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ERRORS IN RECALLING SENTENCES AS AN INDICATOR OF PROCESSING DEFICITS AND READING IMPAIRMENT IN CHILDREN WITH PSYCHIATRIC DISORDERS

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ABSTRACT

Objectives: There are three major goals to the present study: 1) to study the nature of errors in recalling sentences: 2) to investigate how specific errors in recalling sentences relate to expressive grammatical deficits and reading impairment: and 3) to make suggestions for the design of a pilot screening test that could predict processing and reading deficits.

Method: Subjects were 45 children of normal intelligence, ages 8 to 13 years. The children presented with psychiatric disorders, and had been admitted to a day treatment and school program. The most prevalent diagnosis was attention deficit with hyperactivity and aggressive behaviour. A smaller proportion had adjustment and anxiety disorder. Excluded from the sample were severe cases of autism, schizophrenia and physical handicaps. Most of the children exhibited academic impairment and language deficits.

Assessments: The **recalling sentences**, **formulated sentences**, **sentence assembly**, and **sentence structure** subtests of the Clinical Evaluation of Language Fundamentals (**CELF-R**) were administered, as were the **reading decoding** and **reading comprehension** subtests of the Kaufman Test of Educational Achievement (**K-TEA**). To investigate relationships between errors in **recalling sentences** and grammatical deficits and reading impairment, the following statistical analyses were used: correlation, multiple regression, chi-square and kappa analyses.

Results: In **recalling sentences**, errors involving content words occurred more frequently than errors involving grammatical words. Words with a large number of associatives, unfamiliar words, and less frequently occurring words were liable to omissions and substitutions. **Content omissions** affected mostly syntactically unsupported elements (e.g. adjuncts). Most **content** and **grammatical omissions** were words that do not assign thematic roles or have thematic roles assigned to them. **Content substitutions** affected

mostly arguments (e.g., subjects or complements). Most of the substituted words were synonyms of the target word. Deficits in processing and **timing**, in particular, were identified as possible contributors to **content omissions** and **substitutions**.

Grammatical errors occurred in syntactically complex sentences (mostly relative clauses) and affected functive words and expanded auxiliaries. **Grammatical omissions** were more often associated with processing errors, while **grammatical substitutions** were associated with syntactic deficits. Two types of errors were associated with reading deficits: **content omissions** and **grammatical substitutions**. They accounted for 44% of variance in **reading comprehension** and 31% of variance in **reading decoding.**

Conclusion: The findings of the present study, together with an extensive literature review, indicated that sentence recall is a complex task involving both processing and verbal memory, and that it can be used to predict processing deficits and reading disability. Recommendations are made as to the type of sentences to include in a pilot screening test that could predict processing and reading deficits.

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INTRODUCTION

1.1 Rationale for Investigating Sentence Repetition

The present investigator has observed, both in clinical practice with children attending special education classes and as co-investigator in two research projects (Kotsopoulos and Boodoosingh, 1987; Kotsopoulos et al., 1996), that children experiencing academic and language problems often fail a test which requires repetition of sentences. Although the repetition task appears simple, the linguistic processes involved are probably quite demanding. To date, the role of this test in assessing language deficits and its possible usefulness in predicting reading impairment has not been explored.

Deficits in repeating sentences were observed in both studies cited above. In the first study (Kotsopoulos and Boodoosingh, 1987), 21 out of a sample of 46 children presenting with academic and language disorders exhibited deficits in sentence repetition The second study (Kotsopoulos et al., 1996) showed that among several independent variables (socioeconomic level, family composition, behaviour measures, intelligence, and linguistic measures), **recalling sentences** and two other measures (**digit span** and **sentence assembly**) accounted for a significant proportion of the variance of scores in **reading decoding** (**.47**), **reading comprehension** (**.63**), and **spelling** (**.29**).[1]

The goal of the present study is to identify any underlying cognitive factor or factors which link poor performance in sentence repetition tasks with language deficits and reading impairment. To establish this link it will be necessary to carry out an extensive review of the literature pertaining to each of these relationships. We will begin by examining the literature on sentence repetition in assessing verbal memory, which will lead us into an indepth review of verbal memory functions and to an exploration of the

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[1] In addition to academic and language problems the children in both studies presented with psychiatric disorders (mainly behaviour problems). There was no relationship found between emotional/behaviour disorders and learning and language deficits. The behaviour/emotional aspects of subjects were thus considered outside the scope of the present study.

role of working memory (WM) in sentence repetition. This will be followed by a review of previous studies on sentence repetition in assessing grammatical competence, which in turn will bring us full circle back to the relationship of WM, language deficits, and reading impairment. Several hypotheses will then be proposed regarding the outcome of analyses of Kotsopoulos et al. (1996) subjects' performance on a number of tests, including sentence repetition tasks and measures of grammatical and reading ability.

What follows is a brief outline of the main lines of argumentation pursued through the review of the literature (see chapter 2).

1.2 Language Deficits and Reading Impairment

A number of studies have shown significant associations between language deficits and reading impairment (Vellutino, 1987; Wagner and Torgesen, 1987; Man and Brady, 1988; Swanson et al., 1990; Catts, 1996, Snowling, 1991). However, the nature of this association is not clearly understood.

Recent studies have attempted to identify specific linguistic and cognitive deficits that might underlie both language and reading impairment. Prominent among these are measures of repeating digits, words, and sentences, which have been reported to be associated with language deficits (Kirchner and Klatzki, 1985; Wiig and Semel, 1980; Gathercole and Baddeley, 1989c, 1990), as well as reading impairment (Hulme, 1988; Hulme and McKenzie, 1992; Swanson et al., 1990; Swanson, 1994; Leather, 1994). However, a satisfactory explanation is still not available for the nature of this association.

1.3 Sentence Repetition in Assessing Grammatical Competence and Verbal Memory Skills.

Sentence repetition has been used to assess grammatical and verbal memory functions. Specifically, it has been used to assess: **grammatical competence** (grammatical development and grammatical disability), **verbal memory** (short-term memory, auditory memory, working memory), **grammatical competence in second language acquisition,** and **conduction aphasia**. The assessment of grammatical competence and verbal memory will be examined below in brief.

1.3.1 Assessing grammatical competence

There is no agreement in the literature about the usefulness of sentence repetition as a measure of grammatical competence in children. Some researchers support the use of sentence repetition in the assessment of grammatical competence (Menyuk, 1963; Berry-Luterman & Bar, 1971) claiming that children can only repeat sentences containing grammatical structures that they have mastered in their spontaneous speech. Others caution that "systematic probes of imitation must be taken as a conservative estimate of the child's linguistic competence" (Slobin and Welsh, 1973; Connell & Myles-Zitzer, 1982). The absence of agreement about the value of sentence repetition as an assessment tool led to the abandonment of this as a sole task in assessing language competence.

1.3.2 Assessing verbal memory

There has also been limited interest in the use of repetition of sentences in the assessment of verbal memory (particularly short-term memory (STM)). Neurolinguistic studies of aphasic patients (McCarthy and Warrington, 1990) have shown dissociation between the ability to repeat lists of words or digits (a standard task in assessing STM) and the ability to repeat sentences, thus challenging the efficacy of repetition of sentences in assessing STM.

Although an examination of the literature reveals a great deal of controversy regarding use of repetition of sentences as an assessment tool for grammatical competence and short-term (STM) memory, studies in another area, that of WM, suggest a promising link between sentence repetition, linguistic deficits and reading.

1.4 Sentence Repetition and Working Memory

There is controversy in the literature regarding the terms STM and WM. They are used either indiscriminately or as two separate entities. WM is defined as memory that involves both storage and processing (Daneman, 1987; Kylonen and Christal, 1990, as cited by Swanson, 1994), while STM is considered verbatim memory that does not involve access to long term memory (Engle et al., 1992). Recent studies (Potter and Lombardi, 1990 and Lombardi and Potter, 1992) have challenged the belief that sentence repetition is verbatim memory, capable of assessing STM only. They have demonstrated that sentence repetition involves processing, which requires accessing of long term memory and regeneration of the sentence from its gist utilizing the individual's own sentence production mechanisms. Sentence repetition also involves storage, as the subject has to remember and recall the sentence verbatim. Thus sentence repetition may well rely on WM.

1.5 Working Memory

According to Baddeley, WM consists of three components: **The central executive** and two subordinated systems, the **articulatory loop**, and the **visuospatial scratch pad**.(See Review of Related Literature). The function of the **articulatory loop** is often identified with STM Most of the recent studies indicate that WM plays a significant role in the comprehension of language, particularly in the comprehension of longer and syntactically complicated sentences (Caramazza et al., 1981; Hasher and Zacks, 1988; Frisk and Milner, 1990; King and Just, 1991; Baum, 1993; Romani, 1994), in vocabulary development (Gathercole and Baddeley, 1989, 1990, 1990b), and in reading (Hulme and Mackenzie, 1992; Wagner et al., 1993; Swanson, 1994). Inadequate WM, on the other hand, has been associated with reading disability (Wiig & Roach, 1975; Swanson et al., 1990; Hulme and Mackenzie, 1992).

