DEVELOPMENTAL CHANGES IN THE LINGUISTIC PERFORMANCE CORRELATES OF READING DISABILITY: AN EVALUATION OF A THEORY

By

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A current theory postulates that developmental reading disorders represent the behavioral manifestation of an underlying immaturity in the central nervous system. This immaturity is further hypothesized to delay those developmental skills underlying the acquisition of reading according to their ontogenetic sequence of development. Because the early acquisition of reading is more dependent on sensorimotor and preconceptual skills which develop ontogenetically early (e.g., visual-perceptual integration), performance patterns in younger disabled readers (age 5-7) are more likely to reflect problems along this performance dimension (Hypothesis 1). In contrast, because the later stages of reading are more dependent on verbal-conceptual skills which develop ontogenetically later, performance patterns of older disabled readers (age 10-14) are more likely to reflect problems along this performance dimension (Hypothesis 2).

A recent longitudinal study which involved retesting the same children (good and poor readers) at three different ages (5, 8, 11 years) provided some support for Hypotheses 1 and 2. However, the battery of tests failed to include measures of language processing which assessed those morphological and syntactic skills for which developmental psycholinguistics has suggested an earlier development.

Recent work on the acquisition of reading emphasized the importance of those linguistic skills for beginning and more fluent readers. However, the nature and role of these skills for reading acquisition changes with age, so that the possibility of developmental changes in the linguistic performance correlates of reading disability has important consequences for Hypothesis 2.

The present study explored the general issue of developmental changes in the linguistic correlates of reading disabilitiy in an additional test of Hypothesis 2. Along with a Peabody Picture Vocabulary Test and a Verbal Fluency Test, two measures of morphological ability and a test of syntactic comprehension were administered to disabled and nondisabled readers at three age levels (5.5, 8.5, and 11). This study represents one of the first studies of language function in potential reading disabled children at the pre-school age, a period when many linguistic skills undergo primary development. Such an assessment was possible with a two year interval for the youngest groups prior to collecting criterial information.

Results indicated (a) robust age effects across the three ages on all measures; (b) differences between reading groups on the two morphological tests and the highly correlated PPVT at all ages; and (c) between-group differences on the Syntax Test and Verbal Fluency Test only for 11-year-old children, i.e., and age X group interaction. Multivariate analyses of variance indicated a significant age X group interaction suggesting that large differences between reading groups were observed at the oldest age.

Although the results were largely compatible with Hypothesis 2, variables in addition to developmental period of acquisition (earlier vs. later) were invoked to explain the results. It was argued on the basis of this study and additional recent work that the nature of the skill (perceptual vs. linguistic) may be less important for discriminating reading level than the child's developmental readiness for meeting the task demands of reading at different ages. In this respect, the results of the present study were also compatible with models of the acquisition of reading emphasizing the greater importance of linguistically based organizational strategies for older, more fluent readers.

CHAPTER I

INTRODUCTION

The relationship of linguistic factors and reading achievement has been a topic of interest for some time. Rabinovitch (1959) was among the first to suggest a major role for language function in reading disability and argued that linguistic problems might be observed both in the oral reading and expressive language of the disabled reader. More recently, Gibson and Levin (1975) have summarized considerable research showing that language skills and their development are an important component of the beginning and more fluent stages of learning to read. However, the relationship of these linguistic skills to reading acquisition may be age-dependent. The relative importance of different linguistic skills for learning to read may change as the child develops (Doehring, 1976; Gibson & Levin, 1975). This emphasis on relating language and reading skills in normal children has paralleled the greater prominence of linguistically based explanations of reading disability (cf. Vellutino, Note 1). Unfortunately, these explanations have largely failed to address the possibility of age-dependent relationships and the problem of developmental change as a factor in reading disability.

One current theory of reading disability (Satz & Sparrow, 1970; Satz & Van Nostrand, 1973; Satz, Taylor, Friel, & Fletcher, Note 2; Fletcher & Satz, Note 3) specifically addresses the issue of developmental change. As currently stated, the theory recognizes that linguistic, perceptual, and conceptual skills are underlying components of reading disability at all ages. The relative importance of these different skills, however, changes with age according to their ontogenetic sequence of development and importance for learning to read. Because the early acquisition of reading is more dependent on sensorimotor and preconceptual skills which develop ontogenetically early (e.g., visual-perceptual integration), performance patterns in younger disabled readers (age 5-7) are more likely to reflect problems along this dimension (Hypothesis 1). In contrast, because the later stages of reading are more dependent on verbal-conceptual skills which develop ontogenetically later, performance patterns in older disabled readers are more likely to reflect problems along this performance dimension (Hypothesis 2).

A recent longitudinal study (Fletcher & Satz, Note 3) which involved retesting the same children (good and poor readers) at three different ages (5, 8, and 11 years) provided some support for Hypotheses 1 and 2. Perhaps the most serious limitation of this study stems from its choice of language measures (cf. Jansky, Note 4). For example, assessment of those syntactic and morphological skills for which developmental psycholinguistics has suggested an earlier

development (Bloom, 1975; Dale, 1976) was not made. In view of the role of cognitive organizational strategies based on these linguistic skills for beginning and fluent readers (Gibson & Levin, 1975; Smith, 1971), the acquisition of earlier developing linguistic skills in younger disabled readers has important consequences for Hypothesis 2.

The present review will focus primarily on the relationship of developing linguistic skills to the reading process, learning to read, and reading failure. Within the context of Hypothesis 2, particular emphasis will be placed on developmental changes in the linguistic performance correlates of disabled readers. Evidence for age-dependent relationships will be examined in each of three aspects of linguistic performance: the phonological, syntactic, and semantic components of language (Langacker, 1968). Each component will be viewed as a set of rules and strategies for information processing in language, reading, and memory. The phonological component, therefore, will be viewed as a set of rules and strategies learned during language development concerning linguistic sounds and their relationship to obtaining meaning from written and spoken language. The syntactic component will be viewed as a set of rules and strategies for forming acceptable words and word sequences (sentences). Syntactic skills are important for organizing larger units of oral and written language. The semantic component will be viewed as a set of rules and strategies

directly concerned with the meaning of oral and written language. In the present context, word meaning, word access, and the more general division of conceptual experience by language are all pertinent to the semantic component (Langacker, 1968).

For reading acquisition, Gibson (1971) and Gibson and Levin (1975) have argued that the fundamental unit of processing is the word. Words are composed of and constrained by a variety of distinctive features: graphic, phonological, syntactic, and semantic. Processing words in reading involves simultaneous perception along all these dimensions. These constraints form patterns of invariance (redundancy) and a major portion of the development of perception in reading consists of learning strategies for handling increasingly large units of information (Gibson, 1970). However, developmental changes in the acquisition and use of these processing skills during reading acquisition are often observed. These changes involve differences in rate of acquisition, extent of maturation, and the relative importance of these skills for different reading stages. Doehring (1976) evaluated this theory in a study of the acquisition of a number of the rapid visual processing skills involved in learning to read along these dimensions. Graphic and phonological constraints were more important for the rapid visual processing of letters, syllables, and words, characteristic of the earlier stages of reading acquisition. Later stages were characterized by the use of strategies based on semantic and

syntactic constraints for processing units of information larger than the word.

As this digression on reading theory shows, chronological age, the characteristics of language, and language development are all intrinsic to the prolonged process of learning to read. For this review each of these language components will be examined separately. Brief statements concerning the development of these aspects of linguistic performance and their general relationship to the reading process will introduce each section. The major portion of each section will be devoted to research findings with disabled readers. Whenever possible, the possibility of age-dependent relationships and developmental changes in the linguistic performance correlates of reading disability (Hypothesis 2) will be explored. However, as the present review will show, this question is difficult to address on the basis of current research findings. The difficulty stems from multiple methodological and theoretical sources, not the least of which is the general lack of concern for developmental phenomena in the area of childhood reading disorders (cf. Fletcher & Satz, Note 3; Note 5). In fact, age is often either a poorly manipulated or confounded independent variable. Torgeson (1975) underscored the importance of appropriately manipulating the age variable by stating that "studies using subjects at one age may identify deficits associated with reading disability which are different from those found at another age " (p. 421). Perhaps more importantly, confounding the age variable by including children

from several age levels may obscure the relationship between the dependent variable and reading achievement. The present review will emphasize methodological factors only where they are pertinent to the discussion. Major emphasis will be placed on integrating a set of confusing and disparate findings with general theories of language and reading acquisition in an effort to clarify the relationship between age and linguistic skills in disabled readers. An attempt will be made to show that there are age-dependent relationships between language and reading failure. This relationship, however, varies according to the nature of the linguistic variable, its ontogenetic sequence of development (earlier vs. later), and relative importance for reading acquisition.

CHAPTER II

REVIEW OF THE LITERATURE

Phonological Component

Phonological development. As Palermo and Molfese (1972) noted, the literature on developmental phonology is in stark contrast to the relatively advanced state of phonological theory. What is known indicates that five year old children have acquired and can distinguish the majority of the sounds composing their language (Gibson & Levin, 1975). Some advances, particularly in the articulation of certain sound combinations, remain to be made, but even these relatively difficult blends are generally mastered by age 8 (Palermo & Molfese, 1972).

Phonology and reading. Phonological skills are quite important for the initial phases of learning to read. Somehow the child must bring to the task of learning to read the knowledge of language accumulated over his first five years. In this respect, the child must break the written code of language and be able to pronounce and identify individual words (Gibson & Levin, 1975; Golinkoff, 1975-1976). This initial decoding process may be a necessary prerequisite for future advances in reading comprehension.

Breaking the written code of language requires the acquisition of a number of skills and strategies, including visual-discrimination skills and different types of auditory-

mediational strategies (cf. Doehring, 1976; Gibson & Levin, 1975). These latter strategies pertain to the pronounciation of written words, the more complex process of decomposing sounds to their distinctive segments, and the use of intraword redundancies for higher level processing (Gibson & Levin, 1975). Doehring (1976) showed that early in the reading process, skills for processing strings of letters and words seem to require speech mediation. The influence of these mediational skills, however, diminished as the reader progressed. Mature readers appear to be able to directly assess meaning without associating print and speech (Bradshaw, 1975). These stages may be mediated by the use of higher order linguistic relationships (Doehring, 1976; Smith, 1971).

Early stages of reading require different types of linguistic skills and strategies. In establishing the link between oral and written language necessary for early decoding, the child must acquire different auditory-mediational strategies which reflect his understanding of the acoustic structure of speech. However, neither the auditory-mediational skills (nor the visual discrimination skills) underlying the early decoding phases of reading are mastered by children when they begin to read. Although the basic framework has been acquired, the transfer of these skills to the task of reading requires new learning which generally persists until age 8 (Gibson & Levin, 1975). Problems with either visual discrimination or acoustic mediational skills could hamper the child's early ability to deal with the graphic features of written language and master decoding.

It is interesting to note that linguistic skills which the child has already acquired may transfer more directly to the reading process. Both Weber (1970) and Biemuller (1970-1971) compared the oral reading errors of first grade children. Weber found that these errors generally conformed to grammatical constraints (syntactic and semantic) provided by prior grammatical context. Thus, early readers applied their knowledge of language to the new problem of word identification. More importantly, Weber (1970) and Biemuller (1970-1971) found no differences between good and poor readers (first grade) in the number or type of these contextual errors. In terms of correcting these errors, however, good readers were distinctly superior (Weber, 1970). Biemuller (1970-1971) described three stages in the initial process of learning to read. The first phase was characterized by an emphasis on use of contextual information. In the second phase an increase in the number of graphically constrained errors was observed, while the third phase was marked by a co-occurrence of contextual and graphically constrained errors. Most important, however, was Biemuller's finding that the early reader's ability to use graphic information for word identification differentiated good and poor achievers. In other words, group differences emerged on the level of individual words and did not necessarily reflect the use of higher order linguistic relationships.

Difficulties with visual discrimination skills and auditory mediational phonetic segmentation skills concerning the

child's knowledge of the acoustic structure of speech could hamper the early reader's ability to deal with the graphic features processed during decoding. These auditory skills may reflect both earlier developing phonetic segmentation abilities and later developing skills for processing intraword redundancies. Three types of studies regarding the disabled reader's phonetic segmentation skills will be reviewed, along with additional research on rapid naming skills and later developing decoding skills.

Phonetic segmentation skills. Most of the research on phonetic segmentation stems from work by Liberman and Shankweiler (cf. Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977). This work is based on the "assumption that reading is somehow parasitic on speech.... In order to learn to read, the child must map the written word to the spoken word. . .in order to do this, he must have some recognition of the phonetic structure of his spoken language" (Liberman & Shankweiler, 1976, p. 2). In this quotation the direct role of auditory mediational factors for bridging the gap between spoken and written language can be observed. Liberman, Shankweiler, and associates have investigated three aspects of this relationship as it pertains to reading achievement: (1) awareness of phonetic segments; (2) phonetic representations in short-term memory; and (3) oral reading errors.

Awareness of phonetic segmentation. The importance of phonetic segmentation is illustrated by the fact that because the syllable, not the phoneme, is the minimal unit of articulation, learning to read by sounding letters one by one is

impossible. Rather, reading analytically implies the discovery of how letter segments (sounds) can be simultaneously blended to arrive at the correct phonetic representation of each syllable. Therefore, knowing how many phonemic segments form a unit of articulation is vital to relating speech and written language (Liberman et al., 1977).

These phonemic segmentation skills do not come naturally to the child. Liberman, Shankweiler, Fischer, and Carter (1974) explored the ability of four, five, and six year olds (prekindergarten to Grade 1) to identify the number of phonetic and syllabic segments in spoken utterances. The task used required the child to tap a wooden mallet for each of the segments in a list of test utterances. At age 4, no children could identify phonemic segments, while half could identify syllabic segments. At age 6, however, 70 percent could identify phonemic segments and 90 percent could identify syllabic segmentation. In summarizing this area, Gibson and Levin (1975) suggested that phonemic segmentation skills were not fully acquired until age 8.

Using their first grade sample, Liberman et al. (1977) also contrasted good and poor readers on their segmentation skills about four months after initial testing (beginning of Grade 2). Half of the children in the lowest third of the reading achievement distribution had failed the phonetic segmentation task, while all of the top third of the distribution had passed the task.

More rigourous investigations have strengthened the relationship of phonetic segmentation skills and early read-

ing achievement. Helfgott (1976) measured segmentation and blending skills in kindergarten children in an attempt to predict first grade reading achievement. Segmentation of spoken CVC words in kindergarten correlated at .75 with the first grade word recognition subtest of the Wide Range Achievement Test. Zifcak (1976) found a significant correlational relationship between phonetic segmentation on the dowel tapping task (described earlier) and reading achievement in first grade Ss. Treiman (Note 6), in a study of first and second grade inner city children (largely blacks) also found a high correlation between phonetic segmentation (measured by a variation of the tapping task) and reading ability. These results, on diverse samples with different criterion reading measures, suggest that the child's ability to decompose linguistic units into phonetic segments has a high relationship with early reading achievement.

Phonetic recoding. A second set of studies concerns phonetic recoding in short term memory. These studies are predicated on the assumption that before longer segments of speech (and reading) can be processed, a temporary acoustic store must be established. This acoustic store takes the form of a phonetic representation. Therefore, if poor readers have trouble forming phonetic representations of language, as indicated by the segmentation studies, differences between good and poor readers should be observed in the amount of phonetic coding used for short term memory tasks (Liberman & Shankweiler, 1976).

Experiments pertaining to this hypothesis were summarized by Liberman and Shankweiler (1976). Two experiments (Liberman et al., 1977; Shankweiler & Liberman, 1976) compared recall of phonetically confusable (rhyming) and nonconfusable (nonrhyming) strings of letters in second grade reading groups. Results from both studies indicated that regardless of presentation modality, the interference effect of confusable stimuli was more apparent for good readers than poor readers. No disruptive effects were observed on nonconfusable stimuli for either reading group. Thus, tasks requiring a phonetic strategy had a greater disruptive effect on recall in good readers than poor readers, indicating more consistent application of phonetic recoding strategies in the good reader group.

A more rigorous experiment (Mark, 1977) gave beginning readers (age unspecified) a list of 28 words to be read aloud, followed by a recognition list containing the original words and 28 new distractor words. Half the distractors were phonetically confusable but visually dissimilar from an original test word. The other 14 words were not confusable, i.e., didn't rhyme. Again, the inference effect of confusability for recall was more pronounced in good than poor readers.

