine inference-making capabilities. Analysis of responses to this question reveals that inferences are generated which may not have been constructed during text presentation, but which adequately fulfill the question. Responses to the above question generally represented two plausible content areas; however only one was considered relevant to the integration of information presented in the story.

The desired response indicated generation of a complex of physical and enabling inferences which served to connect the initial attempt with the final goal and the intervening series of physically linked outcomes. Of interest was indication of knowledge of the cause/effect relationship between the initial environmental setting (spring) and warm weather which causes ice to melt, enabling boats to travel through water. Several subjects did indicate comprehension of those relationships, including two out of five LLD subjects in the uncontextualized condition. However, the majority of subjects tended to respond that spring is when beavers come out of hibernation, thus allowing hunters to trap them. This response, while perhaps plausible and correct, did not include indication that a necessary enabling connection had been constructed in comprehending the events between the final goal and the initial consequence of wind blowing ice apart. In effect, story content had not been integrated with inferences for this response; therefore it was not considered an adequate representation of text integration. Several normal language and adult subjects retrieved general information not considered appropriate inferences such as "the beaver coats are thicker," "tradition," or "so they have food for the winter."

*What is Lake Stuart like in the winter?*

This question, on analysis, could easily be answered on application of general knowledge alone without integrating with text propositions. All subjects from the three groups adequately responded using terms such as "icy," "frozen," "cold," or "snowy."

In summary, language-learning disabled children generally are as capable as normal children of retrieving real world information to construct causal inferences which serve to integrate story propositions

when cued with open-ended wh-questions. Limitations hold, however, in concluding that this type of inference-making is of the elaborative bridging type described by Keenan et al. (1984), or is merely task-specific for the purpose of answering questions, after the fact (e.g. Frederick, 1981).

If the former conclusion is true, this finding, along with the major finding described initially, substantiates that found by Hilyard (1979). In her study, children between the ages of 6 and 10 years old were capable of deriving inferences targetted by yes/no and open-ended questions when a meaningful context was provided. Ellis Weismer (1981) also discovered that overall language-impaired students performed similarly to children with comparable language abilities on causal inference questions, but generally performed better on causal than spatial inferences. Thus, the present findings coincide with other research which indicates that subjects with weak language-proficiency are more capable of making causal inferences than their general ability at noncausal inference-making would indicate.

Another interesting finding was that for open-ended questions, normal language and adult subjects frequently retrieved information that did not serve to strictly integrate text propositions, and which even acted to confound responses. This effect is related to that noted during the contextualization task, in which NL subjects frequently strayed off-topic, resulting in a lowered premise item score. A suggestion here is that a true difference may in fact exist in the context that is retrieved by NL versus LLD children. Trabasso et al. (1989) suggested that only that information that is necessary (or necessary and sufficient) to integrate propositions through inference-making is accessed. Normal language users may have developed more facility at generating elaborated contests as a strategy in new learning situations (Frederick, 1981). This retrieved information may

in fact confound comprehension in situations where presented material is highly implicit, or may exemplify the various ways that background knowledge can interact with texts in fashions that are unpredictable (Brown & Yule, 1983).

## Causal Network Transition Model

A discussion must be included on the predictive power of the causal network model for story comprehension developed by Trabasso and his associates and presented in Trabasso et al., (1989). The two stories presented in this investigation were analyzed according to the model, and causal inferences were generated from the derived bridging causal connections. However, as can be seen from Figures 2 and 3 in Chapter Two, the representations obtained differed structurally; it is clear that Text 1, a narrative, more closely resembled the general template for story structure depicted in Figure 1 (from Trabasso et al., 1989), than Text 2 did. Text 2 exemplified a discursive, or nonnarrative text, and more obviously differed from the narrative structure template. Differences in inference complexity and type which were considered to be bridging connections also differed between the two texts.

Table XII shows the mean response scores to inference and premise items by the two groups for each story (in the uncontextualized condition). As can be seen, LLD subjects tended to perform better on inference items in the discursive than in the narrative text. As a result, this discrepancy helps to strengthen the predictive power of the model.

