PRINCIPLES OF BINDING AND CONTROL

IN THE GRAMMARS OF GOOD AND POOR READERS

by

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Abstract

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Dava E. Waltzman

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This study investigated the relationship among grammatical knowledge, phonological short-term memory and reading achievement in 63 third grade good (n = 41) and poor (n = 22) readers. The primary intent was to answer questions about differences in grammatical knowledge between the reading groups and to determine whether poor readers have immature grammars as compared to their skilled peers. Underlying grammatical knowledge was assessed through the use of specific constructions associated with Universal Grammar, principles of binding and control. These principles represent modular subsystems of grammar, which can be tapped by a variety of structures and a range of complexity. The subject's interpretation of each grammatical structure was assessed by a sentence-picture matching task in which all of the possible interpretations of verbally presented sentences were depicted. The task required that the subject select the pictorial representation(s) of a sentence that had

been presented orally. Each sentence was repeated as often as required by the subject in order to reduce processing demands on working memory. Decoding skill as a measure of reading ability was also assessed, as was each subject's ability to encode phonological information in short-term working memory. Tasks requiring obedience to oral directions and sentence recall were employed as the memory measures. Differences in the overall grammatical knowledge between the two reading groups were completely accounted for by differential performance on Principle B. This finding is of interest, as it has been suggested in the literature that obedience to Principle B results from a combination of grammatical and pragmatic principles. If performance on Principle B is attributable to the pragmatic Principle P (Wexler & Chein, 1985), then this study suggests another way good readers may differ from poor readers, in addition to syntactic ability or phonological short-term memory. Correlations revealed that the relationship between grammar and short term memory was greater than either was to decoding skill.

Acknowledgements

It is with sincere appreciation and admiration that I thank Dr. Helen S. Cairns for being my Dissertation Chairperson. I truly consider myself fortunate for having had the opportunity of working with her and benefiting from her knowledge and perspective. Her guidance and criticism were always constructive as well as theoretically and practically useful. Because of her integrity, in addition to her outstanding skill as a mentor, advisor and researcher, she fulfills the quintessential definition of the word "professor."

Professor Linnea Ehri was a most helpful committee member. She maintained an interest in the research and readily volunteered input. She personally sought the advice of several of her colleagues in the discipline of reading in order to fully address specific questions that arose in the study. In a gentle soft spoken manner, she provided a needed outlook. She additionally played a significant role in facilitating "user friendly" terminology and ensuring that codes were charted explicitly as an easily decipherable text.

Professor Donald Shankweiler served not only as the outside reader, but did so as an active participant and with demonstration of considerable patience. It was his research in collaboration with his colleagues at Haskins that provided the impetus for the current study. The relationship between reading, language, linguistics and

psychology is intricately entangled. He has helped not only in providing direction regarding how to unravel the interwoven threads, but also in arming future investigators with guidelines for dealing with the knots. His input and continued participation were invaluable.

A book is often judged by its cover, and because of this I am particularly appreciative of the efforts of my daughter, Lynn. She made herself available to assist in computer glitches and was particularly helpful in "lining things up" and thereby turning a draft into the semblance of a doctoral manuscript.

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The support and patience of friends and colleagues was particularly important in order to sustain my efforts, especially when institutional roadblocks could have thwarted forward progress and been an ongoing source of frustration.

And how does one ever begin to thank and acknowledge a family for the love and support that allowed a wife and mother to fulfill the function of student and researcher. Roles shifted and changed, priorities became redefined, and children became adults, but the unwavering sustenance of Mike and Liz, Howard, and Lynn remained strong and empowering. Thank you also Largo, Taver and Windley for being at my side or feet as the case might have been.

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CHAPTER 1

INTRODUCTION

Reading is one of the most important keys to a child's academic success. The ability to acquire written language skills is fundamental to all aspects of learning. As such, the ease and efficiency with which a child performs early reading tasks serves as a significant predictor of his/her future educational success. For some youngsters the ability to decode and comprehend written language, as required for proficient reading, follows a somewhat effortless course. Others, however, experience difficulty and failure enroute to literacy.

Categorizing students according to reading ability is a common educational practice. The assessment of reading skills is employed as a means of identifying and classifying children. Children are readily distinguished as good or poor readers early in their school experience. Reading achievement is initially realized through an increase in alphabetic knowledge. This skill is measured by the child's ability to decode as required for successful word recognition. Such competence requires the acquisition of sound-symbol, phoneme-grapheme, correspondence. As mastery of decoding is attained, text comprehension becomes the criterion by which reading success is determined. Increases in linguistic and world knowledge are contributing factors to this achievement (Perfetti, 1985; Stanovich, 1988).

It is important to examine the differences between good and poor readers in order to ascertain underlying factors that contribute to the disparity in ease of reading acquisition and to understand better the nature of reading disabilities. The primary objective of this study was to assess the grammatical knowledge of good and poor readers in an attempt to answer questions about syntactic development in poor readers. More specifically, it was to determine whether differences in grammatical knowledge exist between good and poor readers, by determining whether poor readers have immature grammars as compared to their peers. A primary question is whether syntactic deficits, independent of phonological processing deficits, play a role in reading failure.

Background

The Relationship between Language and Reading

Since the late 1970's some educators and researchers have suggested that reading is a language based skill, and it is often the case that language disorders underlie reading difficulties (e.g., Liberman, 1983; Liberman & Shankweiler, 1985; Perfetti, 1985; Vellutino, 1979). This concept is fundamental to the "parasitic notion" (Mattingly, 1972) that written language employs linguistic knowledge and processes that have evolved primarily for speaking and listening. Current reviews (e.g., Catts & Kamhi, 1987; Tunmer & Cole, 1985) continue to present and defend this view. Mann (1986) describes one approach to the problem of reading disability as being based on the assumption that reading is predicated on language skill. She identifies the process of learning to read as one which involves learning to decode a

written representation of one's spoken language. Kamhi (1989) proposes that it is not a spoken language deficit that causes reading problems, but rather that both spoken and written language development are affected by an underlying processing limitation. Research in developmental psycholinguistics provides a developmental foundation upon which to understand normal versus delayed language acquisition, and to consider whether specific aspects of language are related to reading acquisition.

Catts and Kamhi (1987) provide the definition of reading as "the process by which one derives meaning from printed symbols" (p. 377). As additional support of this, these researchers, among others, cite Venezky's 1968 argument that the linguistic form into which written language is translated for reading and text comprehension is one that the individual is already capable of processing.

The fact that reading requires specific instruction and does not occur naturally is emphasized by Gough and Hillinger (1980). They, along with others (Ehri, 1992; Ehri & Wilce, 1985; 1987; Gough, Juel & Griffith, 1992), describe the process of learning to read as one which begins with selective or paired-associate learning and then shifts to "cryptanalysis." Code refers to the use of salient cues, whereas cipher requires an understanding of how the alphabetic system maps onto the orthography. The first of these two stages then requires that an association be made between a printed word and its spoken form. Children select visual cues that distinguish one particular word from another. These might include specific sounds, sound combinations, word configuration or word length. Gough and Hillinger (1980) assert that "there must be a basic discontinuity in acquisition where the child who has been

treating the written language as if it were a code must confront the fact that it is a cipher" (p. 184). The second stage is utilized as management of the initial process becomes cumbersome. This occurs as children add items to their reading lexicon and require more cues in order to distinguish the new words. The continued use of a code no longer serves as a facilitative means of approaching novel, unfamiliar word recognition. Children must learn to manage the orthographic cipher in order to approach decoding independently by, "map(ping) visual form onto phonological form, converting a string of letters into a string of phonemes" (p. 40, Gough et al., 1992). Ehri and Wilce (1985; 1987) identified an additional stage. Children initially engage in phonetic cue reading, whereby some letters map onto sounds, as a means of recognizing how to read sight words. This initial stage is distinguished from that of the code because children utilize the alphabet. It additionally differs from the cipher as children have not yet acquired an understanding of how the alphabetic system operates for the decoding of novel words.

Mann (1986) discusses recent research literature that identifies significant parameters in reading acquisition as including "effectiveness of underlying spoken language and sophistication about phonological structures" (p. 134). Poor readers have been identified as having deficits in language specific tasks, including memory for familiar objects, letters, nonsense syllables, and strings of unrelated words (e.g., Brady, Shankweiler & Mann, 1983; Liberman, Mann, Shankweiler & Werfelman, 1982; Liberman & Shankweiler, 1985; Shankweiler, Crain, Brady, & Macaruso, 1992), that distinguish them from children who are better readers. Difficulties with

linguistic tasks have been contrasted with success on nonlinguistic tasks. Brady et al., (1983) found that poor readers performed as well as good readers in identifying environmental words masked by noise, but less successfully when required to identify speech under the masking condition. Liberman et al., (1982) reported that the poor reading group demonstrated greater difficulty than the good readers on tasks requiring memory of such linguistic items as letters, nonsense words and real words, but not for nonlinguistic items, such as unfamiliar faces and drawings. The underlying cause or causes of reading disability in children with normal intelligence who have had adequate opportunity for instruction, however, continues to elude researchers.

Liberman (1983) states that efficient functioning of the higher level processes of syntax and semantics depends upon appropriate representation at the phonological level. Liberman and Shankweiler (1985) further identify the basic relationship of phonology to reading. They claim that the perception or production of a word requires that one employ a phonological structure and that a misperception or misproduction is the result of implementing the wrong phonological structure. Liberman and Shankweiler state that there is evidence that poor readers have difficulty at the phonological level.

Hypotheses that Account for Reading Disability:

Processing Limitation versus Structural Lag

A number of investigators (e.g., Crain & Shankweiler, 1988; Crain, Shankweiler, Macaruso, & Bar-Shalom, 1989; Liberman & Shankweiler, 1985; Shankweiler & Crain, 1986; Shankweiler et al., 1992; Smith, Macaruso, Shankweiler,

& Crain, 1989) have attributed the difficulty experienced by children identified as poor readers to underlying phonological processing deficits. Generally, their studies support a "processing limitation hypothesis," which asserts that poor readers experience difficulty processing phonological information in working memory. This problem then interferes with providing a proper phonological representation to an otherwise intact syntactic processor. Shankweiler and Crain (1986), for example, discuss the role of syntactic complexity in the early stages of reading acquisition. They describe a modular organization of the linguistic structure that views language in a hierarchial perspective in which lower levels of language function are the source of input to higher levels. This interpretation suggests that lower-level aspects of language, such as the processing of phonological information, impact higher-levels, such as syntactic processing. Shankweiler and Crain contend that problems in the verbal short-term memory system, working memory, interfere with the retention of phonological information. Poor performance on sentence-level tasks is explained as resulting from limitations in phonological processing that infringe upon the function of working memory. This disruption then creates problems in the higher level processing of complex syntactic structures, which may then be interpreted by some as difficulty at the syntactic rather than the phonological level.

The Shankweiler and Crain explanation is not universally accepted. Others have suggested that it is syntactic processing deficits that interfere with the acquisition of reading (e.g., Bentin, Deutsch, & Liberman, 1990; Byrne, 1981; Stein, Cairns, & Zurif, 1985). The "structural lag hypothesis" suggests that there are lags, delays

and/or an absence of grammatical knowledge that interfere with higher level syntactic comprehension. This position is based in part on the assumption that there is an order in the complexity of linguistic materials and that language is acquired in a step-wise fashion in which more complex forms are preceded by simpler structures (Crain & Shankweiler, 1988).

The exploration of phonological processing deficits in poor readers, however, provides considerable support for the phonological lag hypothesis as the basis for reading disability in young readers. Studies that advocate this as the underlying cause of reading disability (Crain et al., 1989; Shankweiler et al., 1984; Smith et al., 1989) report that reading achievement is related to the demonstrated level of awareness of the underlying phonological structure of words. Evidence provided demonstrates that poor readers display inadequate phonological processing capabilities on a variety of tests of verbal working memory. Recent research has re-explored earlier studies (Byrne, 1981; Mann et al., 1984) that identified poor readers as having a lag in the acquisition of syntactical knowledge based on the difficulty they encountered compared to good readers on tasks requiring comprehension of complex spoken sentence constructions. Since the poor readers demonstrated the same error types as the good readers, their difficulty is attributed to problems with phonological processing. Poor readers are described as appearing to parse complex sentences as if they lack structural knowledge when short-term memory is heavily taxed and when results are strongly affected by factor of experimental design (Macaruso, Shankweiler, Byrne & Crain, 1993; Mann et al., 1989; Shankweiler & Crain, 1986; Shankweiler et

al., 1992; Smith et al., 1989).

Smith et al. (1989) studied good and poor readers in the second grade in order to differentiate between the structural lag versus processing limitation hypotheses. The study included two experiments that were designed to minimize demands on working memory. The first procedure tested for comprehension of spoken sentences with restrictive relative clauses employing an object manipulation task as a means of replicating the earlier Mann et al., (1984). A major difference, however, was that processing demands that could obscure the demonstration of linguistic knowledge were minimized. This was provided through the use of pragmatically appropriate contexts, a restricted number of animate noun phrases and sentences which described plausible events. The subjects manipulated toy objects in an act-out task as a means of demonstrating their comprehension of verbally presented sentences containing relative clause structures that were either attached to subject or direct object noun phrases as well as subject or direct object role of the unstressed relative pronoun. Both error rate and pattern of error for each of the reading groups were analyzed. Error patterns reflected conjoining rather than embedding. Such a finding had been interpreted by Mann et al. as an indication of less mature syntactic processing. The incidence of errors was not found to differ between the two reading groups; both were similarly affected by differing relative clause structures. Additionally, the error types did not differ between the two groups. These findings were taken as support for the theory that limited phonological coding in working memory may obstruct the comprehension of spoken sentences that are syntactically complex. The poor

performance demonstrated by the poor readers in the Mann et al. study was interpreted as an indication of the effects of the demands placed on working memory during listening tasks that require processing syntactically complex sentences rather than as an indication of insufficient syntactical knowledge. The syntactic difficulties that had been identified by Mann et al. observed in the poor readers were attributed to an underlying phonological deficit, rather than a syntactic one. The second experiment involved a sentence-picture matching task. The poor readers again performed similarly regarding pattern of error as did the good readers. This finding was interpreted as an indication that the difficulties the poor readers had in understanding complex spoken sentences demonstrated by Mann et al. were not attributable to a lag in syntactic development.

Examination of this study and of earlier research (e.g., Crain & Shankweiler, 1988; Shankweiler & Crain, 1986) reveals that syntactic knowledge has been measured by a limited and restricted selection of specific constructions rather than the exploration of components of the grammar. This does not provide a clear evaluation of whether or not poor readers are delayed in their acquisition of grammar and thus have immature grammars. All of these studies purport to assess syntactic knowledge, while using isolated constructions such as relative clauses.

Criticism of the these studies has included that of Torgesen and Rashotte (1988). They argue that the relative clause structures used in structural versus processing studies are excessively complex and organized in an arbitrary manner. The type of relative clause structures employed create an arbitrary and highly unusual

sequence of actions that test verbatim recall rather than grammatical knowledge.

A recent large scale study conducted by Shankweiler, Crain, Katz, Fowler, Liberman, Brady, Thornton, Lundquist, Dreyer, Fletcher, Stuebing, Shaywitz, and Shaywitz (in press), however, provides further support for the phonological processing limitation hypothesis. A large population of early elementary school age children was investigated. These subjects included severely disabled readers as well as children identified with academic deficits and those classified as learning disabled. A wide range of syntactic constructions was included in their assessment of grammatical knowledge. In addition to relative clauses, the stimuli included passives, adjectives with exceptional control properties and pronouns. No support for a syntactic deficit as a characteristic of reading disability was found. Shankweiler et al. claim that the errors made by the subjects on the structures were a manifestation of performance difficulties (i.e., matching a picture to a spoken sentence is easier than detecting a mismatch between a verbally presented sentence and a picture), rather than an indication of delays or lags in the development of adult-like grammar. Differences between reading groups were identified, however, for tasks that involved measures of phonological short-term memory.

Syntactic differences between good and poor reading groups have been identified by Bentin et al. (1990). While good and poor readers performed equally on tasks involving syntactic awareness (sensitivity to and knowledge of basic syntactic structure), the good readers demonstrated superior ability on tasks involving the use syntactic knowledge to detect and correct syntactically incorrect sentences. Although

this study was conducted in Hebrew, the results suggested a direct relationship of syntactic factors to reading disabilities. Bentin et al. concluded that their "data set limits to previous assertions that poor reading is not related to syntactical impairment" (p. 170). The identification of poor readers who were good decoders led them to argue that deficient phonological processing does not account for all aspects of poor reading. They claimed that the linguistic deficit identified in their poor readers lies in the area of syntax itself rather than in the phonological domain.

Studies have been and continue to be conducted in pursuit of understanding whether the processing limitation or structural lag hypothesis best accounts for reading disability in children. The review of this literature indicates that limited phonological coding in working memory appears to impede the comprehension of syntactically complex spoken sentences. Whereas some interpret this as a indication that the differences identified between the performances of good and poor readers is a factor of phonological processing and not syntactic knowledge, others disagree. Earlier investigations that demonstrated syntactic differences have been reinvestigated and the results are now described as a manifestation of listening tasks that taxed working memory. The question remains unresolved whether syntactic complexity or an impairment in phonological coding is what accounts for comprehension impairment.

Principles of Universal Grammar

In the evaluation of the processing limitation versus structural lag hypotheses it is important to assess thoroughly syntactic ability using as great a variety of particular syntactic structures as possible. Government-binding (GB) theory (Chomsky, 1981)

provides a modular framework within which autonomous components of grammatical knowledge are identified. Two specific components, control and binding, propose grammatical principles and constraints that are represented in a mature, adult grammar. The principles of Universal Grammar (UG) are described as innate and, as such, are operative in child grammar from the beginning. Acquisition of the principles of control and binding are further accounted for by Continuity Theory (Pinker, 1984) and Lexical Leaning Theory (Wexler & Chien, 1985). Continuity Theory supports the notion that children's grammars will always conform to UG. Thus, because the principles are part of UG they will be part of child grammars. The Lexical Learning Theory proposes that children will apply principles of UG once they have acquired the requisite lexical and semantic knowledge. What is required in the case of control is the ability to subordinate adverbials, whereas, for the principles of binding children will need to categorize noun phrases (NPs) as reflexives, personal pronouns and referring expressions (all other types of NPs; also called "names"). The principles within these two components govern the interpretation of a variety of sentential constructions that vary in complexity in the development of the grammar. Control and binding, then, represent subsystems of the grammar that are defined by modular representation and can be tapped by a number of constructions. The constructions that have been used in studies designed to measure syntactic knowledge do not address specific modules of the grammar. For example, there is no module for relative clauses. Related to general principles of movement, all relative clauses are linguistically identical, but different types of relative clauses differ in processing

complexity. Further, sentences with relative clauses are by definition complex. Principles of binding and control can be tested, however, with structures employing a range of complexity. Thus, difficulty attributable to linguistic factors can be assessed independently of processing complexity. Investigators have studied the acquisition of the principles of control and binding in young children (e.g., Cairns, McDaniel, Hsu, & Rapp, 1994; Chomsky, 1969; Goodluck, 1981, 1987; Hsu, Cairns, Eisenberg, & Schlisselberg, 1989; Chein & Wexler, 1990; Hsu, Cairns, & Fiengo, 1985; McDainel, Cairns, & Hsu, 1990; McDaniel, Cairns, & Hsu, 1991; Wexler & Chein, 1985).

Control

Research has shown a developmental progression in the acquisition of principles of control (e.g., Cairns et al., 1994; Hsu et al., 1985; Hsu et al., 1989; McDaniel et al., 1991). Control is the relationship between a sentential noun phrase (NP) and PRO, a phonetically null pronominal element that occupies the subject position of many untensed clauses. Generally, the controller of PRO, which is its referent, is determined by the following grammatical rule: The closest c-commanding NP, if there is one, will be the controller; otherwise, reference is arbitrary. C-command is a structural relationship between two NPs. NP_1 c-commands NP_2 if the first branching node above the first dominates the second (Reinhart, 1976). Two types of structures have been used in the study of control, embedded complement and adverbial clauses.

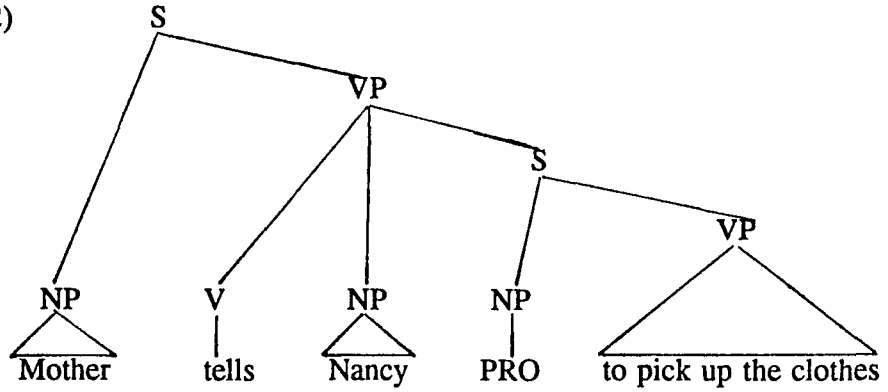
Complement Structures

PRO in verb phrase (VP) complements is object controlled. In such constructions the object of the main clause carries out the action of the complement clause verb. This is illustrated in the following sentence:

(1) Mother tells Nancy PRO to pick up the clothes.

Nancy is identified as the controller of PRO and, therefore, its referent. This example of the complement structure is displayed by the following phrase marker:

(2)



In this sentence the noun phrase (NP) "Nancy" c-commands PRO because the higher node "VP" dominates PRO. Thus, the object is the closest c-commanding noun phrase to PRO, the empty pronominal element. In this structure, the Mother NP also c-commands PRO; but the Nancy NP is closer.

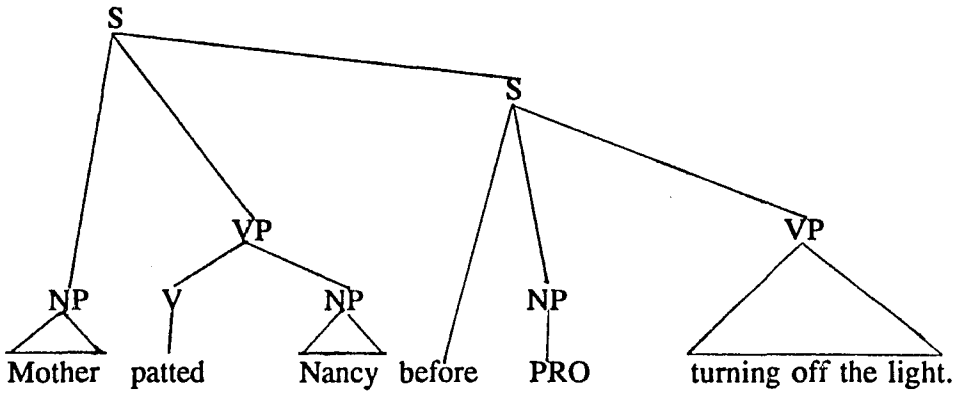
Adverbial Structures

The adverbial structure is subject rather than object controlled. In such a construction the subject of the main clause performs the action. This is illustrated in the following example:

(3) Mother patted Nancy before PRO turning out the light.