Oral reading errors. The third approach to early phonetic encoding is based on research attempts attempting phonetic analysis of reading errors made by second grade (and older) disabled and nondisabled readers. Shankweiler and Liberman (1972) found a distinct pattern of oral reading errors showing

that errors on the final consonant of a CVC syllable were twice those on the initial consonant, while medial vowel errors exceeded both possible consonant errors. In other words, more errors were observed on medial vowel and final position consonants. These results were interpreted as revealing incomplete understanding of the phonological segments of language in these Ss. When scanning from left to right a child with incomplete phonological awareness will search for any lexical word beginning with the initial sound. As such, later errors later in the word would be more frequent because the child failed to process the remainder of the word. These interpretations were buttressed by a recent phonemic analysis of the oral reading errors of second, third, and fourth grade readers (Fowler, Liberman, & Shankweiler, 1976). Although the number of errors decreased with increased age, the error pattern remained the same.

These latter studies have led Liberman and Shankweiler (1976) to argue against visual perceptual problems in explaining these observed error patterns, largely because of the difference in vowel and consonant errors is difficult to explain in terms of distinctive features (physical shapes, etc.) of letters. The absence of errors (e.g., reversals) presumably reflecting perceptual anomalies is also cited as substantiating this argument. Liberman and Shankweiler (1976) concluded that the problems of beginning and disabled readers reflect phonetic segmentation difficulties as opposed to visual-perceptual difficulties. It should be noted, however, that both the oral reading error and the phonetic recoding

studies which support this hypothesis are based on null (not negative) data obtained from relatively older (second grade and above) readers, an age where visual-perceptual problems are expected to be less prominent (Benton, 1962; Fletcher & Satz, Note 3; Note 5). Therefore, while the present series of studies provides strong support for the role of phonological factors in early reading, sweeping generalizations regarding other types of skills are inappropriate because of the restricted age range.

Rapid automatized naming. Another source can be probed for evidence of developmental changes in the linguistic skills underlying decoding differences between reading groups. These studies concern speed of digit and object naming in good and poor readers at several age levels. Spring (1975) attempted to predict first grade reading achievement (N = 44) with a simple measure of digit naming speed. After a five month follow-up, a correlation of .53 between digit naming speed and reading achievement was found. In the large scale longitudinal-predictive study of Jansky and deHirsch (1972), a picture naming test was among the best kindergarten predictors of Grade 2 reading ability, also correlating at .53. Similar results were reported by Lindgren (1975) in a one year follow-up.

With relatively older readers, Spring and Capps (1974) and Spring (1976) examined speech of digit, color, and picture naming in small smaples of poor readers (N = 24) and good readers (N = 24) from seven to 13 years of age. Overall results indicated that disabled readers named more slowly than good

readers across the age range. Denckla and Rudel (1976a) measured performance on several naming tasks in a large sample of reading disabled, minimally brain damaged, and normal Ss at four age levels: 7.5, 8.5, 9.5, and 11.5. Age related group differences were found on all tasks, with a strong trend towards an Age X Group interaction. The nature of this trend, however, was not clear in this study. As opposed to indicating that "dyslexic" children are "dysphasic" as implied by this study and Denckla and Rudel (1976b), these findings are consistent with a model which attributes reduced naming speed to slower phonological coding in disabled readers (Spring & Farmer, 1975). Except for the Denckla and Rudel (1976a) study, these studies provide only moderate evidence for age-dependent relationships in naming tasks. The high correlations with early reading achievement (Jansky & deHirsch, 1972; Lindgren, 1975; Spring, 1975) are intriguing. Again, problems with task definition make it difficult to specify the relationship of these tasks to reading and its underlying components.

Later decoding skills. The preceding studies illustrated the role of speech perception, especially phonological mediation, for the decoding process in early reading. High correlations with reading achievement were obtained, along with group differences between good and poor readers. The importance of these phonological factors is for the early learning of word structures which is facilitated by the child's knowledge of the acoustic structure of speech. Decoding in the intermediate and older ages, however, reflects the use of some higher order intraword relationships. In this respect, factors such as

pronounceability, orthographic structures (e.g., spelling patterns), and other intraword structures are important components of decoding strategies. These intraword structures compose different sources of redundancy which enable the learning reader to efficiently process increasingly large units of information. For earlier phases of reading lower level analyses, e.g., sequential letter recognition and spelling-sound correspondences may characterize decoding strategies. With age and experience, higher levels of analysis including the use of orthographic structure for identifying clusters of letters, become more characteristic (Doehring, 1976).

An earlier developing source of intraword redundancy is letter-sound correspondence. Calfee, Venezky, and Chapman (1969) explored the relationship of the child's knowledge of letter-sound correspondences with reading achievement. Snythetic words incorporating regular and irregular letter-sound patterns were presented for pronounciation to good and poor readers in third grade, fifth grade, high school, and college. Correlations between pronounciation and reading achievement were highest in third graders, decreasing substantially after that age as variables such as IQ accounted for much more of the variability in reading achievement. Differences between good and poor readers were larger at the third grade level, decreasing with age except on more complex patterns. A subsequent study (Venezky & Johnson, 1973) gave similar synthetic words to first,

second,and third grade reading groups. Correlations with reading comprehension were at .77 for first grade readers, dropping to .63 for third grade readers.

In these studies the use of letter-sound correspondences for pronouncing pseudowords is correlated with reading achievement in Grades 1-3, diminishing after this age. Whether this relationship reflects phonological or orthographic sources of redundancy is unclear. Tasks which don't require pronunciation show that the use of spelling patterns for word identification emerges after Grade 2 (Gibson & Levin, 1975). Rosinski and Wheeler (1972) showed that third and fifth graders could use spelling patterns to discriminate the closeness of nonsense words to real words. First grader performance was at the chance level. A reaction time study (Santa, 1976-1977) compared first, second, and fifth grade children and adults in the rapid visual recognition of different linguistic units: single letters, initial and final letter clusters, and whole words. Fifth graders and adults were faster processors for all these units. First graders processed single letters most rapidly, while second graders processed initial letter clusters as rapidly as single letters.

Developmental changes in the use of intraword structures can also be described for groups differing in reading ability. Calfee et al. (1969) and Venezky and Johnson (1973) found larger correlations with reading comprehension in younger reading groups (Grades 1 and 3) than older reading groups

Grade 6) on the ability to use letter-sound correspondences for word recognition. Santa (1976-1977) showed that poor second grade readers were attempting to process different units of information with a sequential letter strategy, while achieving second graders were using strategies based on higher order units of information.

Katz and Wicklund (1972) found no differences in search time for single letters embedded in random letter strings between good and poor readers in Grades 2 and 6.

However, good and poor first grade readers may differ on the use of strategies based on single letter cues for word identification. Rayner and Hagelberg (1975) compared strategies based on letter shapes and whole word shapes in kindergarten and good and poor first grade readers. Results indicated that poor first grade readers employed strategies based on initial letter shape less consistently than their same aged counterparts, though both reading groups preferred letter shape (and not word shape) as a word-recognition cue. Expanding this study to the sixth grade, Rayner (1976) revealed that the first letter strategy was important until Grade 4, at which time whole word shape became the more important cue. Although good and poor readers were not employed in this study, Rayner and Kaiser (1975) compared sixth grade reading groups for reading text mutilated by altering first and last target letters. Good readers were better at identifying the mutilated word irrespective of the location of the mutilation.

Some studies have explored the use of more complex sources of intraword redundancy. In a variant of the Katz and Wicklund (1972) study, Mason (1975) found differences between good and poor sixth grade readers in single letter search time when the letters were embedded in highly redundant strings. Mason, Katz, and Wicklund (1975) showed that this improvement also reflected differences between reader groups for remembering spatial order. Katz and Wicklund (1971) found no differences in the ability of fifth grade reading groups to identify target words embedded within grammatical and nongrammatical sentences, with grammatically facilitating identification for both groups. In contrast, Samuels, Begy, and Chen (1975-1976), comparing fourth grade reading groups, showed that good readers identified words faster when the target words were embedded within contextual (and orthographic) sources of redundancy. This finding was apparent when the groups were equated on visual word recognition ability.

Two major points can be made on the basis of this research on the use of intraword structure for decoding. The first is that strategies based on higher order intraword redundancies characterize later stages of decoding (Doehring, 1976; Mason, 1975; Rayner, 1976). This point shows that the size, if not the nature, of the linguistic unit processed changes as the child develops. The second point is that reading group differences may be age-dependent. For example, while Katz and Wicklund (1972) found no differences in the ability of second and sixth grade reading groups to recog-

nize single letters, Rayner and Hagelberg (1975) found differences in first grade reading groups use of initial letter shape as a word-recognition cue. Although the tasks are different, chronological age may be one variable underlying the results in these studies.

It should be noted, however, that deficits on earlier developing skills underlying decoding strategies seem to persist in disabled readers throughout development. For example, Calfee, Lindamood, and Lindamood (1973) measured performance of kindergarten through twelfth grade Ss on a three subtests of the Lindamood Auditory Conceptualization Test, a variation on phonetic segmentation, as a function of reader ability. On the easier task the largest differences emerged between kindergarten achievement groups, with differences persisting until Grade 4. The two more difficult tasks may have been too difficult for Ss prior to Grade 2, at which point large differences between achievement groups up to Grade 10 were obtained.*

Studies examining general decoding skills in relatively older poor readers also found deficits. Perfetti and Hogaboam (1975) measured oral response latencies to tachistoscopically presented pseudoword stimuli. Reaction time differences were observed between both third and fifth grade reading groups. Similar results were reported by Vellutino, Smith, Steger, and Kaman (1975) for second and sixth grade reader groups for the simple pronunciation of visually

*Good readers in this study did not fully master these tasks even at the high school level.

presented words. More specific studies of decoding ability and access of single word meanings show that relatively older reading groups defined on the basis of comprehension scores still differ on decoding skills. Golinkoff and Rosinski (1976) found both third and fifth grade poor readers to have longer latencies than their respective controls for identifying visually presented trigrams. Pace and Golinkoff (1976) extended this finding to more difficult real words. Interestingly, in this latter study, the difference was larger between third grade than fifth grade reading groups.

One common aspect of all the studies cited as evidence for later decoding problems concerns task requirements for pronounciation of visually presented stimuli. This may reflect a confounding because the pronounciation responses also required "reading" by the disabled readers. A variety of factors underlie reading disorders, so that conclusions are confounded by these task requirements. Age-dependent relationships between reading groups on the use of intraword structure are more apparent when a pronounciation response is not required (Rosinski & Wheeler, 1972; Santa, 1976-1977). Moreover, deficits in the use of later developing higher order intraword sources of redundancy can be described, which could also explain the persistence of these deficits. These examples illustrate some of the problems with task definition that make interpretation of many of these studies difficult (Doehring, Note 7).

Summary. The studies reviewed under the phonological section provide several sources of evidence for developmental

changes in the linguistic performance correlates of reading achievement. The first source concerns the high correlational relationship of performance on phonetic segmentation tasks (Liberman et al., 1977) and naming speed tasks (Jansky & deHirsch, 1972; Spring, 1975) with reading achievement. The second source reflects the tendency for group differences to diminish with increased age on phonetic segmentation tasks (Liberman et al., 1977) and oral reading phonemic error patterns (Liberman & Shankweiler, 1976). The third source concerns larger group differences between relatively older reading groups in the ability to use later developing higher-order intraword redundancies (Mason, 1975; Rayner, 1976; Rosinski & Wheeler, 1972). In general, group differences appear to reflect (a) the size of the linguistic unit processed (b) the importance of the linguistic unit for the reading process, (c) the extent to which auditory mediational factors are involved in processing the linguistic unit, and (d) the unit's ontogenetic sequence of development.

It should be noted that decoding problems, no matter what the source, may characterize poor readers throughout development. This factor may help to explain the persistence of reading problems into adolescence and adulthood (cf. Satz et al., Note 2). As normal children progress in learning to read, many decoding processes become automatized (LaBerge & Samuels, 1974). When processing reaches an automatic level, attention can be devoted to other elements of the reading process. In fluent readers, comprehension is hindered by over-reliance on decoding strategies. Many poor readers,

however, never seem to progress beyond the decoding level of reading acquisition into a higher level comprehension stage (Golinkoff, 1975-1976). They seem less able to minimize their reliance on visual and auditory cues, the "mechanics" of reading, so that more attention can be focuesd on the direct extraction of meaning, i.e., comprehension. Perhaps more importantly, these strategies may not constitute a useful reading strategy for poor readers. Even relatively older readers don't seem to master the basic strategies underlying decoding. Kolers (1975) compared the ability of seventh grade (age 10-14.5) good and poor readers on tasks permitting separation of graphemic and semantic constituents of text. The results indicated that even at this later age good readers were more sensitive to variations in complex sources of graphemic structure (typography) than poor readers.

Several hypotheses concerning the inability of at least some poor readers to master decoding can be provided. The first hypothesis postulates a basic deficit in acquiring the skills underlying decoding (Kolers, 1975; Vellutino, Note 1). However, the evidence for developmental changes in the skills underlying decoding strategies is inconsistent with this hypothesis. A second hypothesis suggests that later comprehension processes are dependent on the acquisition of earlier developing decoding skills (Farnham-Diggory & Gregg, 1976; Golinkoff, 1975-1976). If decoding skills do not reach an automatic level, then higher order comprehension processing cannot be obtained and poor readers have no alternative to their poorly learned decoding skills. Both hypotheses are

supported by the persistence of decoding problems throughout development in poor readers. A third and different hypothesis suggests that different factors underlie the failure to acquire early decoding and later comprehension processes. Under this hypothesis, poor readers continue to rely on inadequate decoding skills because they fail to acquire later developing skills necessary for comprehension. Additional information on this latter hypothesis will accrue from the next two sections, which concern more directly comprehension strategies and processes.

Syntactic Component

Acquisition of syntax. Syntactic development is the most thoroughly analyzed aspect of language acquisition. The acquisition of the different structures and rules composing the syntactic component of language begins at an early age (Bloom, 1975; Brown, 1973). Once begun, development is quite rapid. Earlier studies of syntactic development employed longitudinal-naturalistic observation of very young (ages 1.5 to 3) children and analyzed oral samples of speech for the presence of different syntactic structures (cf. Bloom, 1975; Brown, 1973). It was apparent in these earlier studies that children knew quite a bit about the grammar of their language, which led some authors (McNeill, 1970) to argue that syntactic development was complete prior to age 5. Subsequent experimental investigations (Chomsky, 1969; Kessell, 1970; Scholes, Tanis, & Turner, 1977) showed that the acquisition of some more complex syntactic structures proceeds much later into development. Palermo and Molfese (1972) interpreted these data as

indicating major advances in language development between ages 5-7 and 11-14. Despite this interpretation, it is evident that the major portion of the acquisition of syntax is complete around the child's fifth year.

Organizational constraints and reading. The role of higher order linguistic skills for reading (and language and memory) is for the organization and extraction of written information in units larger than the single word (Gibson & Levin, 1975; Smith, 1971). For example, syntactic rules can be viewed as a system of constraints which increase the redundancy in a string of words. By developing strategies for processing these redundant units, fluent readers can handle larger units of information. This processing reduces the load on short term memory and enables more efficient extraction of information from text (Gibson & Levin, 1975; Smith, 1971). The greater organization of input provided by the application of these higher order linguistic strategies greatly facilitates comprehension. The present section of this review focuses almost exclusively on comprehension, not decoding.

The influence of grammatical constraints on the extraction of information can be demonstrated in a variety of contexts. The large number of studies on eye-voice span (summarized by Gibson & Levin, 1975) show that older readers are progressively sensitive to syntactically constrained units of text. Moreover, older good readers have larger eye-voice spans than younger and/or poor readers. Rode (1974-1975) explored the relationship of syntactic structure to the eye-voice spans of third,

fourth, and fifth grade readers. Although younger readers had shorter eye-voice spans, they also attempted to use syntactic constraints for reading. Older readers, however, tended to use the clause as the basic unit of processing, while younger readers used a smaller unit, the phrase.