There is debate in the literature as to which of the components of WM are linked with language deficits and reading impairment. Some studies have identified dysfunction of the **articulatory loop** as responsible for deficits in comprehension of longer sentences (Crain et al, 1990; Baum, 1993; Romani, 1994), poor vocabulary development (Gathercole and Baddeley, 1989, 1990), and reading impairment (Wagner et al, 1993; Torgesen et al., 1994; Hulme and Mackenzie, 1992). Other studies suggest that the **central executive** might be responsible for reading deficits and poor academic performance (Swanson et al., 1990). Some studies have identified dysfunction of the phonological code in WM as responsible for reading and language deficits (Wagner et al., 1993; Torgesen et al., 1994; Swank, 1994, Gathercole and Baddeley, 1989, 1990) while others have shown speech rate or **timing** as responsible for reading and language deficits (Hulme and McKenzie, 1992; McDougal et al., 1994, Tallal et al., 1985, 1996). These issues are addressed in the current study and reexamined in the discussion of its findings.

1.6 The Potential Contribution of the Present Study

By focusing on errors the children make when repeating sentences, rather than on numerical scores based on the repetition of the whole sentence, the present study could provide greater insight into the factors underlying sentence repetition and may help clarify the role of WM in language deficits and reading impairment. Furthermore, the findings of the study could have practical applications in testing of and therapy for language and reading disorders.

The chapters of the thesis which follow are: **CHAPTER II: REVIEW OF RELATED LITERATURE. CHAPTER III: METHODOLOGY. CHAPTER IV: RESULTS. CHAPTER V: INTERPRETATION OF RESULTS AND DISCUSSION. CHAPTER VI: CONCLUSIONS.**

CHAPTER II

REVIEW OF RELATED LITERATURE

2.0 Sentence Repetition in the Testing of Verbal Memory Language Deficits and Reading Impairment

As was mentioned in the introduction, the relationship between language deficits and reading impairment is well documented in the literature. Reading, particularly reading comprehension, relies not only on intact phonological processing skills but on higher-level language processing which includes semantic, syntactic, morphological and pragmatic operations. Catts (1989a) and Kamhi and Catts (1989 as cited by Catts, 1996) go as far as to consider dyslexia a developmental language disorder. A general review of the literature on the relationship between language deficits and reading impairment is not warranted here, as the focus of the present study is on the relationship of sentence repetition with verbal memory, language deficits and reading impairment.

The organisation of the chapter will be as follows: In the first section of the chapter, the different types of verbal memory (e.g., **short-term memory**, **auditory memory**, **working memory**) will be described and the use of sentence repetition in testing these memories will be discussed. This will lead us to an exploration of the characteristics of verbal memory and to suggestions as to the type of memory involved in sentence repetition. In the second section of the chapter, previous studies on the use of sentence repetition in assessing grammatical development and grammatical disability will be reviewed and the role of working memory in sentence repetition will be explored. In the third section, studies and theories on the relationship of sentence repetition and reading comprehension and decoding will be presented and the relationship of working memory and reading ability and impairment will be examined. Finally, the hypotheses of the study will be proposed.

2.1 Sentence Repetition in Testing Verbal Memory

2.1.1 Short term memory

Interest in short-term memory (STM) goes back to the 1890s. The first recorded experiments on memory span were conducted by Ebbinghaus (1913, as cited by Demster, 1981). However, STM as a topic of study did not achieve popularity until the 1950s, when a number of studies were published in both Britain and the U.S.A. During the `60s and `70s, new concepts related to STM were introduced (e.g., memory capacity, phonological coding etc.). In the `80s, interest in neuropsychological studies of STM increased, with several studies being conducted on brain damaged, mentally retarded, and aphasic patients.

New theories and research findings led to the development of different models of STM. Norman (1970, as cited by Baddeley) refers to as many as 13 models. Until the mid `80s the different models of STM emphasised **structure**. Modal models predominated, stressing the close relationship between short term and long term memory in both encoding and recall. In the mid `80s, however, new studies began to cast doubt on modal models. The emphasis switched from **structure** to **processing**, changing STM from a passive storage bin for information to an active processing system and calling it working memory (WM), although the exact distinction between STM and WM is still under discussion.

2.1.1.1 Testing short-term memory

The most widely used STM test is the immediate memory span test. It usually includes immediate recall of lists of digits and of unrelated words. Early researchers established that more words can be recalled if they are embedded in sentences rather than in lists. This finding led to the use of sentence repetition in assessing STM. One of the first sentence repetition tests to assess STM was the Auditory Attention Span for Related Syllables subtest of the Detroit Test of Learning Aptitude (DTLA, Baker and Leland, 1967). The DTLA was developed in 1934 to assess intellectual skills in children 3 to 19 years of age. The Auditory Attention Span for Related Syllables subtest consisted of 43 sentences ranging from 5 to 22 words. The sentences were grammatically simple and were lengthened by adding more words (e.g., nouns or adjectives) without increasing grammatical complexity. The test was revised in later years. At the present two new versions are used: the DTLA-2 (Hammill, 1985) and the DTLA-P (Hammill and Bryant, 1986). The DTLA-P is designed for children ages 3 to 9 years. The sentence imitation task contains 13 sentences similar in style to the original DTLA, in that sentence length increases by addition of words, without greater grammatical complexity.

Sentence imitation is also included in other tests of intellectual abilities, such as the McCarthy Scales of Children's Abilities (McCarthy, 1970 as cited by Wiig and Semel, 1980). The verbal memory subtest of the McCarthy Scales contains six items: two concrete words unrelated, two abstract words unrelated, and two sentences. The test was standardised on a large number of children and has high reliability and validity rates.

Neurolinguistic studies on aphasic patients (McCarthy and Warrington, 1987a,b) have shown dissociation between the ability to repeat lists of words or digits and the ability to repeat sentences: Patients who were unable to repeat lists of words or digits (often limited to two items) were able to repeat sentences almost intact. These findings challenged the validity of sentence repetition in assessing STM, and led to a slow decline in its use.

The development of transformational grammar generated new interest in sentence repetition. It was widely believed that in language processing the listener uses surface structure to derive deep structure, and that the entire sentence (or at least clause) has to be held in memory before it is processed, and before propositions are developed. These new ideas changed the concept of the memory involved in sentence repetition and replaced STM with the term auditory memory.

2.1.2 Auditory memory

Wiig and Semel (1980) define auditory memory as the process of assimilating, storing, and recalling what has been heard. Sentence repetition is believed to assess this type of memory.

There is confusion in the use of the term **auditory memory**. The terms **short term memory**, **auditory verbal short term memory**, and **auditory memory** are used indiscriminately in the literature.

2.1.2.1 Testing auditory memory

One of the first tests used to assess auditory memory was the **Producing Model Sentences** subtest of the Clinical Evaluation of Language Fundamentals (CELF), developed by Semel and Wiig in 1980. The CELF's **producing model sentences** subtest consisted of 30 sentences in which the vocabulary, sentence length, and sentence complexity were sequenced in order of difficulty. Seven of the sentences violated syntactic and semantic rules. The **producing model sentences** subtest was predominantly a test of auditory memory, but it also assessed knowledge of syntax and the influence of meaning (semantics) in recall. This test was later revised. In the revised version of the CELF (CELF-R), all the sentences that violated syntactic and semantic structures (i.e., the sentences supposed to assess predominantly auditory memory) were deleted, and the emphasis switched from testing memory to testing grammatical skills.

Another test used to assess auditory memory is the Test of Auditory Perceptual Skills (TAPS) (Gardner, 1985). TAPS assesses auditory perceptual difficulties and imperceptions. It contains subtests of memory for numbers, words and sentences as well as subtests on word discrimination, auditory interpretation of directions and auditory processing.

Although this is not intended to be a comprehensive survey of auditory memory, there seems to be a gap in the literature about the transition in the use of short term memory to auditory memory and the gradual decline of the term auditory memory.

Studies (e.g., Caplan and Waters, 1990), which challenged the importance of auditory memory in processing and in particular in comprehending sentences, might have contributed to this decline.

Caplan and Waters (1990) compiled a critical review of patients with limited short term memory (referred to in the literature), which led them to declare that short term memory itself does not play any role in first-pass language processing, and no obligatory role in second-pass language processing. In short, significant reductions in short term memory (auditory memory) have very limited effects on language processing.

Auditory memory, as defined earlier (Wiig and Semel, 1980), involves assimilation of what is repeated. Assimilation is an active process, not a passive one like storage. In this respect auditory memory is closer to working memory than short term memory.

2.1.3 Working memory

The term "working memory" (WM) was first introduced by Baddeley and Hitch in 1974, and was solidified through a substantial number of experiments carried out over a number of years (1974-1986). One technique that they used extensively to test the limited capacity of WM and its relationship to long term memory was the concurrent load technique. Subjects were asked to perform two tasks simultaneously. For example, recalling a list of words (primary task) while reciting a set of digits (secondary task). Baddeley and his colleagues found that the digit repetition did influence the primary task but not catastrophically. The subjects could cope with both tasks reasonably well. This minimal interference indicated that long term memory and WM were not identical but were separate entities.

Baddeley's (1986) model of WM consists of three components: the **central executive** and two subordinate (slave) systems, the **visuospatial scratch pad** and the **articulatory loop.**

The **central executive** is a supervisor or coordinator that selects strategies and integrates information from different processing levels using different codes of representation. There seem to be relationships between the **central executive** and control of attention and between the **central executive** and consciousness, but their exact nature is still unknown.

The **visuospatial scratch pad** is a temporary visuospatial store which retains and manipulates images and is susceptible to disruption by concurrent spatial processing. This system is capable of using auditory information to construct a spatial code.

Most of Baddeley's experimental work was devoted to understanding the **articulatory loop**. This loop is a storage system of limited capacity (6 to 7 items or chunks), with a limited temporal duration of 1.5 to 2 seconds. The **articulatory loop** consists of two parts: a phonological store and an active rehearsal process that involves subvocal articulation.