The main clause subject is the identified controller of PRO and thus its referent. The phrase-marker of this structure displays the operation of the control principle.

(4)



In (4), since the clause is an adjunct and thus is attached to the uppermost S, "Mother" is the only c-commanding NP.

Hsu et al., (1989) identified a developmental sequence in regard to children's interpretation of PRO in normal children between the ages of 3;1 to 8;0 years of age. The subjects initially demonstrated a non-linguistic strategy and then progressed through the immature grammar types to the adult classification. Hsu et al. note, however, that individual children may not manifest all of the stages in their progression toward a mature adult grammar. There was a great deal of individual variation with respect to the ages at which children achieved the various stages. Whereas some very young children, as young as 4;6 years of age, had adult interpretations, a few of the older children did not.

McDaniel et al. (1991) presented a more extensive study of control principles in children's grammars in subjects ranging in age from 3;9 to 5;4 years. Hsu et al. employed an act out task, so it was not possible to know whether children allowed

multiple interpretations of the control sentences. McDaniel et al., however, used an interview technique in addition to an act out task that revealed that some children (unlike adults) allow multiple interpretations for some of the sentence types. Their study provides a developmental sequence of the acquisition of control as described by the following grammar types (GT):

Grammar Type (GT IA): Children identify any character in or out of the sentence as the performer of the action of the clausal verb in both the complement and the adverbial structures so that the subject of the lower clause could refer to any of the characters. For example, in the complement structure (1), children with this grammar type could select Mother, Nancy or Little Sister (another character present in the discourse context) as the performer of the action. They would similarly identify any of the characters present (Mother, Nancy or Grandmother) in the adverbial structure (3), as the controller of PRO. McDaniel et al. hypothesize that these children are coordinating the second clause with the matrix clause rather than subordinating it. This results in a structure in which there is no c-commanding NP for PRO, hence reference is arbitrary.

Grammar Type (GT IB): Children properly control PRO in the complement structures by identifying the object as performer. By hypothesis, they have learned that the second clause in such structures is embedded in the VP. They continue, however, to coordinate the adverbial structure, which entails arbitrary reference and allows them to identify characters in or out of the sentence as the subject for the adverbial clauses. This would be illustrated by selection of Nancy as performer of

the clausal action for the complement structure (1), and any of the characters (Mother, Nancy or Grandmother) in the adverbial structure (3).

Grammar Type (GT II): In this and all of the following grammar types, children demonstrate correct analysis of complement structures. They subordinate the second clause by attaching it to the verb phrase (VP) as illustrated in phrase marker (2). However, they require the same object control of PRO in the adverbial as they require in the complement. For example, in the adverbial structure (3), these children would select Nancy, not Mother nor Grandmother, as the performer of the action. By hypothesis, they are subordinating the adverbial, but attaching it to the VP as in the complement structure rather than to the uppermost S as required for the adverbial. Thus, the matrix object becomes the closest c-commanding noun phrase.

Grammar Type (GT III): Children with this grammar allow either the object or subject to control PRO in adverbial structures. While these children are inconsistent in their identification of the attachment of the adverbial to the uppermost S node and continue to allow attachment to the VP, they never allow reference out of the sentence. This would be illustrated by selection of either Mother or Nancy as performer of the action in sentence (3). It is presumed to be a transitional stage, with attachment of the subordinated clause to either the VP or uppermost S.

Grammar Type (GT IV): Children demonstrate adult like interpretations with respect to PRO (object control of the infinitives and subject control of the adverbial structure). These children would consistently identify Mother as the character performing the action in sentence (3).

McDaniel et al. (1991) suggest that the identified developmental sequence would not necessarily require that every child demonstrate each grammar type, rather that children would initially display GT I and would eventually demonstrate the adult-like interpretation associated with GT IV. They might, however, skip GT II and/or III. This developmental sequence has been corroborated by longitudinal studies (Cairns et al., 1994; McDaniel et al., 1991). These investigators, however, report that they have identified a few adults who are native speakers of English yet have GT III. McDaniel et al. (1991) suggest that such adults have mature grammars that differ from those of most English-speaking adults. These are distinct from the transitional grammars possessed by children who will eventually move into GT IV. They have not, however, attempted to describe such adult grammars.

School age children have also been investigated in regard to their obedience of control type structures. Stein et al. (1984) assessed the syntactic development of reading-impaired and skilled readers who ranged in age from 7 through 10 years. The children were classified according to grammar type modeled after Hsu et al. (1985). The reading-impaired subjects demonstrated less mature grammatical development than the age matched nondisabled readers. This was revealed by a greater number of poor readers classified as GT III. These subjects additionally differed from the skilled readers in their performance on other structure types that included passives and relatives.

The above classification is in agreement with the Continuity Hypothesis, as each grammar type reflects the universal control principle. The progression through

the grammar types is driven by the expansion of the child's lexical and semantic knowledge in respect to subordination of adverbials, which is in accord with the Lexical Learning Hypothesis (McDaniel et al., 1991).

Binding

Binding theory explains relations between elements within a sentence and provides constraints on the reference of pronouns. It includes rules that require reflexive pronouns to have an antecedent, while restricting the antecedents that a personal pronoun may have. The nativist theory of language development states that universal properties of language (accounted for by Universal Grammar), are biologically innate and, therefore, do not need to be learned. What the child must acquire from experience are the specific aspects that differentiate his/her language from other languages. This requires that the child learn the appropriate local domain of the application of the binding principles determined by parameters of his/her language. The domain must be acquired through positive evidence from the child's environment. Because the binding principles constitute a major component of adult syntactic knowledge, researchers in language acquisition have considered it essential to understand the development of the knowledge of binding (Wexler & Chien, 1985).

Within Binding theory, for a noun phrase to be bound means that it is co-indexed (see example below) with a c-commanding noun phrase. Elements that are co-indexed are required to be co-referential. Elements that are not co-indexed are usually not co-referential. A noun phrase is free, as opposed to bound, if it is not co-indexed with a c-commanding noun phrase. Principles A, B and C, the three

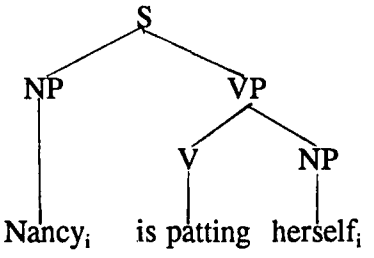
principles of Binding theory that define these constraints, are discussed below in the order of their reported acquisition (A, C, B).

Principle A

Principle A states that all anaphors (e.g., reflexives) must be bound within their local domain. For the purpose of this description, "local" means a clause containing a subject. The following examples illustrate the operation of Principle A in a simple construction (5), as represented by the phrase-marker (6), and two complex structures (7; 8):

(5) $Nancy_i$ is patting $herself_i$.

(6)



(7) $Mother_j$ sees that $Grandmother_i$ is scratching $herself_i$.

(8) $Mother_j$ wants $Nancy_i$ to bandage $herself_i$.

In sentence (5), the noun phrase (NP) Nancy c-commands "herself" and, therefore, must have the same index, i, and co-refer. In sentences (7) and (8), "herself" must refer to Grandmother and Nancy respectively, not to Mother, in order not to violate the constraint of local domain. Unlike other pronouns, a reflexive cannot have a referent external to the sentence.

In agreement with the principles and parameters theory of language and language acquisition, Principle A should be operative as soon as the reflexive pronouns are classified by the child. What the child must learn with regard to Principle A (and Principle B to be discussed later) is the local domain designated by his/her language. It is important to emphasize that although Principle A is a universal principle occurring in all human languages, the definition of "local" varies parametrically, as there are language specific parameters regarding its definition. The child will require positive evidence to know that in English the reflexive pronoun must be bound by a noun phrase within its clause. This rule applies to both tensed clauses, as in sentence (7), "Mother sees that Grandmother is scratching herself", and untensed clauses such as sentence (8), "Mother wants Nancy to bandage herself." The untensed clause is characterized by the infinitive form of the verb. In some languages the reflexive can refer outside an untensed clause, but not outside a tensed clause. All children must adopt the same strategy with respect to discovering the correct domain for their language. This is necessary as no child can know in advance what the right domain for his/her language is going to be. If the strategy selected is to assume initially that both tensed and untensed clauses constitute the correct domain for coreference of the reflexive, then the English-speaking child will be correct. Additionally, the child who needs to acquire a language (unlike English) in which reflexives can refer outside untensed clauses will not have a problem. A sentence such as "Mother wants Bruce to bandage herself" will provide the positive evidence that the child needs to change his/her domain so that it refers only to tensed clauses.

Thus, the strategy of assuming initially any clausal domain, tensed or untensed, would work for all children. If, however, the opposite situation occurs, in which children initially decide that the domain is only tensed clauses, the children in the non-English speaking languages would not have a problem, whereas the English-speaking children would have considerable difficulty. These children would identify "Mother wants Bruce to bandage herself" as a good sentence. Since children are not corrected for grammatical violations, it would be unlikely that they would be explicitly told that their interpretation is a grammatical violation. Simply not hearing a particular grammatical construction does not constitute evidence that it is ungrammatical. Thus, it is difficult to know how they would ever acquire the correct domain for English-type languages. Learnability considerations predict that all children will adopt, as an initial hypothesis, that reflexives cannot refer outside either tensed or untensed clauses.

Research has demonstrated that children obey Principle A at an early age. Chein and Wexler (1990) studied children ranging from 2;6 to 6;6 years of age. The mean age of the subjects was 4;6. They used a "Simon Says" act-out method for eliciting understanding of reflective sentences. A puppet of the same gender as the child gave the command, for example, "Kitty says that (girl's name) should point to herself." Knowledge of Principle A was demonstrated when the child consistently pointed to herself, rather than Kitty. Chein and Wexler found that although the younger subjects demonstrated evidence of knowledge of Principle A, mastery was not exhibited until around the age of 6;0 years.

In another study of the acquisition of Principle A, children demonstrated adult-like knowledge by the age of 4 years. McDaniel et al. (1990) characterized the grammar of each of their subjects (ages 3;9 - 5;4) according to his/her obedience to the binding principles. Performance was assessed by observing the children's performance on an act-out task and obtaining judgments through an interview. In the judgement task, the children watched while the experimenter used small toys to act out various interpretations of verbally presented sentences and were then asked whether the enactment matched the sentence. The children were classified according to their violations. Three distinct Grammar Types (GT) were identified with respect to Principle A:

Grammar Type (GT A) described those children who violated Principle A by allowing reflexives to be free (refer either inside or outside the sentence). For example, GT A children allowed a sentence such as "Grover is washing himself", to mean that Grover washed Grover or that Grover washed Cookie Monster and/or Bert.

Grammar Type B1 (GT B1) characterized children who obeyed Principle A by requiring sentence-internal reference for the reflexive, but who allowed referents outside the correct structural domain. For example, in the sentence "Grover wants Cookie Monster to pat himself," "himself" referred to Grover as well as Cookie Monster.

Grammar Type B2 (GT B2) described children who displayed adult-like interpretations by requiring co-reference for reflexives within all clauses (tensed and untensed) containing a subject and disallowing reference outside such clauses.

McDaniel et al. (1990) found that those children who allowed a reflexive to refer to a character not mentioned in the sentence (GT A), were all younger than 4;1. One subject of 20 in the first study and three of the 19 in the second study were classified as GT B1. Although these subjects demonstrated knowledge of Principle A, they did not obey the domain restriction.

It is important to consider how acquisition theory might account for the violations of Principle A. McDaniel et al. (1990) were surprised to find children who allowed the reflexive to refer outside untensed clauses. For example, in the sentence, "Grover wants Cookie Monster to pat himself," some children allowed "himself" to refer to Grover, although they would not allow it to refer to Bert who was not mentioned in the sentence. Their finding was exactly opposite the prediction of Learnability Theory. McDaniel et al. questioned how children who demonstrate this grammar would ever recover from their domain error, absent negative evidence. They additionally advised that it is important to know at what age children cease to demonstrate domain violations.

Principle C

Principle C requires that names must be free in all domains. From this it follows that a pronoun cannot be co-indexed with any noun phrase that it c-commands. This is illustrated in the following simple (9) and complex (10) structures:

(9) She_i is touching $Nancy_j$.

(10) She_i tells $Mother_j$ that $Nancy_k$ is drawing a picture.

In sentence (9), "she" cannot be co-indexed with Nancy and thus they are given different indexes, i and j. In sentence (10) "she" cannot be co-indexed with either Mother or Nancy. Principle C is not confined to local clausal domains. Since contra-indexes usually imply non-coreference, the pronoun must refer to someone in the discourse context. Violations of Principle C occur when there is internal coreference.

Studies of Principle C acquisition have yielded varying results. An early investigation (C. Chomsky, 1969) showed that while coreference between the pronoun "he" and the noun phrase "Pluto" in a sentence such as, "He knew that Pluto was sad," was allowed by a high percentage of the 5- year old subjects, the 6- year olds tended to know that coreference was not allowed. A more recent study (Crain & McKee, 1985), however, found that a high percentage of the 3- and 4-year olds in their study rejected coreference in similar constructions. Hsu et al. (1989) reported that younger children (ages 3- and 4-years), as compared to older children (age 5-years and older), violated Principle C by allowing internal coreference. Although the studies differ on the age of mastery of Principle C, they do agree that obedience to it is observed by age 6 years.

McDaniel et al. (1990) confirmed previous findings that Principle C is obeyed early. They found that only two of their youngest subjects (ages 3;9 - 5;5) violated Principle C by allowing coreference between "he" and "the zebra" in a sentence such as, "He tells the lion that the zebra is drinking water."

The question remains, given the lexical learning hypothesis, why children

continue to violate Principle C once they have classified anaphors, pronouns and noun phrases to which pronouns can refer. If someone disobeys Principles A, B and C, it is assumed that they have not yet correctly classified pronouns and reflexives. Violations of Principle C, with obedience to Principle A is a problem for the Continuity Theory as well. Issues regarding Principle C require continued investigation.

Principle B

Principle B states that personal pronouns, such as "him" and "her," must be free in their local domain, which entails that personal pronouns not be co-indexed with a c-commanding noun phrase in the local domain. Principle B operates in an opposite manner to Principle A. The following simple (11) and complex (12) constructions illustrate this:

(11) Grandmother$_i$ is kissing her$_j$

(12) Little Sister$_i$ sees that Mother$_j$ is washing her$_{i,\ k}$

In sentence (11), "her" and Grandmother are not co-indexed as indicated by the different indexes of i and j, and for adult speakers of English, they may not co-refer. In sentence (12), "her" can not refer to Mother, but can refer to Little Sister or to a sentence external referent (indicated as "i" and "k" respectively). Little Sister can bind "her" because it is outside the local clausal domain. Obedience to Principle B requires that reference to Grandmother and Mother be disallowed in sentences (11) and (12).

Studies of the acquisition of the binding principles have shown that while

Principle A and C were obeyed early, Principle B violations continued to be demonstrated by older subjects (e.g., Chein & Wexler, 1990; McDaniel et al., 1990; Wexler & Chein, 1985). Wexler and Chien (1985) found that children older than 5;6 years of age displayed more of a tendency to violate Principle B than to violate Principle A. Chein and Wexler (1990) investigated children's knowledge of Principles A and B through use of a "Simon Says" act out task described earlier. They found that even children in their oldest age range (5;6 to 6;6) did not demonstrate adult-like behavior with respect to Principle B. The findings revealed that by age 6 years the children knew Principle A, but continued to demonstrate difficulty with Principle B.

McDaniel et al. (1990) found that approximately half of their 4- and 5- year old subjects violated Principle B by allowing internal coreference for structures such as, "Grover is patting him." They emphasized that the children were not confusing the personal pronoun with the reflexive. This was demonstrated by the fact that when another male character was present in the act-out/discourse space, the children stated that "him" could refer to either Grover or to the other character.

A number of psycholinguists have suggested a variety of possible explanations for why children continue to disobey Principle B after other aspects of their grammar appear to be adult-like. If Principle B is actually not operative in children's grammars, they would coindex rather than contra-index "Grover" and "him" in a sentence such as the one discussed above, "Grover is patting him" (which would then be ungrammatical). This would represent a considerable problem for the Continuity

Theory, as it would constitute a violation of a principle of UG. Chein and Wexler (1990) have suggested that children actually do know Principle B as a relevant syntactic principle within the requirements of the Lexical Learning Hypothesis, but are violating a pragmatic principle, Principle P. This theory purports that Principle B requires reformulation to describe the adult grammar. This process involves two parts. The first part, as characterized earlier, requires that pronouns not be locally bound (i.e., contra-indexed with c-commanding NPs). The second part, however, is different. It is a pragmatic principle, Principle P, which states that contra-indexing usually requires non co-reference. Chein and Wexler have claimed that while children (by Continuity and Lexical Learning Theories) have the first part, they lack the second, Principle P. The suggestion is that "children may know syntactic principles that are relevant to particular sentences, whereas they may not know a particular pragmatic principle" (p. 158). The result is that children may allow noncoindexed noun phrases (NPs) to be interpreted as coreferential, appearing to violate Principle B, when they are actually violating Principle P.

Chein and Wexler demonstrated children's true obedience to Principle B by observing their responses to sentences such as, "Every bear is touching her." In such a sentence a coreferential reading is not possible because a pronoun that is not a bound variable cannot have a distributive reading. This was illustrated by first reviewing an example of a structure for which a distributed interpretation would be possible, "Every bear is touching herself." The constraints of Principle A allow that "every bear" and "herself" are co-indexed and, therefore, must co-refer. The

distributed reading would apply as this sentence means that there are an indefinite number of bears and that each one is touching herself. This is because such an interpretation is possible only if "every bear" and "herself" are coindexed. If, therefore, the structure is "Every bear is touching her", and it is interpreted with the distributive reading, a true violation of Principle B would be demonstrated. Such an interpretation would be possible only if the child were co-indexing "every bear" and "her." Chein and Wexler demonstrated that children who appeared to be violating Principle B in unquantified sentences (i.e., "The bear is touching her") did not do so in quantified sentences (i.e., "Every bear is touching her"). This behavior was interpreted as indicating that such children were not actually violating Principle B, as they were not co-indexing the pronoun with the locally c-commanding noun phrase. Thus, the hypothesis that these children were violating Principle P was indirectly confirmed.

Cairns (in press) summarizes this hypothesis as meaning that children: (1) know Principle B and are not illegally coindexing the noun phrase and the pronoun (in agreement with Principle B); (2) allow coreference despite contra-indexing (which is unusual for adults); (3) fail to know a non-linguistic rule that contra-indexing generally implies non-coreference. While this theory supports the Continuity Theory, it does not answer questions regarding what it is that children lack and how they might acquire grammatical knowledge without positive evidence.

McDaniel and Maxfield (1992) attempt to identify what children need to learn in order to perform like adults in respect to Principle B. They suggest that apparent

violations of Principle B (in which a noun is allowed to corefer with a contra-indexed personal pronoun) that occur in adult speech are accompanied by the pragmatic device of contrastive stress (i.e., "When John looks in the mirror, he doesn't see *me*, he sees *him.*"). They hypothesize that children must acquire the appropriate use of contrastive stress before they will realize when it is and is not acceptable to corefer despite contra-indexing. McDaniel and Maxfield propose a four step progression: (1) noun phrases are not categorized in the child's grammar; thus, binding principles do not apply; (2) noun phrases are categorized in the child's grammar; binding principles are obeyed; (3) the child notices "I choose me", but is not sensitive to the contrastive stress; the child will believe that he has observed adults allowing coreference despite contra-indexing and will then do so himself (he will not, however, allow co-indexing in sentences where the pronoun would be a bound variable); (4) the child becomes sensitive to contrastive stress and understands that co-reference, despite contra-indexing, is restricted to contrastive stress contexts.

McDaniel and Maxfield tested their hypothesis through two measures. First they ascertained children's sensitivity to contrastive stress. They did this by displaying an array of toy fruit that included strawberries that varied according to size. The child was then asked, "Bert doesn't want to eat the BIG strawberry. What do you think he wants to eat?" Those children who understood the pragmatic device of contrastive stress selected the "little" strawberry, while those who did not comprehend contrastive stress selected another fruit. The children were then tested for their obedience to Principle B. McDaniel and Maxfield found that those children

who had low scores on the contrastive stress test appeared to disobey Principle B, while those who achieved high scores had adult-like performance on the Principle B sentences. These results demonstrated both an identified context in which Principle B violations can be observed and a means of testing Principle P.

Grodzinsky and Reinhart (1993) also describe Principle B as a pragmatic rather than a grammatical principle. A different type of operative pragmatic principle is proposed than the ones offered by McDaniel and Maxfield or Chein and Wexler to distinguish children's performance from that of adults. Grodzinsky and Reinhart suggest that the adult considers the various grammatical devices that are available to the speaker and then infers which would be the optimal one under the circumstances. In other words, if a speaker has the intent to communicate coreference, and there is a grammatical device available that will convey that information, such as the bound - coindexed - reflexive, that device will be chosen by the speaker for his/her message (Cairns, in press). Even though coreference, despite contra-indexing, does not violate any linguistic principle, it will not be selected by the speaker when there is a clearer grammatical device available. Thus, the hearer will assume co-reference was not intended. The pragmatic principle defined here differs from that described above, as it is used by adults during the process of evaluating the meaning of sentences such as "Grover hit him," rather than a pragmatic principle used to determine when adults can use coreference despite contra-indexing. Grodzinsky and Reinhart suggest that children do not lack this pragmatic process, which, they claim is innate. However, short-term memory limitations prevent it from being operative in children's language

processing.

Cairns (in press) discusses two significant aspects of Principle B in relation to the remaining unanswered questions relevant to its acquisition: (1) Principle B violations persist in children who are native speakers of English for a considerable time after mastery of the other binding principles has been demonstrated, and thus represents a non-adult characteristic of child language; (2) it represents an example of grammar determining children's behavior, while pragmatics is more of a determining factor for adults. She further suggests that Principle B may represent a situation in which the child's knowledge of grammar is more advanced than his/her knowledge of pragmatics.

The development of binding (except Principle B) and control appear as aspects of the grammar that usually mature long before children learn to read and hence are acquired independent of reading experience. As such, this provides a meaningful way of assessing grammatical knowledge in good and poor readers. It is important to consider syntactic knowledge within the broader definition provided by the principle of Universal Grammar. However, in assessing whether syntactic deficits, independent of phonological processing deficits, play a role in reading impairment, short-term memory must be assessed as well.