Previously cited studies by Weber (1970) and Biemuller (1970-1971) revealed that first grade beginning readers were highly sensitive to syntactic (and semantic) sources of grammatical context. Sawyer (1976) evaluated the ability of adults to recognize target phrases in tachistoscopically produced sentences differing in the amount of grammatical redundancy. Recognition was facilitated when the grammatical structure of the sentence was highly constrained. Wisher (1976) examined the role of syntactic expectations during adult reading. He showed that more rehearsal for recalling a string of numbers occurred while reading a sentence if the reader knew the syntactic structure prior to reading the sentence. Summarizing this interesting area, Gibson & Levin (1975) concluded that by the fourth grade, children regularly used grammatical constraints for reading comprehension.

Organizational constraints and memory. In an important review of developmental changes in the cognitive organization of memory, Hagen, Jongeward, and Kail (1975) suggested that children may use different stimulus attributes for memory at different ages. Younger children (age 5-7) focus on the acoustic and spatial attributes of the items to be remembered, while the strategies of older children resembled those of

adults in their emphasis on syntactic,semantic, and other higher order organizational constraints. The use of these strategies, however, made for better and more efficient comprehension.

Additional research exists on this developmental theory of attribute dominance (Underwood, 1969). In a false recognition memory task, Bach & Underwood (1970) found that recall error was characterized by acoustic features in second graders and by associative features in sixth graders. Perlmutter and Myers (1976) found that the recognition memory of 3 and 5 year olds was not improved by providing verbal labels for the children. McCarver (1972) showed that providing different types of organizational cues (visual and verbal) improved recall in Grade 4 and college level Ss, but not in Grade 1 or kindergarten level Ss. Paris and Lindauer (1976) demonstrated that the use of extralinguistic information was more effective for facilitating sentence comprehension and recall in older (age 11-12) but not younger children (age 6-7). Cramer (1975) used a false recognition paradigm to show that verbal labeling was more characteristic of Grade 4 and 6 children than Grade 2 children. In a similar experiment Cramer (1976) showed that encoding on the basis of visual attributes characterized first graders, while visual and verbal encoding characterized fourth graders.

These studies tend to show developmental changes in the attributes used for information processing. Similar changes may be apparent for learning to read. The new problem presented by learning to read concerns the graphic and phonological

features (visual and acoustic) of written language. Older readers, however, can rely on higher-order linguistic constraints (syntactic, semantic, and extra-linguistic) for processing larger units. In terms of memory organization, younger children seem to rely more on acoustic and spatial attributes for remembering information, while older children and adults use linguistically based skills to organize larger units of information for more efficient processing.

Syntactic function in good and poor readers. These parallels between the acquisition of reading and development of memory attributes are informative. In the preceding section on phonological factors and decoding it was shown that reading group differences tend to emerge as a function of the size of the linguistic unit processed, the importance of the unit for the reading process, and its ontogenetic sequence of development. The present section focuses on units of information larger than the word, the use of which characterizes more advanced readers (Gibson & Levin, 1975). However, a major portion of the syntactic component of language is acquired by the time the child begins reading, a clear contrast to the new learning presented by the graphic porperties of written language. Therefore, it is not clear whether possible age-dependent relationships will reflect mere development (Satz & Van Nostrand, 1973) or a more complex relationship between ontogenetic development and the role of the skill in the reading process. This section will review research on syntactic function in good and poor readers to see what relationships emerge. Several different types of studies have been attempt-

ed, based on (a) morphological knowledge; (b) oral reading errors; (c) oral language performance; and (d) syntactic comprehension.

Morphological knowledge. Morphemes are the smallest meaningful grammatical units. In essence, they are phonemes which have meaning (e.g., -ed, -s, etc.). Just as syntactic rules can refer to the set of formation rules used to generate meaningful sentences, morphemes can be considered a set of word formation rules for creating meaningful words. Linguists generally separate morphemes into two types: inflections (e.g., pluralization) which do not change the grammatical class of a word, and derivations (e.g., adverbalization) which do change word class (Dale, 1976).

Numerous studies have used the Grammatic Closure subtest of the Illinois Test of Psycholinguistic Abilities (ITPA; Kirk, McCarthy, & Kirk, 1968) to explore potential differences in morphology between good and poor readers. Grammatic Closure is a test of morphology using real words as response eliciting stimuli. Studies in this area are generally poorly designed, fail to control for chronological age, and seldom employ children younger than Grade 2. Nonetheless, a simple generalization can be made for good and poor readers at and above the second grade. In summarizing the many studies of the ITPA and academic achievement, Hammill, Parker, and Newcomer (1975) concluded that "Only Grammatic Closure, the most linguistic of the ITPA subtests, consistently predicted academic achievement in that it evidenced significant predictive and

diagnostic relationships in this study" (p. 251). Summarily, Grammatic Closure almost always separates second grade and older good and poor readers.

A similar approach to studying morphology in good and poor readers is based on one of the most important early studies in developmental psycholinguistics (Berko, 1958). Berko measured first and second grader's knowledge of a variety of morphemes using nonsense word stimuli. Berko found that the second graders in her study had acquired most of the morphophomenic forms measured, though other studies have suggested some caution regarding this conclusion (Palermo & Molfese, 1972).

In looking at reading group differences, Brittain (1970-1971) correlated performance on the Berko Test with reading achievement in Grades 1 and 2. A partial correlation (correcting for IQ) of only.36 was obtained with first grade achievement, while the correlation with second grade achievement was .70. Swallow (1972) gave multiple measures of linguistic and nonlinguistic function, including the ITPA and Berko Test, to good (N =30) and poor (N =30) second grade achievers. Group differences were obtained on the Berko Test, Grammatic Closure, and other measures (including the Bender-Gestalt). Wiig, Semel, and Crouse (1973) gave the Berko Test to groups of "High Risk" children and controls and learning disable children and controls (age 9.5). The "High Risk" Ss (age 4.4) were defined in terms of a history of neonatal trauma with subsequent neurological disability. Differences were found between experimental

and control groups at their respective age levels. Vogel (1974, 1975, 1977) gave a variant of the Berko Test, the Berry-Talbot Test of English Morphology (Berry, 1969) and the ITPA Grammatic Closure subtest, to groups of second grade good and poor readers. Robust differences were found on both measures between these well-defined groups. A different sort of study (Barganz,1971) required Grade 5 good and poor readers to inflect and derive different target words embedded within sentence context. Performance by poor readers was poor in all three presentation conditions (oral-oral, oral-visual, and visual-visual).

It is evident that second grade and older poor readers perform more poorly on measures of morphological knowledge. The basis for this difference, however, is not clear, for the construct characteristics of the morphological tests employed have not been clarified. For example, Grammatic Closure almost always loads on the general Verbal Comprehension factor often observed in factor analyses of the WISC (Newcomer, Hare, Hammill, & McGettigan, 1975). Correlations with vocabulary tests are uniformly high. The net effect of these findings is to question the suggestions of some authors (Vogel, 1975; Wiig & Semel, 1976) concerning the specificity of morphological knowledge as an underlying factor in reading disability. Despite these shortcomings, it is important to note that differences in performance are observed at the Grade 5 level, especially in view of the fact that these skills undergo primary development between 5 and 8 years of age (Berko, 1958; Gibson & Levin, 1975). It would be interesting to know the performance

characteristics of potentially disabled readers (age 5) prior to the measurable onset of reading disability (age 8), especially in view of the lower correlations with first grade than second grade reading achievement (Brittain, 1970-1971).

Oral reading errors. Two oral reading studies which failed to find differences in the linguistic error patterns of good and poor first grade readers were described earlier (Biemuller, 1970-1971; Weber, 1970). In both studies, 90 percent of the oral reading errors invariably "made sense" given preceding grammatical context. Somewhat different results were reported by Little (1975), who analyzed oral reading errors of third grade average and disabled readers. These errors were also compared with performance on the Developmental Sentence Scoring Test (Lee & Canter, 1971). Although no relationship between oral reading errors and syntactic development was evident, the errors of average readers did conform more to grammatical constraints within stimulus sentences than for poor readers. Isakson and Miller (1976) defined groups of fourth grade children equivalent on word recognition skills but differing in comprehension ability. Results, based on oral reading errors at the verb position, revealed that poor comprehenders were less disturbed by snytactic (and semantic) violations of sentence structure than good comprehenders, in whom error rates increased. This study replicated similar finding by Clay and Imlach (1971) and Weinstein and Rabinovitch (1971) showing that (relatively older) poor readers seemed insensitive to grammatical constraints, processing words

one at a time. Less use was made of syntactic (and semantic) context cues necessary for processing groups of words. Oakan, Weiner, and Cromer (1971) and Steiner, Weiner, and Cromer (1971) provided different types of comprehension training for good and poor fifth grade comprehenders. Again, oral reading errors indicated that performance was disrupted only in good comprehenders.

These studies show that older poor readers make less use of the organizational facilitation provided by syntactic constraints for reading comprehension. They also show that even when poor and good readers are matched for word recognition skills (i.e., decoding), comprehension difficulties still arise. Cromer (1970) distinguished between two types of poor readers. The "deficit group" was characterized by poor decoding skills, while the other "difference group" possessed adequate decoding skills and poor comprehension skills. Even if the child learned to read word by word (i.e., learned decoding), major comprehension problems may still be evident because of a failure to acquire or use linguistic skills underlying fluent reading. It is unfortunate that this interesting hypothesis has not been examined longitudinally or cross-sectionally across broader (well-defined) age ranges. If inadequate decoding skills characterized poor readers at one age, while poor comprehension skills characterized poor readers at a contrasting age, considerable insight into the developmental course of reading disability would be the result.

Oral language. Several studies have examined the relationship of syntactic characteristics of oral language and reading achievement. From a correlation paradigm, Bougere (1969-1970), Ribovitch (1975), and Mahaffey (1975) all correlated different measures of oral syntax (sentence length, number of kernal phrases, transformational complexity, etc.) with reading achievement in first grade samples. Only Ribovitch (1975) obtained even a moderate correlation with reading achievement, which was lower than the correlation of intelligence and other linguistic and non-linguistic measures. Mahaffey (1975) found letter naming skills to be more predictive, while Bougere (1969-1970) found Metropolitan Readiness Test subtests to be highly correlated with reading achievement. Bougere (1969-1970) concluded that while different measures of oral syntax were not correlated with Grade 1 reading achievement, they may be more important in later grades. Hensley (1974) provided similar results by finding no oral syntax differences between poor, average, and superior first grade readers.

Correlational studies of older readers provide different results. Second grade (Harris, 1975) and seventh grade (Kuntz, 1975) correlations of reading achievement and oral syntax (using the Falk Sentence Construction Test) were quite high (.68 to .70). Experimental studies of oral syntax between relatively older reading groups provide similar results. Fry, Johnson, and Muehl (1970) found differences on a variety of

oral language measures between second grade good and poor readers. Similar findings were reported by Dumas (1976) with third grade reading groups. Calvert (1973) found that the oral language of good fifth and sixth grade readers was syntactically more complex and mature than comparably aged poor readers. Summarily, these oral language studies show that oral syntax is less related to the discrimination of first grade reading ability, but more related to the discrimination of reading abilities in second grade and older children.

Syntactic comprehension. The age effects described for oral reading and oral syntax are largely based on measures of language production. The present section will examine studies based on the comprehension of sentences to see if a similar generalization is possible.

For younger reading groups, two studies are quite pertinent. Falk (1977) compared the ability of good and poor first and second grade readers to answer questions about 23 spoken sentences varying in syntactic complexity. A significant age effect was observed, but reading group differences were apparent only for second grade (not first grade) readers. Taylor (1977) dichotomized first and second grade readers on the basis of Metropolitan Achievement Test scores. He then asked these Ss to judge the grammatical acceptability of disrupted sentences. Correct judgements increased with age, with semantic disruptions more easily identified and correlated with achievement at both grade levels. Syntactic disruptions, however, were correlated with reading achievement only at the second grade level (not first grade).

With older reading groups Vogel (1975) failed to find differences in second grade on the Northwestern Syntax Screening Test (Lee, 1971), a task requiring picture selection on the basis of different sentence types. In contrast, Semel and Wiig (1975) found differences on this measure between reading groups sampled across a broader age range (7-11.5) and therefore slightly older (about one year).

Dawson (1974) attempted a replication of Chomsky (1969) with good and poor third and fourth graders from lower SES backgrounds. Chomsky (1969) studied the acquisition of more complex syntactic forms in children aged 5-9 and found continued development up to age 9. Dawson (1974) obtained an age effect and a significant correlation with reading achievement was reported. However, the order of acquisition was different from that found by Chomsky (1969). Chomsky (1972) examined Ss from her 1969 sample with regard to reading achievement. She found that Ss with greater syntactic competence were also better readers. This conclusion, however, was confounded by chronological age and intelligence differences within her groups.

Berger (1975) and Wiig and Semel (1973, 1975, 1976) examined comprehension of different sentence types in good and poor readers about 11 years old using sentence repetition tasks. Differences in sentence comprehension were found in both studies. Finally, Guthrie (1973) examined the relationship between sentence comprehension and the use of syntactic cues during silent reading. Disabled readers, about 10 years old,

were selected across a broad age range, while younger (7.5 years) and older (10 years) control groups were employed. The task required Ss to read silently and select different words from contrasting syntactic classes which would make the sentence passages acceptable. Results indicated that while comprehension was much lower in disabled readers, the pattern of errors was quite similar. These results are similar to those obtained by Oakan et al. (1971) and Steiner et al. (1971) for oder readers. Rabinovitch and Strassberg (1968) also showed that syntactic cues did not facilitate comprehension in fourth grade poor readers using sentence repetition and sentence learning tasks.

Summary. The syntactic comprehension studies highlight a variety of methodological and substantive issues which plague this research area. For example, many studies confound chronological age either by using disabled readers from a broad age range (e.g., Guthrie, 1973; Semel & Wiig, 1975) or by failing to sample groups across the entire age range (age 5-14). These studies, especially in the comprehension area, uniformly fail to manipulate variables clearly described as syntactic. Identifying target words (Guthrie, 1973), repeating sentences of different syntactic complexity (Wiig & Semel, 1973; Weinstein & Rabinovitch, 1971), or selecting pictures on the basis of two sentences differing in single word meanings (e.g., Northwestern Syntax Screening Test), manipulate a number of lexical, semantic, conceptual, and syntactic variables. These variables, all important for comprehension, may develop at different rates (cf. Section III) and may have different re-

lationships with other skills and abilities (e.g., intelligence). Furthermore, because a variety of linguistic and nonlinguistic deficits affect reading disability, it is not clear that tasks requiring reading of the child (e.g., Guthrie, 1973; Oakan et al., 1971; Steiner et al., 1971) yield conclusions specific to linguistic skills. Finally, few of the studies cited relate substantially to current knowledge concerning language development and the acquisition of reading. Taken together, however, the four types of studies reviewed in this section do provide support for developmental changes in the linguistic performance correlates of reading disability. This evidence is strongest for the oral reading and oral language studies, which show that syntactic variables contribute more to the discrimination of reading level in older children than younger children. The morphological and syntactic comprehension studies also show that syntactic variables separate older reader groups. However, few of these studies have employed younger age groups (before Grade 2), so that conclusions regarding age-dependence from these studies are limited by this empirical shortcoming.

The age-dependent relationships that do emerge in this section are consistent with the third hypothesis outlined in the Phonological section (cf. p. 25). If syntactic skills contribute more to the discrimination of reading level at later years, then the persistence of decoding problems in disabled readers could reflect difficulties with the later

acquisition of skills underlying the development of comprehension strategies.

This possibility does not rule out the other two hypotheses, which postulated a basic defect in decoding skills or attributed later comprehension problems to inadequate development of earlier hierarchically related decoding skills (Farnham-Diggory & Gregg, 1975; Golinkoff, 1975-1976; Perfetti, Note 8). The age-dependent relationships that were described do suggest that even if poor readers acquired earlier decoding, later comprehension problems could still arise.

It should be noted that many syntactic skills are acquired at an age (before Grade 2) which precedes the period when they become more important for the reading process (Grade 4). Of course, having these skills does not necessarily imply that they can be applied in all the appropriate situations (Flavell, Beach & Chinsky, 1966; Torgeson, 1977). Although children may be able to apply their knowledge of syntactic rules to verbal utterances, using these skills for reading (and memory) may require additional development. The acquisition of language has a much broader meaning than simply possessing certain skills and concepts. For the application of these skills to reading, many factors could influence possible age-dependent relationships, including the fact that new skills must be acquired early in the reading process (Gibson & Levin, 1975) and other types of developmental hierarchies (White, 1965). Similar problems were considered

by Doehring (1976; Note 7), who emphasized the need for additional knowledge concerning language, reading, and their development. These interpretive problems have been evident throughout this review and will continue to present difficulties in the section on semantics.