There is still no consensus in the literature on the concept of WM. Some authors (e.g., Baddeley, 1986; Hulme and MacKenzie, 1992; Gathercole and Adams, 1993) consider STM part of the WM system, identifying it with the function of the **articulatory loop** and testing it with similar types of tasks used to assess STM. Others (e.g., Engle, 1992; Cantor et al., 1991; Swanson, 1994) claim that STM and WM are two separate systems that operate independently.

2.1.3.1 Testing working memory

The **memory span** test (Daneman and Carpenter, 1980) was the primary test of WM until recently. Sentence repetition is included in the **memory span** test, but the task is complex: the subject listens to or reads several sentences, repeats each of them, and recalls, after presentation of a certain number of sentences, the last word of each sentence in a list-like manner. This test has been used extensively in research, and until recently was the only test (with small modifications) used to assess WM. In 1994, Swanson introduced new tasks to assess WM. His WM testing battery contains 11 items combining both visual and auditory tasks (e.g., auditory digit sequence, mapping and directions, semantic associations, phrase sequence, spatial organisation etc.). Swanson's conceptualization of WM seems much broader than previous formulations.

To understand the role of verbal memory in sentence repetition, it is important to understand some of its properties. One of the basic characteristics of verbal memory is its increase with age (Chi, 1977; Dempster, 1981; Hulme and Tordoff, 1989). The nature of its growth, however, is not as yet fully understood. Most of the earlier research studies on the growth of verbal memory were on the development of STM. However, as the function of the **articulatory loop** is similar if not identical to that of STM, they may well apply to WM too. In fact, in later studies (Gathercole and Adams, 1993) the term Phonological Working memory is used instead of STM.

2.2 The Development of Short-term Memory

The first signs of goal directed activities in memorization start to appear at the age of 5 years. (Schneider and Pressley, 1989). The average 5-year old can recall approximately 3 digits. The number of items that a child can successfully recall increases with age and the range can generally be calculated by adding or subtracting 2 from the child`s chronological age (Miller, 1956). On average 6 and 7-year olds can recall 5 items, and 9 year-olds can recall 7. Adolescents and adults can recall 9 to 10 items. The number of items or chunks remembered is usually termed "capacity". Capacity is a disputed issue, often regarded as **mental space** or the maximum number of schemas that a person can activate and coordinate simultaneously (Pascua-Leone, 1970).

2.2.1 Factors that influence the development of short-term memory

Research has identified several factors that influence the development of short-term memory. The most commonly cited are the following:

1. Capacity

As mentioned earlier, capacity seems to increase with age, from 3 chunks at the age of 5 years, to 9 chunks in adolescence. There is controversy as to the nature of capacity. Does it increase with maturation, or does processing efficiency affect its growth?

2. Chunking

As children get older, they learn to increase the number of items they can recall by grouping or chunking them together. For instance, its easier to remember 564-9852 as a phone number, than to remember the separate units (5, 6, 4, 9, 8, 5, 2) individually. A number of studies support the relationship between chunking and memory span, covering such diverse areas as chess playing (Chi, 1976), reading, and mathematical computations (Dempster, 1978 as cited in Dempster, 1981).

3. Ordering

The ability to recall information in a sequential order appears to develop with age. Even after extensive coaching, 4 -year-olds cannot reproduce an entire sequence of unrelated words in order (Chi, 1977).

4. Rate of Speech

The faster the rate of speech, the larger the number of items recalled (Hulme and Tardof, 1989). Furthermore, when younger children are given practice in speedy articulation and allowed to recall lists without order, they can do as well as older children in recalling word lists (Case, 1982).

5. Item identification

Differences in the speed of item identification in semantic memory may be a source of span differences (Chi, 1977; Case, 1982). Samuels, Begy and Chen (1975, as cited by Dempster, 1981) found that recognition time decreases with age from 44 msc. at age 10 to 23 msc. in adults.

6. Rehearsal

Rehearsal is the most important strategy in boosting the decaying traces of words and thus enhancing memory span. It can be passive or active. Rehearsal is used regularly by older children and adults, but is not used spontaneously by younger children. Various hypotheses have been proposed as to why young children do not use rehearsal strategies; slow rate of speech and inability to group items together have been two of the most frequently cited reasons.

2.2.2 Critical review of the factors affecting short-term memory growth

Dempster (1981) examined 10 possible sources of individual and developmental differences in span. He divided the developmental differences into strategic variables (i.e., rehearsal, chunking, grouping, and retrieval) and nonstrategic variables (i.e., item identification, item ordering, capacity, susceptibility to interference, search rate, and output buffer). After critically examining most of the relevant studies on each of the 10 sources of difference, he concluded that **item identification** (that is speedy recognition of the word) was probably the major source of difference and that it increased with age.

Similar results were reported by Case et al. (1982). They identified **speed of repetition** (which includes **item identification**) as a major contributor to the growth of short-term memory. In a number of experiments they found that when adults and 6-year olds were matched on speed of articulation (by means of the adults pronouncing words in an unfamiliar foreign language) the memory spans of the children and the adults were no longer different.

The importance of **speed of articulation** and **item identification** was challenged by Henry and Millar (1991). In a study involving 24 children (12 5-year olds and 12 7-year olds), they found that increase in memory span with age cannot be explained by differences in identification time or articulation rate alone. Although both of these factors contribute to memory span, neither of them in itself can account for the difference. Other factors, such as familiarity with the words, seem to play a considerable role too.

Studies by Gathercole and Adams (1993) and Gathercole and Hitch (1995) have further challenged the notion of memory span development. They found that memory span can be assessed as early as 2 or 3 years of age, that the **articulatory loop** is used in much the same way in 4-year olds as in adults (although less efficiently) and that children use a rudimentary type of rehearsal, but are less committed to it.

2.3 Conclusions

Sentence repetition has been used to assess **short-term memory**, **auditory memory**, and **working memory**. These concepts, however, and the factors that influence their growth are not yet fully understood. Whether STM, auditory memory, and WM are distinct entities or components of one memory is still an open question. Engle et al. (1992, as cited by Swanson 1994) describe the difference they perceive between STM and WM as follows: STM is verbatim information maintained at a surface level that does not consciously rely on permanent knowledge, while in WM long-term representations are fully activated. Swanson (1994), in her studies on the contribution of STM and WM to academic achievement, included sentence repetition under tasks assessing short term memory rather than working memory, implying that long term memory is not activated in sentence repetition.

Recent studies (Potter and Lombardi, 1990: Lombardi and Potter, 1992) challenged the belief that sentence repetition is just verbatim memory. Their findings suggest long term memory is activated in sentence repetition.

2.4 Potter and Lombardi's Studies

Potter and Lombardi conducted a number of experiments using as subjects psychology students and children. They hypothesised that if long term memory (semantic memory) is activated in sentence repetition, a word synonymous with the target word in the sentence, introduced at a particular time as a **lure synonym**, would have a good chance of being recalled instead. For example, the subject reads the sentence "The knight rode around the **palace**, searching for a place to enter". The lure synonym **castle** is then introduced in a short list of nouns which the subject reads before recalling the sentence; Potter and Lombardi predicted that **castle** would be recalled instead of **palace**. They tested this hypothesis in a number of experiments involving psychology students. They found that quite often (27%) subjects substituted the **lure** synonym for the target word. The same results were obtained with children as subjects. These results were unaffected by response time: the same processes were observed even when stimuli were presented rapidly. Furthermore, they found that synonyms which were a mismatch to the meaning of the whole sentence rarely affected recall, while those that matched the meaning of the sentence were chosen much more often. Only synonyms, not antonyms, had this effect on recall.

Lombardi and Potter (1992) also tested the hypothesis that the sentence's surface syntax is not kept in memory in a verbatim form, but is regenerated using normal mechanisms of sentence production. They found that when the **lure** synonym in the sentence was a verb of a different syntactical structure than the target verb, subjects changed the whole syntactical structure to go with the lure verb. For example, in the sentence " **The committee has to talk about the issue before it makes a decision**", the verb **talk** requires a prepositional phrase as a compliment. However, when the **lure** verb **discuss**, which requires a direct object, was introduced, the sentence was changed to "**the committee has to discuss the issue before it makes a decision**". In other words, the test results supported the view that sentence recall involves regeneration of the sentence using a mental conceptualisation of the sentence and the subject's internalised grammar to reconstruct it.

In conclusion, Potter and Lombardi's studies have shown that sentence repetition is not superficial memory of the sentence, but rather involves accessing of long term memory, comprehension of the sentence and regeneration of it using the gist of the sentence and the individual's internal mechanisms of sentence production. Sentence repetition also involves storage, as the subject is supposed to recall the sentence verbatim. Thus sentence repetition may well rely on WM. This notion of WM involved in sentence repetition will be further explored in the present study.

2.5 Testing Grammatical Competence

This section will discuss the use of sentence repetition in testing grammatical development and grammatical disability, and will examine the role of verbal memory in sentence repetition and in language deficits. To gain a clearer perspective on the role of sentence repetition as a measure of grammatical competence, we begin with a brief review of earlier studies.

2.5.1 Sentence imitation in language acquisition

The literature exhibits controversy as to how important sentence imitation is in the development of grammatical structures during language acquisition. Detailed recordings of children's language reported in the literature (e.g., Adam and Eve (Brown and Bellugi, 1964), Echo (Slobin & Welsh, 1973), Ivan (Bloom et al., 1974)) show that children frequently imitate adult speech. However, it is still not clear what role imitation plays in the development of grammatical structures.