Measurement of Phonological Short Term Memory

Poor readers experience difficulty processing phonological information in short-term working memory (Shankweiler & Crain, 1986). The question, however, of how best to measure phonological coding in memory does not have a direct answer

and is identified by Shankweiler (personal correspondence to L. Ehri, 1993) as a "vexed" issue. Measurements used in the past studies are not necessarily employed in current research due to identified problematic issues. The Mann, Liberman and Shankweiler (1980) study is such an example. The performance of good and poor readers was compared on a task involving recall of rhyming (phonetically confusable) and nonrhyming (phonetically nonconfusable) words-strings. The good readers demonstrated a rhyme decrement, as they experienced considerably more difficulty on the rhyming versus the nonrhyming word groups. The poor readers generally were not sensitive to the advantage of the nonconfusable nonrhyming strings and additionally recalled fewer words overall than the good readers. Such performance was taken as an indication that the poor readers were deficient in their use of phonological codes. This methodology has not been utilized repeatedly, however, because of concerns regarding certain features of the test; it is also unclear how test materials should be constructed for different age groups.

The use of digit and word (real and/or noncewords) serial recall measures have also been criticized. Daneman and Carpenter (1980) argue that on-line recall represents the storage rather than the processing component of working memory. The parsing of syntactical structures is described as being reliant upon the retention of information in short-term working memory because, "parts of the sentence may need to be held in memory while the overall structure is worked out" (Daneman & Tardif, 1987, p.20).

Wagner (personal correspondence to L. Ehri, 1993) recommends the use of

the Linguistic Concepts-Oral Directions of the *Clinical Evaluation of Language Fundamentals* (CELF) (Semel, Wiig & Secord, 1989) as a means of ascertaining a child's ability regarding phonological encoding skills and short term memory. Others (Kamhi & Catts, 1986; Stahl & Erickson, 1986) have found that performance on sentence imitation tasks differentiates between language-impaired and reading-impaired children and also between skilled and poor readers. The CELF has such a subtest, Recalling Sentences. These measures were, therefore, employed as a means of assessing short-term memory in the present study.

The Current Study

The primary objective of this study was to examine grammatical knowledge in relation to reading achievement. The intent was to answer questions about syntactic development in good and poor readers. More specifically, it was to answer questions about differences in grammatical knowledge between good and poor readers and to determine whether poor readers have immature grammars as compared to their skilled peers. Through the use of constructions that represent modules of language, control and binding, underlying grammatical knowledge can be assessed. Grammatical structures were repeated as required by the subject in order to reduce demands on working memory during listening tasks that involved the processing of syntactically complex sentences. The study also ascertained the ability of both proficient and poor readers regarding their skill in encoding phonological information in short-term working memory. Tasks involving following oral directions and those requiring the recall of sentences were employed as a measure of short-term memory. Of interest

additionally were questions regarding whether there is a relationship between obedience to Principle B and short-term memory, as Grodzinsky and Reinhart would seem to suggest. This study was designed to provide a means of ascertaining whether particular aspects of UG, control and binding, constitute grammatical features that distinguish between good and poor readers. It also investigated the relationship between reading skill (as measured by decoding ability) and grammatical knowledge to memory, as well as these aspects to one another.

CHAPTER 2

METHOD

Subjects

Sixty-three third grade children served as the subjects of this study. The children had been identified according to school grouping criteria as good or poor readers, which were defined by specific guidelines. Good Readers (GRs) were those children who demonstrated the ability to read at or above grade level. This was determined by classroom and school-wide measures of reading, and by teachers who judged the students to be skilled, motivated readers with independent work habits. Poor Readers (PRs) were those children who were reading below grade level as measured by standardized tests including evaluations at the end of reading texts. They required more intensive basic skill development and reading instruction than the skilled readers and were identified by their teachers as having difficulty decoding and/or comprehending written language. Some demonstrated reduced motivation and lacked independent work habits.

The subjects were drawn from regular mainstreamed class placements of two schools within two school districts located in southern Connecticut, which were comparable socioeconomically and held similar educational philosophies. Each of the schools had determined the specific reading group placements at the end of the

students' second grade year. Both good and poor readers were considered by their teachers to have received adequate opportunities for reading instruction. Subjects included in the study were all of the children whose parents had granted permission for their participation and who had no reported history of special education placement, phonological disorder, language impairment or intervention, recurrent middle ear pathology or surgery, hearing loss, or identified neurological findings. The following characteristics of each of the participating subjects was known at the start of the study: date of birth, gender, ethnic classification, class room placement, and reading group assignment. After the data were collected, the examiner obtained the Degrees of Reading Power scores of the Connecticut Mastery Test, given to students in School 1, and the Grade Equivalency scores of the Iowa Tests of Basic Skills administered at School 2.

Specific Group Description

Subjects from School 1 (n = 36) had been placed in one of four assigned reading groups based on their reading and academic performance at the end of grade 2. Appendix A provides an individual profile of each of the subjects. Children in the first two of these groups (1 and 2) had been designated by the teaching staff as good readers (n = 20; Subjects 1-20). Of these, 12 were in the highest group, and 8 were in group 2. The good readers were generally instructed through a whole language literature approach to reading comprehension. The poor reading group consisted of groups 3 and 4. Eight children from each of these groups participated (n = 16; Subjects 21 - 36). These children received direct instruction that included emphasis

on the development of decoding skills, in addition to a whole language approach to reading. Children in Groups 1 and 2 received their reading instruction from one of the three third grade teachers, not necessarily their homeroom based teacher. Children in Group 3 received their reading instruction from the remedial reading specialist. Instruction for Group 4 was facilitated by one of the third grade teachers with consultation services provided by the school designated Federally mandated Chapter 1 teacher.

Subjects from School 2 (n = 27) were drawn from two home room based classes, which had two reading groups. Those children who were described as average, above average, good readers and/or "high" good readers were instructed together within their respective classrooms as the good reading group (n = 21). Eleven of these children were from the same classroom, the other ten were from the second. The good readers received a combination of whole language and basal reading instruction. Those children who had been identified by their first grade year as being at high risk for reading failure and read at or below grade level were members of the second reading group within each class (n = 6). Five of these children were placed and instructed in the same classroom, while the other youngster was one of the poor readers in the second class. All had received preventive instruction in basic reading skill development during their first and second grade years. The poor readers continued to be instructed in basic decoding skills and were placed in lower level basal reader texts.

General Procedures

The general procedures of the study required each subject to be seen individually for two to three 30 minute sessions or sufficient time and sessions to complete the assessment procedures. Generally three 30 minute sessions were required. Individual session length and frequency were closely monitored in order to prevent fatigue and sustain attention. Each child was seen in a quiet room within his/her school. The child's participation was coordinated with the classroom teacher to ensure that important instructional time was not missed. Assessment of decoding skills, practice items and the first group of experimental sentences (assessing principles of binding and control) where administered in the initial session. The second and third sessions were devoted to the presentation of the remainder of the stimulus sentences and the administration of the language screening.

Decoding Skills

Decoding ability was ascertained and served as a measure of reading ability for every child participating in study. Subtest II: Phonic Patterns of the *Decoding Skills Test* (DST) (Richardson and DiBenedetto, 1985) was administered as a means of obtaining information about each subject's ability to apply phonic and structural analysis skills for the decoding of printed real words and the application of that knowledge to nonsense words. The DST score represented the total number of accurately read real words (n = 60) and pseudowords (n = 60) from the lists provided. The word lists consisted of mono- and polysyllabic words with phonic patterns of short vowels preceded by singleton consonants, two consonant singular

phonemes (e.g., sh, th) and consonant clusters (e.g., fl, pr); long vowel combinations (e.g., silent "e", ae) preceded by singleton consonants and then consonant clusters, and vowel diphthongs. The real and nonsense words contained syllable structures that represented types that occur in English. These included CVC, CCVCC, CVCC, CVVC, and CCVVCC structures.

Phonological Memory

Two subtests of the *Clinical Evaluation of Language Fundamentals-Revised Screening Test*, CELF-R Screening (Semel, Wiig, & Secord, 1989) were used as measures of phonological memory, Linguistic Concepts-Oral Directions (LC-OD) and Recalling Sentences (RS). Linguistic Concepts-Oral Directions (LC-OD) measured the subject's ability to follow verbal directions of increasing linguistic complexity (i.e., "Point to all the big houses and all but one of the small stars.") The auditory component of the task was supported by an illustration of the objects and/or shapes to which the subject pointed at the completion of the statement. As specified by the test protocol, no repetitions were allowed. For the purpose of this study, Linguistic Concepts-Oral Directions (LC-OD) was considered both for its individual value as a measure of short-term working memory and in combination with Recalling Sentences (RS). Recalling Sentences (RS) required verbatim repetition of sentences of increasing length and linguistic complexity (i.e., "The girl mailed a package to the man who moved away last month.") As with the other measure of short-term working memory, no repetitions were allowed. Unlike Linguistic Concepts-Oral Directions (LC-OD), however, there were no pictures to support the auditorily

presented material. The scores of each of these two subtests served both as separate variables and in combination as a total memory score, called MEM. Linguistic Concepts-Oral Directions (LC-OD) had a maximum score of 8 points whereas that of Recalling Sentences (RS) was 24 points. The highest memory score (MEM) attainable was 32 which equaled the combined scores of Linguistic Concepts (LC-OD) and Recalling Sentences (RS).

Language Function

In addition to the two subtests described above, the remaining subtests of the CELF-R Screening were administered in order to determine that language skills were within normal limits on standardized measures. Various aspects of receptive and expressive language were screened, which included the ability to perceive associative relationships among word concepts, interpret semantic relationships in sentences, and assemble phrases into grammatically and semantically acceptable sentences. All subjects met the criterion for inclusion in the study that specified that they not be language impaired. This included 60 children who achieved CELF-R Screening scores that fulfilled the age criteria designated by the measure and three subjects (all poor readers) who demonstrated performance below the criterion score on the CELF-R Screening, but had been evaluated for language function and not identified as language impaired. (This information was revealed in their school records.)

Grammatical Knowledge

Procedures

Two specific aspects of grammatical knowledge, principles of binding and

control, were tested to assess the status of these principles in the grammar of each of the subjects. The subject's interpretation of the grammatical structure in question was indicated through a sentence-picture matching task that depicted all of the possible interpretations of verbally presented sentences. The task required that the subject select the pictorial representation(s) (presented serially) of a sentence that had been orally presented. The procedure and specific instructions were as follows:

> "I am going to tell you a sentence and then I will show you three pictures. I will show the pictures to you one at a time. I want you to look at each picture carefully and then tell me whether or not it matches my sentence; whether or not it was a good drawing for my sentence. Sometimes more than one picture can be a good drawing for the sentence. Be sure to pick all of the drawings that describe the sentence that I said. I will repeat the sentence so you can remember the sentence while you decide. Let me know if you want me to say the sentence again. Be sure not to change the sentence in your head so it will match the picture. Just find the one or ones that match(es) my sentence."

Repetition of the sentence was essential in order to minimize demands for holding the words in working memory. The procedure was demonstrated through the presentation of a set of practice sentences that did not replicate the exact structures of interest. This was done in order to ensure that the subject understood the requirements of the task and was ready to proceed with the stimulus sentences. The child was also informed that there were no time constraints. The presentation of the sentences was

then initiated. The first sentence was read, after which the subject was shown each of the three illustrated sentence interpretations and asked after each presentation whether it matched the sentence. The examiner pointed to the characters in the pictures to make sure that the referents of the pronominal elements were clear to the child. For example, while uttering the sentence, "She tells Mother that Nancy is drawing a picture," as displayed in Figure 1, the following gestures were specified as each of the pictures was viewed by the subject: for the top drawing, the examiner pointed to Grandmother when she said "she," to Mother when she said "Mother" and to Nancy when she said "Nancy;" for the second drawing, the examiner pointed to Little Sister when she said "she," to Mother when she said "Mother" and to Nancy when she said "Nancy;" for the third drawing, the examiner pointed to Nancy when she said "she," to Mother when she said "Mother" and then again to Nancy when she said "Nancy." (As described earlier, the pictures were presented in a serial order not as displayed in Figure 1.)

Careful monitoring was established to ensure that the child understood the task. If, for example, during the presentation of the initial sentence, which was always a simple sentence with a reflexive pronoun, the child appeared to misinterpret the sentence or to change the sentence to match the picture (as demonstrated by his/her spontaneous repetition of the sentence) he/she was interviewed in order to assure that the task was fully comprehended. In such a situation, the child was reminded not to change the sentence, asked to describe a picture that would illustrate his/her sentence, and then was required to listen again to the examiner's sentence in

order to identify whether or not the picture being presented matched the sentence.

The order of presentation was balanced so that the picture matching the adult interpretation was presented first one third of the time, second one third of the time, and last one third of the time. Of particular importance was the fact that the method allowed for all possible interpretations to be selected by the child, rather than merely the preferred one.

Materials

There were 40 experimental sentences. Appendix B provides all of the sentences and a description of each of the illustrations, as well as the four practice sentences of a different syntactic structure which were employed to familiarize the subjects with the format. The sentence presentation was divided into four blocks of ten sentences each. Each block was composed of the seven binding and two control structures of interest, and one conjoined structure as a filler sentence (e.g., Mother bought popcorn and Nancy and Little Sister fed the animals). In total there were four exemplars of each of the structures distributed to appear in the same order in each block. The order of presentation is provided in Appendix C. The sentences were illustrated by drawings of four sets of characters:

Set - 1: Family (female) - Grandmother, Mother, Nancy, Little Sister

Set - 2: Sesame Street Characters (male) - Bert, Ernie, Grover, Cookie Monster

Set - 3: Farm Animals (female) - Cow, Horse, Pig, Sheep

Set - 4: Domestic Animals (male) - Dog, Cat, Squirrel, Rabbit

There were four simple structure tokens, one for each set, for each of the three binding principles (e.g., Principle A: Little Sister is patting herself; Principle B: Grandmother is kissing her; Principle C: She is touching Nancy). In addition, there were complex "that" structures for Principle B (Little Sister sees **that** Mother is washing her) and Principle C (She tells Mother **that** Nancy is drawing a picture), as well as two complex structure types for Principle A, "that" and "want" (e.g., Mother sees **that** Grandmother is scratching herself; Mother **wants** Nancy to bandage herself). The pictures for assessment of the child's obedience to the binding principles included one choice that illustrated the interpretation compatible with the adult grammar along with other choices that violated co-reference rules and/or domain restrictions. Some sentences were designed to demonstrate that in English a reflexive can never refer outside an embedded clause (Principle A). For example, "Mother sees that Grandmother is scratching herself" was illustrated by the following three drawings: (1) Mother watching while Grandmother scratches her own back, (2) Mother watching while Grandmother scratches Little Sister's back, (3) Mother watching while Grandmother scratches Mother's back. Only selection (1) would represent the adult grammar interpretation. Selection of the other two choices would be in violation of Principle A, with an English definition of locality.

There were two construction types that were presented for the investigation of control. These included four tokens each of object controlled complement structures (e.g., Mother tells Nancy to pick up her clothes) and four each of subject controlled adverbial structures (Mother pats Nancy before turning out the light). The pictures

for sentences evaluating obedience to principles of control included an illustration of the scene that depicted the initial clause of the structure (for the adverbial clause "Pig hugged Sheep before jumping rope", Pig is shown hugging Sheep while Horse watches), and three separate pictures illustrating subject control, object control and arbitrary control (i.e., Pig jumping rope; Sheep jumping rope; Horse jumping rope). The subjects were asked to identify which one or more of these choices "Tells what happened." The adult grammar in this example was reflected only by selection of the subject as actor. Appendix D presents a reference chart of binding and control types, an abbreviation code, sentence examples and obedience and violation patterns.

Scoring

Based on each child's selection of the pictures and, therefore, his/her interpretation of the sentence, grammar type (GT) classifications were assigned for patterns of responses to the complement and adverbial control structures and for Principle A. Responses to both the simple and complex constructions with regard to Principles B and C were scored as "obeyed" or "violated" depending upon whether or not the adult-like interpretation(s) were demonstrated. There were 4 tokens of each sentence type. For a child to be classified as a particular grammar type he/she must have interpreted all 4 tokens in the manner consistent with that grammar type. Similarly, to be classified as obeying Principles B and C, all 4 responses required adult-like interpretations.

1. Grammar type (GT) with reference to control:

GT IA. Children within this category would be characterized as allowing any

character in or out of the sentence as performer of the action of the clausal verb in both the complement and adverbial structures. For example, in the complement structure, "Mother tells Nancy to pick up her clothes," a GT IA child would select Mother, Nancy or Little Sister, and, similarly, Mother, Nancy or Grandmother as performer of the action in the adverbial structure, "Mother pats Nancy before turning out the light."

GT IB. Children within this category would be characterized as requiring the object to be the performer of the complement action, demonstrating adult-like control of PRO (i.e., selection of Nancy as the one who picks up the clothes for the sentence, "Mother tells Nancy to pick up the clothes"). Characters in or out or the sentence would be identified as performers of the action for the adverbial (as in GT IA).

GT II. Children within this grammar type would have adult-like interpretation of the complement structure (as in GT IB). However, they require object control of PRO in the adverbial (e.g., selection only of Nancy as performer of the action in "Mother pats Nancy before turning out the light.")

GT III. Children within this group are characterized as selecting either the object or subject to control PRO in adverbial structures (i.e., Nancy or Mother chosen as performer of the action in "Mother pats Nancy before turning out the light"). They have adult-like object control for the complements.

GT IV. Children in this category are characterized by adult-like interpretations of both complement and adverbial structures.

2. Grammar type (GT) with respect to Principle A:

GT1. Children within this category would allow the reflexive to be free in violation of Principle A. They permit the reflexive to refer out of the sentence. For example, in the sentence, "Little Sister is patting herself," the child would select pictures of Little Sister patting Mother or Nancy.

GT2. Children within this category would obey Principle A by requiring sentence internal reference for reflexives, but allow reference outside the correct structural clausal domain (outside the clause for both A-Want and A-That). For example, in the A-That structure, "Mother sees that Grandmother is scratching herself", Mother was selected, but not Nancy.

GT3. These children would allow the correct domain for the tensed clause, but not for tenseless clause. They would go outside the clause for A-Want only. For example, although Mother would be selected in the structure, "Mother wants Nancy to bandage herself," this would not be the case in the untensed clause, "Mother sees that Grandmother is scratching herself."

GT4. Children within this classification demonstrate adult-like interpretation by requiring co-reference for the reflexive within all clauses containing a subject and disallowed reference outside such clauses.

3. Obedience to Principle B in simple and in complex sentences:

Simple. In a sentence such as "Grandmother is kissing her," obedience to Principle B would be demonstrated by the selection of the pictures of Grandmother kissing Nancy and/or that of Grandmother kissing Little Sister. A violation would be demonstrated by the selection of the picture of Grandmother kissing Grandmother.

Complex. In a sentence such as "Little Sister sees that Mother is washing her," obedience to Principle B would be demonstrated by selection of the picture of Little Sister watching as Mother is washing Little Sister and/or that of Mother washing Nancy. A violation would be demonstrated by the selection of the picture of Little Sister watching as Mother washes Mother.

4. Obedience to Principle C in simple and in complex sentences:

Simple. In a sentence such as "She is touching Nancy," obedience to Principle C would be demonstrated by the selection of the picture of Grandmother and/or Mother touching Nancy. A violation would be demonstrated by the selection of the picture of Nancy touching Nancy.

Complex. In a sentence such as "She tells Mother that Nancy is drawing a picture," obedience would be demonstrated by the selection of the picture of Little Sister and/or Grandmother talking to Mother and pointing to Nancy. A violation would be demonstrated by selection of the picture of Nancy talking to Mother and pointing to herself.

CHAPTER 3

RESULTS

The presentation of the data has been organized into sections that initially offer the results of the statistical measures of comparisons for differences between the two reading groups (good versus poor) and then presents analyses that characterize the performance of individuals within each of the groups.

Group Data Analysis

Two types of analyses were conducted on the data. One compared good and poor readers on measures of reading and grammatical measures. All analyses of variance (ANOVAs) and the multivariate analyses of variance (MANOVAs) were corrected for the unequal numbers of subjects within the reading groups. The other type of analysis was a set of correlations that employ DST as a reading measure and evaluated its relationship to memory and grammatical measures.

Reading Performance

Two measures of reading performance were obtained: teacher determined school placement and DST. DST scores were used as a measure of reading ability across all subjects and not as criterion for inclusion or for group placement. In order to verify the placement measure made by the schools, it was essential to determine whether the two reading groups differed in their DST scores. It was also necessary to

analyze the data by schools as a means of identifying whether there were any significant differences between them.

A two way factorial analysis of variance (ANOVA) of DST scores by school (2 schools) by group (good vs. poor readers) revealed a significant main effect of group for DST (GRs, M = 101.73 vs. PRs, M = 62.23) [F (1, 59) = 54.19, $p < .001$]. Means and standard deviations are presented in Table 1, and the source table for the ANOVA is given in Appendix E (Source Table 1). Clearly, children who were classified as good readers were much better decoders than were those who had been classified as poor readers. There was no main effect of school (F = 2.81), but there was a significant Group by School interaction [F (1, 59) = 4.13, $p < .05$]. Whereas the good readers performed equally well at both schools, the poor readers at School 2 (M = 79.33) did better than those in School 1 (M = 55.8), ($p < .01$), by the Newman-Keuls' procedure for multiple comparisons. The DST score distribution is presented in Appendix F.

Differences in Total Grammar Score

The data were additionally analyzed using a oneway analysis of variance (ANOVA) comparing the two reading groups (good readers vs. poor readers) on their total grammar scores (GRAM). This score was determined by adding each subject's scores for all the individual constructions: Control Types (Complement + Adverbial) + Binding Types (Principle A [Simple+ Want + That] + Principle B [Simple + That] + Principle C [Simple + That]). The highest possible GRAM score was 36 (each construction type had a maximum score of 4). The obtained range was 17 - 36.

Scores of the good readers (M = 32.46) differed significantly from those of the poor readers (M = 29.11), [F (1,61) = 5.26, p = .025]. Means and standard deviations are presented in Table 2 and the source table for the ANOVA is given in Appendix E (Source Table 2). Thus, the good readers demonstrated more adult like interpretations of the grammatical structures than did the poor readers.

Differences in Sentences Assessing Principles of Control

A further analysis of variance evaluated the two reading groups' performance on the repeated measures variable of Control Type (Adverbial vs. Complement) structures. Means and standard deviations are presented in Table **3**, and the source table for the ANOVA is given in Appendix E (Source Table 3). There was no main effect of group; the good and poor readers performed in a similar manner ($F < 1$). There was, however, a significant main effect of Control type [F (1,61) = 27.91, $p < .001$]. This was because there were more non-adult interpretations of the adverbial structures than of complements (Adverbial, M = 3.29; Complement, M = 3.94). Differential or unequal effects of control type accounted for 19.17% of the total variation in the control type scores. There was no significant interaction of group by control type ($F < 1$). Thus, the significant difference demonstrated between the two groups in overall grammar score could not be accounted for by the Control data.

Differences in Sentences Assessing Binding Principles

The data assessing obedience to the binding principles were analyzed using a multivariate analysis of variance (MANOVA) with planned orthogonal comparisons of

reading groups (good readers and poor readers) with repeated measures of sentence complexity (simple and complex) and binding type (Principles A, B, C). The two levels of the complexity variable were simple structures (simple constructions for each of the binding principles: A-S, B-S, C-S) and complex structures (constructions containing "that" clauses for each of the binding principles: A-Th, B-Th, C-Th). The A-Want construction, to be discussed below, was not included in this analysis.