Semantic Component

Semantic system and its development. Theoretical generalizations regarding the nature of the semantic system are difficult to support (Dale, 1976). The semantic component of language is generally defined as having to do with meaning, i.e., the "ideas" expressed by language. Ordinarily it includes a lexicon, or word dictionary, and a set of rules relating lexical entries to one another (internally) and to other aspects of language and cognition (externally). The size of the lexicon and its organization concerns the internal aspects of the semantic component. How the system relates to other components of language and to more general extralinguistic and conceptual aspects of cognition are external semantic concerns. These latter aspects of semantics pertain to the organization of our conceptual experience provided by language (Dale, 1976; Langacker, 1968).

Developmental generalizations regarding semantic processes are even more difficult to maintain. Anglin (1970), McNeil (1970), and Slobin (1971) all contended that the semantic component develops more slowly in childhood than the syntactic and phonological components of language. Dale (1976), however, showed that this generalization is quite dependent on the method of study employed and the specific words and

word types employed. Development proceeds rather early for some aspects of semantics. Frasure and Entwisle (1973) compared kindergarten, first and third grade children of different social class backgrounds in their ability to use syntactic and semantic cues to facilitate sentence recall. Contrary to the idea of later, more gradual semantic development, semantic cues facilitated performance at every grade level. Also contrary to the idea of earlier and more rapid syntactic acquisition was the finding that syntactic cues were facilitative only at later grades, especially for lower class children. These findings are consistent with studies of certain types of semantic cues, e.g., taxonomic clustering, which children may use for recall at relatively early ages (Lange, 1973).*

It may be that generalizations which relate semantic development to more general aspects of conceptual development will prove more useful in the long run. In this respect,

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* These studies do show early use (Age 5) of semantic strategies by children and may on the surface conflict with the review of organizational constraints in memory (cf. p. 27) However, it is not clear that the use of these cues in younger children reflects more than lower order associative skills, such that different strategies may underlie the facilitative effects of these cues at different ages (Lange, 1973; Hagen et al., 1975). Also, it is not clear that these attributes are more important than acoustic and spatial attributes at an earlier age.

Slobin (1971) has argued that syntactic and semantic processes do not develop in unison. Semantic development must be preceded by more general cognitive development--an idea must exist before it can be expressed. Palermo and Molfese (1972) argued that this notion applies to all aspects of language, such that a general theory of language must be embedded in a general theory of cognition. More specifically, Dale (1976) noted that the issue of what idea is expressed (semantically) is difficult to separate from the formal aspects of how ideas are expressed. Conceptual development, at least in terms of comprehension, seems to develop well into adolescence, so that it may be more reasonable to expect semantic development to proceed in a similar fashion. However, separating semantic and conceptual variables will be difficult when attempts are made to "measure" these constructs, so that this conclusion may not be entirely accurate. There is less evidence suggesting rapid phases of acquisition for semantic and conceptual skills, in contrast to common descriptions of syntactic development (McNeill, 1970; Palermo & Molfese, 1972).

Semantic function in good and poor readers. This digression may be of little assistance in conceptualizing studies of semantic function in disabled readers. One suspicion, however, is that developmental changes will be more difficult to describe. Semantic aspects of language are important for reading throughout development. Even younger children understand the need to read for meaning (Gibson & Levin, 1975).

Unfortunately, semantic theory is not sufficiently developed to provide any clear resolution of those problems. Studies with disabled readers reflect more of the traditional verbal learning emphases instead of the recent structural linguistic emphases. Therefore, the studies reviewed under this section largely concern associative and mediational processes in four areas: (a) paired-associative learning; (b) auditory-visual integration; (c) memory processes and (d) conceptual-linguistic function. At the end, a few studies will be reviewed in a fifth area pertaining more specifically to a theory of semantics in disabled readers.

Paired associate learning. As Gibson and Levin (1975, pp. 285-287) have noted, several conventional theories of early reading acquisition viewed paired associate learning (PAL) as the basic process involved. This view highlighted the need for verbal responses to printed verbal stimuli, in essence a "visual-verbal" associative task (Vellutino, Note 1). While this view is simplistic, it does provide a rationale for examining PAL in different age groups of good and poor readers.

Several studies have examined the predictiveness of rate of learning various PAL for early reading achievement. Lambert (1970) found that rate of PAL correlated significantly with first grade reading achievement even after demographic patterns were incorporated into prediction. Stevenson, Parker, Wilkinson, Hegion, and Fish (1976) found that a verbal recall PAL task administered in kindergarten reliably contributed to

reading achievement in Grades 1-3.

These correlational studies, of course, do not necessarily imply differences between younger good and poor readers. Several studies have examined PAL performance in experimentally defined reading groups. These studies have used a variety of PAL tasks in different modalities (auditory, visual, and tactical) and have used PAL tasks to investigate both learning efficiency variables and the possibility of a general verbal associative deficit in poor readers. Alworth (1974) compared performance of good and poor readers in Grades 1 and 2 on a variety of visual-verbal PAL tasks. Differences between groups in learning rate were not reliably obtained. Otto (1961) found differences in PAL learning rates between good and poor second, fourth, and sixth grade reading groups. Although differences were significant at each age, an Age X Group interaction was also obtained. This interaction revealed larger differences between second grade than sixth grade reading groups. However, the task may have been too easy for the sixth grade controls. In a subsequent experiment, Otto, Koenke, and Cooper (1968) found a similar Age X Group interaction for both visual-visual and visual-verbal PAL learning rates. While second grade reading groups made more errors and were slower on both types of PAL tasks, no differences between fifth grade groups were found because the task was too easy.

Differences between older reading groups on different types of PAL tasks are reliably obtained. Vellutino, Steger,

Harding, and Phillips (1975) compared reading group performance (Grades 4-6) on visual-visual (nonverbal) and visual-verbal PAL tasks. The groups differed only on the visual-verbal PAL tasks (score = absolute errors). Similarly, Rudel, Denckla, and Spalten (1976) compared 10 year old reading groups on tactual-verbal (Braille letters) and auditory-verbal (Morse code) PAL learning. Poor readers learned fewer letters regardless of modality, leading Rudel et al. (1976) and Vellutino (Note 1) to argue that these differences reflected general verbal encoding and retrieval difficulties. Reinforcing this conclusion is a study by Gascon and Goodglass (1970) with fifth grade reading groups. These authors compared PAL performance using nonsense forms containing different degrees of visual and auditory enrichment. Differences were found regardless of modality and enrichment.

Task ceilings and floors are apparently very important factors in these PAL studies. Samuels and Anderson (1973) found differences between second grade reading groups on an easy PAL task, but not on a more difficult PAL task, suggesting the possibility of a floor effect. Camp and Dahlem (1975) performed a study (confounding the age variable) which compared PAL and serial learning in older poor readers (no controls). Performance on the tasks were highly correlated, with task difficulty forming the major determinant of performance.

The influence of task difficulty on PAL tasks suggests that group differences may reflect more general learning efficiency variables as opposed to specific verbal associative

deficits. Differences on these PAL tasks emerge regardless of presentation modality (Gascon & Goodglass, 1970; Otto, 1961; Rudel et al., 1976) and for verbal and nonverbal material (Otto, 1961; Samuels & Anderson, 1973).* Moreover, group differences often appear to be largely quantitative in nature. Camp (1973) examined learning curve differences on PAL tasks between good and poor readers aged 8 to 18. Quantitative patterns were observed which tended to attenuate, while qualitative differences in learning curves were not apparent. Bartel, Grill, and Bartel (1973) looked for qualitative differences in the achievement of the syntagmatic-paradigmatic shift, which is usually complete between ages seven to nine (Riley & Fite, 1974). No differences in paradigmatic word association responses were found in 8 year old good and poor readers.

Interpretation of these studies in terms of developmental change is difficult. In general, group differences are obtained between reading groups at all ages from Grades 2 to 6 (Otto, 1961). Prior to Grade 2, Stevenson et al. (1976) found a verbal PAL task to be an important predictor of reading achievement, while Alworth (1974) was not able to obtain reliable group differences on PAL tasks in Grades 1 and 2. Bartel et al. (1973) found no qualitative differences between

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*The study by Vellutino, Steger et al. (1975) is an exception to this general finding.

second grade reading groups in the achievement of an important development change, the syntagmatic-paradigmatic shift. Group differences beyond Grade 2 were reliably obtained, but with several PAL tasks under different presentation conditions. Searching for developmental changes in PAL learning tasks illustrates many of the problems with task definition and surplus construct variance also evident in the next section concerning auditory-visual integration.

Auditory-visual integration. A traditional research topic in reading disabilities concerns auditory-visual integration (AVI), matching visual and auditory sequential patterns. Initial experiments (Birch & Belmont, 1964; 1965) were based on the idea that decoding graphic symbols to sounds involved integrating auditory and visual input. These experiments required matching spatially arranged dot patterns with patterns tapped by a pencil. Results revealed group differences mainly in Grades 1 and 2. After Grade 2 performance was more related to IQ, leading Birch and Belmont (1965) to argue that early reading disability was more related to perceptual deficits, while later reading disabilities were more related to the measurement characteristics of IQ.

The major reason for including these experiments in this section concerns subsequent AVI studies by Blank and Bridger (1966) and Blank, Weider, and Bridger (1968). These authors argued that the AVI performance of 7 and 9 year old disabled readers reflects difficulty in conceptually labeling

sequential patterns, such that performance differences reflect verbal mediational problems instead of perceptual factors. This argument is based largely on the observation that while both reading groups attempted to label the patterns in their study, the disabled reader group was much poorer at labeling.

This argument has received considerable popular but only moderate empirical support. The major reason for discussing it under semantic processing is that these experiments are so often cited as indicating "verbal coding" problems in disabled readers (cf. Vellutino, Note 1). Several factors, however, provide shortcomings for this hypothesis. Most basic to the point that children at the age when AVI was related to overall reading achievement (especially first grade) in Birch and Belmont (1965) do not seem to spontaneously apply verbal coding and rehearsal strategies for processing information (Hagen et al., 1975). Although these strategies do come into prominence at age 9, a recent experiment by Drader (1975) with older (11-12 years) reading groups questioned the assumption that reading groups differ in verbally encoding sensory information. Drader required good and poor readers to verbally label temporally presented patterns of lights, sounds, and finger taps. No group differences were found for labelling temporal patterns in auditory, visual, or tactual modalities. However, the labelling task was very difficult for all Ss, suggesting the possibility of a floor effect. Even so, if verbal labelling of sequential patterns is too difficult for

11 year olds, why invoke it as an explanation of performance differences in 9 year olds (Blank & Bridger, 1966; Bridger et al., 1975)? Moreover, two factor analytic studies with younger children show that measures of AVI tend to load with measures of sensorimotor-perceptual skills as opposed to verbal-conceptual skills. Beran (1971) factored four AVI measures, two IQ tests,two reading achievement measures, and several visuospatial and auditory-temporal tasks in a small sample (N = 96) of first graders. Three factors emerged: a general sensory factor, an intelligence factor, and a temporal relations factor. Performance on AVI tests was related to Factor I and III tests, not the intelligence factor (II). In a much larger study (N = 425 second graders), Fletcher and Satz (Note 3) factor analyzed a measure of AVI (Birch & Belmont, 1965) and several measures involving somatosensory, visual-perceptual, visual-motor, and verbal-conceptual abilities. The AVI measure loaded on a general sensori-motor-perceptual factor and not on either of two additional verbal factors. Finally, if the sum of this evidence does not provide some reservations regarding the AVI verbal mediation hypothesis, Blank, Berenzweig, and Bridger (1975) performed a series of AVI studies on 9 year old good and poor readers. Not once was the verbal encoding hypothesis offered, with the authors suggesting that group differences reflected selective attentional factors and would probably be obtained for processing any sort of complex, meaningful information.

Semantic factors in memory. A few studies have examined rehearsal strategies in memory for good and poor readers.

Leslie (1974) compared the effect of rehearsal instructions on the spatial order short term memory of second and fifth grade reading groups. One group of good and poor readers was instructed to name and cumulatively rehearse the names of sequentially presented common objects while the control groups were told to simply reproduce the sequence of objects. Results indicated no effect of rehearsal at Grade 2, with good readers having better overall recall than poor readers. However, at Grade 5, rehearsal hindered performance of both reading groups, with no overall group differences in recall! These latter findings are inconsistent with normal developmental research on rehearsal (Hagen et al., 1975). A better designed study (Tarver, Hallahan, Kaufman, and Ball, 1976) showed age-linked performance differences between good and poor readers at 8.5 and 10 years of age, and an additional 13.5 year old poor reader group. Using the Hagen Central-Incidental learning task, a serial learning recall task, results revealed the presence of a primacy effect in controls, but not younger disabled readers. Furthermore, the primacy effect exhibited by 10 year old disabled readers resembled that of eight year old normals, with performance by the 13.5 year old disabled group resembling normal 11 year old performance. Tarver et al. (1976) summarized their results by noting that "the evidence suggests that a developmental lag of about 2 years is characteristic of the learning disabled" (p. 383). It should be noted that the task was not employed with younger (age 5-7) or older groups (age 14-16) so that the possibility of earlier differences or of catching up cannot be attested to.

Earlier differences seem unlikely in as much as the verbal rehearsal strategy underlying performance does not spontaneously emerge until Grade 2 (Hagen et al., 1975), though the age related improvements and possibility of catching up are intriguing. Kastner and Rickards (1974) also reported differences in verbal rehearsal strategies between Grade 3 reading groups. In this study, good third grade readers consistently used verbal rehearsal, while poor readers seemed to waver, alternating between verbal and visual strategies for repeating serial sequences of novel and familiar tapped stimuli.

Several studies have investigated the role of conceptual-semantic organization in facilitating short term retention of disabled and nondisabled readers. These studies are reminiscent of Clay and Imlach (1973), Weinstein and Rabinovitch (1971), and Guthrie (1973), each of which manipulated variables of a more syntactic nature. Freston and Drew (1974) provided a group of disabled readers (mean age = 11) with free recall lists of paradigmatic associations. These lists were either unorganized or organized via retrieval cues (conceptual categories) embedded within the list. Material organization had no effect on recall. Parker, Freston, and Drew (1975) expanded this experiment by including a control group. Free recall lists were again provided to reading groups (mean age = 10) and two variables were manipulated: material organization and difficulty level. Although difficulty level influenced performance for both groups, material organization facilitated recall only for the control group. These findings

do seem related to research on temporal ordering (Bakker, 1972) and serial memory deficits (Corkin, 1974) in disabled readers.

A well conceived study by Waller (1976) employed a semantic integration task (Paris & Carter, 1973; Paris & Lindauer, 1975) to tease out differences in sentential recognition memory between fifth grade reading groups. Each subject read a series of "acquisition" sentences. After an interference task, a recognition test composing either original sentences or different transformations of the acquisition sentences was presented. The child was required to respond "yes" or "no" if he recognized the sentence as being identical to the original acquisition sentence. No group differences were observed if the new sentence was a true or false premise, or a false inference. If the sentence was a true inference, i.e., derived directly from the acquisition list, or if it changed number or tense, poor readers performed more poorly.

An alternative approach to studying memory functions in good and poor readers was reported by Torgeson and Goldman (1977). These authors investigated the possibility that memory deficits often observed in poor readers reflect "a lack of ability or inclination to use efficient task strategies" (p. 56). A memory task permitting observation of the use of verbal rehearsal was employed with second grade reading groups (cf. Flavell et al., 1966). Differences were obtained for total recall and the actual use of rehearsal strategies. In

a second phase of the experiment, Ss performed a task which facilitated use of rehearsal. After completion of this task, group differences were not observed,with concommitant significant increases for amount of rehearsal and total recall in poor readers. Showing that an apparent deficit reflected a failure to apply a previously acquired strategy is consistent with an intriguing hypothesis expressed by Torgeson (1977). This hypothesis suggests that problems with executive and organizational functions underlie apparent poor reader deficits on many tasks. Poor readers may be deficient in applying strategies, but not in the actual acquisition of the strategy.