In the early '60s, the contribution of sentence imitation in language acquisition was overemphasised. This led to critical studies on the topic - studies that challenged the importance of imitation in language acquisition. Opinions regarding the role of imitation in language acquisition fall into three main categories (Snow, 1981): (1) imitation of adult sentences plays a substantial role in language acquisition ; (2) imitation of adult sentences contributes to the development of vocabulary ; (3) imitation of adult sentences makes no contribution to grammatical development.

Support for the importance of imitation in language acquisition comes from studies such as Clark (1977) and Moerk (1977). Clark analyzed children's utterances as reported in the literature (i.e., Adam and Echo) as well as those of her own son. She concluded that imitation plays a considerable role in language acquisition. Even utterances that appear to be novel (e.g., Brown's (1968) examples of children's questions: "What he wants?", "Why you can't open it?", "What his name is?" are very likely parts of common statements that adults make to children (e.g., "Ask him what he wants", "I'll tell you what his name is"). According to Clark, children imitate parts of adult sentences, which they couple with other parts of sentences, making longer utterances. Coupling means combining fragments of speech, like railway cars in a train, without changing their internal structure. Clark also claims that imitation does not necessarily presuppose comprehension. Children can copy phrases without completely comprehending them.

Another study in support of imitation as essential to grammatical development was conducted by Moerk in 1977. Moerk studied the spontaneous verbal interaction of two children (D and T) with their babysitter over a period of half a year. Both subjects were 2 years old at the beginning of the study. Observation sessions occurred weekly and lasted one hour. Moerk found that new grammatical structures appear in imitative speech before they are mastered in spontaneous speech, and that imitation is grammatically progressive. She also found that imitation helped in the development of vocabulary.

The arguments against the importance of imitation in language development can be summarised as follows: not all children imitate; very few of children's utterances are verbatim repetition; the development of grammatical structures is not progressive; if children relied only on sentence imitation to develop language, they would need a lifetime to acquire language proficiency. Ervin-Tripp (1964, as cited by Slobin, 1968) concluded, "there is not a shred of evidence supporting the view that progress toward adult norms of grammar arises merely from practice in overt imitation of adult sentences". Thus even the sturdiest critics of the importance of imitation in first language acquisition acknowledge that it does occur.

Despite controversy in the literature regarding the role of sentence imitation in the development of grammatical structures in childhood, and despite only partial understanding of the process of sentence imitation, sentence repetition has been used extensively in assessing both language development and language disability.

2.5.2 Assessing grammatical development and grammatical disability

Sentence repetition has been used to evaluate grammatical competence in both normal and language disordered children.

Menyuk (1963) was one of the first researchers to use sentence imitation to assess normal grammatical development. She found that when nursery school-age children imitated sentences, their performance depended on their competence in using grammatical rules rather than on sentence length. Further support for the use of elicited sentence imitation in the assessment of language development comes from studies such as McNeill (1968, as cited by Berry-Luterman, 1971) and Slobin and Welsh (1973). Slobin and Welsh analysed 1000 elicited speech imitations from a child they referred to as Echo, collected between the ages of 2 years, 3 months, 2 weeks, and 2 years, 5 months, 3 weeks. They found that the number of words in the sentences to be recalled was not as important as the sentence's grammatical complexity. They also found that the underlying meaning of the sentence was usually preserved, and that the sentence was filtered through the child's productive linguistic system before it was reproduced. Slobin and Welsh concluded that elicited imitation can be a valuable tool in research on language development in assessing grammatical ability, but that it should be used in combination with analysis of samples of spontaneous speech. Lust, Flynn and Foley (1996) also stress the importance of sentence imitation as a research method in assessing children's syntax. They claim that sentence repetition allows the researcher to focus on specific syntactic factors, that it can be used with very young children and it can be used easily in cross cultural studies. Menyuk was one of the first researchers to use sentence imitation in the assessment of language disordered children. In a 1964 study that involved children with "infantile speech", Menyuk found that, when imitating sentences, the children with infantile speech omitted the grammatical structure they had not mastered, while the normal children used either substitutions or redundancies.

2.5.3 Studies in support of using sentence imitation to assess grammatical disability

The usefulness of elicited imitation[1] in assessing grammatical disability and in planning and evaluating language therapy programs was investigated by Schwartz and Daly (1978). The study involved 96 subjects attending a speech and hearing camp, ranging in age from 7-and-a-half years to 19 years. All the subjects had undergone at least 3 years of individual speech and language therapy. The subjects were divided in four groups, based on the deficits they exhibited: a language group, a combined language and articulation group, an articulation group and a fluency (stuttering) group. The Programmed Conditioning for Language Test (Grey and Ryan, 1973) was administered. This is an

[1] In earlier studies the terms sentence imitation and elicited imitation are used instead of sentence repetition. The authors original terms will be maintained in the present review of the literature, when referring to these studies.

elicited imitation test, which assesses auxiliary verbs, non auxiliary verb forms and interrogative reversals. Subjects in the language group made significantly more errors than subjects in the other three groups. Post-therapy results showed that language disordered children made the most progress. Progress mirrored their therapy stimulation, most of the progress being with auxiliaries. A few changes were noticed in the articulation group, and no differences were observed in the fluency group. This study confirmed the usefulness of elicited imitation in the assessment of language disability as well as in the planning and evaluation of therapy programs.

Another study that supported using elicited imitation in the diagnosis and prognosis of grammatical disability in language disordered children was carried out by Berry-Luterman and Bar (1971). They studied the speech of four speech and language disordered subjects (ages 13.5, 10, 9.8 and 5.2 years) to determine whether there was a high level of association between spontaneous speech and elicited imitation. The children's performance was assessed using three conditions: S (repetition of grammatically incorrect sentences taken from the child's own production, e.g., I going new school). C (repetition of grammatically correct versions of these sentences, e.g., I am going to a new school). R (repetition of sentences in reverse order, e.g., school new a to going am I). The children's performance on these three tasks provided information for diagnosis, prognosis, and planning of therapy. Children who were able to imitate the correct version (C) had very good prognosis. Children who could imitate their own incorrect spontaneous utterances (S) had a good prognosis and an indication for a starting level of therapy. Children who included a syntactic structure in condition R which they omitted in S and C had a poor prognosis, as the R condition does not provide the child with any syntactic structure (the sentence resembles a list of words), repetition relies mostly on memory. The inclusion of a syntactic structure in condition R which was omitted in condition C indicated that the syntax of the sentence did not help to produce the structure. For children who were unable to include a structure under any of the conditions, the prognosis was extremely poor. The findings of this study should be taken with caution as the number of subjects was very small and the difference in their ages large.

The association between sentence imitation and spontaneous speech led to the development of tests that used elicited imitation to assess children's level of language development. Sentence repetition is included in most of the well-known language tests (e.g., Test of Language Development-Primary and Intermediate (TOLD-P, and TOLD-I), as well as the CELF-R). One test that relies exclusively on sentence repetition to assess grammatical development is the Carrow Elicited Language Inventory (CELI), developed by Carrow (1975). The CELI consists of 51 sentences, 47 in active voice and 4 in passive. The syntactic structures assessed (i.e., affirmative, negative, declarative, interrogative, and imperative) include most of the grammatical categories and features found in children's grammar, and reflect grammaticality as it increases by age. The test was standardised on 475 children, ages 3 years to 7 years 11 months. According to Carrow, elicited imitation measures more capacity than performance, as it can assess structures that are not yet present in spontaneous speech but are being developed.

2.5.4 Studies not supporting the use of imitation in assessing grammatical disability

Other studies have challenged the efficacy of elicited imitation in diagnosing grammatical disability. Although there is a relationship between sentence imitation and spontaneous speech, there are differences too. For instance, spontaneous speech includes communicative intention of the speaker, which is missing in imitation. Also, in imitation, sentences are artificial: they do not include words from the child's environment, which are present in spontaneous speech. Connell and Myles-Zitzer (1982) examined the use of elicited imitation in predicting performance in spontaneous speech, as well as the effect of contextual cues on the accuracy of recall. Seven children were chosen (ages 2.7 to 3.8 years), and a 100 utterances from their spontaneous speech were recorded and analysed. Twenty stimulus sentences were used to elicit imitation. These sentences depicted actions that could be easily illustrated and they involved the following close class items and inflections: auxiliary verbs, progressive inflection -ing, and past tense -ed. Each sentence was presented to the subjects orally, under one of four video conditions, which illustrated the meaning of the sentence and provided non-linguistic context. The video conditions included: line drawings, actors in still poses, actors moving through an action, blank screen.

There were similarities between the children's spontaneous speech and their performance on the elicited imitation task. For instance, major lexical items (nouns, verbs, adjectives) were more correct than close class items and inflections and the hierarchy of grammatical complexity was the same in both tasks. Also, in one of the morphemes, "**ed**", spontaneous and imitative performance was the same. There were differences, however, in the children's performance with the two other morphemes. As differences were not uniform, performance in one task could not be used to predict performance on the other. The children's overall performance was better in spontaneous speech than in elicited imitation. Non-linguistic context (video presentations) did not have any effect on the accuracy of sentence recall. The researchers concluded that the relationship between spontaneous speech and elicited imitation is not clear-cut. The results of elicited imitation can be valid, but should be accepted with caution and should be verified with other testing methods.