The main effect of reading group (GRs, M = 3.63 vs. PRs, M = 3.24) was significant [$F(1, 61) = 5.44$, $p = .023$]. Means and standard deviations are presented in Tables 4a and 4b, and the source table for the MANOVA is given in Appendix E (Source Table 4). Thus, the good readers generally did better than the poor readers on tasks requiring knowledge of the binding principles. There was also a main effect of binding type [$F (2, 122) = 29.55$, $p < .001$]. A contrast comparing binding types B versus A and C (Contrast 1 as indicated on Appendix E, Source Table 4) was significant [$F (1, 122) = 51.06$, $p < .001$] indicating that performance on Principle B sentences was worse over-all than on those assessing Principles A and C. A comparison of Principles A and C, Contrast 2, shown in Appendix E (Source Table 4) was also significant [$F (1, 122) = 7.30$, $p = .009$], demonstrating that performance on A was better than on C overall. The order of difficulty, then, was A - C - B. For the combined groups, Principle A sentences produced the most adult-like performance, then Principle C sentences, and last, Principle B sentences.

There was a significant reading group by binding type interaction [$F (2, 122) = 7.04$, $p < .001$] which was solely attributable to differential performances on B,

not on A and C, as indicated by Contrasts 1 and 2 (Appendix E, Source Table 4). Whereas performance on B was poorer than A and C for both groups, B was more difficult for the poor readers than it was for the good readers [F (1, 122) = 13.58, p = <.001] (Contrast 1, Group by B vs. A and C). Although on Figure 3 the groups appear to diverge on Principle C scores, Contrast 2 (Group by A vs C) was not significant (F <1), which demonstrated that while performance on A versus C was different over-all, with A being less difficult, there was not a significant difference in the pattern of performance by the two groups on these two Principles. Figures 2, 3 and 4 illustrate that in the group by binding type interaction, it was Principle B that differentiated the two groups, and that, while both groups had difficulty with B, the poor readers had significantly more difficulty. Thus, the binding types differed among themselves and Principle B discriminated between the two groups.

There was a main effect of complexity, as the simple structures were easier than the complex structures (Simple, M = 3.52; Complex, M = 3.35) [F (1,61) = 11.45, p = .001]. Means and standard deviations are displayed on Table 4b. However, none of the interactions, Group by Complexity (F <1); Binding Type by Complexity (F = 1.09); or Group by Binding Type by Complexity (F <1) were significant.

To summarize, these data indicated that a comparison of good and poor readers revealed a significant difference in the grammar scores achieved by these two groups. However, a significant difference was found between the good and poor readers only for performance on Principle B. Principle B appears to be what accounts

for the significant difference between the reading groups on the overall grammar score. The overall binding type effect accounted for 11.08% of the variation. The two orthogonal contrasts break down that amount into two components (9.74% and 1.34%); Contrast 1 (Principle B vs. A and C) accounted for nearly all (88%) binding type effect. However, the significant reading group by binding type interaction accounted for only 2.64% of the total variance. Virtually all (98%) of that (2.59%) was attributable to the differential performance on Principle B by the two groups.

Differences in Principle A Types (Simple, That, Want)

A MANOVA to assess the children's performance on the three types of sentences relevant to Principle A revealed no significant main effect of reading group ($F = 1.60$). Means and standard deviations are presented in Table 5, and the source table for the MANOVA is given in Appendix E (Source Table 5). However, there was a significant main effect of A-Type [$F(2,122) = 18.78$, $p = < .001$]. Comparison of A-Want ($M = 3.33$) versus A-Simple ($M = 3.95$) and A-That ($M = 3.68$) (Contrast 1) was significant [$F(1,122) = 27.63$, $p < .001$], indicating that A-Want was more difficult than the other two A-types. Comparison of A-Simple and A-That was also significant [$F(1, 122) = 7.78$, $p = .007$], indicating that A-Simple was easier that A-That. There was no interaction of reading groups by A-Type ($F < 1$). Both reading groups demonstrated similar patterns of performance.

School Analysis

The only difference between reading groups was their performance on the binding sentences. Since there was a significant school by reading group interaction

on the analysis of DST scores, it was necessary to determine whether the effect of reading group on binding type interacted with school. An ANOVA given in Appendix E (Source Table 6) demonstrates that there was no significant interaction for reading group by school ($F < 1$), reading group by school by binding type ($F < 1$), reading group by school by sentence complexity ($F = 1.91$), or reading group by school by binding type by sentence complexity ($F < 1$). Thus, the relation of reading group to binding type was the same for both schools.

Correlations

A series of correlations was performed to evaluate the relationship among reading ability, grammar scores, and short-term memory. DST was used as an index of reading ability; the total grammar score (GRAM) was used as an index of grammatical ability; Linguistic Concepts-Oral Directions (LC-OD) and Recalling Sentences (RS) were used as individual indices of memory whereas their combined scores served as the total memory measure (MEM). Table 6 displays the correlations. There were significant correlations revealed between DST and GRAM (grammar score) ($r = .289$, $p = .022$) and between DST and LC-OD (Linguistic Concepts-Oral Directions) as a measure of memory ($r = .263$, $p = .037$). However, the correlation of RS (Recalling Sentences) as a measure of memory with DST was not significant ($r = .182$, $p = .155$). Of note, however, was that LC-OD (Linguistic Concepts-Oral Directions) and RS (Recalling Sentences) were significantly correlated ($r = .513$, $p < .001$). This correlation allowed for their use in combination as an index of memory (MEM). The correlation between DST and MEM ($r = .225$.

$p = .076$) was not significant.

The significant moderate correlation between GRAM and LC-OD ($r = .388$, $p = .002$) and RS ($r = .318$, $p = .011$), as well as the combined LC-OD + RS (MEM) correlation with GRAM ($r = .373$, $p = .003$) indicated that GRAM and the two measures of memory were more highly correlated with one another than any were with DST. Scatter plots, see Figures 5, 6, and 7, illustrate the relationship among DST, MEM and GRAM.

The relationship between total grammar score (GRAM) and reading (as measured by decoding scores on the DST) ($r = .288$, $p < .05$) is depicted on the scatter plot in Figure 5. While the correlation was significant, little shared variance was accounted for ($r^2 = 8\%$). The scatter plot, however, reveals an interesting relationship between the variables. Whereas some poor readers (as measured by DST scores) demonstrated good GRAM scores, good readers generally did not display low GRAM scores. Thus, it could be that a good GRAM score is necessary, but not sufficient for good reading ability.

Figure 6 illustrates the slight but significant relationship between DST and MEM ($r = .225$, $p < .05$) ($r^2 = 5\%$). The scatter plot in this case reveals little of interest. There were children who exhibited good DST scores and had poor memory scores, as well as children with poor DST scores and good memory scores.

The correlation between GRAM and MEM utilizing the combined scores of LC-OD and RS was significant ($r = .368$, $p < .01$) ($r^2 = 13\%$). This relationship is displayed in Figure 7. Although there were children with relatively good GRAM

scores and low MEM scores, there were none with poor GRAM scores and high MEM scores. Thus, it could be that a good GRAM score is necessary, but not sufficient for a good MEM score.

Analysis of the shared variance of DST with both GRAM and LC-OD revealed that the variance shared by GRAM and DST (4.4%), independent of LC-OD, was greater than that shared by LC-OD and DST (2.9%), independent of GRAM.

Analysis of the shared variance of DST, GRAM and RS revealed that there was little variance shared between RS and DST that was independent of the correlation of RS with GRAM. However, GRAM and DST share 6.3% of the variance independent of RS. A multiple regression analysis indicated that neither GRAM nor MEM were significant predictors of DST. Despite this, it was of some interest that GRAM and memory measures were more related to one another than either were to DST.

Analyses of Individual Children

The analysis thus far has focused on a description of the group data. A second kind of inquiry analyzed every child according to his/her performance on the grammatical structures. Each child was classified in terms of his/her grammar type (GT) as demonstrated by obedience to the grammatical principles and patterns of violation. This was done for performance on the adverbial and complement control structures according to classificatory criteria described earlier. Two additional unclassified (UN) categories became necessary for those individuals who did not conform to those criteria. These included the following: UNa - children who

allowed either the subject or object to control PRO in both complement and adverbial structures; UNb - children who allowed either the subject or object to control PRO in complement structures, however, demonstrated adult-like control in adverbials.

Two analyses of Principle A were conducted. One examined whether children obeyed or violated Principle A in both A-Simple and A-That sentences. The other investigated whether the knowledge of domain was correct with regard to A-Want. All of the binding principles (A, B and C) were analyzed in both simple and complex structures in order to identify whether they were consistently obeyed or violated. Violation patterns of the binding sentences were also examined.

Control Grammar Type (GT) Analysis

The Control type grammar scores were analyzed as a means to identify each subject's grammar type (GT) and to compare the demonstrated patterns by reading groups. Table 7 provides the grammar type (GT) classification of the subjects. Twenty good readers (49%) demonstrated adult-like interpretations of both complement and adverbial structures, which qualified them for classification as GT IV. Of the remaining good readers, nineteen (46%) were classified as GT III (none were classified within GT I or GT II). These subjects exhibited adult-like interpretations of the complement, but allowed either object or subject control in the adverbial structure. The other two good readers did not fulfill the definition of any of the grammar type categories and were, as a result, identified as Unclassifiable. One of these subjects was identified as UNa, as she allowed either the subject or the object to control PRO in both complement and adverbial structures. The subject classified

as UNb allowed subject or object control in the complement structure while demonstrating adult-like control of the adverbial.

A slightly lower percentage of poor readers displayed adult-like control. Nine subjects (41%) qualified for classification within GT IV. Ten poor readers (45%) were classified as GT III. Unlike the children in the group of good readers, one subject was classified as GT IB. This youngster appeared to be moving into GT III, as she exhibited all three types of responses (subject, object and outside) as controller of PRO. As with the good readers, however, none were within GT IA or GT II and a few demonstrated patterns that made them Unclassifiable. One fulfilled the definition of UNa, a second qualified for categorization within UNb. This individual demonstrated adult-like control in the adverbial, but in one construction identified the subject as controller of PRO in a complement structure.

Grammar Type Analysis for Principle A

An equivalent percentage of children in the two groups (GRs = 54%; PRs = 55%) demonstrated adult-like interpretations of all twelve Principle A sentences. As displayed on Table 8, these children were classified as GT4. A considerably higher percentage of poor readers than good readers (32% vs. 20%), however, demonstrated GT1 behavior by allowing the reflexive to be free in violation of Principle A. (There were two children, both of whom were poor readers, who allowed the reflexive to be free in simple sentences.) Only 3 good readers demonstrated GT2 interpretations in which they violated the clausal domain. These subjects allowed reference inside the sentence but outside of the clause which was tensed for the sentences with "that" and

untensed for sentences with "want" (note that McDaniel et al. did not identify any such children). A higher percentage of good readers than poor readers (20% vs. 14%) were also classified as GT3. These subjects allowed the correct domain for the tensed clauses, but not for the tenseless ones. GT3 children violated the local domain for English.

Classification Analysis

In order to see how the individual subjects within the two reading groups patterned in terms of their responses, the number of correct versus the number of incorrect responses for each of the grammatical measures was analyzed. The responses of the children were classified as "obey" or "violate." "Obey" was defined as the adult-like interpretation on all four tokens; "violate" included one or more non adult-like interpretations. Each of the tallies were then subjected to a 2-way Chi-Square analysis to see if the poor readers patterned differently from the good readers. Table 9 presents the results of this analysis. The data demonstrate that the pattern of obedience to the grammatical structures did not differ significantly for the two groups for any of the binding or control principles. This was true even for the Principle B structures. This was, however, the only x^2 that approached significance ($x^2 = 2.769$ $df = 1$, $p = .096$), although more than two-thirds of the poor readers were violators as compared to just over half of the good readers. What was of primary interest here was the comparison of individual children's performance on the principles of interest.

Classification of Violation Patterns for Binding Sentences

Analysis of the data revealed that the subjects tended to demonstrate fewer violations for Principle A than for C, and fewer for C than for B. Individual performance patterns were analyzed in order to ascertain which subjects followed this pattern and to identify variations from this basic pattern. Four response patterns were apparent, as displayed on Table 10. Group 1 was defined by perfect scores on all the sentences assessing the binding principles. A total of 18 subjects (GRs = 13; PRs = 5) or 29% of the combined groups (GRs = 32%; PRs = 23%) demonstrated adult-like interpretations for all of the binding sentences. Group 2 consisted of those children whose violations were Principle specific. While a total of three subjects violated Principle A only (no poor readers fell within this category) and one individual (a poor reader) demonstrated Principle C only violations, 16 youngsters, 26% of the combined group (GRs = 20%; PRs = 36%), demonstrated B only violations. Group 3 included those subjects who demonstrated patterns in which Principle A was less difficult than or equal to C, which was less difficult than or equal to B. Eighteen subjects, 29% of the combined group (GRs = 29%; PRs = 26%) demonstrated this pattern. Group 4 consisted of patterns that reflected any other ordering (i.e., a stronger performance on B than C or A; a stronger performance on C than A). This group represented the greatest amount of individual variation and totaled only 7 subjects (GRs = 9%; PRs = 12%) and 11.8% of the subject population.

Selected Performance Patterns

In order to analyze the findings fully, it was necessary to examine the patterns exhibited by individual children. Variation from the group performance on the measures of decoding skills (DST), grammatical knowledge, and binding type violations were examined.

Patterns of Performance on the Test of Decoding and Other Placement Criteria

The DST scores for the total subject population ranged from 12 to the maximum score of 120. The good readers generally achieved decoding scores of 74 or higher, while the majority of the poor readers demonstrated accurate decoding at or below a score of 70. DST score distributions are displayed in Appendix F. DST scores were used as a measure of reading ability across all subjects, not as a criterion for inclusion or for group assignment. There were seven subjects who demonstrated "crossover" patterns. One good reader obtained a score of 43, whereas six poor readers achieved decoding scores of 87, 90, 92, 95, 100, 105. These "cross-over" subjects were analyzed according to other information available regarding their school evaluation data.

School 1 assessed their students through use of the Connecticut Mastery Test, whereas School 2 administered the Iowa Test of Basic Skills. The Connecticut Mastery Test yields Degrees of Reading Power (DRP) scores as an indication of how well students understand what they read. The grade equivalent (GE) of the Iowa Test of Basic Skills represents the average of vocabulary and reading subtests, which include responding to questions that refer to facts as well as those that require

inference and generalization. A DRP score of 32 qualified as the remedial "cut off" for third grade students. A GE of 3.0 represented third year zero months. DRP/GE score distributions are presented with DST scores in Appendix G.

The DST scores of the six poor readers with "cross-over" DST scores were compared to their respective DRP or GE scores. This information is displayed in Appendix H. Two of the subjects were notably below grade level, whereas the other four were just within the grade level range. This discrepancy was accounted for by the schools' philosophies. The teachers considered supplementary factors in determining academic placement decisions for youngsters who are just within the "cut-off" criteria (i.e., 5 - 10 points above or below a remedial "cut-off.") These included general academic growth, observed maturity, attendance records, and an enriched, stimulating home environment versus a deprived, unstimulating one. Of additional importance in grouping children for reading instruction was the intensity of basic skill development that would be available to the individual child in one reading group as compared to another. All of these aspects appeared to be relevant to the grouping decisions of the subjects for this study. The DST scores for these subjects may have reflected the benefits these children garnered from their instruction, as well as a factor of individual maturity. Early identification of the School 2 poor readers as being at "high risk" for reading failure resulted in the initiation of an intensive basic skills intervention program prior to grade 3. This was not the case for the School 1 poor readers and may have contributed to their demonstrated lower decoding skills.

One subject had both a low decoding score and a DRP score close to the

remedial criterion score of 32 in relation to others in his group of good readers. His teachers maintained his reading placement as he was generally achieving academically and performed within reading group expectations regarding comprehension skills.

Low Overall Grammar Scores Compared to Performance on Binding Sentences

Four children had very low grammar scores with violations across all of the binding principles. This information is represented on Table 11 along with decoding (DST) and memory (MEM) scores. One youngster was a good reader; three were poor readers. Of interest was the shared patterns of performance of these individuals. As a group, their low grammar scores were not attributable to their scores on the control type structures. They, however, violated either all or three of the four sentences for the simple and complex structures of Principle B and the simple structures of Principle C. Individual patterning, however, was demonstrated. One subject violated all the complex Principle C (C-That) structures, whereas the others demonstrated obedience to two or three of the structures. Only one subject violated a simple Principle A structure; that subject and two others demonstrated violations of the complex Principle A-Want and A-That structures; whereas one subject had all adult-like interpretations for that Principle. The reading scores revealed that the good reader achieved the lowest decoding score of her group (not including Subject 14 discussed earlier whose decoding score was outside of the group). Thus, this good reader demonstrated a pattern of performance that fit with the three poor readers. Of additional interest was the fact that all of these subjects had low memory scores.

B Only Violations

Sixteen subjects were identified as having violated only Principle B structures. Although the number (but, of course not the percentages) was equally divided between the good and poor readers, patterns of violation differed. This information is presented in Table 12. Five of the good readers demonstrated adult-like knowledge of Principle B-Simple, displaying violation only for the complex structures. Only three of the poor readers displayed this pattern. They additionally demonstrated more Principle B-Simple violations over-all (7 vs. 3). There were poor readers who made a greater number of violations as compared to the good readers; no good reader violated as many as three of the sentences, but two of the poor readers did so. Among these children a high grammar score was not necessarily accompanied by a high memory score. This was especially apparent for three of the good readers.

CHAPTER 4

DISCUSSION

This study set out to investigate questions regarding selected differences between good and poor readers. The purpose was to identify specific characteristics that differentiate children who have been classified according to reading achievement as good or poor readers. The specific intent was to investigate the syntactic development of children in each of these groups and to determine whether poor readers have immature grammars compared to their achieving peers. It sought to ascertain whether particular aspects of grammar, principles of control and binding, could distinguish between the reading groups. These specific aspects of syntax had not been previously investigated in studies of good and poor readers. The children's grammars were evaluated with respect to the control principle in infinitival complement and adverbial clause constructions and all three of the binding principles (Principles A, B and C) in both simple and complex structures. A sentence-picture matching judgment task that assessed all of the possible interpretations of each of the sentences was employed. In addition to grammatical knowledge, decoding ability and short-term memory were measured.

The primary findings of this study can be summarized as follows:

1. Children classified as good readers were significantly better decoders than

those classified as poor readers.

2. The good readers scored significantly higher than the poor readers on over-all measures of syntactic knowledge .

3. The two reading groups performed in a similar manner with regard to the grammatical principle of control. There were both good and poor readers who allowed either subject or object control in temporal adverbial clauses (i.e., Nancy or Mother were chosen as the performer of the action in "Mother pats Nancy before turning out the light") in violation of the adult-like interpretation. These subjects were, therefore, classified as having GT III grammar types.

4. Both reading groups demonstrated the same pattern of difficulty for the binding type sentences. The order of difficulty was A - C - B for the combined groups. Performance on Principle A sentences was better than for Principle C. Principle B sentences were problematic for both the good and poor readers.

5. The only aspect of syntax that differentiated the two reading groups was performance on Principle B of the binding theory. Whereas both groups disobeyed Principle B by allowing pronouns to have local referents, the poor readers did so significantly more than did the good readers.

6. The two reading groups performed in a similar manner with regard to the binding Principle A. There were both good and poor readers who allowed the reflexive to refer outside an untensed clause (i.e., Mother or Nancy were chosen as the performer of the action in "Mother wants Nancy to bandage herself.") Thus, these children did not have the correct domain specified in their grammars for the

application of Principle A.

7. Overall grammar score and short-term verbal memory were more highly correlated with one another than either was with decoding.

A discussion of each of these findings follows.

Decoding Performance

The performance of children identified as good versus poor readers according to teacher judgement and school placement was markedly different on the measure of decoding skill (DST). As anticipated, the good readers demonstrated significantly higher decoding scores than did the poor readers. There were seven subjects who were exceptions to this finding. The decoding scores of these children represented "crossover" scores (good readers with scores below 74; poor readers with scores higher than 70). One good reader obtained a score of 43 which was within the range exhibited by the poor readers, whereas six poor readers demonstrated decoding scores within the range of the good readers. Factors other than decoding ability contributed to their reading group assignment. The one child (Subject 14) classified as a good reader who had a low DST score attained a perfect grammar score of 36 and a memory score that was higher than the mean for the good readers. He was, additionally, able to maintain academic performance expectations of his assigned reading placement, despite his poor decoding skills. The profiles of the poor readers who demonstrated decoding proficiency commensurate with the good readers did not generally parallel those of the good readers. The high decoding scores of these poor readers probably reflected their responsiveness to intensive basic skills instruction,

and did not indicate that they had been misclassified.

Performance on Grammatical Measures

Poor readers scored significantly lower than good readers on over-all grammar score. This difference in performance was further investigated by an examination of performance on sentences involving both control and binding principles.

Control

The pattern of performance of the two groups on measures of control was similar, as both groups demonstrated greater difficulty with the adverbial structures than with the complement clauses. Since there was no significant main effect nor interaction involving reader group, performance on control type sentences did not account for the grammar differences demonstrated by the two reading groups.

An analysis of control type responses according to grammar types (GTs) modeled after McDaniel et al. (1991) demonstrated that a high percentage of responses for children classified within each of the reading groups (good readers = 49%; poor readers = 41%) were adult-like interpretations in both complement (e.g., Mother tells Nancy to pick up the clothes) and adverbial (i.e., Mother patted Nancy before turning out the light) structures. These subjects fulfilled the definition of GT IV by allowing the object to be the controller of PRO in the complement structure (e.g., the selection of Nancy as the performer of the action) and the subject to be the controller of PRO in the adverbial (i.e., the selection of Mother as the subject of the matrix clause). There was also a high proportion of children (good readers =46%; poor readers = 45%) who selected either object or subject as controller of PRO in

the adverbial structure (e.g., Nancy or Mother chosen as performer of the action in the sentence "Mother pats Nancy before turning out the light.") These children were classified as GT III. It is curious that such a high percentage of children as old as third graders demonstrated this "immature" grammatical pattern. The earlier study by McDaniel and her colleagues reported several adults classified as GT III. These individuals were described as having a distinct grammar, rather than a transitional one in which they were passing from GT I to GT IV, as was the analysis for the young subjects. This could mean that the GT III children have not learned the adverbial nature of subordinating conjunctions. Another possible explanation could be that these older children who were classified as GT III did not have immature grammars, but will turn out to be GT II adults as identified by McDaniel et al.

Unlike the studies reported earlier, which utilized younger subject populations (Cairns et al., 1994; McDaniel et al., 1991), there were no children who allowed a sentence external character to be the referent of PRO in any of the complement structures and only one, a poor reader, who identified a character out of the sentence as controller of PRO in an adverbial clause. This performance indicated that everyone had correctly learned lexical cues to subordination.