Conceptual-semantic function. The Torgeson hypothesis is quite interesting, but may fail to explain findings resulting from more global non-mnemonic studies of conceptual-semantic function in good and poor readers. LaPointe (1976) compared performance of learning disabled and nondisabled adolescents on the Token Test, a general measure of receptive language. Differences were obtained and appeared to relate to the retention of critical sentential elements across subtests. The relationship of this test to age and general intelligence was explored by Silverstein, Raskin, Davidson, and Bloom (1977). These authors gave the Token Test and WISC to 46 reading disabled children (mean age = 9.5 years). Age was moderately correlated with performance on the Token Test ($r = .42$). Partial correlations (holding age constant), were reported for WISC subtests and scaled scores, including Verbal IQ ($r = .61$) and Full Scale IQ ($r = .54$).

Several cross-sectional studies comparing disabled and nondisabled readers on a variety of conceptual-linguistic ("semantic") have been conducted. Satz, Rardin,and Ross (1971) and Satz and Van Nostrand (1973) compared performance of good and poor readers at two age groups (7 and 11) on a variety of perceptual and linguistic tests. The linguistic measures largely involved measures of verbal fluency, vocabulary, abstract reasoning, and dichotic listening. Group differences on these conceptual-linguistic measures were obtained between older but not younger groups. Sabatino and Hayden (1970) performed separate principle component analyses on a variety of sensorimotor-perceptual and conceptual-linguistic measures in two large samples of disabled readers. For younger readers (age 7.5) the major proportion of the variance was explained by sensorimotor-perceptual measures, while for older readers (age 9-11) "psycholinguistic" measures were more explanatory. Gruen (1972) compared the predictive accuracy of a battery of perceptual-motor and cognitive-intellectual tasks administered to a large group of first grade (N = 204) and third grade Ss (N = 202) against end of year reading achievement (1 year follow-up). The multiple regression analyses showed that the perceptual-motor tests accounted for more of the explained variation in reading achievement scores (vocabulary and comprehension) for first grade boys and girls. In contrast, the cognitive-intellectual tests accounted for more of the explained variation in reading achievement scores for third grade boys and girls. Finally, in a

longitudinal study involving repeat testing of the same group of children at three ages 5, 8, 11 years), Fletcher and Satz (Note 3) showed that measures of conceptual-linguistic skill (word comprehension, verbal fluency, vocabulary, etc.) are more related to reading achievement in older reading groups (age 10-14) than younger reading groups (age 5-7).

It should be apparent that the definition of "semantics" in this section has now expanded to include more general studies of conceptual-linguistic function, i.e., thinking with language. In this section on semantics the first two topics, PAL and AVI were criticized in terms of the extent of their relationship to semantic and verbal processing. Furthermore, early deficits on these tasks could be related to perceptual as well as language functioning. This section explored the more general area of thinking with language and regularly observed a greater contribution of conceptual-linguistic variables in older (age 8-14), but not younger (age 5-7) reading groups. These studies are consistent with experimental and clinical observations of general verbal comprehension deficits in intermediate and older disabled readers on standardized language (ITPA; Newcomer & Hammill, 1975) and intelligence tests (WAIS; Belmont & Birch, 1966; Sattler, 1973). With regard to semantics, the relationship broached concerns the use of language to organize conceptual experience (Dale, 1976; Langacker, 1968). To the extent that conceptual factors must be included in a theory of semantics, this latter section does address developmental changes in semantics between disabled and nondisabled readers.

Specific semantic skills. Whether these age linked conceptual-linguistic differences extend to more specific semantic skills (e.g., lexical access), is not clear. A trio of studies (Golinkoff & Rosinski, 1976; Pace & Golinkoff, 1976; Rosinski, Golinkoff, & Kukish, 1975), summarized in Golinkoff (1975-1976) are quite pertinent here. These studies employed good and poor comprehenders in Grades 3 and 5. Single word access was measured with a series of picture-word interference tasks and timed sets of decoding tests. Interference tasks required Ss to label common pictures as rapidly as possible while ignoring printed words and trigrams superimposed on the pictures. Group differences were obtained on the decoding tasks, but the effects of semantic interference were equal for the two groups. Rosinski et al. (1975) interpreted these results as indicating that decoding and semantic access skills are independent, with minimal decoding skills required for accessing single word meanings. Golinkoff (1975-1976) summarized these findings by noting that "poor comprehenders may readily obtain the meaning of common printed words" (p. 639). On the other hand, Perfetti (Note 8) found fifth grade poor readers to be deficient on other types of semantic skills, e.g., semantic categorization. This suggests that along with deficiencies in semantic knowledge, poor comprehenders are less proficient in the use of semantic cues than good comprehenders. Nonetheless, as Golinkoff (1975-1976) notes, not all aspects of semantic access separate good and poor readers, an intriguing hypothesis.

Contrasting results using a rather different paradigm were reported by Denner (1970), who required first grade good and poor readers and third to fifth grade poor readers to perform tasks based on an experiment by Farnham-Diggory (1967). This experiment used pictures of different movements and objects to represent contrasting activities. Denner (1970) found differences between reading groups (both ages) only when Ss were presented cards depicting several actions and asked to perform. In this case poor readers apparently could not synthesize the individual cards into an integrated activity despite their ability to perform activities represented by single cards.

Kolers (1975), using a task permitting separation of graphemic and semantic aspects of word processing (cf. p 24), found no differences in the semantic processing of fifth grade good and poor readers. These two studies show age-dependent relationships in the opposite direction of those described for conceptual-semantic skills. Again, problems of task definition makes interpretation of these results difficult.

Summary. No ready generalizations emerge in closing this section. It should be noted that a number of the oral reading and language studies cited earlier (e.g., Biemuller, 1970-1971; Frey, Johnson, & Muehl, 1970; Weber, 1970;) also pertain to semantic issues. These studies explored linguistic constraints in terms of whether the errors made sense, therefore conforming to either syntactic or semantic acceptibility. More generally, it appears that semantic-conceptual skills

(vocabulary, verbal fluency, etc.) develop into adolescence and contribute more to the separation of reading groups at older ages. Other semantic variables, including verbal rehearsal and reconstructive processes in memory have been studied, but exclusively in children beyond Grade 2. These studies tend to show differences between whatever age groups were examined. Studies using PAL and AVI tasks presented substantial interpretative problems. Differences were obtained at several ages, but the interpretation of these differences for verbal processing was not clear. The tentative nature of these conclusions may reflect the unintegrated status of semantic theory at the present time (Dale, 1976) and the lag in applying these concepts to reading theory.

Statement of the Problem and Hypotheses

Overall summary. The present review has described research on language function in disabled and nondisabled readers within the phonological, syntactic, and semantic components of language. Particular emphasis was given to the possibility of developmental changes in the linguistic correlates of reading disability. This emphasis stemmed from the hypothesis (Satz, et al. Note 2) that larger differences in language function would be observed between older (age 10-14) than younger (age 5-7) reading groups.

Literature reviewed in phonology was not consistent with this hypothesis, though developmental changes were apparent. Phonological processes are more important for the

decoding process characteristic of early reading. In this respect, different skills based on the child's understanding of the phonetic structure of language (e.g., phonetic segmentation) are important for relating oral language to written language. Because these skills are largely acquired by age 8, it would seem unlikely that disabled readers would have more difficulty with phonetic representation at older ages. Developmental changes, however, were apparent and may relate to the need to process increasingly large intraword units of information (e.g., orthographic structures) for progress in reading. As such, the age-dependent relationships that emerged seemed to reflect the size of the linguistic unit processed, its ontogenetic development (earlier vs. later), and its role in the reading process. Skills with a phonological basis appear to diminish in importance with age and reader experience (Calfee et al., 1969; Doehring, 1976; Gibson & Levin, 1975) and meaning may be directly accessed in mature readers as decoding processes become automatized (Bradshaw, 1975; Golinkoff, 1975-1976; LaBerge & Samuels, 1974). It was noted that decoding problems seemed to persist at least in some disabled readers throughout development. The persistence of this problem did not seem to reflect a complete failure to acquire earlier developing decoding skills, though this hypothesis could not be ruled out. Alternative hypotheses concerning disabled readers continued use of an inefficient and poorly learned reading strategy (decoding) suggested that later developing comprehension skills are dependent on the acquisition of earlier developing decoding skills. Similarly,

a third hypothesis attributed the persistence of decoding, difficulties to age-related problems in the later acquisition of comprehension skills.

Like phonological skills, syntactic skills appeared to develop primarily in the younger years (Dale, 1976) though acquisition of more complex syntactic structures proceeds much later in development (Palermo & Molfese, 1972). Unlike phonological skills, syntactic skills are important for the comprehension processes characteristic of more advanced stages of reading (Gibson & Levin, 1975; Smith, 1971). Thus, it is unclear as to what aspect of development would produce age-linked performance change between reading groups: early acquisition or importance of the skill for the reading process. Caution should be exercised in formulating these problems since language development takes place in a context much broader than simple verbal utterances. Applying syntactic skills in all the appropriate situations may require later development (Flavell et al., 1966).

In reviewing the literature concerning syntactic skills, age-dependent relationships could be described which suggested that tasks requiring the use of grammatical skills were more likely to produce differences between <u>older</u> reading groups. This possibility was not fully resolved because the chronological age variable was often confounded or insufficiently manipulated. Also, the measurement characteristics of tasks employed often confounded a variety of linguistic and reading variables. These variables may develop at different rates and

be differentially involved in the reading process at different ages.

Semantic development appears highly related to conceptual development (Slobin, 1971). Although semantic development appears to develop slowly and proceed late into adolescence, such a conclusion appears to depend on what aspect of semantics is measured (Dale, 1976). With advances in the theory of semantics, such a conclusion will undoubtedly require modification.

In a sense, semantic processes are always involved in reading, for even beginning children understand the need to obtain meaning from reading. From an organizational point of view, however, semantic aspects of language are more involved in the advanced comprehension stages of reading when decoding skills are less important. The fluent reader uses a variety of syntactic and semantic skills to organize written language so that larger units of information can be efficiently processed. Such a conclusion is consistent with research on the role of cognitive strategies in the development of memory (Hagen et al., 1975).

Literature concerning reading group differences on semantic processing tasks presented considerable interpretive difficulty. Most studies were based on relatively older age groups and differences were generally observed across the age range employed (Grade 2 and above). On semantic tasks with a strong conceptual component, age-dependent relationships did emerge, and suggested larger differences between older (age 10-14) than younger (age 7-8) reading groups. More specific

conclusions regarding semantic processes in disabled readers awaits progress in both reading and semantic theory.

Problem and hypothesis. The problem to be explored for this dissertation concerns possible age-dependent relationships for syntactic comprehension skills in disabled readers. This problem is particularly interesting because of the relatively early development of those syntactic skills used in language (Dale, 1976). Despite this earlier acquisition, organizational strategies based on syntactic comprehension are more important for later developing stages of reading acquisition. In this respect, it is not clear whether the crucial postulate of the Satz et al., prediction (Hypothesis 2) concerns the ontogenetic sequence of development or the relative importance of the skill for learning to read. Earlier versions of this theory (Satz and Van Nostrand, 1973) predicted group differences largely on the basis of rate of ontogenetic development. This version would predict larger differences on syntactic comprehension tasks between younger reading groups (age 7-8), despite the greater importance of this skill for later reading stages.

In this study careful consideration will be given to measuring linguistic variables clearly described as syntactic and not confounded by lexical processing requirements. The chronological age variable will be carefully controlled. Furthermore, this study will assess earlier developing language skills at an age (5.5) prior to the onset of reading disability, but at a period when many of these skills undergo

primary development (age 5 to 8). By assessing these skills across a broad age range (5.5 - 11), the issue of ontogenetic sequence of development versus importance of the skill for reading can be addressed. Finally, an attempt will be made to measure language skills using tasks important to other studies (e.g., morphology, vocabulary, and verbal fluency) so that developmental interpretations of these skills can be made for reference comparison. Verbal fluency measures are particularly important, inasmuch as it is a later developing skill (Thurstone, 1955), with differences more often found between older than younger reading groups (Satz et al. 1971; 1973).

One specific hypothesis can be stated, which is based on the Satz et al. theory (Hypothesis 2):

1. Measures of linguistic function will contribute more to the discrimination of reading level at older ages (10-14) than younger ages (5-7).

Confirmation of this hypothesis would suggest that factors in addition to ontogenetic sequence of development must underlie developmental changes in the linguistic performance correlates of reading disabilities (Satz & Van Nostrand, 1973). This finding would also be compatible with models of the acquisition of reading highlighting the importance of linguistically based organizational strategies for fluent reading. If this hypothesis is not confirmed, then earlier versions of the Satz et al. theory (Satz & Van Nostrand, 1973) which predicted on the basis of ontogenetic sequence of development would be confirmed. This finding is less likely in view of previous research (cf. Syntax section) suggesting

that syntactic skills in oral reading and language contribute more to the discrimination of reading level at older ages than younger ages. Whether this finding extends to syntactic comprehension skills was not clear because previous research has not been employed sufficiently for young age groups (5-7 years). It should be noted that this view of syntactic development derives from studies based on the application of these skills for verbal utterances. To reiterate, language development takes place in a much broader context and the application of these skills in appropriate situations (e.g., reading, memory) may require later development (Flavell et al., 1966).

No differences between reading groups at any age would be contrary to the theory of developmental changes in the performance correlates of reading disability (Fletcher & Satz, Note 3). Over and above this hypothesis, however, the present study represents an attempt to clarify the relationship between chronological age and language development in disabled readers. If linguistic skills figure prominently in reading disabilities, then language problem difficulties should also be observed in nonreading language performance of disabled readers (Rabinovitch, 1959).

CHAPTER III

METHOD

Subjects. The children for this study were selected at three age levels (5.5, 8.5, and 11 years) from three different longitudinal samples followed since kindergarten (1970, 1971, and 1974). The 11 year old Ss were selected during Grade 5 from the initial kindergarten population of white males (N=497) obtained in 1970 (Satz et al., Note 2). The 8.5 year old Ss were selected during Grade 3 from a subsequent cross-validational sample of white males followed since kindergarten year (1971). The 11 and 8.5 year old Ss both came from the three schools participating in the project with the largest number of Ss. The 5.5 year old Ss were white males selected during kindergarten from a third sample (N=120) obtained in 1974.

To obtain reading criteria on the 5.5 year old Ss, a two year time interval was allowed to lapse. At the end of Grade 1, criterion information based on the actual classroom reading level of the Ss was collected. Children were assigned to the reading disabled group (RD) if their classroom reading level was below the Primer level and to the control group (C) if reading was at or above the First Grade reader. A similar age appropriate criterion, along with scores on standardized reading tests, was previously available for the 8.5 and 11 year old Ss.

To ensure the objectivity of group formation, four judges classified Ss on the basis of criterion group information for each project year available and the initial (KG) prediction of the Satz-Friel Screening Battery (cf. Satz et al., Note 2). Initial inclusion criteria constituted agreement of (1) reading level criterion during the year Ss received the language tests and (2) judges' classification. Because less criterial information was available for the 5.5 year group, potential Ss were excluded if the judges' classification (RD vs. C) was different from the prediction of the Satz-Friel Screening Battery. This additional requirement resulted in the exclusion of five potential controls who were predicted RD subjects (i.e., false positives). Sufficient information was available on the 8.5 and 11 year old groups so that group membership could be determined with considerable certainty. Additionally, a Peabody Picture Vocabulary Test (PPVT) IQ of at least 85 was required for the two older groups to screen out Ss with gross intellectual handicaps. Such a criterion was not used with the 5.5 year old group because of the unreliability of the PPVT IQ score at that age and possible bias in the youngest age group by screening out Ss with severe language handicaps. Table 1 presents the results of the selection process, including sample sizes, ages, PPVT IQ scores, SES levels, and mean criterion reading group. It should be noted that no significant Age effects or Age X Group interactions were obtained on PPVT, SES, and reading

TABLE 1

Descriptive Statistics by Age (5.5, 8.5, 11) and Group (Reading Disabled vs. Control)

Age	Group	N	AGE	SES	PPVT	Reading Group[a]
5.5	RD	11	65.09	1.45	92.91	1.27
	C	23	66.43	1.95	113.30	3.61
8.5	RD	12	105.25	1.67	101.33	1.42
	C	12	104.75	1.92	110.08	3.25
11	RD	12	130.75	1.75	101.58	1.25
	C	15	131.67	1.93	121.67	3.40

[a]Based on the following scale:

1 = Severe Reading Disability

2 = Mild Reading Disability

3 = Average Reading Ability

4 = Superior Reading Ability

group ($F > .05$). However, groups at each age level differed on reading group ($t < .05$), while the youngest reading groups (5.5) were significantly different on SES ($t < .05$). Overall, the effect of these sampling differences does not appear to bias significance tests in the direction of rejecting the null hypothesis.