A further challenge to the validity of elicited imitation as a means of assessing grammatical ability comes from a study by McDade et al. (1982). McDade argued against the use of imitation in studying grammatical development and ability, using examples from studies that supported it. For instance, in Menyuk's (1969) study that supported the use of elicited imitation, one of the findings was that children's spontaneous productions may be superior to imitation performance, which indicates a difference between elicited imitation and spontaneous speech. Furthermore, Carrow (1974b), to establish validity for CELI, compared it with Lees' (1974) Developmental Sentences Score (DSS) test. The significant correlation ($\underline{r}$=-.79) found between the two tests was taken to imply that both tests assessed the same set of skills. McDade points out, however, that the regression on coefficient indicated that only 62% of the scores in Carrow Elicited Language Inventory can be explained by variability in Developmental Sentence Score. One variable which seemed to contribute to the differences between the two tests is short term memory (STM). According to McDade, one could not rule out the possibility that correct imitation is achieved through rote memory, particularly when the sentence is within the subject's memory span. Controlling the effect of STM is difficult, however, because an increase in sentence length usually leads to more complicated grammatical structures.

To investigate the relationship between imitation, memory comprehension, and spontaneous production, McDade (1982) conducted two experiments. Experiment 1 examined the role of decoding memory processes during elicited imitation, while Experiment 2 investigated whether delaying imitation could improve the correlation between the performance in DSS and CELI. Imitation was performed under three conditions: 1. repeat the sentence then point to the appropriate picture; 2. after listening to the sentence, point to the appropriate picture and then repeat. 3. after delays of three and five seconds, repeat the sentence. For the first experiment, six subjects (ages 4:1 to 4:7) were used and three lists of 16 sentences were created. The results showed that subjects repeated more sentences under condition 1. However, when the researchers considered those sentences that the children understood, the differences between conditions 1 and 2 were not significant. In Experiment 2, nine subjects ages (4:4 to 5:1) participated. The results showed that a subject's ability to imitate a sentence was at its best immediately after the sentence was completed. Correlation between the DSS and CELI was best with a three second delay and poorest with immediate recall. This finding suggests that, in immediate recall, the children remembered the sentences from rote memory, while, after a three-second delay, their performance better reflected their true level of grammatical ability. Clearly then, short term memory can falsely elevate performance in sentence repetition, and should be taken into consideration when interpreting results.

Additional information about the role of sentence repetition in assessing grammatical competence comes from studies on second language acquisition.

2.5.5 Sentence Imitation in Assessing Proficiency in Second Language Acquisition.

The controversy over the importance of elicited imitation in assessing language ability has been extended to assessing proficiency in second language acquisition. Naiman (1984) conducted a study that supported elicited imitation in assessing second language proficiency. Fifty-six grade one and fifty-six grade two children enroled in French immersion programs in the Ottawa area were involved. Three processes were tested: imitation, comprehension, and production. The comprehension task involved identifying the correct picture out of three illustrating the sentence presented by the examiner. The production task included spontaneous talk about the sentence used in comprehension or translation of the sentence presented by the examiner in English, or in French. The elicited sentences imitation test included 12 sentences (15 syllables long) containing three examples each of four syntactic structures: direct and indirect objects that occurred before and after verbs. The structures were presented in initial, medial, and final positions. To assess whether comprehension was different in imitation versus production, subjects in group 1 were told before hand whether they were to imitate or translate the sentence, while in group 2 the subjects were given this information after they heard the sentence.

In all the syntactic structures studied, performance on comprehension was superior to imitation, which was in turn equal to or superior to production. The results of this study amply demonstrated how useful imitation can be in research on second language acquisition. Once the child has successfully passed the interpretation stage of the sentence, given sufficient memory capacity, the encoding stage will depend on the presence or absence of the grammatical structure in the child's production system. Regarding STM, it seemed to affect all the tasks, particularly imitation. Additional support for the use of elicited imitation in assessing proficiency in second language acquisition comes from studies by Hamayian et al., (1975) and Cook, (1973).

An investigation of the role of elicited imitation in assessing competence in the use of a second language was carried out by Balcom (1990). The subjects of the study (6 females and 9 males) were the control group of a larger study which investigated adult L2 acquisition. All of Balcom's control subjects were students at the University of Ottawa and native speakers of English. Balcom questioned the validity of using sentence imitation to assess acquisition of particular syntactic structures in second language acquisition, as there are no norms on how native speakers imitate sentences. To assess the native speakers' skills in sentence imitation, she used twenty-five sentences (five fillers and 20 test sentences) assessing mostly relative clauses. A quarter of the sentences were ungrammatical and the rest were grammatical. The results showed that only 54% of the sentences were repeated verbatim. Specifically, 52% of the grammatical sentences, 91% of the fillers and 24% of the ungrammatical sentences were repeated correctly. The high level of incorrect repetitions of the ungrammatical sentences was most likely due to subjects wanting to make them grammatically correct. Furthermore, it is important to note that the most common error with the grammatical sentences was the elimination of the complimentizer "that" or the replacement of a relative pronoun with "that". In both types of instances, the resulting sentences were still grammatical. If these errors had been made by foreigners learning a new language, they would have been considered errors; however, when made by native speakers, they are considered more task-specific performance than competence errors. In conclusion, when using sentence imitation to assess proficiency in a foreign language, it should be made clear whether these sentences can be repeated correctly by native speakers.

2.5.6 Conclusions

The role of sentence imitation in grammatical acquisition and its use in assessing grammatical ability in normal and language disordered children is not fully understood. Performance on sentence imitation differs from performance on spontaneous speech. The reasons for this discrepancy is not entirely clear. Children may have more knowledge of grammatical systems than their spontaneous speech indicates, and elicited imitation may tap that knowledge. Also, verbal memory seems to contribute to the differences between sentence repetition and spontaneous speech performance. However we still do not know whether it is short-term memory or working memory that is involved, or how and to what extend they contribute.

2.5.7 Verbal Memory and Language Deficits

The use of sentence repetition to assess grammatical competence is in agreement with Potter and Lombardi's studies (1990, 1992) which have shown that sentence repetition involves processing (comprehension and production of the sentence). Although processing of sentences involves memory, its role is not clearly defined. Models of language processing either describe the role of memory in a global way (Fraser and Fodor, 1978), or include only the **articulatory loop** in their illustrations (Caplan, 1992).

Unfortunately, there are no studies dealing with the development of the interaction between language processing and working memory in children. Evidence of the role of verbal memory in processing comes mostly from studies on aphasic patients and children with language and reading disorders. Some of these studies on the contribution of verbal memory to language processing will be reviewed below.

2.5.7.1 Verbal memory and language comprehension

Two early studies which investigated the contribution of verbal memory to language processing in adults (Vallar and Baddeley, 1984b; Caramazza et al., 1981) found sentence comprehension deficits in patients with STM deficits. However, recent studies (Crain et al., 1990; King and Just, 1991; Baum, 1993) tend to limit the contribution of STM to the comprehension of complex sentences only. According to Crain, WM (the **articulatory loop**) is involved in the comprehension of the following syntactic structures: **relative clauses**, sentences involving the temporal concepts **before** and **after**, and sentences with ambiguities such as the **garden path effect**. Romani (1994), in a review of the literature and a detailed study of the speech and memory span of a 50-year old woman, concluded that WM, and in particular phonological STM memory (i.e., **the articulatory loop**), plays an important role in comprehension: it functions as a back-up system operating whenever the parser is working under non optimal-conditions. Non-optimal conditions include noisy environment, lack of familiarity with the language, or incomplete proficiency of the parsing system, (as in children developing language, or in patients with brain damage).

In contrast, Caplan and Waters (1990), in a critical review of the literature, state that STM (function of the **articulatory loop** in WM) is not involved in comprehension of automatic spontaneous speech, but only in sentences requiring a second pass (e.g., in sentences where there is a need to check if the assignment of thematic roles is correct). Caplan and Waters claim that the mechanisms for syntactic processing and for WM are separate systems.

2.5.7.2 Verbal Memory and Language deficits

Studies on the relationship between language disorders and verbal memory in children are also relatively few. Wiig and Semel (1980) claim that limited STM affects remembering of spoken messages, particularly those including instructions (e.g., for arts and crafts activities, for recipes, for road directions etc.).

In a series of studies, Gathercole and Baddeley (1989, 1990) found the **articulatory loop** (i.e., phonological memory) to play a central role both in natural vocabulary acquisition and in tasks requiring explicit name learning. According to Gathercole and Baddeley, the best way to assess phonological memory is by repetition of nonsense words. In a number of experiments, they found language disordered children were much worse at pseudo word repetition and serial recall than the control group (children with the same chronological age) and a group of younger children matched in language skills with the language-disordered children. After a number of additional experiments, the researchers found that language disordered children are sensitive to phonological similarity and word length effect, and that their articulation rates are within the normal limits. They concluded that language disordered children's memory deficits most likely reflect an impairment in the storage of phonological information. Similar results were obtained by Kamhi and Catts (1986) and Kamhi et al. (1988), who found that language impaired children had more difficulty repeating nonsense multisyllabic words than did either reading delayed or normal children.

In summary, research suggests that verbal memory deficits and, in particular, disturbances in the **articulatory loop** (phonological storage of information) may be associated with deficiencies in vocabulary development and in the processing of syntactically complex sentences (e.g., relative clauses, subordinate clauses, sentences with ambiguities). However, the nature of the relationship between language deficits and verbal memory is not clearly understood. The contribution of verbal memory to sentence repetition becomes even more perplexing as, in addition to memory involved in processing, memory which helps to repeat the sentence verbatim (the rehearsal process) must also be considered.