Binding

The good readers generally did better than the poor readers on tasks requiring knowledge of the binding principles. However, patterns of performance across the binding principles except for the complex structure of Principle B were the same for both reading groups. Performance was better overall on Principle A than on Principle

C, and both groups demonstrated the greatest difficulty with Principle B. Poor readers, however, displayed a greater number of errors. This was the largest study to have demonstrated the A > C> B pattern; it also involved older subjects than have other studies. Earlier studies (e.g., Chein & Wexler, 1990; McDaniel et al., 1990; Wexler & Chein, 1985) that investigated younger subjects have suggested this ordering of difficulty for the binding principles.

Principle A

According to the Lexical Learning Hypothesis, Principle A should be operative as soon as the reflexive pronouns are classified by the child. An equivalent percentage of good and poor readers demonstrated this, in that they required that the reflexives refer to a c-commanding noun phrase (NP) and not to a character outside the sentence. Both good and poor readers, however, violated the locality condition on Principle A in sentences containing untensed clauses (A-Want). For example, in a sentence such as, "Mother wants Nancy to bandage herself," these children selected both "Nancy" and the character outside the clausal domain, "Mother," as possible referents for "herself." Obedience to the local domain for English requires that "herself" refer only within the clausal domain, to "Nancy." Three good but no poor readers violated the locality condition in sentences with tensed clauses. These subjects allowed "herself" and "Mother" to co-refer in "Mother sees said that Grandmother is scratching herself." The demonstrated violations by good readers only suggested that this behavior was not related to reading ability.

The difficulty encountered with the untensed structures relative to Principle A

involves a "domain" issue. The reflexive pronoun must only be co-indexed with a c-commanding noun phrase in its clause. Many good and poor readers violated the clausal domain in the complex Principle A-Want structure. The fact that the children did not allow the reflexives to refer outside the sentences showed that they have correctly classified the reflexives. The question at issue here is how could these children ever change their grammars and get the domain correct for English. There seems to be no positive evidence that they could receive that could cause them to change their grammars. They would have to utter sentences like "Mommy wants Daddy to help herself" and be corrected for their errors. We are confident that this kind of negative evidence is not universally available to children learning English. The importance of this finding for children as old as nine is that even if negative evidence were available, they surely would have received it. Thus, the existence of twelve third graders who violated the locality of Principle A in English presents a major learnability problem. It does not, however, present a problem for Continuity Theory. There are languages which allow reflexives to refer to c-commanding noun phrases out of an untensed clause.

Cairns (in press) has suggested that perhaps the English language is changing with respect to the locality domain of the application of Principle A. An alternative proposal is that there are individuals who reach adulthood with the parameters set differently than do most speakers of English. There would, then, be differing dialects of English that are characterized by different locality conditions on the domain of application of Principle A.

Principle C

Principle C requires that a pronoun not be coindexed with any noun phrase that it c-commands, in or out of its clausal domain. The noun phrase and the pronoun must be contra-indexed and, thus, should not co-refer. The pronoun, therefore, must refer to someone in the discourse context. The children demonstrated fewer violations of Principle C than of Principle B; however, they obeyed it less frequently than they did Principle A. One subject violated Principle C only, as compared to sixteen who disobeyed Principle B only. This helps to resolve earlier studies that provide somewhat differing results regarding the acquisition of Principle C (e.g., Chein & Wexler, 1990; Chomsky, 1969; Crain, 1991; Crain & McKee, 1985; McDaniel et al., 1990; Wexler & Chein, 1985). The children in the present study obeyed Principle C more often than Principle B. Comparison of Principles B and C are of interest because both involve restricted reference of personal pronouns, and both allow reference within the discourse context. Performance on both of these structures demonstrated that complexity was a factor. Both good and poor readers displayed more violations on the complex structures than on the simple constructions. The question remains, however, given the lexical learning hypothesis, why children continue to violate Principle C once they have classified anaphors, pronouns and noun phrases. Disobedience of both Principles C and B results from co-reference between a pronoun and a contra-indexed noun phrase. If the prohibition of such co-reference is a pragmatic, rather than a grammatical principle, then we assume that what must be learned is Principle P. A further question this raises, however, is why children

demonstrate knowledge of it earlier for Principle C than for B.

Principle B

The children in the present study demonstrated more difficulty with Principle B than with the other binding principles. Twenty six percent of the total subject population violated only Principle B. Whereas the subjects generally had more difficulty with the Principle B structures, the poor readers displayed more violations of Principle B only (36 percent) than did the good readers (20 percent). The single aspect of syntax that differentiated the two reading groups was obedience to Principle B. The differential performance on Principle B, therefore, accounted for the significant difference between the reading groups on the overall grammar score. This distinction was attributable to the poor reader's lower performance on the complex structures involving Principle B. Subjects who violated Principle B allowed co-reference within the clause. For example, in the sentence, "Little Sister sees that Mother is washing her," these children selected "Mother" as well as "Little Sister" or "Nancy" as a possible referent. According to Principle B, "her" cannot refer to "Mother;" it must refer to Little Sister or an external referent. "Her" can refer to "Little Sister" or the external referent because both are outside the local clausal domain.

The fact that poor readers in this study performed more poorly on Principle B sentences than good readers represented a small, but stable effect. The analysis revealed that the main effect of binding type and its interaction with reading group were both significant at the .001 level. Nearly 88% of the binding type effect was

attributable to the contrast of Principle B versus A and C. Similarly, nearly all of 98% of the interaction was accounted for by the contrast of Principle B versus A and C. Thus, while the Principle B effect was significant, it was small relative to the total variance, but large relative to the other binding principles. However, when the individual scores of the subjects were considered the Principle B effect was maintained. Analysis of the individual data revealed that nearly 2/3 of the poor readers had some Principle B problems, while only half of the good readers did. For example, 17 of the 22 poor readers violated at least one of the Principle B structures.

Although Principle B has not been previously explored in relation to differences in reading skill, it has been identified as late developing and problematic as compared to the other binding principles. Acquisition for some children has been believed to continue into late childhood, but it is not known how old children must be before they attain adult performance with respect to Principle B. Children in the present study, however, were the oldest group to demonstrate violations of Principle B. Thus, it appears that even nine year olds still violate Principle B.

Various researchers (Chein & Wexler, 1985; Grodzinsky & Reinhart, 1993; McDaniel & Maxfield, 1994) have suggested that the difficulty children have with Principle B is related to the development of principles of reference that are pragmatic, rather than syntactic. Non co-reference for contra-indexed noun phrases (NPs) may be the result of what Chein and Wexler identify as Principle P, the pragmatic principle, and what McDaniel and Maxfield describe as being related to the understanding of contrastive stress. This notion is further supported by Grodzinsky

and Reinhart, who theorize that adults compare possible grammatical means of expressing coreference. Both are compared in short-term memory, and the hearer assumes that if the speaker intended co-reference he should have used the co-indexed form. Thus, "Grover scratched himself" is an unambiguous way to convey the message that Grover scratched Grover. "Grover hit him," though grammatical, is not as effective a means of conveying that information. They suggest that short-term memory limitations in children may play a role in the difficulties encountered in the acquisition studies in the interpretation of pronouns affected by Principle B. Although this theory was not examined directly in this study, there was a relationship between total grammar score (which included obedience to Principle B) and verbal short-term memory.

Currently, it is not known at what age children demonstrate adult-like interpretations of Principle B. What appears evident, however, is that children continue to demonstrate non-adult like interpretations of Principle B into the school age years and after reading skills have been acquired. The observed difference between good and poor readers in their obedience to Principle B suggests a distinction between these two groups that may be independent of basic syntactic ability. These two groups appear to differ in regard to pragmatic or referential aspects of language. The impact of this limitation upon reading comprehension must be explored in future research.

Grammar Score and Memory

Two measures of phonological short-term memory were employed in this

study, and a weak but significant correlation between grammar score and memory was demonstrated, despite the fact that the grammatical task was designed not to put a strain on short-term memory. The relationship between the total grammar score (including Principle B performance) and short-term memory was greater than either was to reading skill as measured by decoding ability. While some subjects achieved high grammar scores and performed poorly on the short-term memory tasks, no child demonstrated a low grammar score accompanied by a high memory score. It is possible that the weak demonstrated correlation between grammar score and short-term memory can be attributed to a relationship between a more mature grammar and the ability to encode sentences in memory. Such a relationship could be the result of the fact that the quality of storage depends upon the quality of coding in memory enabled by the grammar. Perhaps a more mature grammar allows more effective chunking of information for short-term memory (Miller, 1967). Another explanation can be provided by Grodzinsky and Reinhart (1993), in that poor performance on Principle B sentences is attributed to short-term memory problems. A causal connection between grammar and memory, however, cannot be inferred from the indicated correlation. Perhaps both are related to a third factor, such as cognitive ability.

General Conclusions

Although this study did not find differences in grammatical knowledge (except for Principle B which may have been due to pragmatic rather than grammatical knowledge), the performances on memory tasks did not support the processing

limitation account of poor reading. This hypothesis asserts that poor readers experience difficulty processing phonological information in working memory and that this problem then interferes with providing a proper phonological representation to an otherwise intact syntactic processor (Shankweiler et al., in press). Whereas the present study identified a lack of decoding skill in poor readers, it did not identify short-term memory problems. Of the two measures of short-term memory used, following oral directions of increasing linguistic complexity and recalling sentences, only linguistic concepts-oral directions was found to be related to reading ability. Additionally, although the two indices of short-term memory (linguistic concepts- oral directions and recalling sentences) correlated with one another, when they were combined, the total memory score (MEM) did not correlate significantly with reading ability. There currently is, however, a measurement problem across studies, characterized by a lack of agreement regarding how to best assess working short-term memory in young school aged children.

The processing limitation hypothesis denies that poor readers have immature grammars. They appear, rather, to have syntactic deficits because of their phonological processing problems which interfere with holding the structures in short-term memory. The good and poor readers in the current study did not differ in syntactic ability when measured for knowledge of the control principles (complement and adverbial) and two of the binding principles (A and C). The one grammatical measure they did differ in was Principle B. This is an interesting finding as it is a binding principle that linguists have identified as possibly not syntactic. If adult

performance on Principle B is attributable to the pragmatic Principle P, then this study suggests yet another way good readers may differ from poor readers independent of syntactic ability or phonological short-term memory. This study did not look at severely disabled readers. The question remains whether greater differences would have been displayed with a more diverse population of poor readers and with a larger and more balanced proportion of good and poor readers.

Implications of the Study

This study sought to investigate whether principles of Universal Grammar, control and binding, would provide a more clearly defined means of ascertaining the syntactic knowledge of good and poor readers in order to identify whether poor readers' grammars are immature as compared to their achieving peers. It also examined whether these specific aspects of grammar could further distinguish between and characterize the two reading groups. Generally, although the good readers performed significantly better on measures of overall grammar, both groups demonstrated similar responses with regard to the principles of control, and two of the binding principles, A and C. Both groups additionally displayed the same pattern of difficulty for the binding type sentences; Principle A structures were easier than those of Principle C and Principle B were the most difficult. Differences in the grammatical knowledge between the two reading groups were completely accounted for by differential performance on Principle B, as the poor readers had significantly more difficulty.

Current research has provided considerable information regarding differences

between good and poor readers. (An extensive review, for example, is provided by Liberman and Shankweiler, 1985). A precise answer to the question of phonological versus syntactic lag as a primary cause of reading delay, however, has not been provided. Although the results of this study do not purport to furnish the explanation, they supplement the identified differences between these reading groups and, as such, have implications for further study. The finding that good and poor readers differ on Principle B is of interest, as it has been suggested in the literature that obedience to Principle B results form a combination of grammatical and pragmatic principles (Grodzinsky & Reinhart, 1993; Wexler & Chein, 1985). Grodzinsky and Reinhart (1993) suggest that the ability to select the correct grammatical form is one that requires the analysis of alternative forms. This proposal then presupposes the need to reflect upon and analyze language in an opaque rather than translucent manner, thus utilizing metalinguistic rather than a purely linguistic skills. The metalinguistic skills that would be required for this analysis seem to be most closely related to the ability to paraphrase and the ability to detect ambiguity. The first of these skills requires that the individual have the capability to generate an alternative form for the one that has been provided, while holding the original form in working memory. Ambiguity detection requires the ability to simultaneously derive two meanings for a particular form. Differential memory is a component of both of these tasks, suggesting that short-term memory and metalinguistic skills are related. Whereas good and poor readers have been identified as differing in metalinguistic skills and now there is evidence that they differ in their performance on Principle B,

further investigation of the relationship among short-term memory, metalinguistic skill and Principle B is indicated. It would be of interest to ascertain whether metalinguistic skills of good and poor readers are related to performance on Principle B/P. It is not known at what age children cease to violate this principle. Perhaps there is a relationship between obedience to Principle B/P and the late middle age during which time children appear to have a firmer command of metalinguistic knowledge.

Measures of short-term verbal memory require clearer definition, design and norms than currently available in the literature. The reported research reflects various measures that are not consistent across studies. One aspect revealed by this current investigation is that the use of the control and binding structures that represent specific constructions associated with Universal Grammar may provide a viable alternative to the type of sentences currently used in tasks that purport to measure sentence recall. These principles can be assessed by a variety of structures and a range of complexity. Short-term memory additionally needs to be distinguished from decoding skill. One means of addressing this would be to design a study that would compare good and poor readers who can decode.

The findings in regard to Principle B need to be demonstrated on a large population of children who represent a wide range of reading skill. Severely disabled readers have been previously identified as different from those classified as moderately disabled. Implications of this subject population for further research are evident. Additionally, whereas studies have been conducted on monolingual English

speaking children, there is a need to study the acquisition of literacy skills in English dominant bilingual speakers as well. It is important to identify whether there is the same relationship that has been observed in monolingual children.

This study was initiated in order to investigate whether the structural lag hypothesis provided a clearer account for reading disability than the processing limitation hypothesis. Rather than answering this question, a third factor was identified that might be different from both of these theories and in turn has opened new avenues of research.

Table 1. Decoding score (as measured by DST) cell means and standard deviations for schools by reading groups. (Maximum Score = 120)

	School 1	School 2	Mean (SD)
Good Readers	100.85 (18.42)	102.57 (13.11)	101.73 (15.74)
	(n = 20)	(n = 21)	(n = 41)
Poor Readers	55.81 (23.27)	79.33 (23.61)	62.23 (25.19)
	(n = 16)	(n = 6)	(n = 22)
Mean (SD)	80.33 (30.52)	97.41 (18.34)	87.94 (27.61)
	(n = 36)	(n = 27)	(n = 63)

Table 2. Grammar score cell means and standard deviations by reading groups. (Maximum Score = 36)	
	Grammar Score Means (SD)
Good Readers (n = 41)	32.46 (3.52)
Poor Readers (n = 22)	29.11 (5.81)
Grammar Score = CT [Control Type (Adverbial + Complement)] + BT [Binding Type (Principles A-S, Wa, Th; B-S, Th; C-S, Th)]; Total 36 (CT = 8; BT = 28)	

Table 3. Adult-type responses on sentences assessing control principles; cell means and standard deviations for control types by reading groups. (Maximum Score = 4)

	Adverbial	Complement	Mean (SD)
Good Readers (n = 41)	3.29 (0.93)	3.95 (0.22)	3.62 (0.47)
Poor Readers (n = 22)	3.27 (0.77)	3.91 (0.29)	3.59 (0.40)
Mean (SD)	3.29 (0.87)	3.94 (0.25)	3.61 (0.44)

Table 4a. Adult-type responses on sentences assessing binding principles; cell means and standard deviations for reading groups and binding type (Principles A, B and C). (Maximum Score = 4)

Binding type:	A	B	C	Mean (SD)
Good Readers (n = 41)	3.86 (0.36)	3.42 (0.79)	3.62 (0.62)	3.63 (0.47)
Poor Readers (n = 22)	3.75 (0.55)	2.57 (1.28)	3.41 (1.12)	3.24 (0.86)
Mean (SD)	3.81 (0.43)	3.12 (1.06)	3.55 (0.83)	3.49 (0.65)

Table 4b. Good and poor readers' adult-type responses for sentences assessing binding principles. Variables are complexity (simple, complex) and binding type (Principle A, B, C); means and standard deviations for reading groups and total sample. (Maximum Score = 4)

	Binding type			
	A	B	C	Mean (SD)
Good Readers (n = 41)				
Simple	4.00 (0.00)	3.56 (0.92)	3.56 (0.87)	3.70 (0.53)
Complex	3.71 (0.72)	3.27 (0.84)	3.68 (0.52)	3.55 (0.45)
Mean (SD)	3.86 (0.36)	3.42 (0.79)	3.62 (0.62)	3.63 (0.47)
Poor Readers (n = 22)				
Simple	3.86 (0.47)	2.68 (1.32)	3.46 (1.30)	3.33 (0.88)
Complex	3.64 (0.72)	2.46 (1.37)	3.36 (1.22)	3.15 (0.89)
Mean (SD)	3.75 (0.55)	2.57 (1.28)	3.41 (1.12)	3.24 (0.86)
B Mean (SD)	3.81 (0.43)	3.12 (1.06)	3.55 (0.83)	3.49 (0.65)

Table 5. Cell means and standard deviations for Principle A-types (Simple, That, Want) by reading groups. (Maximum Score = 4)

	A-S	A-Th	A-Wa	Mean (SD)
Good Readers (n = 41)	4.00 (0.00)	3.71 (0.72)	3.44 (0.74)	3.72 (0.43)
Poor Readers (n = 22)	3.86 (0.47)	3.64 (0.79)	3.14 (1.08)	3.55 (0.64)
Mean (SD)	3.95 (0.28)	3.68 (0.74)	3.33 (0.88)	3.66 (0.51)

Table 6. Correlations of reading, grammar and memory.

	DST	Gram	RS	LC-OD	MEM
DST	--------				
GRAM	0.2886	--------			
	(p = 0.022)				
RS	0.1885	0.3181	--------		
	(p = 0.155)	(p = 0.011)			
LC-OD	0.2632	0.3881	0.5129	--------	
	(p = 0.037)	(p = 0.002)	(p = 0.000)		
MEM	0.2249	0.3730	0.7091	0.9690	--------
	(p = 0.076)	(p = 0.003)	(p = 0.000)	(p = 0.000)	

DST: Decoding Skills Test scores (Real Words/Nonsense Words); Total: 120

GRAM: Grammar score: CT [Control Type (Adverbial = Complement)] + B [Binding Type (Principles A-S, Wa, Th; B-S, Th; C-S, Th)]; Total: 36 (CT = 8; B = 28)

LC-OD: Linguistic Concepts-Oral Directions; Total: 8

RS: Recalling Sentences; Total: 24

MEM: Linguistic Concepts-Oral Directions + Recalling Sentences; Total : 32.

Table 7. Grammar Type (GT) classification by reading groups.

	GT IA	GT IB	GT II	GT III	GT IV	UNa	UNb
Good Readers							
(n = 41)							
n	0	0	0	19	20	1	1
%				46	49	2	2
Poor Readers							
(n = 22)							
n	0	1	0	10	9	1	1
%		4.5		45	41	4.5	4.5

GT IA: identification of any character in or out of the sentence as performer of the action of the clausal verb in both the complement and adverbial structures.

GT IB: identification of the object as performer of the complement, demonstrating adult-like control of PRO, identify a character in or out of the sentence for the adverbial.

GT II: adult-like interpretation of the complement structure. Object control of PRO in adverbial as required in the complement.

GT III: selection of either object or subject control of PRO in adverbial structures.

GT IV: adult-like interpretation in both complement and adverbial structures.

UNa: allow either subject or object to control PRO in both complement and adverbial structures.

UNb: allow either subject or object to control PRO in complement structure. Adult-like control of the adverbial.

Table 8. Grammar type (GT) analysis for Principle A.

	GT1	GT2	GT3	GT4
Good Readers (n = 41)				
n	8	3	8	22
%	20	7	20	54
Poor Readers (n = 22)				
n	7	0	3	12
%	32		14	55
Total (n = 63)				
	15	3	11	34
%	24	5	18	54

GT1 (McDaniel et al. GT A): Children who allow the reflexive to be free in violation of Principle A. The reflexive can refer out of the sentence.

GT2 (McDaniel et al. GT B1): Children who obey Principle A (requiring sentence internal reference for reflexives) but who allow reference outside of the correct structural clausal domain (outside the clause for A-Wa and A-Th).

GT3 (McDaniel et al. GT B2): Children who allow the correct domain for the tensed clause but not for tenseless clauses (outside the clause for A-Wa only).

GT4: Adult-like interpretation (require co-reference for the reflexive). Children who allow reference within all clauses containing a subject and disallow reference outside such clauses.

Table 9. 2-way Chi-Square analysis of obedience and violation of grammatical structures.

Principle A	RG	Obey: GT4 (No violations)	Violate:GT1-3 (A violations)	x^2	P
A-GT1	GR	22	8		
	PR	12	7	.57	n.s.
A-GT2	GR	22	3		
	PR	12	0	1.57	n.s.
A-GT3	GR	22	8		
	PR	12	3	.24	n.s.
Principle B	**RG**	**Obey (No violations)**	**Violate (Any violations)**	**x^2**	**P**
	GR	18	23		
	PR	5	17	2.77	n.s.
Principle C	**RG**	**Obey (No violations)**	**Violate (Any violations)**	**x^2**	**P**
	GR	25	16		
	PR	15	7	.32	n.s.
Complement	**RG**	**Obey (No violations)**	**Violate (Any violations)**	**x^2**	**P**
	GR	39	2		
	PR	20	2	.43	n.s.
Adverbial	**RG**	**Obey (No violations)**	**Violate (Any violations)**	**x^2**	**P**
	GR	21	20		
	PR	10	12	.19	n.s.

GT1: The reflexive can refer outside of the sentence.
GT2: Reference outside the clause for A-Wa and A-Th.
GT3: Reference outside the clause for A-Wa only.
GT4: Adult-like interpretation (no violations).

Table 10. Violation patterns for sentences assessing the binding principles.

	Good Readers (n = 41)	Poor Readers (n = 22)	Total
Group 1			
Perfect binding principle scores	13	5	18
%	32	23	29
Group 2			
A (only)	3	0	3
%	7	0	4.8
C (only)	1	0	1
%	2	0	2
B (only)	8	8	16
%	20	36	26
Total	12	8	20
%	29	36	32.8
Group 3			
A>C>B	6	4	10
%	15	18	16
A>C=B	5	1	6
%	12	4	10
A=C>B	1	1	2
%	2	4	3
Total	12	6	18
%	29	26	29

Table 10. Continued

Group 4			
A>B>C	2	1	3
%	5	4	4.8
C>A>B	0	2	2
%	0	9	3
C>B>A	1	0	1
%	2	0	2
B>C>A	1	0	1
%	2	0	2
Total	4	3	7
%	9	12	11.8

Group 1: Perfect scores on the sentences assessing the binding principles. (Total = 28)

Group 2: A, C, or B violations only.

Group 3: Patterns in which A is less difficult than or equal to C which is less difficult than or equal to B.

Group 4: Patterns that reflect different ordering.