Tests. The tests included a verbal fluency measure, two tests of morphological ability, and a measure of syntactic comprehension. None of these tests required the children to read. Verbal Fluency (Spreen, 1965) requires the child to encode (orally) under timed conditions as many words as possible denoting objects in different categories (e.g., rooms in the house, foods). Alternative forms were used at different ages to control for possible floor and ceiling effects. Verbal Fluency represented a reference point with previous cross-sectional studies (e.g., Satz, Rardin & Ross, 1971).

The ITPA Grammatic Closure subtest (Kirk, McCarthy, & Kirk, 1968) requires oral inflections of a variety of real words, thus assessing the child's ability to use plurals, possessives, and other grammatical morphemes. The Berry-Talbot Test (Berry, 1969) assesses the child's knowledge of English morphology by requiring inflection and derivation of nonsense words from various stimuli. Thus, for pluralization the child is shown a picture of a bird-like creature and told it is a "nad." Then, two of the pictured creatures are presented and the child is asked to

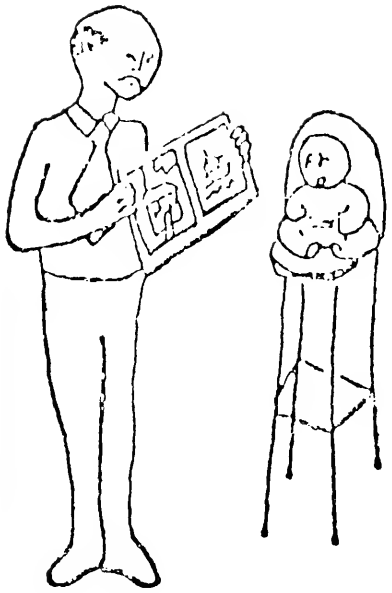
finish the sentence "There are two _____" (i.e., nads). Items and acceptable response for the Berry-Talbot Test are presented in Appendix 1. These morphological tests have been shown to tap linguistic skills developing primarily between ages 5 to 8 (Berko, 1958). Both tests have been administered to relatively older reading disabled children (Vogel, 1975; Wiig & Semel, 1976).

The Syntax Test (Scholes, Tanis, & Turner, 1977) assesses the child's ability to use syntactic clues based on the location and presence of the article "the" in the resolution of direct-indirect object constituents. As Table 2 indicates, these constituents are presented in several different ways. Two levels of Reading (I and II) are given, representing different locations of the direct and indirect objects. Within each level of Reading, two clues are given as to location, either presence of the Article (A) or substitution of a pause or Disjuncture (D). Three levels of derivational complexity are also presented under each Reading level. The Base form (B) is the basic unambiguous form of these sentences. The second set of linguistic forms (A and D) are more complex and present the ambiguity of direct-indirect object constituents. An additional pseudo-cleft transformation (AT and DT) was applied to these forms (A and D), making the Base form even more complex. This third structure is designed to ensure appropriateness of the measure for the older Ss.

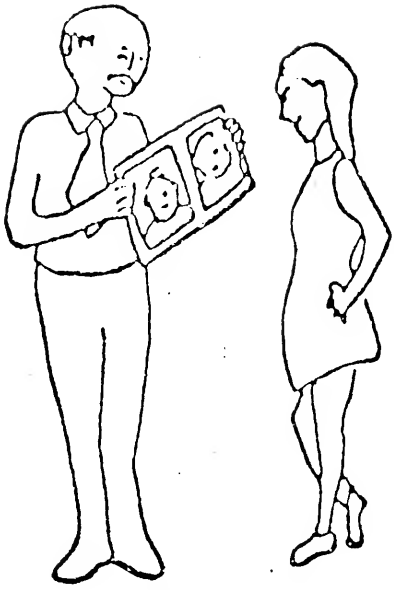
TABLE 2

Examples of Stimulus Sentences for Syntax Test

Reading	Clue	Sentence
I	B	He showed pictures to the girls' baby.
I	A	He showed the girl's baby the pictures.
I	D	He showed the girl's baby / pictures.
I	AT	It's the girl's baby the pictures were shown to.
I	DT	It's the girl's baby / pictures were shown to.
II	B	He showed baby pictures to the girls.
II	A	He showed the girls the baby pictures.
II	D	He showed the girls / baby pictures.
II	AT	It's the girls the baby pictures were shown to.
II	DT	It's the girls / baby pictures were shown to.
Ambiguous		He showed the girls baby pictures.



1



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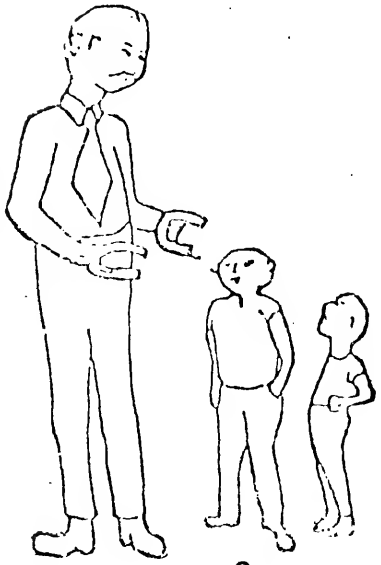

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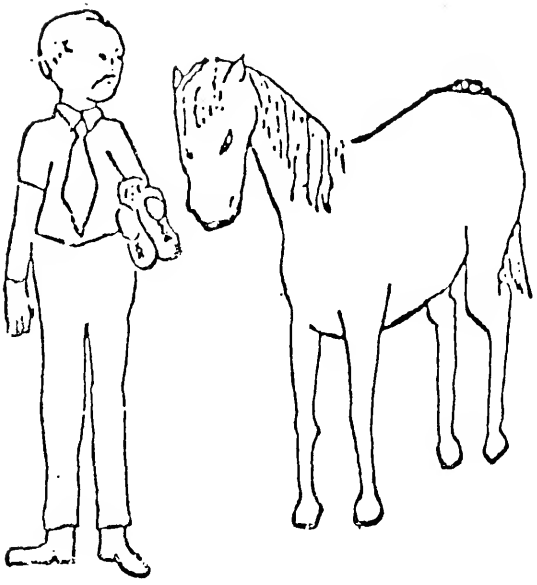

4

Fig. 1. Examples of Picture Stimuli for Syntax Test

Four pictures were given for each of the three sets of sentences (N=33). Two pictures represented the opposing types of Reading. To show how this test works, consider Figure 1 and sentences 2 and 7 in Table 2. Should a child fail to process the syntactic information by sentence 2 (picture 1), then the wrong type of Reading, sentence 7, would be selected (picture 3). The other two pictures (2 and 4) represent lexically inappropriate forms of the sentence stimulus. In the event of a failure to process the major lexical items or lack of attention, an equal probability for selection of an inappropriate sentence representation is embedded within the test. Additionally, an Ambiguous form (Amb) of these sentences with no clearly depicted interpretation was included to assess preference for one or the other levels of Reading (sentence 2 vs. 7).*

Testing Conditions. All Ss were tested individually in a quiet setting (usually in a mobile laboratory parked outside the school) by experienced examiners trained by the author. The order of testing was constant, as follows: Grammatic Closure, Berry-Talbot, Syntax, and Verbal Fluency. The 5.5 and 8.5 year old Ss were tested in the Fall and Winter of 1974-1975. The 11 year old Ss were tested in the Spring of 1976. Testing was performed without knowledge of the Ss reading group membership (RD vs. C).

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* This test has been used to measure the acquisition of syntax in a variety of normal and deaf samples (cf. Scholes, 1977).

CHAPTER IV

RESULTS

Test of overall significance. Because performance on the four dependent variables is correlated, a 3 x 2 multivariate analysis of variance was conducted on the four measures simultaneously. The MANOVA takes advantage of the dependent structure among correlated measures, making for greater power and control over Type I error rates (Hummell & Sligo, 1971; Timm, 1975). Results of this test indicated a significant Age effect ($F=138.20$; $df=2,79$; $p < .0001$), significant Group effect ($F=156.68$; $df=2,79$; $p < .0001$), and a significant Age X Group interaction ($F=9.42$; $df=2,79$; $p < .01$). Following the significant MANOVA, the relative contribution of each dependent variable to the obtained effect must be determined. Although both univariate F-tests (Hummell & Sligo, 1971) and Bonferroni t-tests for planned comparisons were used (Timm, 1975), the present analysis sought the linear composite of dependent variables maximizing these effects. Following a significant MANOVA, each dependent variable can be correlated with the derived discriminant function maximizing the effect. Higher correlations reveal a greater contribution to the observed effect. For the Age effect, approximately equal contribution of each measure was obtained. The two morphological measures, Berry-Talbot ($r=.88$) and Grammatic Closure ($r=.81$) had the greater contri-

bution to the Group effect, while Verbal Fluency (r=.72) and Syntax (r=.62) maximized the Age X Group interaction. This analysis indicates that only two measures, Verbal Fluency and Syntax, contributed to the interaction predicted by the hypothesis tested.

Univariate analyses of variance. To extend interpretation of the MANOVA, separate 3 x 2 univariate ANOVA's were conducted on each dependent measure separately and are contained in Table 3.* Specific planned comparisons (q=9) were also completed using Bonferroni t-tests on each dependent and are presented in Appendix 3. In each case comparisons between each level of age within RD and C groups were made (q=6), along with comparisons between groups at each age (q=3). Comparisons were considered significant if mean differences were greater than the critical value of Bonferroni's t at the .05 level. It should be noted that this comparison procedure always keeps the critical value of alpha at or below the experiment-wise alpha level, thus lowering the probability of Type 1 errors (Timm, 1975). These results are not presented in detail and the reader is referred to Appendix 3 for specifics.

For Verbal Fluency, results from the univariate ANOVA indicated a significant Age effect ($F=72.49$; $df=2,79$; $p < .0001$), significant Group effect ($F=9.87$; $df=1,79$; $p < .002$) and a

*Basic descriptive data are presented in Appendix 2 which should be consulted regarding variability and the adequacy of test floors and ceilings. These data are not specifically presented because of the detail, except where this information is essential.

TABLE 3

Summary of Univariate Analyses of Variance Results for Four Language Measures by Age (5.5, 8.5, and 11) and Reading Group (Reading Disabled vs. Control)

		Verbal Fluency		Berry-Talbot		Grammatic Closure		Syntax	
Source	df	F	Prob > F	F	Prob > F	F	Prob > F	F	Prob > F
AGE	2,79	72.49	.0001	49.64	.0001	70.17	.0001	51.51	.0001
GROUP	1,79	9.87	.002	46.43	.0001	39.43	.0001	5.38	.02
AGE*GROUP	2,79	4.94	.01	1.10	.34	<1	--	4.56	.01

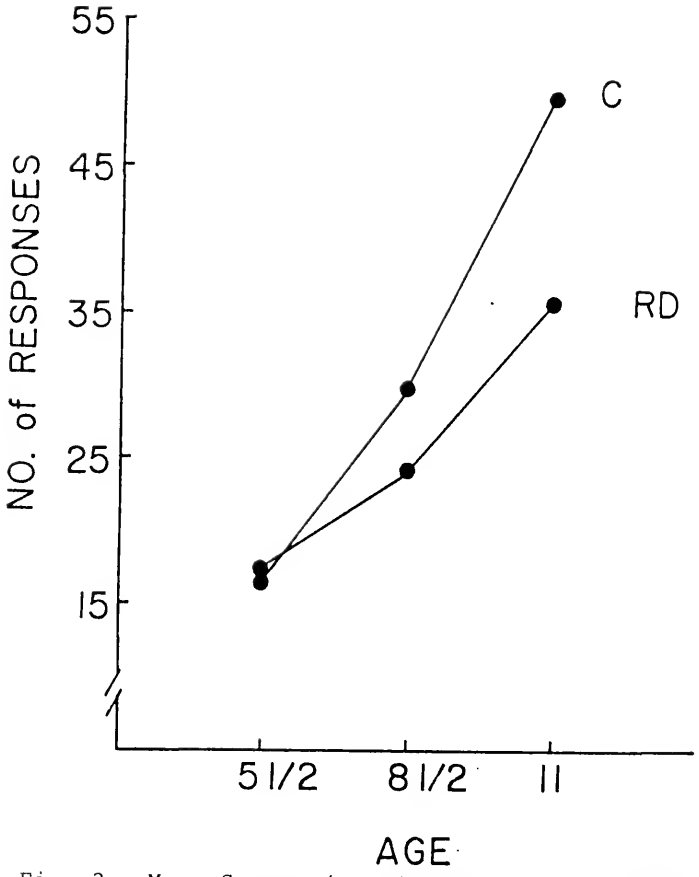

Fig. 2. Mean Scores (No.of Responses) on Verbal Fluency Test by Age (5.5, 8.5, 11 years) and Group (Reading Disabled vs. Control).

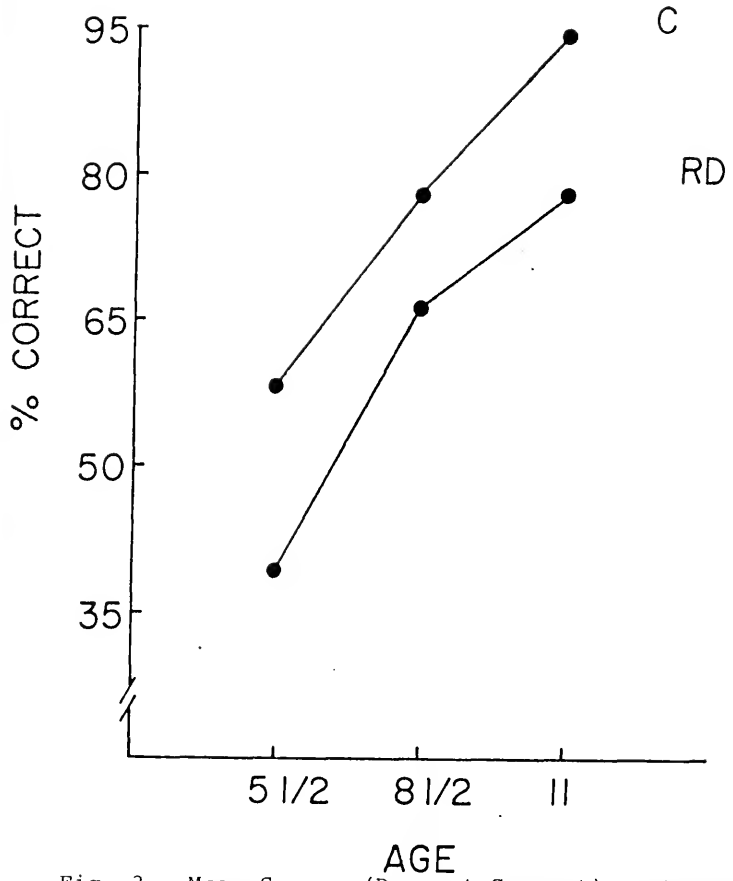

Fig. 3. Mean Scores (Percent Correct) on Berry-Talbot Test by Age (5.5, 8.5, 11 years) and Group (Reading Disabled vs. Control).