Table XII. *Mean scores on inference and premise items in individual stories by LLD and NL groups in the uncontextualized condition.*

| | Story | | | |
|---|---|---|---|---|
| | Text 1 | | Text 2 | |
| Group | Inference | Premise | Inference | Premise |
| LLD Group | 3.2 | 4.8 | 4.6 | 4.4 |
| NL Group | 5.0 | 5.6 | 4.4 | 5.8 |

Analysis of the inference types from both stories reveals some considerable differences. For Text 1, inference items were developed which attempted to reflect the bridging causal connections as depicted in Figure 2. However, some inference items were found to be a complex of inferences involving two or three inferential bridges (according to the derived model), such as item 2, "The Tache men must wait for the ice to melt before trapping." On the other hand, all inference items from Text 2, except for item 4, were determined to be comprised of a complex of several causal bridging inferences according to the model. Item 4, "Cedar breaks apart easily in winter storms," was considered an intersentential inference. As mentioned by Trabasso et al. (1989), and as is suggested by the data shown in Table XII, causal connectedness can predict story comprehension. That is, the inference items from Text 2 were composed of several bridging inferences acting to connect the story propositions. LLD subjects tended to correctly respond to more inferences from this text than from Text 1; thus it is suggested that complex inferences enhance comprehension for LLD children by providing more causal connections between propositions than simple inferences comprised of a single bridge.

Furthermore, if such a suggestion is true, then these findings add strength to the predictive power of the causal network model to generate inferences. Power of the model is further strengthened by considering that valid inferences from narrative and nonnarrative structures can be generated. The present findings corroborate findings by Trabasso et al. (1989), who demonstrated that within a story context, when a category had several direct, causally related conjoined antecedent categories, comprehension of the relationship between any given two categories was strengthened (as operationalized in a judgement task).

An interesting question remains as to the effect that text structure has on inference-making. Several researchers have investigated inference-making using short texts (e.g. Ellis Weismer, 1981; Paris, Lindauer & Cox, 1977), and longer narrative texts (e.g. Crais & Chapman, 1987, Hilyard, 1979; Trabasso, 1986). Some studies have shown that narrative texts which provide a meaningful context enhance inference-making (e.g. Hayes & Tierney, 1982; Steffensen, 1985; Trabasso, 1986; Trabasso et al., 1989) even for young children (Hilyard, 1979). However, very little, if any, contemporary research has investigated the production and comprehension of nonnarrative texts, such as discursive texts. Detailed representations of these texts in terms of the content categories and structural connections that may exist for language-users are relatively scarce. Even more remote are applications of this information to language-developing and language-disordered populations. As is suggested by the present investigation, inherent differences between narrative and nonnarrative structures may be evident in the ways these texts are either represented or constructed during comprehension. In terms of inference-making, it is predicted that discursive texts may facilitate the comprehension process by providing more concrete content that is causally

related. Causal relationships may be more obvious in these texts. This area provides a rich domain for further investigation.

## Selection of LLD Subjects

One final methodological issue addressed in this discussion of the results regards the choice and selection of experimental group subjects and the implications of this choice. A decision was made in the present investigation to select subjects who did not display deficits in lexical semantic or sentence structure comprehension. This selection criterion differed from that utilized by other researchers such as Ellis Weismer (1981), who tested subjects who demonstrated such problems and had been diagnosed as specific language-impaired. The present selection criterion also differed from that seen in Crais & Chapman (1987), whose subjects were enrolled in a learning disabilities program and were also diagnosed as specific language-impaired displaying delays in "oral language expression and/or auditory comprehension" (Crais & Chapman, 1987: 51). All experimental subjects were at the time of testing receiving speech-language therapy. Both sets of researchers compared the experimental group to a vocabulary-matched, younger group. In both studies, the LLD group performed similarly to this younger group. These findings again raise the issue that it is necessary to show that poor performance is neither due to a lack of understanding of lexical items or sentence structures within the presented stories, nor to a weak memory capacity.

Subject selection in the present investigation attempted to overcome this issue. The study included subjects who were assumed to have general oral language deficits, as reflected by poor academic achievement. In other words, these children had been identified as learning disabled within

their particular school district. Several disadvantages are evident in adopting this criterion. First, each of the three participating school districts had a different definition of "learning disability"; it is clear from the literature and from institutions that utilize the LD notion, that a distinct definition that selects a particular, homogeneous population of "learning disabled" students does not exist (e.g. McKinney, 1984). Indeed, it is even doubtful that a distinct "learning disorder" or a population which shares a common learning disorder alone exists.