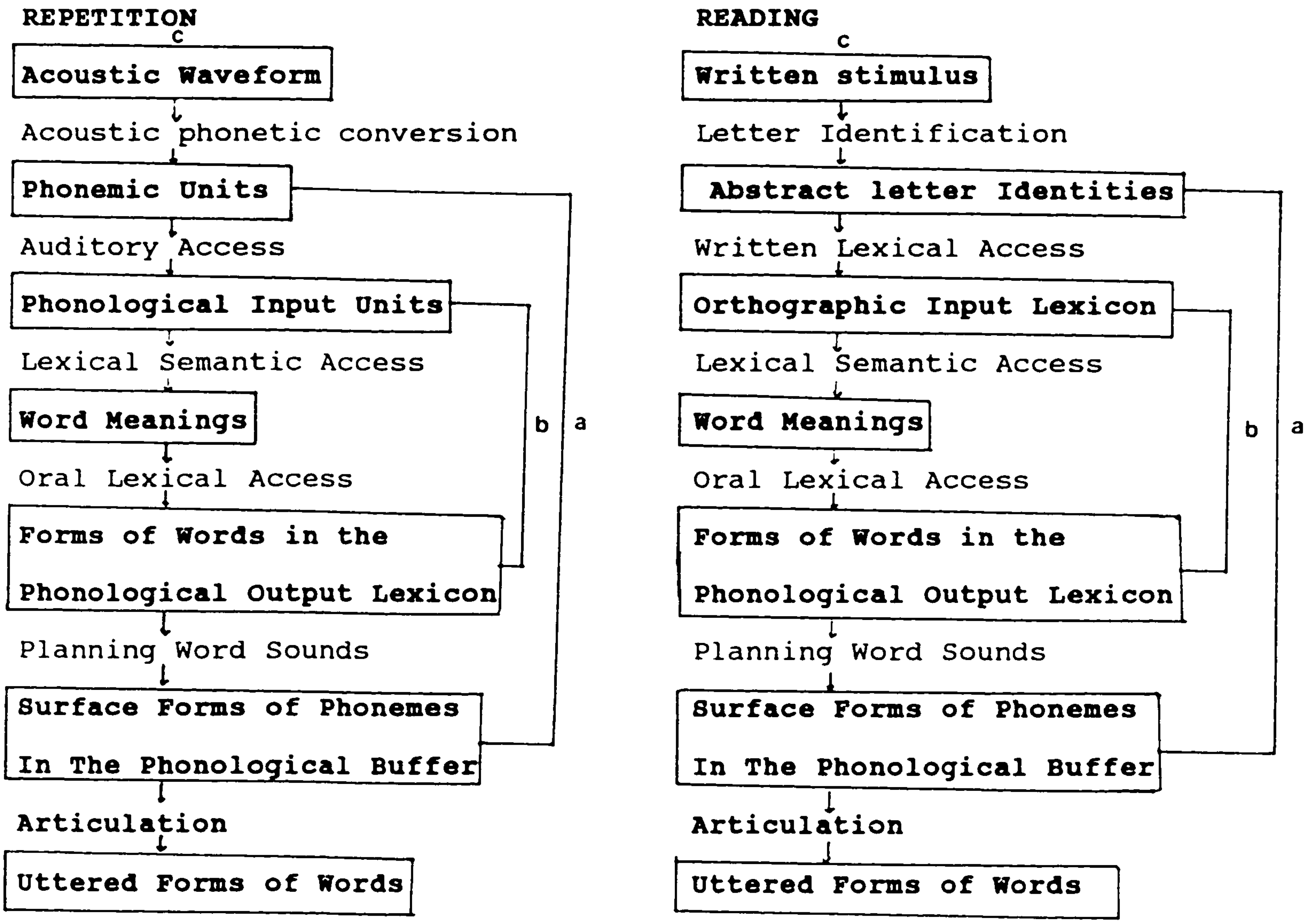
In the present study, an attempt is made to shed new light on the contribution of verbal memory to sentence recall.

2.6 Sentence Repetition and Reading Ability

The association between measurements in repetition of digits, words, and sentences **(short-term memory)** and in **reading ability** is well documented in the literature (e.g., Hulme, 1988; Hulme & Mackenzie, 1992; Wagner et al., 1993; Swanson, 1994).

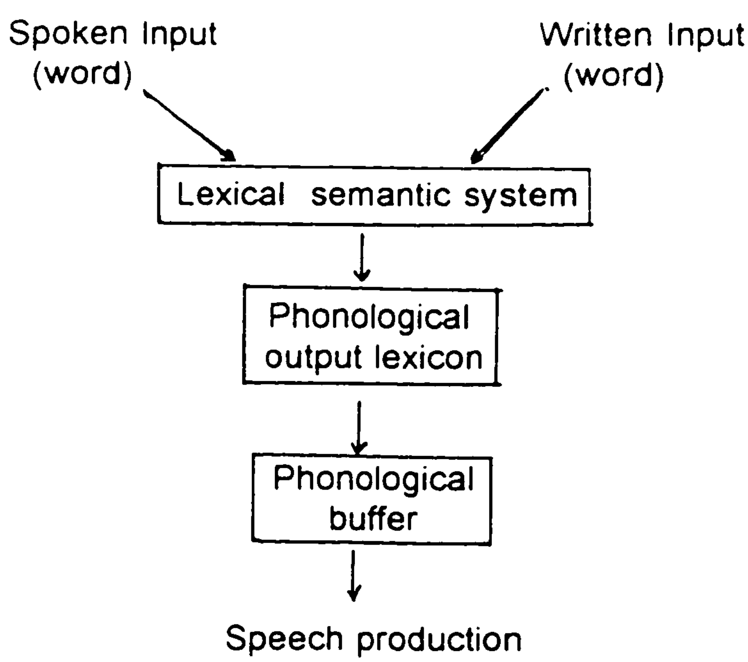
According to Catts (1989), the association between word and sentence repetition and reading is due to overlapping processes between the two brain functions. A comparison between two models proposed by Caplan (1992), one for word repetition and another for reading, clearly illustrates the overlapping processes. These models were based on studies with adult aphasic subjects. However, the inclusion of all the basic processes in reading and repetition render them applicable to the child populations.

See next page for a graphic illustration of these models.



As the models show, after initial decoding and translation of input (into the **orthographic lexicon** in reading and the **phonological lexicon** in repetition), the remaining processes of reading and repetition are identical. Furthermore, the **orthographic lexicon** maps onto the **phonological lexicon** (Caplan, 1992), making the processes even more similar. Also, both reading and repetition can be processed by the following routes: **Route a: Repetition:** from sublexical phonemic units to sublexical output phonological units as in repetition of nonsense words. **Reading:** from abstract letter identities to sublexical phonological units as in reading of nonsense words. **Route b:** **Repetition:** from whole word input directly to whole word output as in repetition of words without access to meaning. **Reading:** from whole word orthographic lexicon to whole word output as in reading of words without access to meaning. **Route c:** **Repetition:** from whole word input to semantics to whole word output. **Reading:** from whole word input to semantics to whole word output as in reading for meaning.

The close relationship between repetition and reading can also be seen in a model of reading, writing and repetition developed by Caramazza (1991). In Caramazza's model the processes of reading and repetition are depicted at later stages of development, when the grapheme to phoneme conversion of the word is bypassed and the written word maps straight into the lexical semantic system. This makes the relationship between reading and repetition even stronger. Below is a graphic illustration of these processes which constitute part of Caramazza's model.



2.6.1 Sentence repetition and reading comprehension

If Caplan's model is correct, once initial decoding of the word has taken place, the remaining processes of repetition and reading are identical. However, the relationship between sentence repetition and reading comprehension has been examined in only a few studies (Daneman and Carpenter, 1980; Leather and Henry, 1994).

Leather and Henry (1994) investigated the contribution of **simple word span** (i.e., ability to repeat lists of words), **listening memory span** (ability to repeat the last word of each sentence of a cluster of sentences), and **phonological awareness** (phonological analysis and synthesis) to **reading accuracy, reading comprehension**, and **arithmetic** in 71 normally achieving grade two children. Hierarchical multiple regression analysis showed that the **listening span scores** and the **phonological awareness** scores made a significant contribution to the variance in all three cognitive abilities. **Listening span** accounted for **31%** of the variance of **reading accuracy** and **33%** of **reading comprehension**. Another interesting finding was that **listening span** and **simple span** were not highly related, while **listening span** and **phonological awareness** were. Unfortunately, Leather and Henry did not include a simple sentence repetition task in their battery.

An extensive literature search identified only two recent studies (Swanson, 1994; Kotsopoulos et al., 1996) that found a relationship between sentence repetition and reading comprehension. However, in Swanson's study the statistical analysis combined both single word and sentence repetition. It is hoped the present study will provide additional evidence for the relationship of sentence repetition and reading comprehension.

2.6.2 Sentence repetition and reading decoding

The relationship between sentence repetition and reading decoding[2] is extremely complex. Reading decoding depends on the development of certain phonological processes. These are identified by Wagner et al. (1993) as follows: **phonological awareness** (i.e., phonological analysis and synthesis, measured by such tasks as phoneme omission, sound isolation, sound categorization, and blending of phonemes into words and nonwords); **phonological code retrieval** (measured by such tasks as naming digits and letters, in isolation and serially); **phonological coding in working memory** (measured by digit span, sentence repetition, and WM tasks).