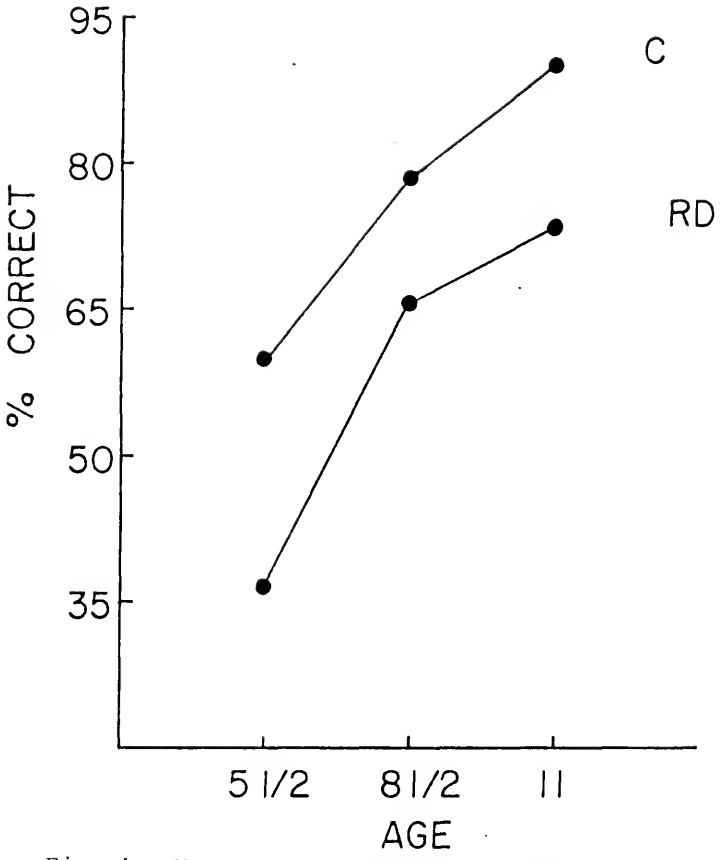

Fig. 4. Mean Scores (Percent Correct) on ITPA Grammatic Closure Subtest by Age (5.5, 8.5, 11 years) and Group (Reading Disabled vs. Control).

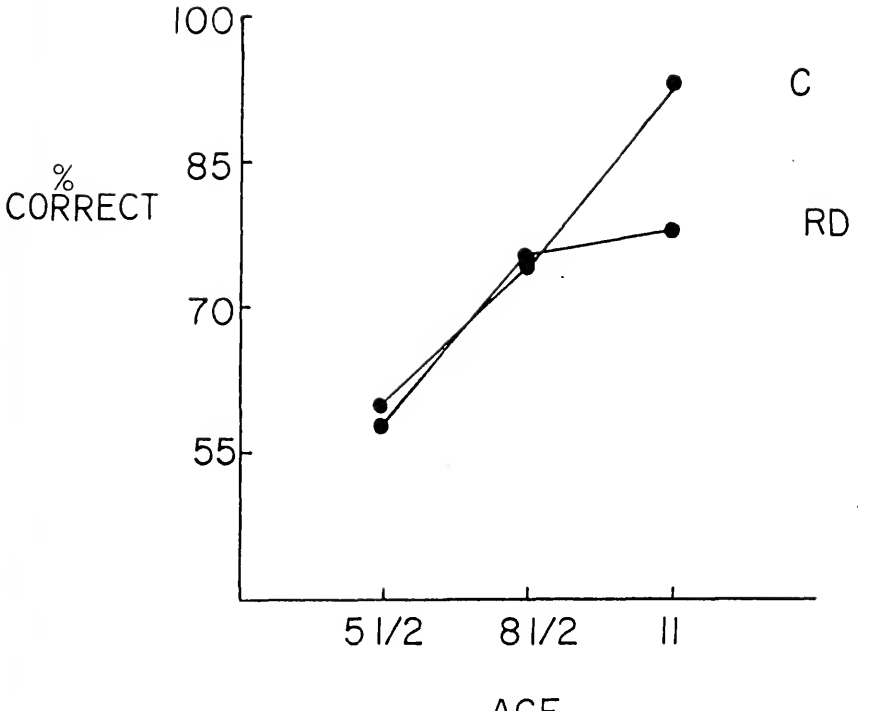

Fig. 5. Mean Scores (Percent Correct) on Syntax Test by Age (5.5, 8.5, 11 years) and Group (Reading Disabled vs. Control).

significant Age X Group interaction ($F=4.94$; $df=2,79$; $p < .01$). Figure 2 shows that differences across all three ages were significant. However, despite the trend towards increased between-group differences across age, only at age 11 were the differences between groups statistically significant (cf. Appendix 3). Performance at age 11 was poorest for the RD group.

Results for the two morphological measures were somewhat different. As Table 3 indicates, significant differences across ages ($p < .0001$) and between groups (p .0001) were apparent. However, there was no Age X Group interaction ($F < 1$), indicating a parallel performance between groups across age. Figure 3 (Grammatic Closure) and Figure 4 (Berry-Talbot) summarize these findings. The figures show that differences across all ages and between groups at each age were significant, with lower performance by the RD group at each age. However, the rate of development was parallel across age, hence the absence of an Age X Group interaction.

The variable of major theoretical interest in this study is the Syntax Test. Figure 5 displays the direction of the overall results. As Table 3 indicates, there was a significant Age effect ($F=51.51$; $df=2,79$; $p < .0001$), significant Group effect ($F=5.38$; $df-1,79$; $p < .02$), and significant Age X Group interaction ($F=4.56$; $df-2,79$; $p < .01$). Figure 5 shows the direction of this interaction: Increased differences between groups across age. Indeed, although differences across all ages were significant, reading groups

differed only at age 11, with the RD group performing more poorly (cf. Appendix 3). This finding did not emerge as a function of floor effects. Both groups at the younger age were correct in 60 percent of their responses. Furthermore, group differences were not apparent at the 8.5 year level, when both groups were correct on 85 percent of their responses.*

Additional analyses: Berry-Talbot. The purpose of these analyses was to explore some of the linguistic determinants underlying performance. For this analysis Berry-Talbot scores were divided into Inflected and Derived subscores. Stimuli were scored as Inflected when the morphological operation required did not change the word class of the stimulus (e.g., as in noun pluralization). Derived scores reflect a change in word class, e.g., changing the noun "spot" to the adverb "spotty." Derivation is a more complex linguistic operation and may have a slower rate of development. The major question addressed was the possibility of different performance between groups as a function of the morphological operation required (Inflected vs. Derived). The question was treated as a multivariate problem with two correlated measures in a 3 x 2 design. A MANOVA across the two measures indicated a significant Age effect ($F=63.77$; $df=2,79$; $p < .0001$) and Group effect ($F=45.89$; $df=1,79$; $p < .0001$). The Age X Group

*For further information concerning the floors and ceilings of the tests used, consult Appendix 2.

interaction was not significant ($F=2.84$; $p < .10$). A univariate ANOVA on Inflected scores revealed only significant Age ($F-33.25$; $df=2,79$; $p < .0001$) and Group ($F=46.20$; $df=1,79$; $p < .0001$) effects, with between group performance parallel across ages. For Derived scores, significant univariate Age ($F=39.96$, $df=2,79$; $p < .0001$) and Group $F=8.77$; $df=1,79$; $p < .004$) effects were observed. Although there was no Age X Group interaction ($F<1$), between group differences were significant only at the 8.5 and 11 year old ages. This finding probably reflects a floor effect for Derived stimuli at the 5.5 year age, thus documenting the complexity of the Derivation task.

Additional analyses: Syntax Test. A second set of analyses explored the underlying dimensional performance on the Syntax Test. The major question concerned the role of later acquisition of structural forms embedded within the Snytax Test (cf. Table 2) in producing the between group differences at the 11 year age. The first analysis compared performance as a function of the two levels of Reading. Reading I is acquired and later in childhood than Reading II (Scholes, Tanis, & Turner, 1977; Suarez, Note 9). A MANOVA across Readings revealed a significant Age effect ($F=63.54$; $df=2,79$; $p < .0001$), a significant Group effect ($F=4.88$; $df=1,79$; $p < .05$) and an Age X Group interaction ($F=4.23$; $df=2,79$; $p < .05$). Subsequent univariate ANOVA's for Reading I produced an Age effect ($F=11.93$; $df=1,79$; $p < .0001$), marginally

significant Group effect ($F=3.59$; $df=1,79$; $p < .05$) and an Age X Group interaction ($F=3.18$; $df=2,79$; $p < .05$). For Reading II, only the Age effect was significant ($F=37.89$; $df=2,79$; $p < .0001$). Thus, as Figure 6 shows, the interaction between Age and Group was apparent largely on the later developing Reading I stimuli.

The next question concerned the development of the different structural forms within Reading I and II and their contributions to the Age X Group interaction observed on the Syntax Test. A separate study (Suarez, Note 9) explored performance on the Syntax Test in a much larger sample (N=192) of normal children unselected for reading ability. Three age groups (5.5, 8.5, and 11.5) were used, with performance on the Syntax Test largely comparable with that of the control Ss in the present study. Suarez (Note 9) also showed that the Base forms (Reading I and II) were acquired earliest, while the Disjuncture forms (ID and IDT) were acquired latest.

To explore this question, a MANOVA was conducted across the 10 sentence types. Then each dependent variable was correlated with the discriminant function derived for the overall effect. Because the discriminant function represents the linear combination of variables maximizing an effect, higher correlations indicate a greater relative contribution to the observed effect (Timm, 1975). This approach circumvented problems associated with high Type I error rates with the number of dependent F-tests and simultaneous comparisons

otherwise involved in interpreting the MANOVA.

The MANOVA across the 10 sentence types revealed a significant Age effect ($F=81.25$; $df=2,79$; $p < .0001$), Group effect ($F=11.54$; $df=1,79$; $p < .01$) and a significant Age X Group interaction ($F=11.07$; $df=2,79$; $p < .01$). The highest correlations with the discriminant function could be ranked as follows: ID ($r=.62$), IDT ($r=.52$), IAT ($r=.37$), and IA ($r=.33$). This ranking shows that the major contribution to the Age X Group interaction observed on the Syntax Test was made by Reading I sentence structures. Also, the degree of contribution corresponded exactly to the order of acquisition observed by Suarez (Note 9).

A final analysis concerned the Ambiguous forms of the sentences and is important in understanding preference for Reading I vs. Reading II. Because Reading II stimuli are probably more frequently heard in conversation, preference for this Reading is likely to be observed (Scholes, Tanis & Turner, 1977). Figure 7 shows the direction of changes in preference across age and by group. It is apparent that these changes were non-linear, which was also apparent in Suarez (Note 9), represented in Figure 7 as the Standardization (S) group. The major finding here is that when Reading I was preferred, marginally significant univariate Group effects were observed ($F=3.65$; $df=1,79$; $p < .06$), but no Age effect or Age X Group interaction. Inspection of Figure 7 shows that although choices on the Ambiguous forms were non-linear and parallel across the younger groups, differences emerged between the 11 year old groups. Here the control group indi-

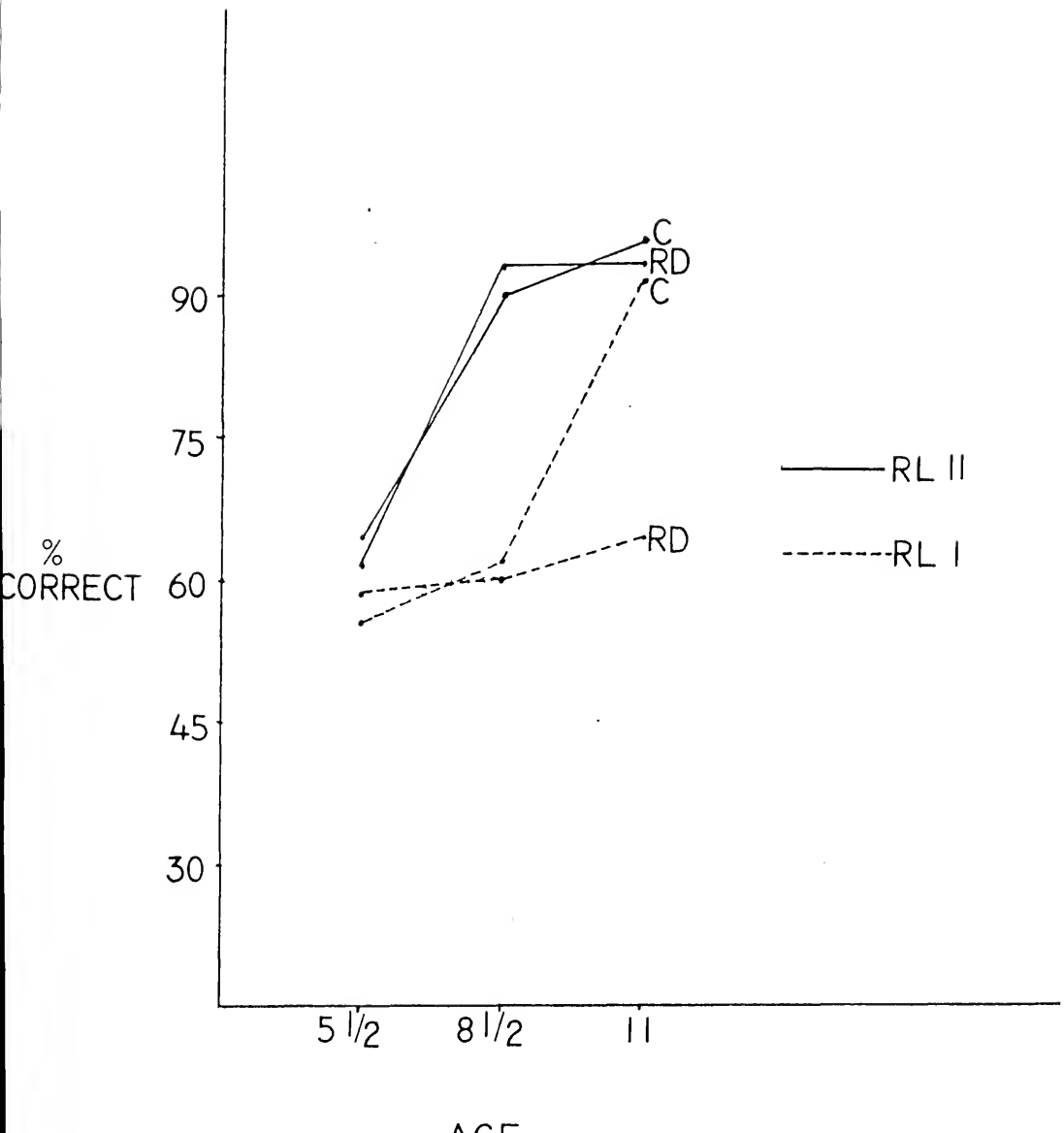

Fig. 6. Mean Scores (Percent Correct) on Reading Levels I and II (Syntax Test) by Age (5.5, 8.5, 11 years) and Group (Reading Disabled vs. Control).

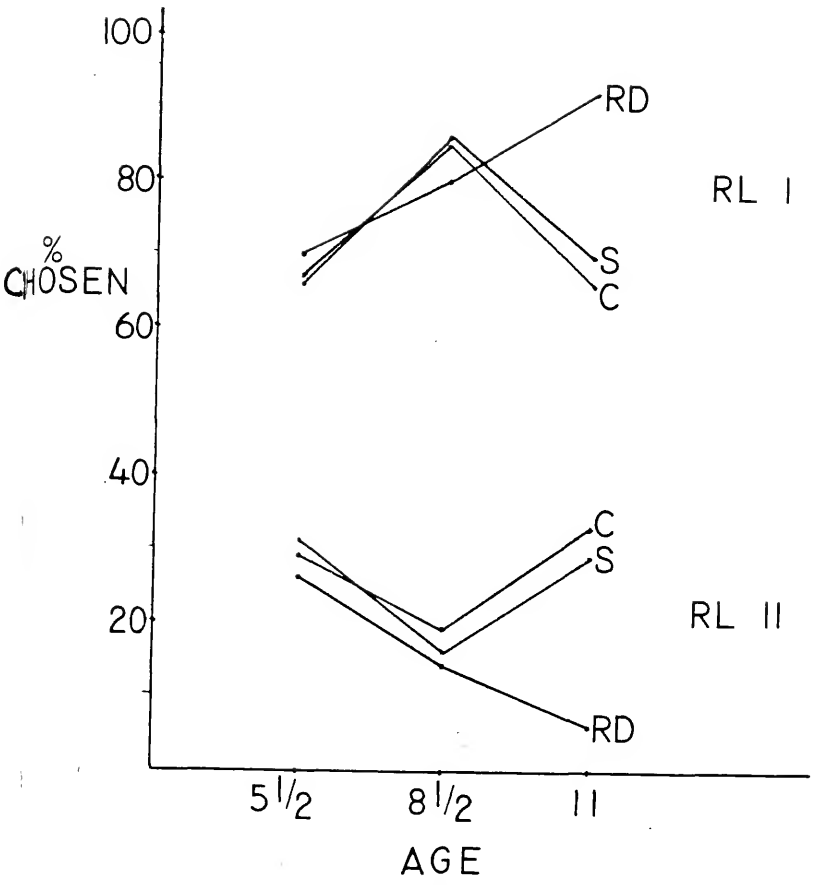

Fig. 7. Preferred Interpretations (Reading Level I vs. II) of Ambiguous Sentences (Syntax Test) by Age (5.5, 8.5, 11 years) and Group (Reading Disabled vs. Control).

cates a continued increase in preference for Reading I interpretations, while the reading disabled group shows no such increase, preferring Reading I interpretations at about the same frequency as their 5.5 year old counterparts.