A second disadvantage involves selecting subjects who had been discharged from speech-language therapy. A more controlled method of comparing these children to "normal" control subjects is desired to more clearly distinguish those subjects with definite language delays (including extrasentential deficits) from those who do not. Some control group subjects may have had such deficits without demonstrating academic problems. Conversely some experimental group subjects did not suit the selection criterion of having received direct therapy for language delays (for example, subject S6). This issue highlights the definitional and diagnostic problems many face when attempting to distinguish among the many subgroups of disordered populations, if distinct demarcations exist at all.

However, if one is to assume that the subjects in the present study did exemplify a generally homogeneous group demonstrating weak oral language skills, but normal comprehension of lexical items and sentences, an interesting conclusion arises. Subjects within the present LLD group demonstrated inference-making to the level that their recall abilities would suggest. Subjective analysis indicated that retrieval of prior knowledge was adequate for the purposes of causal inference-making during a question-answering task, and was adequate for the

comprehension of narrative and nonnarrative texts. Other studies have shown that language-impaired subjects with sentence-level comprehension deficits did demonstrate weak inference-making skills, and yet from the present study, those with adequate comprehension failed to demonstrate the same degree of weakness. Therefore, it may be concluded that inference-making is not a supersentential process; some factor operating at the linguistic, structural level may account for inferencing deficits seen in language-disordered children. This conclusion supports that by Crais & Chapman (1987) and to an extent Hilyard (1979). Hilyard claimed that weak language proficiency predicts poor performance on tasks requiring decontextualized manipulation of propositions to construct arbitrary (i.e. spatial or transitive) inferences. And to reiterate, Ellis Weismer (1981) also noted that even LD subjects performed more poorly on spatial versus causal inferences.

## Future Directions and Clinical Implications

The major findings of this study indicated that inference-making processes are subject to a variety of factors which both impede and enhance their operation. As discussed in Chapter One, retrieval of prior knowledge is an important aspect of the inference-making process, and one which clearly facilitates comprehension of text material. Regarding language-learning disabled children, it appears that inference-making is related to the extent to which material is understood and retained in memory. Familiarity of material also likely plays a role in the level to which extant knowledge can be applied to enhance comprehension. Others have suggested that the text's function and the environmental context interrelate with these issues to affect inferencing skills.

Further research is required to clarify the results of the present study. One area of investigation regards the population of interest to be studied. Subjects in the present study had developmental oral language difficulties, but demonstrated comprehension skills at age-appropriate levels at the time of testing; they did not differ from their age-matched peers in terms of inference-making. Two conclusions are evident here. First, as hypothesized in the first chapter, language-learning disabled children are able to retrieve sufficient and necessary causal information from their own previous background knowledge to be integrated with text information. However, a second, perhaps contradictory, conclusion can also be drawn. Since word- and sentence-level comprehension was basically equivalent for the two groups in the present study, it was assumed that the experimental group contained subjects who were representative of a group of learning-disabled students with subtle, supersentential, discourse processing difficulties. Therefore, either the experimental group did not have discourse processing difficulties; or if they did, then causal inferential comprehension does not require supersentential processes.

Investigation can further tease apart these complex relationships. Further study with specific language-impaired subjects who demonstrate word- and/or sentence-level delays may shed light on how sentence-level processes interact with comprehension of texts when inferences are required. Other studies have not clearly shown that difficulties are not due to sentence-comprehension deficits alone; therefore material that is interpretable at subjects' language levels should be utilized. Comparison of inference-making skills to those of normal age-matched and normal language-matched peers may clarify how knowledge retrieval abilities interact with language skills. It is predicted that, for young and language-impaired subjects, material with familiar content should facilitate the

retrieval of background knowledge, facilitate inference construction and enhance comprehension of text material. Inferences requiring the manipulation of linguistic forms alone (such as noncausal inferences) or inference-making in an unfamiliar context should prove to be difficult for the disordered population.