Several processes have been identified as evidence for the phonological coding of working memory. They are summarised as follows:

a. Phonological similarity effect

It is more difficult to repeat phonologically similar sequences of letters or words than dissimilar ones (Baddeley, 1986; Hulme and Tordoff, 1989; Gathercole and Baddeley, 1995). As well, when subjects try to recall sequences of consonants which are presented to them visually, their errors tend to be based on phonological rather than orthographic similarity. For instance, B is more likely to be pronounced as D than as R. The

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[2] In the present thesis the term **reading decoding** refers to reading the word aloud rather than sounding it out. According to Scholes (1998) reading aloud is " the process of recovering a word from graphic input and pronouncing the spoken form of it", while sounding out means "treating strings of letters as phonetic transcriptions".

phonological similarity effect vanishes when the subject is prevented from rehearsing visually presented items by means of an articulation-suppressing task.

b. Word length effect

Long words are harder to recall than short words: subjects usually recall more short than long words in serial recall tasks. Hulme and Tordoff (1989) attribute this difference to differences in speech rate, while McDougall et al. (1994) add familiarity with the word as an additional factor.

c. Unattended speech

Baddeley (1986) asked subjects to remember lists of words while being exposed to either white noise or repeated words. He found that meaningful words had a significant effect on recall while white noise had very little. He consequently hypothesised that unattended speech impairs performance by corrupting the phonological store rather than by serving as a general distractor.

An intact phonological code is essential in the development of reading. In a study involving 93 kindergarten children and 89 second grade students, Wagner et al. (1993) found phonological processing skills to be stable, and their changes over the years coherent. For memory span and phonological analysis, a single underlying source was identified, particularly at the kindergarten level: both phonological analysis and memory span require **efficient coding** in working memory. "Efficient phonological coding provides the beginning reader with an accurate set of phonemes or sounds to blend, as well as frees the maximum amount of cognitive resources for the difficult part of blending the sounds into words" (Wagner et al., 1993, p.84). They felt that impoverished, degraded phonological representations might be responsible for impaired phonological awareness and weak memory span performance.

These findings were substantiated in a longitudinal study by the same team of authors (Torgesen et al., 1994) involving 248 children, who were assessed at the kindergarten, grade one and grade two levels. Again they found that individual differences in phonological skills were remarkably stable in the early years of learning to read. The relationship among the different phonological skills was also stable, which suggests that phonological processing skills are part of a child's cognitive constitutional ability, and not a reflection of knowledge or skills acquired as a result of learning to read.

2.6.3 Phonological coding, working memory and reading ability

The role of WM in reading performance is explained by Swank (1994) as follows. Phonological coding in working memory is the ability to keep phonological information on line in WM until a task is completed. According to Swank, keeping phonological information efficiently in WM can help the child acquire reading skills in three ways:

Blending. The child must remember individual sounds to be able to blend them to form words.

Mapping. English orthography is not a one-to-one correspondence between grapheme and segments of the acoustic signal. The child has to keep the signal in memory to be able to map it.

Sentence context. Information that is stored in working memory in a sentence context can be used to facilitate word identification in reading. If children have difficulty remembering the part of the sentence they have just read, they cannot take full advantage of context to help them identify new words and thus understand what they are reading.

According to Swank (1994), sentence repetition can be used to assess WM coding. If a child can repeat only the first or the last part of the sentence, he/she may be having difficulty in the phonological coding of WM.

Recently, the importance of the role of phonological awareness in reading has been questioned. A number of studies conducted by Scholes and his collaborators (Scholes, 1991,1998; Scholes and Willis, 1990) have shown that phonemic segmentation does not precede reading. Preschool children and illiterate subjects found it extremely difficult to perform metalinguistic tasks that involve phonemic segmentation (e.g., say 'grow', then say it again without the 'g'). On the contrary, reading and writing skills affected the way university students conceptualized the phonemic structure of the word. These findings led them to the conclusion that "the source of phonemic competence is literacy".

In addition, the explanation of the phonological code being responsible for the relationship between STM (the **articulatory loop** in WM) and reading decoding has been challenged. McDougal et al., (1994) investigated the relationship between short-term memory, reading ability, and phonological awareness skills in 69 poor, average and good readers, 7.6 to 9.6 years of age. The researchers found that phonological awareness skills (rhyme awareness and phoneme deletions) and **speech rate** distinguished between good, average, and poor readers, while STM in itself did not have much effect on learning to read. What accounted for the relationship between reading skills and STM was **speech**

rate. They concluded that STM skills are important as predictors of reading ability, because they tap individual differences in **speech rate**, not because of the phonological code that phonological awareness and STM share. **Speech rate** affects **timing** of processing.

Deficits in **timing** of processing have also been linked with language and learning disorders. Tallal (1985) conducted a study comparing 26 8.5 year-old children with Specific Language Impairment (SLI) to 30 normals. The children performed 6 tasks assessing temporal perception and production skills. Based on the children's performance, Tallal was able to correctly classify 100% of the normal children and 96% of the SLI children. She incorporated her theories of timing into therapy with apparently successful results (Time magazine, January, 1996). Also, in an exhaustive review of new theories on SLI children, and of her own studies, Bishop (1992) considers one possible cause of SLI to be a slower rate of information processing that leads to impairment of integration of rapidly presented information. It is hoped the present study will provide new information that could lead to better understanding of these relationships.

2.6.4 Working memory and reading impairment

Evidence for the relationship between working memory (**articulatory loop**) and reading impairment comes from studies involving dyslexic, learning disabled, and generally poor readers. A number of studies have shown a close relationship between STM (as measured by repetition of digits, words, and sentences) and reading impairment (Baver, 1977; as cited by Mann, Liberman, and Shankweiler, 1980; Wiig and Roach, 1975; Hulme, 1992).

As noted earlier, researchers disagree on the question of whether STM and WM are a unitary system or distinct subsystems that function independently. To address this question, Swanson et al. (1990) performed a study involving 50 learning disabled children. They conducted a number of well planned experiments using such tasks as the **memory span** (reading of sentences, verifying whether they are right or wrong, and recalling the last word of each sentence in a list-like manner), **preload task** (repetition of word lists, followed by immediate repetition of digits), and **concurrent task** (simultaneous processing of digits and sorting out shapes or pictures according to categories such as clothes, animals, jobs etc.). The researchers found that reading, as well as academic performance, can be predicted by performance on the **memory span** task, and even more so by performance on **concurrent** tasks. Performance on the preload task, which assesses STM, was least predictive of reading skills. They concluded that deficits in WM can account for reading deficits and academic performance. The authors proposed that accessing information in long term memory and transferring information from short term memory to long term memory is responsible for the weaknesses observed in the learning disabled children's academic performance. They attributed these difficulties to the malfunctioning of the **central executive.**

Swanson's views were further strengthened in a study involving 75 children and adults with learning disabilities and 86 adults and children used as controls. In this study, which investigated the contribution of WM and STM to reading achievement (Swanson, 1994). both STM and WM were thoroughly assessed. Eleven sophisticated tasks (both auditory and visual) were created to assess working memory. For the assessment of

STM, 4 tasks were used. It was found that WM and STM reflect two different processes. Both WM and STM correlated with academic achievement in the learning disabled children. However, only WM correlated with general academic achievement, consistently differentiating between students with and without learning disability.

In summary, there seem to be relationships between short term-memory and reading decoding, and between working memory and reading decoding and comprehension. However, the nature of this association is not as yet understood. There is debate in the literature regarding which components of working memory are responsible for this relationship, as well as whether phonological code dysfunction or **timing** are the factors that underlie this relationship.

2.7 HYPOTHESES

Potter and Lombardi's (1990) findings regarding substitution errors support the notion that processing (comprehension and regeneration) is involved in sentence recall. My own observations of language disordered children's errors in repeating sentences confirm Potter and Lombardi's experimental findings. In the present study, Potter and Lombardi's findings are tested more formally on a sample of 45 children presenting with academic and language problems. This is not simply a replication of Potter and Lombardi's study, as both the type of errors, as well as their frequency of occurence, are investigated. By focussing on error types and the factors that lead to their occurence, we may gain a greater understanding of the mechanisms involved in sentence repetition. This could lead to the identification of a link or links between sentence repetition, language deficits and reading underachievement.

The first hypothesis is:

HYPOTHESIS I: Children with language deficits and academic impairment, when repeating sentences, spontaneously (i.e., without the use of lure synonyms) make the same type of errors as those reported by Potter and Lombardi in adults and normal children.

If sentence repetition involves regeneration of the sentence from its conceptual meaning (Lombardi and Potter, 1992) and subjects use their own expressive grammatical skills to reconstruct the sentence when repeating it, they will be expected to make the same type of errors in recalling sentences as they make in their spontaneous speech. Hypothesis II reads as follows:

HYPOTHESIS II: The children make the same type of grammatical errors in tests of sentence production as they do in a recalling sentences test.

It is hoped that a comparison of the children's performance on sentence imitation and production may shed new light on the relationship of grammatical competence and verbal memory involved in sentence repetition. Furthermore, we may address the following question: do certain types of grammatical errors (e.g., omissions, substitutions etc.) in **recalling sentences** differentiate between syntactic and memory deficits?

Most of the previous studies on the relationship of sentence repetition and reading have used subjects' performance on the whole sentence in their statistical investigations. In the present study, the associations between specific types of errors in recalling sentences (e.g., omissions or substitutions) and **reading comprehension** as well as **reading decoding** are explored. It is hoped the type of errors linked with reading performance may provide new evidence of underlying factors explaining the relationship between sentence imitation and reading. The data will be examined to determine whether the following hypothesis is valid.