Table 11. Individual patterns: Comparison of low overall grammar scores to performance on binding sentences. (Maximum Score = 4)

Subj[a]	RG[b]	GRAM[c] CT/BT	B Violations[d]							DST[e]	MEM[f]	
			B-S	Th	C-S	Th	A-S	Wa	Th			
41	GR	18 5/13	4	3	4	1	0	1	2	74	20	(4/16)
28	PR	19 7/12	4	4	4	4	0	0	0	55	23	(7/16)
32	PR	18 6/12	3	3	3	2	2	1	2	26	20	(3/17)
63	PR	17 8/9	4	3	4	1	0	3	3	70	13	(4/19)

[a]Subj: subject number

[b]RG: reading group (GR = good reader; PR = poor reader)

[c]GRAM: total grammar score (maximum score = 36); CT (Control Type maximum score = 8); BT (Binding Type maximum score = 28)

[d]BT Violations: binding types violations (the number 4 indicates that no structures were interpreted
with an adult-like grammar, etc.)

[e]DST: Decoding Skills Test (maximum score = 120)

[f]MEM: total score (maximum score = 32) for Linguistic Concepts-Oral Directions + Recalling Sentences (LC-OD/RS); (maximum score = 8/24)

Table 12. Individual patterns of subjects with Principle B only violations. (Maximum sore = 4)

	Subj[a]	GRAM[b]	Violations[c]		DST[d]	MEM[e]	(LC-OD/RS)[f]
			B-S	B-Th			
Good Readers	1	34	0	1	101	22	(6/16)
	4	32	1	1	116	24	(6/18)
	15	34	0	1	76	15	(4/11)
	17	34	0	1	91	16	(6/10)
	18	34	1	1	82	24	(6/18)
	45	33	0	2	105	25	(5/20)
	50	32	1	1	113	18	(4/14)
	57	34	0	1	111	26	(7/19)
Poor Readers	21	30	3	2	58	17	(5/12)
	23	34	0	2	61	27	(7/20)
	24	32	0	1	95	20	(5/15)
	25	35	0	1	63	22	(4/18)
	29	32	1	1	41	26	(8/18)
	30	35	1	0	32	29	(6/23)
	31	35	1	0	43	26	(6/20)
	35	29	1	3	67	21	(4/17)

[a]Subj: subject number

[b]GRAM: total grammar score (maximum score = 36)

[c] Violations: the number 4 indicates that no structures were interpreted in an adult-like grammar for binding Principles B-Simple and B-That

[d] DST: Decoding Skills Test (maximum score = 120)

[e]MEM: total score (maximum score = 32) for Linguistic Concepts-Oral Directions + Recalling Sentences

Figure 1. Example of the Experimental Sentence Pictures

Principle C-That: "She tells Mother that Nancy is drawing a picture."

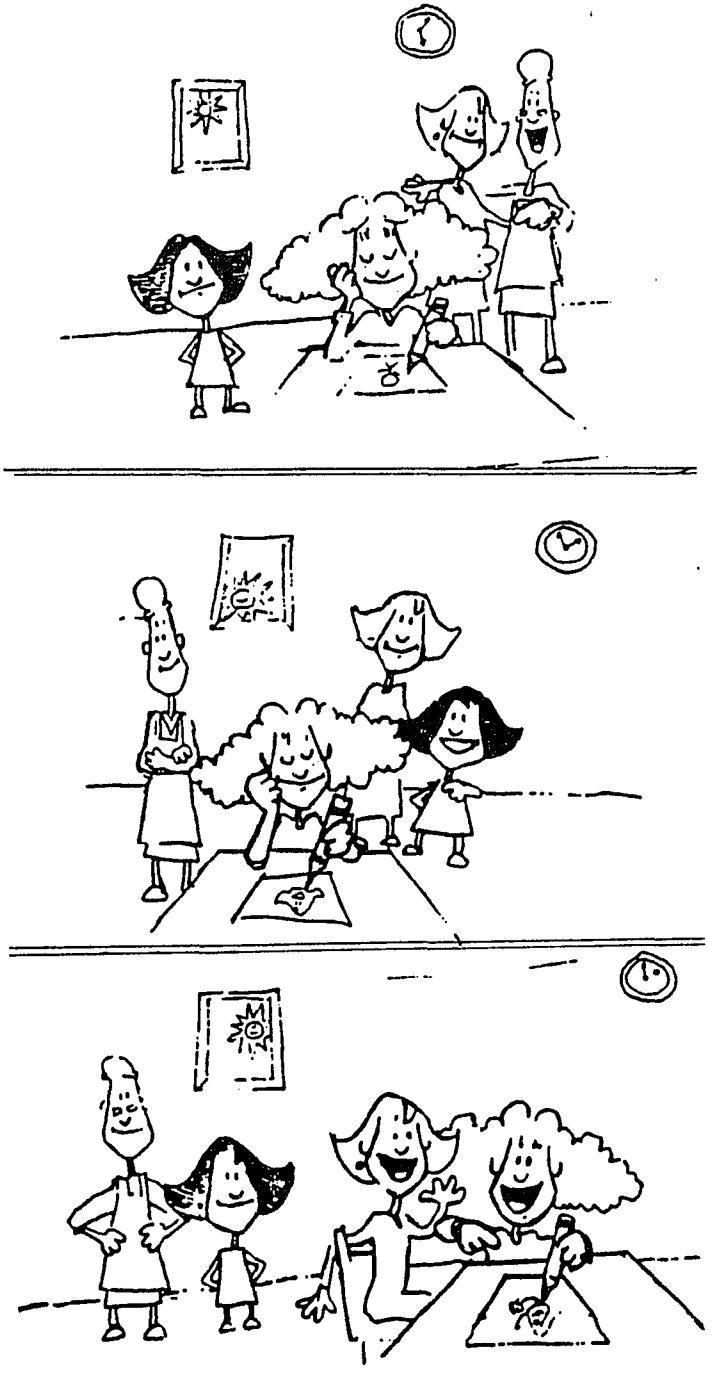


Figure 2. Performance of reading groups for simple structures of binding principles. (Maximum score = 4)

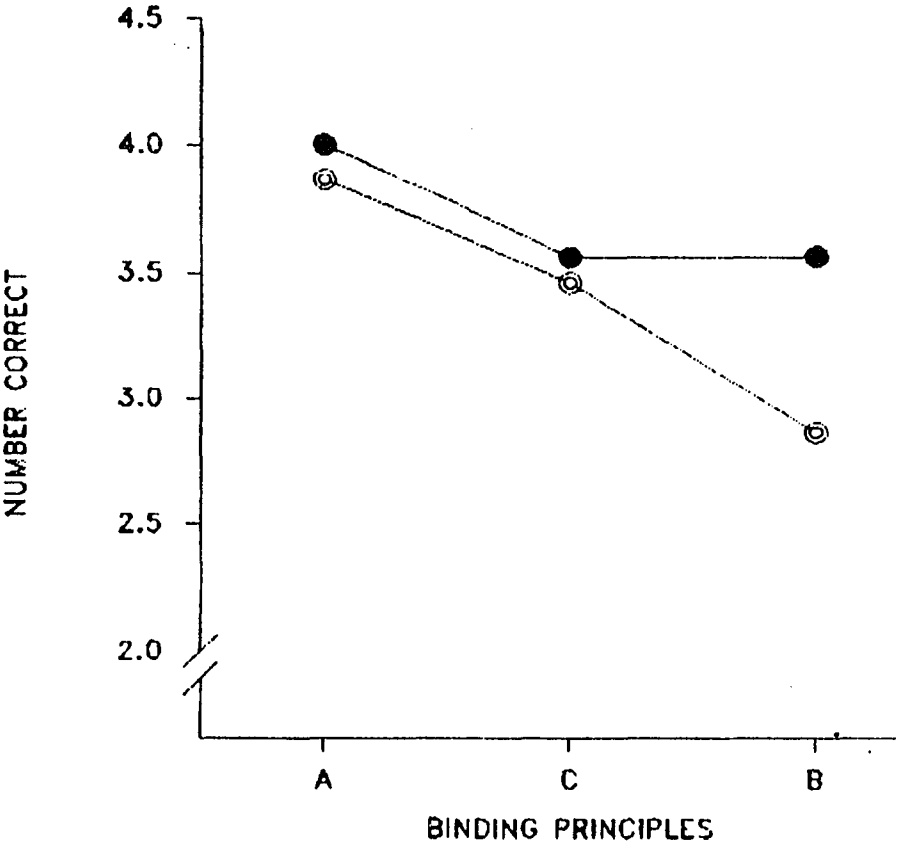


Figure 3. Performance of reading groups for complex structures of binding principles. (Maximum score = 4)

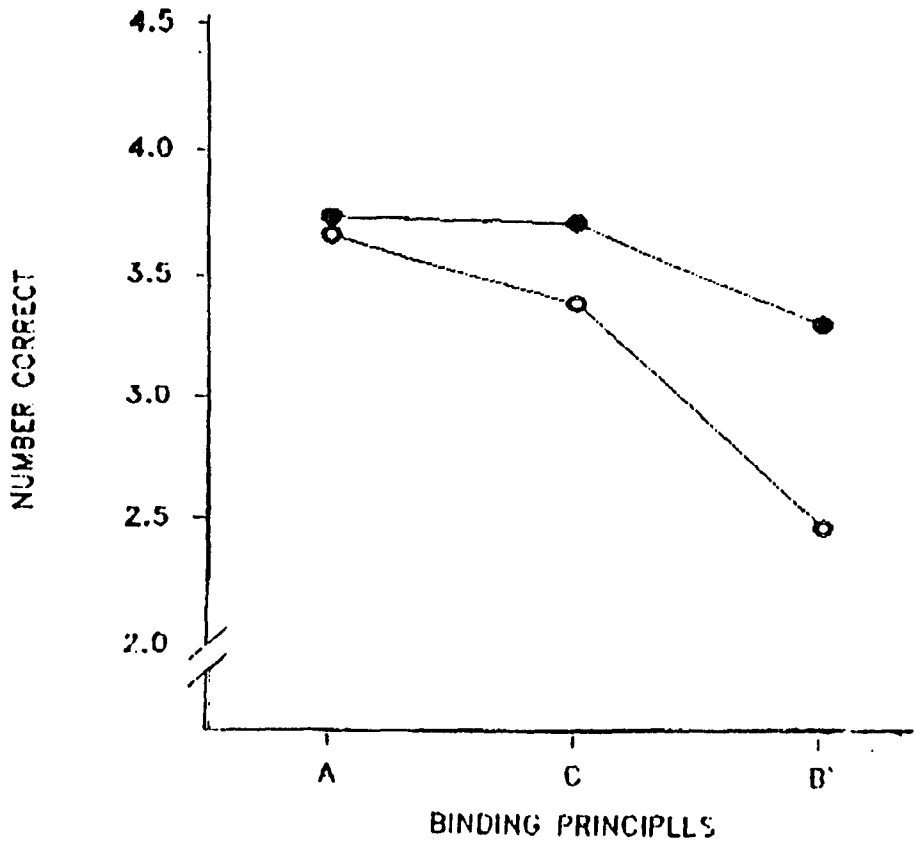


Figure 4. Performance of reading groups for combined simple and complex structures of binding principles. (Maximum = 4)

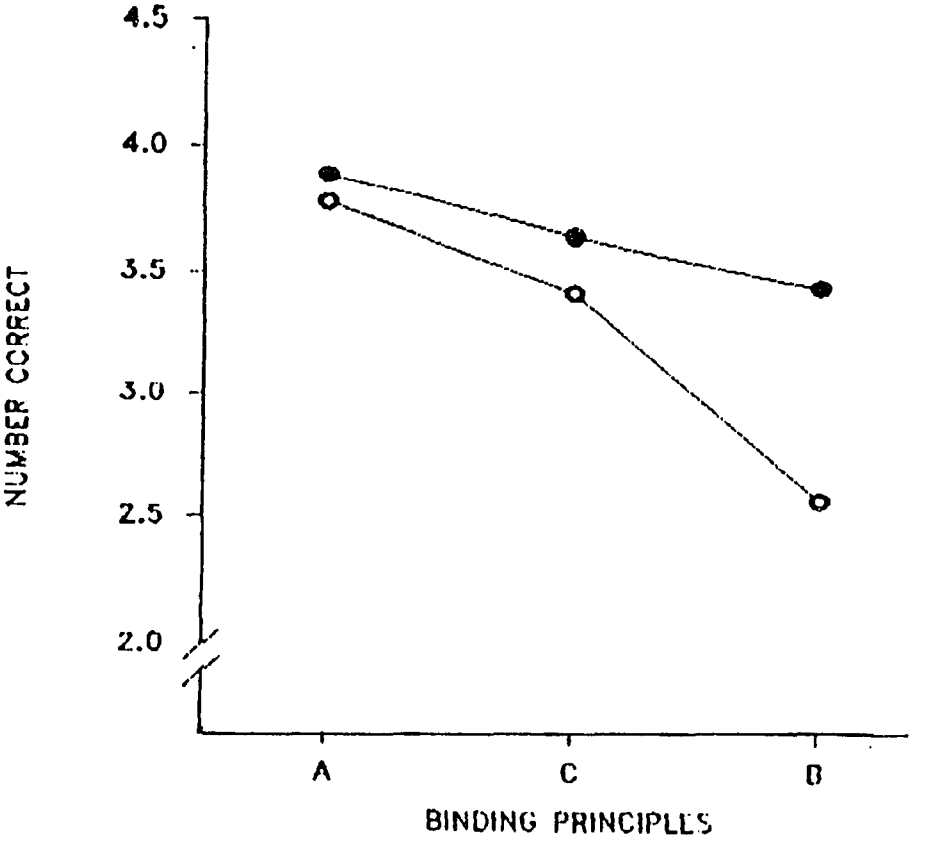


Figure 5. Scatter Plot of DST with Gramscor

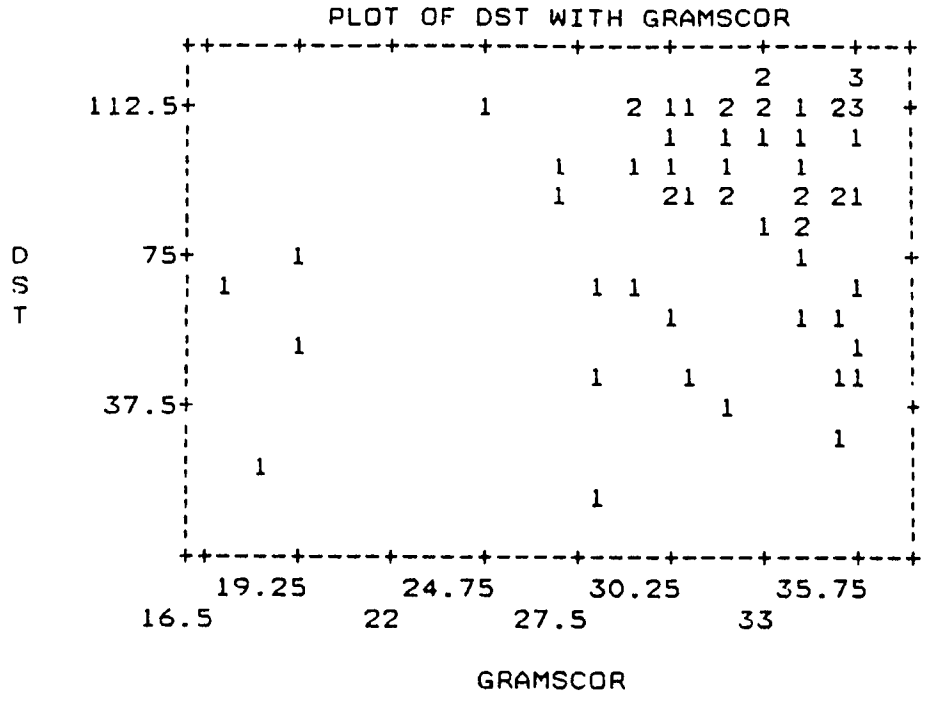


Figure 6. Scatter Plot of DST with MEM (LC-OD and RS)

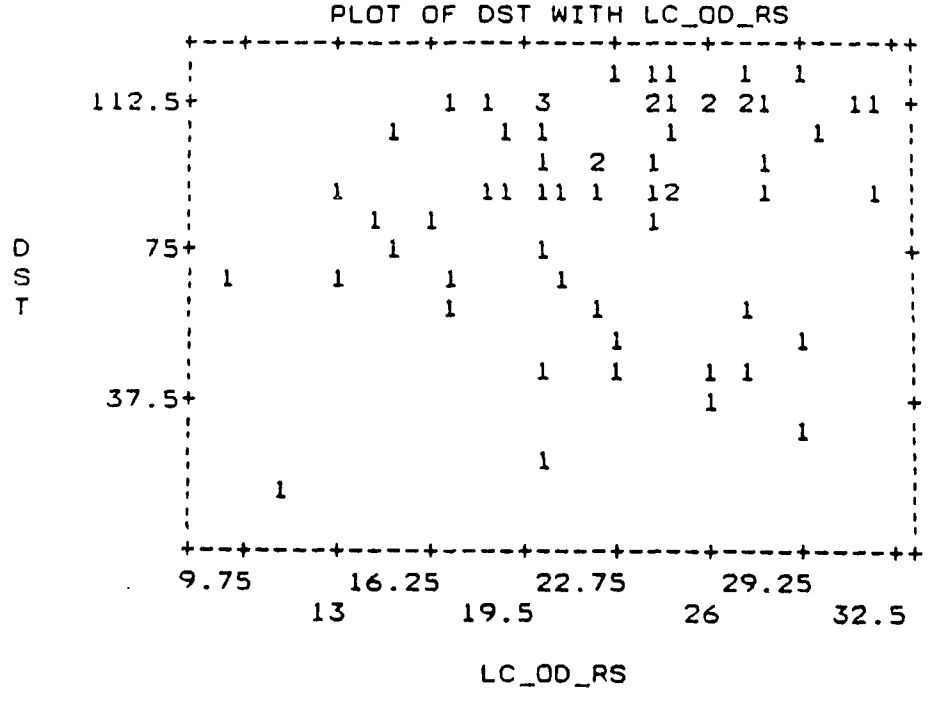
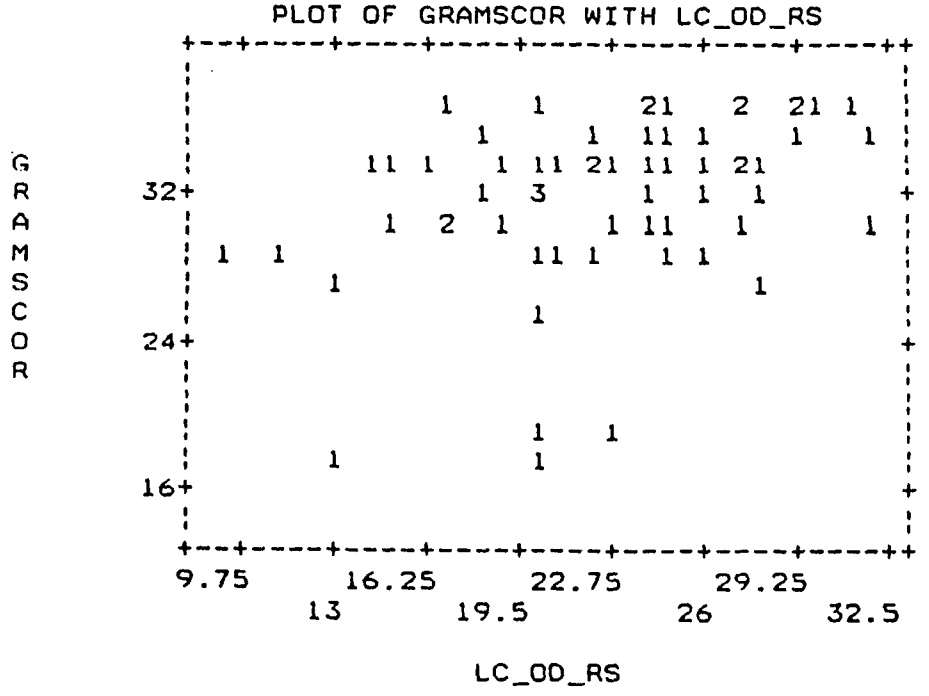


Figure 7. Scatter Plot of Gramscor with MEM (LC-OD and RS)



APPENDIX A
SUBJECT DESCRIPTION

School 1

Subj.	Age	G/EG(a)	RG(b)	DST(c)	GRAM(d)	MEM(e)	DRP(f)
01	9.4	M W	GR-1	101 (58/43)	34 (7+27)	22 (6/16)	61
02	8.10	M W	GR-1	110 (59/51)	36 (8+28)	31 (8/23)	74
03	8.3	M W	GR-1	112 (57/55)	25 (7+18)	20 (3/17)	74
04	8.5	M W	GR-1	116 (59/57)	32 (8+24)	24 (6/18)	61
05	8.7	F W	GR-1	113 (59/54)	29 (6+23)	25 (5/20)	66
06	8.9	M W	GR-1	108 (58/50)	32 (7+25)	20 (5/15)	55
07	8.10	M A	GR-1	110 (60/50)	35 (8+27)	24 (7/17)	61
08	8.11	F W	GR-1	113 (60/53)	35 (7+28)	32 (8/24)	74
09	8.4	M W	GR-1	117 (60/57)	33 (7+26)	23 (5/18)	61
10	8.6	F W	GR-1	119 (60/59)	36 (8+28)	29 (6/23)	74
11	8.10	F W	GR-1	112 (58/54)	33 (7+26)	20 (4/16)	45
12	9.0	F A	GR-1	109 (55/54)	30 (7+23)	17 (5/12)	55
13	9.2	M W	GR-2	90 (53/37)	28 (5+23)	19 (6/13)	47
14	8.8	M W	GR-2	43 (33/10)	36 (8+28)	27 (6/21)	33
15	8.6	F W	GR-2	76 (42/34)	34 (7+27)	15 (4/11)	29
16	8.5	M W	GR-2	99 (54/45)	28 (5+23)	22 (5/17)	44
17	9.0	F B	GR-2	91 (54/37)	34 (7+27)	16 (6/10)	45
18	8.3	F W	GR-2	82 (50/42)	34 (8+26)	24 (6/18)	37
19	9.0	F W	GR-2	87 (50/37)	31 (5+26)	20 (5/15)	47
20	8.7	F W	GR-2	109 (57/52)	31 (7+24)	26 (6/21)	53
21	8.5	M W	PR-3	58 (35/23)	30 (7+23)	17 (5/12)	21
22	8.10	M W	PR-3	87 (48/38)	35 (7+28)	18 (6/12)	34
23	8.10	F W	PR-3	61 (34/27)	34 (8+26)	27 (7/20)	26
24	9.0	M H	PR-3	95 (50/45)	32 (7+25)	20 (5/15)	34
25	9.0	F W	PR-3	63 (41/22)	35 (8+27)	22 (4/18)	38
26	8.1	F B	PR-3	49 (32/17)	36 (8+28)	29 (7/22)	28