Several of the effects noticed in the present study may be strengthened by merely increasing the sample size to a level that would provide sufficient data for a clear interpretation. For example, increase of sample size may elucidate the context effect in which memory for story premises is decreased, but causal inference-making is improved. This effect has clinical implications as well: contextualization of story or nonnarrative textbook material in terms of the student's or patients' previous experiences and own knowledge has proven to be an effective method to facilitate comprehension. The effectiveness of this procedure is strengthened by the fact that even when the causal connections which are important for story structure are implicit, comprehension appears to be facilitated. Further, the present study indicates that event when memory for literal story premises decreases during the contextualization procedure, general knowledge of content and interpropositional relationships is improved.

Finally, the second area of research concerns the causal network transition model developed by Trabasso et al., (1989). Further investigation is justified, since the results of the present study appeared to support findings of the original researchers in terms of the generation of inferences of different type and complexity. The predictive power of the model was noted, in that it also allowed for the generation of inferences in both narrative and nonnarrative types of text.

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# APPENDIX A

## Text 1

1. It is spring/
2. The long winter is over at last/
3. and at the Indian reserve of Tache in northern British Columbia the time for trapping beaver is here/
4. The men get their riverboats ready/
5. As soon as they can they will set out/
6. They wait with excitement/
7. One morning the wind is blowing/
8. All the ice piles up on a rock in the middle of Lake Stuart/
9. Big spaces of bright blue appear in the water/
10. Tomorrow will be the day to go trapping/

*True Inference Statements*

1. The Tache men use riverboats to hunt beaver.
2. The Tache men must wait for the ice to melt before trapping.
3 The wind causes the ice to break up in Lake Stuart.

*False Inference Statements*

4. The Tache men hunt beaver in the winter.
5. The Tache riverboats can travel through ice.
6. The Tache must wait for the beavers to arrive before trapping.

*True Premise Statements*

7. The men waited with excitement.
8. The wind is blowing one morning.
9. This story takes place in Tache.

*False Inference Statements*

10. In the story, it is wintertime
11. The Tache men live in Alberta.
12. The men of Tache set out right after getting their boats ready.

*Wh-questions*

1. How do the men get their boats ready?
2. Why will the men leave tomorrow?
3. Why do the Tache men go beaver hunting in the spring?
4. What is Lake Stuart like in the winter?

# APPENDIX B

## Text 2

1. The Haida of the Queen Charlottes greatly valued the cedar tree/
2. They looked for the best red cedar they could find/
3. The Haida tested it to see if it was solid all the way through/
4. The grain of the wood is straight/
5. and its wood is soft and easy to carve/
6. Yet the cedar lasts for a long time in wet, rainy weather/
7. The early Haida needed houses, canoes and totem poles that would not rot quickly/
8. They needed canoes that would not break apart against the pounding waves of winter storms/
9. The Haida found many ways to use the cedar/
10. They learned to chop, carve, smoothe, steam, soften, and bend cedar to meet their needs/

*True Inference Statements*

1. The weather is wet and rainy in the Queen Charlottes.
2. Cedar does not rot quickly.
3. The Haida used cedar to make houses and canoes.

*False Inferences Statements*

4. Cedar breaks apart easily in winter storms.
5. Rain causes cedar to rot quickly.
6. The Haida used many types of trees to make houses and canoes.

*True Premise Statements*

7. The Haida learned to bend cedar wood.
8. Cedar is easy to carve.
9. The Haida used canoes.

*False Premise Statements*

10. The Haida used any tree they could find for bending and smoothing.
11. The Haida lived on Vancouver Island.
12. The tree most valued by the Haida was the fir tree.

*Wh-questions*

1. Why was solid cedar the best type of cedar to use to make houses and canoes?
2. What other things did the Haida use cedar for?
3. Why did the Haida not use other types of trees to make canoes?