DISCUSSION

The present study provides some additional evidence for developmental changes in the linguistic performance correlates of reading disabilities. Although reading group differences in language processing were obtained across several ages, the magnitude of these differences varied with chronological age. In this respect, the results were consistent with a hypothesis advanced by a theory of developmental reading disorders (Fletcher & Satz, Note 3; Satz et al. Note 2; Satz & Sparrow, 1970; Satz & Van Nostrand, 1973) which predicts larger differences in linguistic function between older disabled and nondisabled readers. These results were also compatible with several longitudinal-predictive follow-up studies (cf. Fletcher and Satz, Note 3; Satz et al., Note 2) and cross-sectional studies (Satz, Rardin & Ross, 1971; Satz & Van Nostrand, 1973; Sparrow & Satz, 1970) which employed language tests primarily sensitive to semantic-conceptual skills (e.g., verbal fluency, dichotic listening, vocabulary, and abstract reasoning). These studies uniformly showed that measures of language processing contributed more to the discrimination of reading level at older ages (10-14 years) than younger ages (5-7 years).

Perhaps equally intriguing is the indication from the present study that performance differences seemed age-dependent only on certain types of language measures. Verbal Fluency and the Syntax Test made the major contribution to the multivariate Age X Group interaction, while group differences on the two morphology measures were essentially parallel across age. Some insight into this latter finding is afforded when the relationship of these two tests and the PPVT is examined. Correlating the morphological measures and the PPVT in the 1974 kindergarten sample (N = 120) showed that these measures shared similar variances ($r > .70$). In view of the large differences in PPVT IQ between reading groups across the three ages (cf. Table 1), group differences on the morphology measures may reflect more of a general verbal comprehension and intellectual deficit often noted in reading disabled groups (Eisenberg, 1966). Vocabulary tests are the best single measures of general intelligence ("g") and the PPVT IQ score does correlate substantially with, for example, WISC Verbal IQ scores (about .75; Buros, 1973).

Factor analyses of vocabulary tests place them on a general Verbal Comprehension factor. Similar findings are apparent for factor analyses of the Grammatic Closure subtest, which also tends to load on a general Verbal Comprehension factor, along with measures of vocabulary and reading comprehension (Newcomer & Hammill, 1975). Recent studies of the relationship of a factor composed of vocabulary, abstract reasoning, verbal fluency, and dichotic listening tests to

reading achievement (Satz et al., Note 2; Fletcher & Satz, Note 3) have shown that this construct dimension contributes more to the discrimination of reading level at older ages than younger ages. These findings emerged despite the presence of univariate group differences on these measures at all ages (5-11 years) considered. Therefore, even though group differences are readily observed at all ages on measures such as the PPVT and the morphological measures, these skills contributed less to the discrimination of reading level at younger ages than other types of linguistic and nonlinguistic skills.

The age-dependent relationship observed for Verbal Fluency and the Syntax Test appears to be multiply determined. Thurstone (1955), in a series of prospective and cross-sectional studies, showed that a Verbal Fluency factor peaked some eight years after a Perceptual Speed factor. In this respect, the age dependent relationship observed for the Verbal Fluency measure used in this study and other studies (Satz et al., 1971 ; Satz & Van Nostrand, 1973) may reflect the later ontogenetic development of this skill. Similar interpretations can be provided for the Syntax Test. On linguistic forms which are acquired earlier (i.e., Reading II stimuli), no group differences were observed at any age. This was apparent even when Ss (age 8.5) were correct on 85 percent of their responses. However, group differences and an Age X Group interaction suggesting poorer performance by older reading disabled Ss were apparent on the later developing

Reading I stimuli. If differences in language function between normal and disabled readers are independent of age, then the absence of differences on earlier developing Reading II stimuli and the contrasting Age X Group interaction on later developing Reading I stimuli is difficult to explain.

The fact that the latest developing stimuli under Reading I (ID and IDT) made the greatest contribution to the age-dependent relationship buttresses these findings. Disjuncture stimuli are more susceptible to misinterpretation because of the pause than linguistic forms which include the article. Furthermore, all Ss showed a distinct preference for Reading II interpretations of the Ambiguous stimuli. This preference suggests the presence of a comprehension strategy (Scholes, Tanis, & Turner, 1977) which leads to better performance on Reading II stimuli and a bias for misinterpretation of Reading I disjuncture stimuli--hence the later acquisition of Reading I stimuli. At the oldest age, however, reading groups differed in their preferences for alternative interpretations (I vs. II) of the Ambiguous stimuli, with disabled readers showing an even greater preference for Reading II interpretations. Greater preference suggests increased reliance on the comprehension strategy, which would lead to more errors on the Reading I disjuncture stimuli by the 11 year old poor readers. Thus, it might be hypothesized that language skills continued to develop in the control group, which led to less reliance on the comprehension

strategy and better performance on Reading I stimuli. The older disabled readers, however, may have experienced difficulty in the acquisition of later developing language skills. Over-reliance on a comprehension strategy which produced large group differences on the ID and IDT stimuli would be the result.

Despite these findings and hypotheses, the fact remains that performance on certain types of language skills were related to reading achievement at all ages. While this relationship was less robust at earlier ages than other types of measures, factors in addition to ontogenetic sequence of development may underlie the differential performance correlates associated with reading disability. In this respect, Fletcher and Satz (Note 3, Note 5) argued that the nature of the skill (perceptual vs. linguistic) may be less important for discriminating reading level than the child's developmental readiness for meeting the task demands of reading at different ages. In the present study, reading group differences were more prominent at older ages. At the older age, linguistic skills, especially those measured by the Syntax Test, are important underlying components of the comprehension strategies characteristic of fluent readers (Gibson & Levin, 1975; Smith, 1971). Gibson and Levin (1975) noted that the use of grammatical skills to process units of information in reading units larger than the word, comes into prominence around Grade 4. Therefore, the age-dependent relationships observed in this study may reflect the later development of

the skills measured and the greater importance of higher order linguistic strategies for later stages of learning to read.

This interpretation is buttressed by studies which show age-dependent relationship for those earlier developing linguistic skills important for earlier stages of reading acquisition. For example, phonetic segmentation skills (Liberman and Shankweiler, 1976) are important components of the decoding process characteristic of beginning readers. Moreover, Gibson and Levin (1975) have noted that the major period of development for these linguistic skills occurs between ages 5 to 8. From the developmental perspective (cf. Fletcher & Satz, Note 5) differences between younger reader groups are more probable on skills which develop earlier and are intrinsic to earlier stages of reading acquisition. At later ages, reader group differences are more probable on skills which develop later and are intrinsic to more advanced stages of reading acquisition. Although many advances in theory and research are needed to investigate this hypothesis, it does provide an alternative to interpretations based on some sort of unitary deficit hypothesis (e.g., Vellutino, Note 1).

Interpreting the performance correlates of reading disability is a complex problem. Different age-dependent relationships are apparent for different linguistic skills as a function of their ontogenetic sequence of development and importance for learning to read. Even so, caution must be exercised regarding this interpretation. Problems with construct validity were apparent for many of the tasks used to show

change. These problems concern limitations not only with defining the measurement characteristics of these tasks, but also with the general lack of theoretical agreement on the constructs which should be measured. Resolution of these problems await considerable progress in theory and research on the nature and development of language, reading, and human ability (Doehring, Note 7).

The present dissertation also illustrates the value of interpreting deficient linguistic skills within the context of theory concerning the reading process and reading acquisition. The failure to relate deficit skills to actual reading behavior constitutes one of the major shortcomings of traditional neuropsychological approaches to reading disability (Bender, 1957; Orton, 1937; Rourke, 1975; Satz & Sparrow, 1970). These approaches attempt hypotheses based on deficient skills and a hypothetical construct implying brain dysfunction (e.g., "incomplete cerebral dominance," or "maturational lag"). The validity of these hypothetical constructs is inferred on the basis of the relationship of the pattern of deficits to a model of brain function--not a model of reading behavior. As such, the hypothetical construct can predict only the pattern of deficits, which does not necessarily imply predictiveness for the actual reading problem. If these hypothetical constructs were postulated so that they mediated two different observable events, the reading problem and the pattern of subskill deficits, the inferential quality of these constructs might be improved. More importantly, broader aspects of the problem could be incorporated within the theory. Such an

approach is represented by the attempt in this discussion to relate age-linked linguistic performance changes in disabled readers to models of reading and reading acquisition and to the general concept of developmental readiness. Developmental readiness could be construed as a hypothetical construct representing brain maturation which mediates the actual reading problem and the age-linked developmental deficit. Again, these intriguing hypotheses require considerable progress in theory and research concerning reading, language, the central nervous system, and their development.

APPENDICES

APPENDIX 1

Scoring Key for Berry-Talbot Test of Morphology

ITEM	CORRECT RESPONSE	GRAMMATICAL OPERATION
1	NADS	Plural (I)
2	CUBASHES	Plural (I)
3	TROMMED	Past Tense (I)
4	LUTZES	Plural (I)
5	FLITCHED	Past Tense (I)
6	NADDY, NADLING, NADLET	Diminutive (D)
7	NADHOUSE	Compound (D)
8	GOOBS	Plural (I)
9	TROPPY, TROPPED	Adverbalization (D)
10	GANS	Plural (I)
11	SPUZZES	Plural (I)
12	ROUTED	Past Tense (I)
13	ROUTER	Derived Noun (D)
14	DOWS	Plural (I)
15	FOOZES	Plural (I)
16	HOWTED	Past Tense (I)
17	GISHES	Third Person Singular (I)
18	GEIFS	Plural (I)
19	TASSES	Plural (I)
20	LINGED, LANG	Past Tense (I)
21	LINGER	Derived Noun (D)
22	GIZZLES	Third Person Singular (I)
23	BAZINGED, BAZANG	Past Tense (I)
24	SPUZ'S	Singular Possessive (I)
25	SPUZZES'	Plural Possessive (I)
26	SINGED, SANG	Past Tense (I)
27	SINGER	Derived Noun (D)
28	NAD'S	Singular Possessive (I)

ITEM	CORRECT RESPONSE	GRAMMATICAL OPERATION
29	NADS'	Plural Possessive (I)
30	TROPPIER	Comparative (I)
31	TROPPIEST	Superlative (I)
32	GLIPPING	Progressive (I)
33	GLIPPER	Derived Noun (D)
34	DOW'S	Singular Possessive (I)
35	DOWS'	Plural Possessive (I)
36	MELTED	Past Tense (I)
37	LIGGY	Adverbalization (D)
38	LIGGIER	Comparative (I)
39	LIGGIEST	Superlative (i)
40	BINING	Progressive (I)
41	BINER	Derived Noun (D)
42	LUDGES	Plural (I)
43	LUDGE'S	Singular Possessive (I)
44	LUDGES'	Plural Possessive (I)
45	LUDGISH, LUDGY	Derived Adverb (D)
46	FROWISH, FROWY	Derived Adverb (D)
47	FRANDS	Present Participle (D)
48	IS CRUDGING	Third Person Singular (I)

APPENDIX 2

Means, Standard Deviations, and Ranges for Six Language Variables by Age (5.5, 8.5, 11) and Group (Reading Disabled vs. Control)

Age	Group	Verbal Fluency			Berry-Talbot[c]			ITPA Grammatic Closure[d]		
		$\bar{X}$	SD	RANGE	$\bar{X}$	SD	RANGE	$\bar{X}$	SD	RANGE
5.5	RD	17.28	3.85	12-24[a]	17.28	7.55	7-35	13.00	4.17	5-19
	C	16.96	4.23	11-29	27.83	5.05	20-36	19.39	4.04	14-30
8.5	RD	24.42	7.95	13-37[b]	30.00	6.80	16-40	22.08	4.21	13-29
	C	29.42	9.89	18-51	36.25	3.82	26-40	25.67	3.82	16-32
11	RD	35.83	9.81	24-56[b]	33.92	6.61	20-42	25.58	4.14	18-32
	C	49.80	13.08	28-76	41.53	2.29	38-46	30.93	1.03	28-32

		Syntax[e]			RLI[f]			RLII[f]		
		$\bar{X}$	SD	RANGE	$\bar{X}$	SD	RANGE	$\bar{X}$	SD	RANGE
5.5	RD	17.37	2.50	13-21	8.45	3.80	3-15	8.91	3.73	2-13
	C	18.09	3.33	13-24	8.35	3.02	4-15	9.74	2.75	4-14
8.5	RD	22.75	4.11	16-28	8.91	4.05	2-14	13.83	4.05	2-14
	C	22.25	3.13	17-26	9.25	3.23	2-13	13.00	1.48	10-15
11	RD	23.50	3.68	16-29	10.08	3.32	2-14	13.67	1.23	11-15
	C	28.07	1.62	25-30	13.93	1.44	10-15	14.13	.92	13-15

[a] Form I

[b] Form II

[c] Max Score = 48

[d] Max Score = 33

[e] Max Score = 30

[f] Max Score = 15

APPENDIX 3

Summary of Bonferroni T-Tests for Planned Comparisons

COMPARISON		TEST					
RD	C	WF	GC	BT	SYN	RLI	RLII
5.5- 8.5		7.14*	9.08*	12.72**	5.39**	.47	4.92**
8.5-11.0		11.41**	3.50*	3.92**	.75	1.16	.16
5.5-11.0		18.55**	12.58**	16.64**	6.14**	1.63	4.76*
	5.5- 8.5	12.46**	6.28**	8.42**	4.16*	.90	3.26*
	8.5-11.0	20.38**	5.26**	5.28**	5.81**	4.68**	1.13
	5.5-11.0	32.84**	11.55**	13.70**	9.97**	5.58**	4.39*
5.5	5.5	.32	6.39**	10.55**	.73	.10	.83
8.5	8.5	5.00	3.59*	6.25**	.50	.32	.83
11.0	11.0	13.97**	5.35**	7.61**	4.56**	3.85**	.83

*$p < .05$

**$p < .01$

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BIOGRAPHICAL SKETCH

On a cool gray morning (e.g., August 27, 1952) the bleating cry of a little boy wailed across the cliffs overlooking the Gracie River. His parents, recently acquired, lived in the cool gray mansion shrouded in mist like New York City and walked about gray decaying rooms in gay daze. At last, an heir!--as their withered faces may well have expressed.

But it was not to be. Almost at once the child began to run amuck. Slowly at first, then more and more muckier. Everyone said: This boy needs a shrink. Father said: I need a shrink. As the boy's childhood home began to rot, mother said: You're right. One night, while walking the gray walls of the old mansion in Upper Elmira County, the boy heard them. At once in his imbecilic stupor a devious thought entered his mind: I'll become a shrink!

The great plan was set in motion. Father became aggressive and demanding; Mother: whiny and demanding. First exposure to behavior modification: Mr. Tole's paddle, awesomely long (five feet), and made from two split Louisville Sluggers with the four halves pasted together. It often splintered. Mr. Smith introduced the world of psychodynamics to the boy by interpreting his affect like this: "You're angry" or "you're running amuck." Psychotherapy: running from Mr. Tole into Mr. Tole and accepting a Valium from Jean, the school nurse.

It worked. The boy went to Graduate School. Although he continued to run amuck, he received an M.A. for a study concerning the influence of airplane glue on the MMPI interpretations of professional psychologists. His Rorschach shows signs of increasing disorganization (possible Valium addiction), but this is his dissertation.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the Degree of Doctor of Philosophy.

Paul Satz, Chairman
Professor of Clinical Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the Degree of Doctor of Philosophy.

Hugh C. Davis
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the Degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the Degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the Degree of Doctor of Philosophy.

Robert J. Scholes
Professor of Speech

This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Arts and Sciences and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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