27	9.0	M B	PR-3	92 (53/40)	36 (8+28)	24 (5/19)	29
28	8.4	M W	PR-3	55 (34/21)	19 (7+12)	23 (7/16)	25
29	8.2	F B	PR-4	41 (25/16)	32 (7+25)	26 (8/18)	41
30	8.10	F B	PR-4	32 (21/11)	35 (8+27)	29 (6/23)	22
31	8.6	M B	PR-4	43 (25/18)	35 (8+27)	26 (6/20)	18
32	8.3	F W	PR-4	26 (26/01)	18 (6+12)	20 (3/17)	24
33	8.5	M B	PR-4	68 (40/28)	28 (7+21)	9 (2/7)	22
34	8.11	M B	PR-4	44 (27/17)	28 (6+22)	20 (3/17)	16
35	8.9	M H	PR-4	67 (41/26)	29 (6+23)	21 (4/17)	19
36	8.10	M B	PR-4	12 (09/03)	28 (7+21)	11 (2/9)	16

School 2

Subj.	Age	G/EG(a)	RG(b)	DST(c)	GRAM(d)	MEM(e)	GE(g)
37	8.1	M W	GR	113 (58/55)	36 (8+28)	20 (6/11)	3.7
38	8.2	M W	GR	100 (54/46)	30 (8+22)	24 (7/17)	3.4
39	8.3	F W	GR	114 (60/54)	33 (8+25)	28 (4/24)	4.3
40	8.2	F W	GR	93 (53/40)	31 (6+25)	25 (7/18)	3.9
41	8.4	F B	GR	74 (40/34)	18 (5+13)	20 (4/16)	3.2
42	8.0	F W	GR	86 (50/36)	34 (8+26)	14 (3/11)	3.4
43	9.2	M W	GR	93 (46/47)	35 (8+27)	25 (6/19)	3.7
44	8.8	F W	GR	84 (51/33)	33 (7+26)	16 (5/11)	3.0
45	8.6	F W	GR	105 (55/50)	33 (8+25)	25 (5/20)	4.8
46	8.6	M W	PR	100 (53/47)	27 (6+21)	28 (5/23)	3.4
47	8.7	M W	GR	118 (60/58)	36 (8+28)	25 (6/19)	4.6
48	8.10	F W	GR	92 (53/40)	32 (7+25)	28 (5/23)	4.9
49	8.5	F W	GR	105 (57/48)	34 (7+27)	19 (6/13)	4.2
50	8.7	F W	GR	113 (59/54)	32 (7+25)	18 (4/14)	4.0
51	7.10	F W	GR	105 (58/47)	36 (8+28)	30 (6/24)	4.9
52	9.3	M W	GR	91 (53/39)	34 (8+26)	21 (5/16)	3.2
53	8.4	M W	GR	116 (59/57)	29 (8+21)	26 (4/22)	4.1

54	8.11	M	W	GR	112 (60/52)	36 (8+28)	27 (7/20)	5.0
55	9.2	F	W	GR	120 (60/60)	33 (7+26)	27 (8/19)	4.6
56	9.11	F	W	GR	92 (56/36)	30 (8+22)	32 (8/24)	3.4
57	8.1	F	W	GR	111 (56/55)	34 (8+26)	26 (7/19)	4.6
58	8.6	M	W	GR	117 (60/57)	36 (8+28)	24 (6/18)	6.4
59	8.11	F	W	PR	105 (54/51)	29 (8+21)	15 (4/11)	2.3
60	8.9	F	W	PR	69 (41/28)	36 (8+36)	17 (4/13)	3.2
61	8.8	F	W	PR	42 (30/12)	31 (5+26)	23 (4/19)	2.9
62	8.2	M	W	PR	90 (49/41)	23 (8+15)	13 (4/ 9)	2.4
63	8.2	F	W	PR	70 (41/29)	17 (8+9)	13 (4/ 9)	2.2

(a) G/EG: Gender/Ethnic Group (A = Asian; B = Black; H = Hispanic; W = White)

(b) RG: Reading Group: GR = Groups 1+2 (School 1) and Average+Above (School 2); PR = Groups 3+4 (School 1) and Below Grade Level (School 2)

(c) DST: Decoding Skills Test scores (Real Words/Nonsense Words); Total: 120 (60/60)

(d) GRAM: Grammar score: CT [Control Type (Adverbial+Complement)]+B [Binding Type (Principles A-S, Wa, Th; B-S, Th; C-S, Th)]; Total: 36 (CT = 8; B = 28)

(e) MEM: Memory Score [LC-OD (Linguistic Concepts/Oral Directions)+RS (Recalling Sentences)]; Total: 32 (LC-OD = 8; RS = 24)

(f) DRP: Degrees of Reading Power (Connecticut Mastery Test-School 1), Remedial = 32

(g) GE: Grade Equivalency Score (Iowa Test of Basic Skills), Grade.month

Summary information for Appendix A

A 1. Groups by gender and ethnic group					
		Ethnic Group			
	Gender	W	AA	A	H
Good Readers (n = 41)					
	Male (n = 18)	17	0	1	0
	Female (n = 23)	20	2	1	0
Poor Readers (n = 22)					
	Male (n = 12)	5	5	0	2
	Female (n = 10)	7	3	0	0

W: White

AA: African American

A: Asian

H: Hispanic

A 2. DST, GRAM, MEM, DRP/GE score means by school and reading group.

		DST	GRAM	MEM	DRP/GE
School/RG					
1	Good Readers (n = 20)	100.85	32.30	22.80	54.8
	Poor Readers (n = 16)	55.81	30.63	21.38	25.8
2	Good Readers (n = 21)	102.57	32.67	23.81	4.2
	Poor Readers (n = 6)	78.5	27.17	18.15	2.7

A 3. DST scores for real words and nonsense words by reading group.		
	RW	NW
Good Readers (n = 41)		
Mean	54.8	46.92
Range	33 - 60	10 - 60
Poor Readers (n = 22)		
Mean	36.68	25.54
Range	9 - 54	1 - 51
RW: real words; total possible score = 60		
NW: nonsense words; total possible score = 60		

A 4. Memory score components by reading group.		
	LC-OD	RS
Good Readers (n = 41)		
Mean	5.63	17.85
SD	1.30	3.79
Poor Readers (n = 22)		
Mean	4.73	15.77
SD	1.67	4.80
Total (n = 63)		
Mean	5.32	17.13
SD	1.49	4.25
LC-OD: Linguistic concepts-oral directions; total score = 8		
RS: Recalling sentences; total score = 24		

APPENDIX B
EXPERIMENTAL SENTENCES

Practice Sentences
P-1. Grover and Bert are playing catch. (1 correct picture choice; 2 wrong)
P-2. Grover, Cookie Monster, Bert, and Ernie are playing basketball. (1 correct; 2 wrong)
P-3. Little Sister is getting dressed for school. (2 correct; 1 wrong)
P-4. Grandmother, Mother, Little Sister, and Nancy are skating. She fell down. (3 correct)

Binding Sentences and Descriptions

Principle A:
A-S-1 Little Sister is patting herself.
A-S-2 Grover is kissing himself.
A-S-3 Sheep is touching herself.
A-S-4 Dog is drying himself.

A-that-1 Mother sees that Grandmother is scratching herself.
A-that-2 Ernie sees that Bert is bandaging himself.
A-that-3 Horse sees that Sheep is feeding herself.
A-that-4 Dog sees that Cat is washing himself.

A-wants-1 Mother wants Nancy to bandage herself.
A-wants-2 Cookie Monster wants Grover to feed himself.
A-wants-3 Sheep wants Cow to wash herself.
A-wants-4 Dog wants Rabbit to scratch himself.

Principle B:
B-S-1 Grandmother is kissing her.
B-S-2 Cookie Monster is patting him.
B-S-3 Horse is drying her.
B-S-4 Cat is touching him.

B-that-1 Little Sister sees that Mother is washing her.
B-that-2 Ernie sees that Grover is scratching him.
B-that-3 Cow sees that Pig is bandaging her.
B-that-4 Squirrel sees that Rabbit is feeding him.

Principle C:
C-S-1 She is touching Nancy.
C-S-2 He is drying Grover.
C-S-3 She is kissing Cow.
C-S-4 He is patting Squirrel

C-that-1 She tells Mother that Nancy is drawing a picture.
C-that-2 He tells Grover that Cookie Monster is eating a cookie.
C-that-3 She tells Horse that Cow is cooking dinner.
C-that-4 He tells Rabbit that Dog is raking leaves.

Descriptions:
Principle A:

A-S-1 Little Sister is patting herself.
(1) Little Sister is shown sitting on a straight back chair in the middle of the living room. One hand is on her cheek patting her face. Mother and Nancy are sitting on a couch to the right of the picture watching her.
(2) Nancy is shown sitting on a chair in the middle of the living room as described above. Little Sister is standing behind Nancy patting Nancy's Head. Mother is sitting on the couch (as described above) watching.
(3) Mother is shown sitting on a chair in the middle of the living room as described above. Little Sister is standing behind Mother patting Mother's head. Nancy is sitting on the couch (as described above) watching.

A-S-2 Grover is kissing himself.
(1) Grover is shown standing outdoors (center) kissing his paw. Cookie Monster and Bert are sitting on steps (off to the side) watching.
(2) Grover is shown kissing Cookie Monster's paw (center). Bert is sitting on steps (as above) watching.
(3) Grover is shown kissing Bert's hand (as above with a character swap). Cookie Monster is sitting on steps watching.

A-S-3 Sheep is touching herself.
(1) Sheep is shown (center stage) sitting on a chair at the kitchen table, facing forward. She is touching her hoof to her opposite arm. Cow and Pig are standing off to a side watching.
(2) Sheep and Cow are shown sitting at the kitchen table. Cow's arm is resting on the table. Sheep is touching Cow's arm. Pig is standing off to a side watching.
(3) Sheep and Pig are shown sitting at the kitchen table. Pig's arm is resting on the table. Sheep is touching Pig's arm. Cow is standing off to a side watching.

A-S-4 Dog is drying himself.
(1) Dog is shown standing outdoors in front of a large tub. He is drying himself with a towel. Squirrel and Rabbit are sitting on steps off to the side watching him.
(2) Dog and Squirrel are shown standing in front of the tub. Dog is behind Squirrel drying Squirrel's back with a towel. Rabbit is sitting on steps off to the side watching.
(3) Dog and Rabbit are shown standing in front of the tub. Dog is behind Rabbit drying rabbit's back with a towel (as above except for a character swap). Squirrel is sitting on steps off to the side watching.

A-that-1 Mother sees that Grandmother is scratching herself.
(1) Mother and Grandmother are shown in the center of the living room (side view). Grandmother's back is facing Mother. Mother is looking at Grandmother as Grandmother scratches her own back (her left arm is crossed over her back in a scratching gesture.) Grandmother faces forward. Nancy is shown to the far right of the picture sitting on a chair reading a book.
(2) Mother and Grandmother are shown standing in the center of the living room (as above with character swap). Mother's back is facing Grandmother. Mother's head is turned in order for her to watch as Grandmother scratches her back (Grandmother's arm is extended forward touching Mother's back). Nancy is depicted as described above.
(3) Grandmother and Nancy are standing in the middle of the living room (as above) with Nancy's back to Grandmother. Nancy looks forward as Grandmother scratches her back. Mother is shown watching Grandmother scratch Nancy's back.

A-that-2 Ernie sees that Bert is bandaging himself.
(1) Bert is shown sitting at the kitchen table wrapping a gauze bandage around his arm. Ernie is sitting at the table watching him. Grover is off to the side.
(2) Bert and Ernie are shown sitting at the table. Ernie looks at Bert as Bert wraps a gauze bandage around Ernie's arm. Grover is in the same position as above.
(3) Bert and Grover are shown sitting at the table (Grover is sitting where Ernie had been). Ernie is watching as Bert wraps a gauze bandage around Grover's arm.

A-that-3 Horse sees that sheep is feeding herself.
(1) Sheep is seated at the kitchen table with a plate of food placed in front of her. She is holding a fork on which there is a piece of food. Her arm is bent so that the food is almost in her open mouth. Horse is watching from the opposite side of the table. Pig is at the sink with her back to the action.
(2) Horse and Sheep are seated at the kitchen table. Sheep is holding a fork (as above) which is extended toward Horse's open mouth. Horse is looking at the food on the fork (seeing herself being fed). Pig is at the sink as described above.
(3) Sheep and Pig are at the table. Sheep is in the same seat as depicted above; Pig is where Horse had been. Horse is watching as Sheep feeds Pig (as above).

A-that-4 Dog sees that Cat is washing himself.
(1) Cat is shown in a large tub (out doors). He has a wash cloth in his hand and is washing himself. Dog is behind the tub watching the activity. Squirrel is to the right of the picture looking up at the sky with his back to the activity.
(2) Dog is shown in a large tub (as above). Cat is behind the tub with a wash cloth in his hand leaning toward Dog washing Dog's chest as Dog watches the activity. Squirrel is depicted as above.
(3) Squirrel is in the tub. Cat is behind the tub with a wash cloth in his hand leaning toward Squirrel washing Squirrel's chest as Squirrel watches. Dog is watching.

A-wants-1 Mother wants Nancy to bandage herself.
(1) Nancy is sitting on a chair along side the kitchen table. A box of bandaids is on the table. She is sitting in a manner that reveals a cut on her shin. Mother is handing Nancy a bandage while pointing to Nancy's shin. Little Sister is off to the side watching.
(2) Mother is sitting on a chair along side the kitchen table (as described above). She is sitting in a manner that reveals a cut on her shin. She is handing a bandage to Nancy while pointing to her own shin. Little Sister is off to a side watching.
(3) Little Sister is sitting on a chair along side the kitchen table (as described above). She is sitting in a manner that reveals a cut on her shin. Mother is handing a bandage to Nancy while pointing to Little Sister's shin.

A-wants-2 Cookie Monster wants Grover is feed himself.
(1) Cookie Monster and Grover are sitting at the dining room table. There is a bowl in front of Grover in which a spoon is evident. Cookie Monster is reaching across to Grover, putting Grover's paw on the spoon and pointing to Grover. Bert is at the end of the table watching.
(2) Cookie Monster and Grover are sitting at the dining room table (as described above). Cookie Monster is reaching across to Grover, putting Grover's paw on the spoon and pointing to himself. Bert is at the end of the table watching (as above).
(3) Same as above (Cookie Monster is putting Grover's paw on the spoon), however, this time Cookie Monster is looking at Grover while he is pointing to Bert.

A-wants-3 Sheep wants Cow to wash herself.
(1) Cow is in the bathtub. Sheep is in front of the tub (side view of Sheep) handing Cow a washcloth while pointing to Cow. Horse is behind the tub watching.

(2) Sheep is in the bathtub. Cow is in front of the tub (side view of Cow) looking at Sheep. Sheep is handing Cow a washcloth while pointing to herself. Horse is watching.
(3) Horse is in the tub. Sheep is in front of the tub (side view) handing Cow a washcloth while pointing to Horse.

A-wants-4 Dog wants Rabbit to scratch himself.
(1) Dog and Rabbit are shown standing out doors. Dog places Rabbit's paw (claws showing) on Rabbit's chest while pointing at Rabbit. Cat is sitting on steps watching.
(2) Dog places Rabbit's paw on Dog's chest while looking at Rabbit and pointing to himself (as above). Cat is watching.
(3) Dog places Rabbit's paw on Cat's chest while looking at Rabbit and pointing to Cat.

Principle B:

B-S-1 Grandmother is kissing her.
(1) Little Sister is crying and holding her finger while she is pointing at an iron sitting on an ironing board in the kitchen. Grandmother is kissing Little Sister's burnt finger. Nancy is standing to the side watching.
(2) Same as above except that Nancy and Little Sister swap positions. Nancy's burnt finger is being kissed by Grandmother while Little Sister watches.
(3) Grandmother is kissing her own finger while standing near the iron on the ironing board and pointing to it. Nancy and Little Sister are watching.

B-S-2 Cookie Monster is patting him.
(1) Grover and Bert are sitting at a table. Grover has a glass in his hand. Cookie Monster is standing behind him patting his back. Bert is sitting at the table eating.
(2) Grover and Bert have switched places. Cookie Monster is standing behind Bert patting his back. Grover is sitting at the table eating.
(3) Grover and Bert are sitting at the table eating . Cookie Monster is standing behind them holding a glass. His arm is extended behind him patting his own back.

B-S-3 Horse is drying her.
(1) Horse is shown (side view) standing behind Sheep out doors in front of a large tub. She is holding a towel in her hands and is using it to dry Sheep's back. Cow is watching.
(2) Horse is shown as above. Sheep and Cow have switched places. Horse is drying Cow's back. Sheep is watching.
(3) Horse is standing in front of the tub (as above). She is drying herself with a towel. Sheep and Cow are watching her.

B-S-4 Cat is touching him.
(1) Cat and Dog are sitting out doors on a bench. Cat's arm is extended across his chest with his hand reaching out so that his finger is touching Dog's arm. Rabbit is watching.
(2) Cat is shown as above. Dog and Rabbit have switched places. Cat is touching Rabbit while Dog watches.
(3) Cat is shown sitting on the bench by himself. He is touching his own arm with a finger of his opposite hand. Dog and Rabbit are watching.

B-that-1 Little Sister sees that Mother is washing her.
(1) Little sister is shown in the bathtub. Mother is kneeling along side the tub with a washcloth in her hand washing Little Sister's chest. Little Sister's eyes are focused on the washcloth and Mother (she is watching herself being washed). Nancy is looking out the window.

(2) Nancy is in the bathtub. Mother is depicted as above. Little Sister is sitting on a stool close to the tub looking at Mother wash Nancy.
(3) Mother is in the tub washing herself. Little Sister is sitting on a stool (as above) looking at Mother. Nancy is looking out of the window.

B-that-2 Ernie sees that Grover is scratching him.
(1) Grover is standing behind Bert. His arm is extended toward Bert's back and he is depicted scratching Bert's back. Bert is looking forward. Ernie is behind watching.
(2) Bert and Ernie switch positions. Grover is scratching Ernie's back. Ernie's head is turned so that he is able to watch as Grover scratches his back (his eyes are focused on Grover and his claws). Bert is sitting to the right looking ahead.
(3) Grover is standing (front view) with his paws on his chest. He is depicted in a manner that indicates that he is scratching himself. Ernie is behind and to one side looking toward Grover and Bert is on the other side.

B-that-3 Cow sees that Pig is bandaging her.
(1) Cow is standing in the bathroom in front of the sink and medicine cabinet with her arm outstretched. Cow is watching as Pig wraps a gauze bandage around her arm. Sheep is to the left of the picture.
(2) Sheep is standing in the bathroom (as described above) with her arm outstretched as Pig wraps gauze around her arm. Cow is standing nearby watching.
(3) Pig is standing in the bathroom (as described above) wrapping a bandage around her arm. Cow is standing nearby watching the activity. Sheep is looking out of the window.

B-that-4 Squirrel sees that Rabbit is feeding him.
(1) Rabbit and Cat are shown sitting at the dining room table. Rabbit has a fork in his hand (there is an obvious piece of food on the prong). His arm is extended toward Cat's open mouth. Squirrel is also seated at the table eating.
(2) Rabbit is shown as depicted above. Squirrel and Cat have changed places. The fork in Rabbit's hand is extended toward Squirrel's open mouth. Squirrel is watching as he is being fed. Cat is eating.
(3) Rabbit, Cat and Squirrel are sitting at the table (as above) eating. Rabbit is shown placing the fork in his own mouth. His eyes are fixed on the food entering his mouth.

Principle C:

C-S-1 She is touching Nancy.
(1) Mother is shown sitting on a couch next to Nancy in the center of the living room. Her finger is touching Nancy's arm. Grandmother is shown in the picture watching.
(2) Grandmother and Mother switch positions (Grandmother is on the couch touching Nancy's arm while Mother watches). The rest of the picture is as described above.
(3) Nancy is sitting on the couch. She has a finger of one hand placed on her other arm. Grandmother and Mother are standing to the right of the picture watching.

C-S-2 He is drying Grover.
(1) Grover is shown in front of a bathtub (water is dripping from him). Cookie Monster is standing next to him (side view) wiping him with a towel. Ernie is standing to the right watching.
(2) Grover is shown as above. Ernie and Cookie Monster switch positions. Ernie has the towel in his hand and is wiping Grover while Cookie Monster watches.
(3) Grover is shown standing in front of a bathtub wiping himself while Cookie Monster and Ernie watch.

C-S-3 She is kissing Cow.
(1) Cow is standing in the center of the living room. Sheep is next to her (side view) lips extended planting a kiss on her cheek. Horse is watching.
(2) Cow is shown as above. Horse and Sheep switch places (Horse is planting a kiss on Cow's cheek while Horse watches.)
(3) Cow is shown standing in the middle of the room holding her hoof up to her mouth and with lips extended is planting a kiss on her hoof. Sheep and Horse are watching.

C-S-4 He is patting Squirrel.
(1) Squirrel is shown (side view) standing in the kitchen with a glass in one hand. (He is coughing and choking on the liquid he is drinking.) Rabbit is standing behind him patting his back. Dog is watching.
(2) Squirrel is shown as above. Rabbit and Dog switch places (Dog is patting Squirrel's back as Rabbit watches).
(3) Squirrel is shown as above except that his other arm is now extended across his chest enabling him to pat his own back. Rabbit and Dog are watching.

C-that-1 She tells Mother that Nancy is drawing a picture.
(1) Nancy is sitting at the kitchen table drawing a picture (pencil in hand completing a figure on the piece of paper in front of her). Mother and Grandmother are to the right of the table. Grandmother is pointing to Nancy while facing and speaking to Mother. Little Sister is to the left of the picture watching.
(2) Nancy is depicted as shown above. Grandmother and Little Sister swap positions (Little Sister is pointing to Nancy while speaking to Mother; Grandmother is to the left watching).
(3) Nancy is depicted as above. Mother is bent over next to Nancy looking at her. Nancy is pointing to the picture with one hand, drawing with the other while looking up at Mother and speaking to her. Grandmother and Little Sister are to the left watching.

C-that-2 He tells Grover that Cookie Monster is eating a cookie.
(1) Cookie Monster is standing at the kitchen counter, in front of him is a jar of cookies. He is taking a bite out of the cookie. Bert and Grover are talking. Bert, with mouth open, is pointing to Cookie Monster. Ernie is looking out a window.
(2) Cookie Monster is depicted as above. Ernie and Bert have changed positions. Ernie is speaking to Grover as Bert looks out the window.
(3) Cookie Monster is depicted as above. Grover is standing next to him. Cookie Monster is talking to Grover while pointing to the cookie and himself. Ernie and Bert are looking out to the window.

C-that-3 She tells Horse that Cow is cooking Dinner,
(1) Cow is shown stirring a pot on the stove. Horse and Pig are to the right talking. Pig's mouth is open and she is pointing at Cow. Sheep is to a side looking out the window.
(2) Cow is depicted as above. Sheep and Pig change positions (Sheep is now speaking to Horse and pointing at Cow while Pig is off to the side).
(3) Cow is depicted as above. Horse is standing next to her. Horse and Cow are looking at one another. Cow is talking (mouth open) while pointing to herself and the pot. Sheep and Pig are off to the side.