# APPENDIX C

clause unit number

B

| A | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | E | E | E | E | Ph | E | E | E |
| 2 | | | E | E | E | E | E | E | E | E |
| 3 | | | | Ps | Ps | Ps | | | | |
| 4 | | | | | M | | | | | E |
| 5 | | | | | | Ps | | | | M |
| 6 | | | | | Ps | | | | | |
| 7 | | | | | | | | Ph | E | |
| 8 | | | | | | | | | Ph | E |
| 9 | | | | | | | | | | E |
| 10 | | | | | | | | | | |

Causal inference distribution matrix for Text 1. Symbols represent causal relations between individual clause units. A clause units down columns; B clause units along rows. See Appendix A for story clauses. Definitions as follows (from Trabasso, van den Broek & Suh, 1989):

E: enabling causal inference

M: motivating causal inference

Ph: physical causal inference

Ps: psychological causal inference

# APPENDIX D

clause unit number

B

| A | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | E | E | | | | E | E | E | E |
| 2 | | | E | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | E | | | | Ph | | E | E | E | E |
| 5 | E | | | | | | | | | |
| 6 | | Ps | E | | | | Ps | Ps | Ps | Ps |
| 7 | | M | M | | | | | | M | M |
| 8 | | M | M | | | | | | M | M |
| 9 | | M | M | | | | | | | Ps |
| 10 | | M | M | | | | | | Ps | |

Causal inference distribution matrix for Text 2. See Appendix B for individual clause units. See Appendix C for definition of symbols.

APPENDIX E

| | *Cond | True Inference | | | False Inference | | | True Premise | | | False Premise | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LD | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| S1 | A | C/c | C/c | E/c | C/e | C/e | E/e | C/c | C/c | C/e | E/e | E/c | E/c |
| S2 | B | e/C | c/C | e/C | e/C | e/C | e/C | c/C | c/C | c/C | c/E | c/C | c/C |
| S3 | C | e/C | c/C | c/C | e/C | c/C | e/C | c/C | c/C | c/C | e/C | c/C | c/C |
| S4 | D | E/e | C/c | C/c | C/c | C/c | E/c | E/e | C/c | C/c | C/c | C/c | E/c |
| S5 | A | C/c | C/c | C/c | C/c | E/e | E/e | C/e | C/c | C/c | E/e | E/e | C/c |
| S6 | D | C/c | E/c | C/c | C/c | C/c | C/c | C/c | C/c | C/c | C/c | C/e | C/c |
| S7 | B | c/C | c/E | e/C | e/E | c/E | c/E | c/E | c/E | c/C | e/E | c/E | e/C |
| S8 | A | C/c | C/c | E/e | C/c | C/c | C/c | C/c | E/c | C/c | C/c | C/c | C/e |
| S9 | C | c/C | c/C | c/C | c/E | c/C | e/C | c/E | c/C | c/C | e/C | c/C | e/C |
| S10 | C | e/C | c/C | c/C | c/C | e/E | e/C | c/C | c/C | c/C | c/E | c/C | e/C |
| NL | | | | | | | | | | | | | |
| C1 | A | E/c | C/e | C/c | C/c | C/c | C/c | C/c | C/c | C/c | c/E | c/C | c/C |
| C2 | B | C/c | C/c | C/c | C/c | C/c | C/e | C/c | C/c | C/c | C/c | C/c | C/c |
| C3 | C | c/C | c/E | c/C | c/C | c/C | e/C | c/C | c/C | c/C | c/C | c/C | c/C |
| C4 | D | C/e | C/e | C/c | E/e | C/e | E/c | E/c | C/e | C/c | E/c | C/c | C/c |
| C5 | A | E/e | C/e | C/c | E/c | C/c | C/c | C/c | C/c | C/c | C/c | C/c | E/c |
| C6 | B | c/C | e/E | c/E | e/C | c/C | c/C | c/C | c/E | c/C | c/C | c/C | e/E |
| C7 | C | c/C | c/C | c/C | c/C | c/C | e/C | c/C | c/C | c/C | c/C | c/C | c/C |
| C8 | D | E/c | C/c | C/c | C/c | C/c | C/c | C/c | C/c | C/c | C/c | C/c | E/c |
| C9 | A | C/e | C/c | C/c | C/c | C/c | E/c | E/c | C/c | C/c | E/c | C/c | C/c |
| C10 | C | c/C | c/C | c/C | c/C | c/C | c/C | c/C | c/C | c/C | c/C | c/C | e/C |

Data points for language-learning disabled and normal language subjects. (C) and (c) indicate correct response to test item in Contextualized and Uncontextualized conditions respectively. (E) and (e) indicate incorrect response to test item in same conditions.

*Condition indicates the story and condition presentation order. See Table III for explication of the conditions.