C-that-4 He tells Rabbit that Dog is raking leaves.
(1) Dog is raking leaves into a pile. Squirrel and Rabbit are shown talking to one another (Squirrel's mouth is open). Squirrel is pointing to Dog. Cat is sitting off to the side.
(2) Dog is depicted as above. Cat and Squirrel change positions (Cat is speaking to Rabbit and pointing to Dog while Squirrel sits off to the side).

(3) Dog is depicted as above. Rabbit is standing next to him. Rabbit and Dog are looking at one another. Dog's mouth is open (talking) while he points to himself and the rake. Cat and Squirrel are sitting off to the side.

Control Sentences and Descriptions

Complement Sentences:
Comp-1 Mother tells Nancy to pick up the clothes.
Comp-2 Bert chooses Cookie Monster to bat the ball.
Comp-3 Cow picks Pig to dry the dishes.
Comp-4 Dog orders Rabbit to close the door.

Adverbial Sentences:
Adv-1 Mother patted Nancy before turning out the light.
Adv-2 Bert chased Ernie before throwing the ball.
Adv-3 Pig hugged Sheep before jumping rope.
Adv-4 Dog touched Squirrel before running under the chair.

Descriptions:

Comp-1 Mother tells Nancy to pick up the clothes.
Mother and Nancy are shown in Nancy's bedroom. Mother is looking at Nancy while pointing to a pile of clothing on the floor. Little Sister is standing to the side watching.
(1) Nancy is shown bent over the pile of clothing with several of the items in her hand. (No other characters are visible.)
(2) Mother is shown bent over the pile of clothing with several of the items in her hand as depicted above except for the character swap. (Only one character is visible.)
(3) Little Sister is shown bent over the pile of clothing with several of the items in her hand as depicted above except for the character swap. (See above description.)

Comp-2 Bert chooses Cookie Monster to bat the ball.
Bert is shown in a baseball cap and shirt which is lettered "COACH". Cookie Monster (dressed in baseball garb) is facing him. Grover, also dressed in baseball garb, is sitting on a bench near Cookie Monster facing Bert.
(1) Cookie Monster is shown in a batting stance with a bat in his hands. (No other characters.)
(2) Grover is shown in a batting stance with a bat in his hands. (No other characters.)
(3) Bert is shown in a batting stance with a bat in his hands. (No other characters.)

Comp-3 Cow picks Pig to dry the dishes.
Cow and Pig are shown standing in the kitchen. Cow (wearing an apron) is washing dishes in the sink. She is holding a dish toward Pig while pointing to her. Sheep is standing next to Pig facing toward Cow.
(1) Pig is shown drying a dish. (No other characters.)
(2) Sheep is shown drying a dish. (No other characters.)
(3) Cow is shown drying a dish. (no other characters.)

Comp-4 Dog orders Rabbit to close the door.
Dog is shown standing in the living room of a cabin type structure in which there is a fire roaring in the fireplace. The door to the cabin is open revealing a raging blizzard. Rabbit is standing near the door looking at Dog. Dog is pointing at him while looking toward the open door. Squirrel is standing near Rabbit looking at Dog.

(1) Rabbit is shown closing the door. (No other characters.)
(2) Dog is shown closing the door. (See above description.)
(3) Squirrel is shown closing the door. (See above description.)

Adv-1 Mother patted Nancy before turning out the light.
Nancy is in bed getting ready to go to sleep. There is a lamp nearby. Mother pats Nancy on the cheek. Grandmother is standing nearby.
(1) Mother turns out the light. (No one else is in the picture.)
(2) Nancy turns out the light. (No one else is in the picture.)
(3) Grandmother turns out the light. (No one else is in the picture.)

Adv-2 Bert chased Ernie before throwing the ball.
Bert chases Ernie. Cookie Monster stands nearby.
(1) Bert throws the ball. (No one else is in the picture.)
(2) Ernie throws the ball. (No one else is in the picture.)
(3) Cookie Monster throws the ball. (No one else is in the picture.)

Adv-3 Pig hugged Sheep before jumping rope.
Pig hugs Sheep. (Horse stands nearby.)
(1) Pig jumps rope. (No one else is in the picture.)
(2) Horse jumps rope. (No one else is in the picture.)
(3) Sheep jumps rope. (No one else is in the picture.)

Adv-4 Dog touched Squirrel before running under the chair.
Dog touches Squirrel. Cat is nearby.
(1) Dog is under a chair. (No one else is in the picture.)
(2) Cat is under a chair. (No one else is in the picture.)
(3) Squirrel is under a chair. (No one else is in the picture.)

Filler Sentences and Descriptions

Filler-1 At the zoo Mother bought popcorn, and Nancy and Little Sister fed the animals.
Filler-2 Cookie Monster watched, and Bert and Ernie rode a roller coaster.
Filler-3 Nancy gave Mother the pocketbook and ran out the front door.
Filler-4 Grover hid his eyes and Ernie, Bert, and Cookie Monster found a hiding place.

Descriptions:

F-1 At the zoo Mother bought popcorn, and Nancy and Little Sister fed the animals.
Mother is shown near a sign the says "Popcorn". An outstretched hand is holding a bag of popcorn.
(1) Grandmother is feeding a camel. (No one else is in the picture.)
(2) Nancy and Little Sister are on either side of a lion. Each is offering him a fish.
(3) Same as above except that Nancy and Little Sister are offering bananas to a gorilla.

F-2 Cookie Monster watched, and Bert and Ernie rode a roller coaster.
Cookie Monster is sitting on a bench along side a roller coaster.
(1) Bert and Ernie are in a roller coaster car riding past Cookie Monster.
(2) Ernie and Bert a riding bumper cars.
(3) Grover and Bert are in a roller coaster car riding past Cookie Monster.

F-3 Nancy gave Mother the pocketbook and ran out the front door.

Nancy is shown handing Mother a pocketbook.
(1) Nancy is running down the walkway away form the front door of a house.
(2) Mother is walking down the walkway as depicted above.
(3) Little Sister is running down the walkway as depicted above.

F-4 Grover hid his eyes and Ernie, Bert, and Cookie Monster found hiding places.
Grover is standing outdoors holding his hands over his eyes.
(1) Grover is shown as above. The others characters are each partially behind an object.
(2) Cookie Monster, Ernie and Bert are playing marbles.
(3) Cookie Monster, Ernie and Bert are outdoors.

APPENDIX C
SENTENCE PRESENTATION

PRACTICE					
P-1	G, CM, B and E are playing basketball.	C	F1	F2	
P-2	G and B are playing catch.	F1	C	F2	
P-3	Little Sister is getting dressed for school.	C	C	F	
P-4	This is a story about Grandma, Mommy, Nancy and Little Sister. They are skating. She fell down.	C	C	C	
GROUP I					
A-S-1	Little Sister is patting herself.	LS	M	N	
Comp-4	Dog orders Rabbit to close the door.	R	S	D	
B-th-2	Ernie sees that Grover is scratching him.	B	G	E	
C-S-3	She is kissing Cow.	P	H	C	
A-th-3	Horse sees that Sheep is feeding herself.	S	H	P	
Filler	At the zoo Mother bought popcorn and Nancy and Little Sister fed the animals.	N	Y	Y	
C-th-1	She tells Mother that Nancy is drawing a picture.	GM	LS	N	
A-wa-2	Cookie Monster wants Grover to feed himself.	G	CM	E	
Adv-3	Pig hugged Sheep before jumping rope.	S	P	H	
B-S-4	Cat is touching him.	D	C	R	
GROUP II					
A-S-2	Grover is kissing himself.	G	B	CM	
Comp-1	Mother tells Nancy to pick up the clothes.	M	N	LS	
B-th-3	Cow sees that Pig is bandaging her.	C	P	S	
C-S-4	He is patting Squirrel.	R	D	S	
A-th-4	Dog sees that Cat is washing himself.	C	S	D	
Filler	Cookie Monster watched, and Bert and Ernie rode a roller coaster.	Y	N	N	
C-th-2	He tells Grover that Cookie Monster is eating a cookie.	B	CM	E	
A-wa-3	Sheep wants Cow to wash herself.	C	S	H	
Adv-4	Dog touched Squirrel before running under the chair.	S	C	D	
B-S-1	Grandmother is kissing her.	LS	G	N	

Appendix C: Continued

GROUP 3					
A-S-3	Sheep is touching herself.	S	C	P	
Comp-2	Bert chooses Cookie Monster to bat the ball.	B	G	CM	
B-th-4	Squirrel sees that Rabbit is feeding him.	S	C	R	
C-S-1	She is touching Nancy.	G	M	N	
A-th-1	Mother sees that Grandmother is scratching herself.	M	GM	N	
Filler	Nancy gave Mother a pocketbook and ran out the front door.	Y	N	N	
C-th-3	She tells Horse that Cow is cooking dinner.	P	C	S	
A-wa-4	Dog wants Rabbit to scratch himself.	R	C	D	
Adv-1	Mother patted Nancy before turning out the light.	N	GM	M	
B-S-2	Cookie Monster is patting him.	G	E	CM	
GROUP 4					
A-S-4	Dog is drying himself.	D	S	R	
Comp-3	Cow picks Pig to dry the dishes.	P	C	S	
B-th-1	Little Sister sees that Mother is washing her.	N	LS	M	
C-S-2	He is drying Grover.	CM	G	E	
A-th-2	Ernie sees that Bert is bandaging himself.	E	G	B	
Filler	Grover hid his eyes and Ernie, Bert, and Cookie Monster found hiding places.	N	Y	N	
C-th-4	He tells Rabbit that Dog is raking leaves.	C	S	D	
A-wa-1	Mother wants Nancy to bandage herself.	M	N	LS	
Adv-2	Bert chased Ernie before throwing the ball.	B	CM	E	
B-S-3	Horse is drying her.	S	C	H	

APPENDIX D
BINDING TYPES/CONTROL TYPES ABBREVIATIONS, SENTENCE EXAMPLES AND OBEDIENCE AND VIOLATION PATTERNS

Binding Type	Abbreviation	Sentence Example
Principle A		
Principle A - Simple	(A-S)	Little Sister is patting herself. Obedience = (1) selection of the picture of Little Sister patting herself. Violation = (1) selection of Little Sister patting Mother; (2) selection of Little Sister patting Nancy
Principle A - That	(A-Th)	Mother sees that Grandmother is scratching herself. Obedience = (1) selection of picture of Mother watching while Grandmother scratches her own back Violation = (1), (2) selection of either the picture of Mother scratching Grandmother or of the outside character, Nancy, scratching Grandmother
Principle A - Want	(A-Wa)	Mother wants Nancy to bandage herself. Obedience = (1) selection of the picture of Mother handing Nancy a bandage and indicating that Nancy should bandage her own knee. Violation = (1), (2) selection of the picture of Mother bandaging Nancy or of the outside character, Little Sister, bandaging Nancy
Principle B		
Principle B - Simple	(B-S)	Grandmother is kissing her. Obedience = (1) selection of the picture of Grandmother kissing Little Sister's finger; (2) selection of the picture of Grandmother kissing Nancy's finger Violation = (1) selection of the picture of Grandmother kissing her own finger
Principle B - That	(B-Th)	Little Sister sees that Mother is washing her. Obedience = (1) selection of the picture of Mother washing Little Sister (2) selection of the picture of Mother washing Nancy Violation = (1) selection of the picture of Mother washing herself

Principle C

Principle C - Simple	(C-S)	She is touching Nancy. Obedience = (1) selection of the picture of Mother touching Nancy (2) selection of the picture of Grandmother touching Nancy Violation = (1) selection of the picture of Nancy touching herself
Principle C - That	(C-Th)	She tells Mother that Nancy is drawing a picture. Obedience = (1) selection of the picture of Grandmother talking to Mother and pointing to Nancy (2) selection of the picture of Little Sister talking to Mother and pointing to Nancy Violation = (1) selection of the picture of Nancy talking to Mother while pointing to herself

Control Type	**Abbreviation**	**Sentence Example**
Complement	(Comp)	Mother tells Nancy to pick up the clothes. Obedience = (1) selection of the picture of Nancy picking up clothes from the floor Violation = (1), (2) selection of the picture of Mother picking up clothes; and/or selection of the picture of Little Sister picking up clothes
Adverbial	(Adv)	Mother patted Nancy before turning out the light. Obedience = (1) selection of the picture of Mother turning out the light Violation = (1), (2) selection of the picture of Nancy turning out the light; and/or selection of the picture of Grandmother turning out the light

APPENDIX E
SOURCE TABLES

Source Table 1. ANOVA of DST scores by schools and reading groups.

Source	df	SS	MS	F	p	η^2
School	1	990.24	990.24	2.81	0.099	2.34%
Group	1	19095.85	19095.85	54.19	0.000	45.11%
School X Group	1	1454.21	1454.28	4.13	0.047	3.44%
*Subjects w/i School X Groups	59	20791.46	352.40			
Total		42331.76				

Source Table 2. Oneway ANOVA 36 - item grammar score by reading groups.

Source	df	SS	MS	F	p	η^2
Group	1	103.66	103.66	5.26	0.0253	7.94%
*Subjects w/i Groups	61	1202.06	19.71			
Total		1305.72				

Group: reading group (good readers; poor readers)
Grammar score (GRAM): CT [Control Type (Adverbial + Complement)] + B [Binding Type (Principles A-S, Wa, Th; B-S, Th; C-S, Th)]; Total 36 (CT = 8; B = 28)

Source Table 3. Repeated measures analysis of variance of control types by reading groups.

Source	df	SS	MS	F	p	η^2
Group	1	0.03	0.03	0.07	n.s.	
Subjects within Groups	61	24.42	0.40			
Control Type	1	12.00	12.00	27.91	0.00	19.17%
Group X Control	1	0.00	0.00	0.00	n.s.	
Control X Subjects w/i Groups	61	26.16	0.43			
Total		62.61				

Control Types: Adverbial; Complement

Source Table 4. MANOVA with planned orthogonal comparisons for reading groups (good, poor), binding type (Principles A, B, C) and complexity (simple, complex).

Source	df	SS	MS	F	p	η^2
Reading Groups	1	12.91	12.91	5.44	0.023	3.70%
*Subjects within Groups	61	144.75	2.27			
Binding Type	2	38.69	19.35	29.55	<0.001	11.08%
Contrast 1	1	34.00	34.00	51.06	<0.001	9.74%
Contrast 2	1	4.69	4.69	7.30	0.009	1.34%
Group X BT	2	9.21	4.61	7.04	0.001	2.64%
Contrast 1	1	9.04	9.04	13.58	<0.001	2.59%
Contrast 2	1	0.17	0.17	0.27	n.s.	
*BT by Subj. within Grps.	122	79.86	0.65			
Simple - Complex	1	2.43	2.43	11.45	0.001	0.70%
Grp X Simple - Complex	1	0.02	0.02	0.08	n.s.	
*S-C by Subj. within Grps.	61	12.94	0.21			
Binding X S-C	2	1.45	0.72	1.90	n.s.	
Grp X BT X S-C	2	0.37	0.18	0.48	n.s.	
*Binding by S-C by Subj. within group	122	46.51	0.38			
Total		349.19				

Contrast 1: (Binding Principle B vs. A and C)

Contrast 2: (Binding Principle A vs. C)

Source Table 5. MANOVA of the three A-types (Simple, That, Want) by reading group.						
Source	**df**	**SS**	**MS**	**F**	**p**	η^2
Group	1	1.24	1.24	1.60	n.s	
*Subjects w/i Groups	61	49.40	0.78			
A-type	2	12.03	6.01	19.59	0.001	12.00%
Contrast 1:						
(A-Wa vs A-S+A-Th)	1	10.09	10.09	27.63	0.001	10.06%
Contrast 2:						
(A-S vs A-Th)	1	1.94	1.94	7.78	0.007	1.93%
Group by A-type	2	0.14	0.20	0.67	n.s.	
*A-type by Subjects within Groups	122	37.45	0.31			
Total		100.26				

Source Table 6. ANOVA comparing reading groups (good readers, poor readers) by school (school 1, 2), reading groups by school by binding type (Principles A, B, C), and reading groups by school by binding type by complexity (simple and complex).

Source of Variation	df	SS	MS	F	Sig of F
GP	1	15.78	15.78	6.56	0.013
School	1	2.12	2.12	0.88	0.352
GP by school	1	1.96	1.96	0.82	0.370
* S wi. GP by school	59	141.73	2.40		
Binding Type	2	33.67	16.83	24.96	0.000
GP by BT	2	7.95	3.97	5.89	0.004
School by BT	2	0.36	0.13	0.19	0.825
GP by school by type	2	0.08	0.04	0.06	0.942
* S wi. GP school type	118	79.58	0.67		
SC	1	2.72	2.72	12.79	0.001
GP by SC	1	0.10	0.10	0.47	0.496
School by SC	1	0.07	0.07	0.31	0.581
GP by school by SC	1	0.41	0.41	1.91	0.172
* S wi. GP by school by SC	59	12.54	0.21		
BT by SC	2	1.40	0.70	1.78	0.172
GP by BT by SC	2	0.24	0.12	0.31	0.734
School by BT by SC	2	0.19	0.09	0.24	0.788
GP by school by BT by SC	2	0.04	0.02	0.06	0.944
* S wi. GP by school by BT by SC	118	46.25	0.39		

GP: reading groups (good readers, poor readers)

BT: binding type (Principle A, B, C)

SC: complexity (simple, complex)

APPENDIX F
DST SCORE DISTRIBUTION

DST[a]	Subj[b](RG[c] /Sch[d])	DST	Subj (RG/SCH)
120	55 (GR/2)	70	63 (PR/2)
119	10 (GR/1)	69	60 (PR/2)
118	47 (GR/2)	68	33 (PR/1)
117	09 (GR/1); 58 (GR/2)	67	35 (PR/1)
116	04 (GR/1); 53 (GR/2)	63	25 (PR/1)
114	39 (GR/1)	61	23 (PR/1)
113	05 (GR/1); 08 (GR/1); 37 (GR/2); 50 (GR/2)	58	21 (PR/1)
112	03 (GR/1); 11 (GR/1); 54 (GR/2)	55	28 (PR/1)
111	57 (GR/2)	49	26 (PR/1)
110	02 (GR/1); 07 (GR/1)	44	34 (PR/1)
109	12 (GR/1); 20 (GR/1)	43	31 (PR/1); 14 (GR/1)
108	06 (GR/1)	42	61 (PR/2)
105	45 (GR/2); 49 (GR/2); 51 (GR/2); 59 (PR/2)	41	29 (PR/1)
101	01 (GR/1)	32	30 (PR/1)
100	38 (GR/2); 46 (PR/2)	26	32 (PR/1)
99	16 (GR/1)	12	36 (PR/1)
95	24 (PR/1)		
93	40 (GR/2); 43 (GR/2)		
92	48 (GR/2); 56 (GR/2); 27 (PR/1)		
91	17 (GR/1); 52 (GR/2)		
90	13 (GR/1); 62 (PR/2)		
87	19 (GR/1); 22 (PR/1)		
86	42 (GR/2)		
84	44 (GR/2)		
82	18 (GR/1)		
76	15 (GR/1)		
74	41 (GR/2)		

[a]DST: Decoding Skills Test (maximum score = 120)
[b]Subj: Subject number (01 -36 = School 1; 37 - 63 = School 2)
[c]RG: Reading group (GR = good readers; PR = poor readers)
[d]Sch: School (1; 2)

Summary of DST score means and standard deviations and range by reading group:

	Good Readers (GR) (n=41)	Poor Readers (PR) (n=22)
Mean (SD)	101.73 (15.74)	62.23 (25.19)
Range	43-120	12-105

APPENDIX G
DRP/GE SCORE DISTRIBUTION

DRP Score[a]	Subject [b](Reading Group[c])/DST Score[d]:			
School 1				
74	02 (GR)/109;	03 (GR)/112;	08 (GR)/117;	10 (GR)/119
66	05 (GR)/113			
61	01 (GR)/101;	04 (GR)/116;	07 (GR)/111;	09 (GR)/117
55	06 (GR)/108;	12 (GR)/109		
53	20 (GR)/109			
47	13 (GR)/90;	19 (GR)/87		
45	11 (GR)/112;	17 (GR)/91		
44	16 (GR)/99			
41	29 (**PR**)/41			
38	25 (**PR**)/63			
37	18 (GR)/82			
34	22 (**PR**)/87;	24 (**PR**)/95		
33	14 (GR)/43			
29	27 (PR)/92;	15 (**GR**)/76		
28	26 (PR)/49			
26	23 (PR)/61			
25	28 (PR)/55			
24	32 (PR)/26			
22	30 (PR)/32;	33 (PR)/68		
21	21 (PR)/58			
19	35 (PR)/67			
18	31 (PR)/43			
16	34 (PR)/44;	36 (PR)/12		

[a]DRP Score: Degrees of Reading Power of the Connecticut Mastery Test; remedial level = 32
[b]Subject: Subject number (School 1 = 01 - 36)
[c]Reading Group: GR = good readers; PR = poor readers; highlighted reading group (**GR/PR**) indicates students above or below remedial standard (DRP = 32) given reading group placement.
[d]DST: Decoding Skills Test Score (maximum score = 120)

GE Score[a]	Subject[b] (Reading Group[c])/DST Score[d]			
School 2				
6.4	58(GR)/117			
5.0	54(GR)/112			
4.9	48(GR)/92;	51(GR)/105		
4.8	45(GR)/105			
4.6	47(GR)/118;	55(GR)/120;	57(GR)/111	
4.3	39(GR)/114			
4.2	49(GR)/105			
4.1	53(GR)/116			
4.0	50(GR)/113			
3.9	40(GR)/93			
3.7	37(GR)/113;	43(GR)/93		
3.4	38(GR)/100;	42(GR)/86;	56(GR)/105;	46(**PR**)/100
3.2	41(GR)/74;	52(GR)/91;	60(**PR**)/69	

Appendix G. Continued

3.0	44(GR)/84
2.9	61(PR)/42
2.4	62(PR)/90
2.3	59(PR)/105
2.2	63(PR)/70

[a]GE Score: Grade Equivalency score of the Iowa Test of Basis Skills (i.e., 3.1 = grade 3, 1 month)
[b]Subject: Subject number (School 2 = 37 - 63)
[c]Reading Group: GR = good readers; PR = poor readers; highlighted reading group (GR/PR) indicates students above or below grade level expectation (GE = minimum 3.0) given reading group placement
[d]DST: Decoding Skills Test Score (maximum score = 120)

APPENDIX H
"CROSS-OVER" SUBJECTS

Comparison of DST scores with DRP/GE scores of "cross-over" subjects.

	Subj.[a]	SCH/RG[b]	DST[c]	DRP[d]/GE[e]
Poor Readers with high DST scores (n = 6)				
	22	1/PR(3)	87	34
	24	1/PR(3)	95	34
	27	1/PR(3)	92	29
	46	2/PR	100	3.4
	59	2/PR	105	2.2
	62	2/PR	90	3.4
Good Reader with low DST score (n = 1)				
	14	1/GR(2)	43	33

[a]Subj: Subject number
[b]SCH/RG: School/reading group (School 1 sub-grouping)
[c]DST: Decoding Skills Test: maximum score = 120
[d]DRP: Degrees of Reading Power (School 1); remedial score 32
[e]GE: Grade Equivalency (School 2); grade.month

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