HYPOTHESIS III: Specific errors in recalling sentences predict impaired performance in reading decoding and reading comprehension.

It is hoped the findings of the study might enhance our understanding of the relationship of sentence repetition, reading impairment and processing deficits and may also lead to practical applications: For example, sentence repetition or repetition of certain types of sentences may be used as a screening test to predict language and reading deficits in children exhibiting academic delay.

CHAPTER III
METHODOLOGY

3.0 Data

All data employed in the present study were gathered as part of a larger research project at the Royal Ottawa Hospital, Ottawa. The project investigated the association between psychiatric disorders and academic delay. The present investigator carried out the speech and language assessment of all the children who participated in the project.

3.1 Subjects

The subjects were 50 children admitted consecutively to the Day Treatment program. There were 42 males and 8 females, ranging in age from 7 to 13 years. (x=10.22, SD=1.6). Excluded from the study were subjects with IQ below the normal range, sensory handicaps (e.g., cerebral palsy, deafness, autism, and schizophrenia). The subjects presented with severe behavioral problems that could not be handled in the classroom or in special classes at the various school boards. In the Day Treatment program, a multidisciplinary team works within a special school set-up. Treatment includes pharmacotherapy, supported psychotherapy, speech language therapy, social skills training, parent management, and so on. English was the mother tongue of all the children.

To identify possible differences, or biases, in academic performance related to disruptive behaviour, subjects with behaviour disorders were compared to those primarily without behaviour disorders on the three academic measures of **reading decoding, reading comprehension**, and **spelling**. No statistically significant differences were found between the two groups. Therefore, no further distinctions were made between subjects with and without disruptive behaviour.

The subjects' speech and language skills were assessed using the Clinical Evaluation of Language Fundamentals-Revised (CELF-R). The CELF-R has a different scoring scale for children below 8 years of age. In order to have uniformly scored data on the language assessment battery, this investigator removed 5 subjects whose age was lower than 8 years from the sample of the present study. Thus, the present sample consists of 45 children: 38 males and 7 females ranging in age from 8 to 13 years (x=10.3).

3.1.1 Psychiatric profile of subjects

The psychiatric profile of the subjects, according to the criteria of the American Psychiatric Association DSM-III-R (1987), was as follows. The psychiatric disorder groups were **attention deficit hyperactivity disorders** - often associated with **aggressive behaviour** - (40%); **conduct disorders** (24%); **adjustment disorders** with **mixed emotional and conduct features** (22%); **anxiety disorders** (12%); and **obsessive-compulsive disorder** (2%).

During the assessment period, 23 of the subjects were taking stimulant drugs (either methylphenidate or dextroamphetamine) to control classroom behaviour. Stimulants have been found to normalize behaviour in classes (Berkley, 1990) and often improve academic performance on a short term basis (Elia et al., 1993; Swanson et al., 1991, as cited by Kotsopoulos et al., 1996). Stimulants may well have influenced the subjects' performance. This was unavoidable, however, and in some ways even helpful: all the 45 children cooperated in being thoroughly assessed, while without medication they might not have been able to do so.

Most of the subjects presented with moderate to severe reading deficits.[1] Two opposing models exist of the relationship of mild to moderate forms of reading deficits and more severe specific reading disability. One presented by Rutter and Yule (1975, as cited by Kotsopoulos et al., 1996) considers specific reading disability (dyslexia) distinct, and qualitatively different from mild to moderate reading deficits. Dyslexia forms a "hump" at the extreme lower end of the continuum of reading ability. The second view proposed

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[1]In recent years a number of studies have shown significant associations between psychiatric disorders and reading impairment (Rutter et al., 1975; Sturge, 1982; Stevenson and Graham, 1993), as well as between psychiatric disorders and language deficits (Gualtieri et al., 1983; Cantwell and Baker, 1985; Beitchman et al. 1986; Cohen et al, 1993).

by Shaywitz et al. (1992, as cited by Kotsopoulos et al., 1996) claims that mild and severe forms of reading disability, including dyslexia, are parts of the lower end of the continuum of reading abilities. Failure to identify any variables that could distinguish severe from mild reading disability adds further support to their claim.

No distinction has been made between mild reading impairment and severe, specific reading disability in either the larger project (Kotsopoulos et al., 1996) or the present study. In this study, the terms reading impairment or reading deficits are used to describe the children's reading problems.

Although the performance of most of the subjects was low to very low for reading decoding, reading comprehension, and spelling, a notable number of them (**40%** in **reading decoding** and **38%** in **reading comprehension**) had average to above average skills in these areas. The same was true for the subjects' linguistic ability: although the majority of the subjects scored below average in the different subtests of the **CELF-R**, a substantial number of them (**42%** in **receptive language tasks** and **25%** in **expressive**) achieved average and above-average scores (See Appendix IIA and IIB).

There were no significant specific associations between clinical psychiatric diagnostic groups and academic or language deficits. In other words, all psychiatric groups presented equally with poor overall academic and linguistic skills. There were significant associations, however, between language skills and academic performance measures. As mentioned in the Introduction, two linguistic measures, **recalling sentences** and **sentence assembly**, accounted for a large proportion of the variance in **reading decoding**, **reading comprehension** and **spelling**.

Articulation, voice, and fluency were assessed informally. Only three children presented with some problems. One had mild lisping (interdental sigmatism), another showed imprecise articulation of clusters in spontaneous speech, and one stuttered mildly. As the average age of the subjects was 10.3 yrs., we cannot exclude the possibility of speech problems that may have been present at earlier ages.

3.2 Assessment Instruments

In the wider psychiatric project a variety of behaviour and cognitive tests were used, including the following: Blishen Scale, to assess socioeconomic status; Child Behaviour Checklist for parents and for teachers; Conners Scale for teachers; Wechsler Intelligence Scale for Children-Revised (WISC-R); Clinical Evaluation of Language Fundamentals-Revised (CELF-R); Kaufman Test of Educational Achievement (K-TEA); and informal assessments of phonological competence, voice, and fluency. For the present investigation, the following assessment measures were used: for language assessment, CELF-R (Semel, Wiig, and Secord, 1987) and for academic level, (K-TEA) (Kaufman & Kaufman, 1985).

The children's academic skills were assessed by a psychometrist who administered the K-TEA. This test consists of subtests that assess **spelling**, **reading decoding**, **reading comprehension**, **mathematic applications** (i.e., reasoning skills and mathematical concepts), and **mathematical computations**. The testing ages range from grade one to grade twelve. Measurements of only two subtests (**reading decoding** and **reading comprehension**) were used in the present study. The **reading decoding** subtest measures ability to identify letters and to read words of gradually increasing complexity. The **reading comprehension** subtest measures comprehension of two types of items: sentences containing commands (i.e. open your mouth), which the child reads then performs, and paragraphs of varying length and complexity, which the child reads aloud or silently, together with questions about the passage. The subject then responds orally or with gestures to the questions.

The **CELF-R** was used to assess the children's speech and language skills. The CELF-R consists of 11 subtests assessing both receptive and expressive syntactic, morphological, and semantic skills. Measurements from four of the subtests (**recalling sentences, formulated sentences, sentence assembly**, and **sentence structure**) were used in the present study. The **recalling sentences** subtest was the main focus of the study.

The **recalling sentences** subtest, rather than the **sentence assembly**, was chosen to be the focus of the study for the following reasons: target responses in **recalling sentences** are uniform, making test results easier to compare and interpret. In the **recalling sentences** subtest, only the auditory channel is used, while in **sentence assembly**, stimuli are presented both auditorily and visually. The **recalling sentences** subtest has been used in recent research studies and has been found to be sensitive to identifying children who presented with language disability (e.g., Bishop, 1992) .

3.2.1 Description of the four CELF-R subtests assessing grammatical skills

1. Recalling Sentences

The **recalling sentences** subtest consists of 26 sentences which get progressively longer and syntactically more complex. The first 9 sentences range from 3 to 9 words. They include simple active sentences, actives with coordination, interrogatives (passives and negatives). For example, sentence number 9 reads, "Has the mouse been chased by the cat?". The remaining list includes 3 active sentences with subordinate clauses, 2 passives with coordination, 5 actives with relative clauses, 2 actives with coordination, one active with conjunction deletion, one sentence with a passive subordinate clause, 2 passive negatives, and one sentence with ellipsis. The longest and most syntactically complex sentence is, "The boy who didn't show up for practice wasn't allowed to play on the team until a week later."

2. Formulated Sentences

The **formulated sentences** subtest contains two parts. In the first part, one word is provided by the examiner (e.g., "before") accompanied by a picture depicting a situation where the word "before" can be used and the child has to formulate a sentence using this word. In the second part, the examiner provides two words (e.g., "before" and "if") accompanied again by a picture, and the child has to formulate a sentence using both of the words. The **formulated sentences** subtest assesses ability to formulate compound and complex sentences. It includes the following word categories: noun, verb, modifier, and conjunction (coordinating, subordinating, correlative).

3. Sentence Assembly

The **sentence assembly** subtest consists of 22 sentences. Each sentence contains words and phrases in a scrambled order. The child has to put the words in the right order and produce at least two types of sentences that are syntactically and semantically correct. For example, given the stimuli **in the box - the ball- is**, the child could respond **The ball is in the box** and **Is the ball in the box?**. He/she must give both responses to achieve a correct score. The following syntactic structures are assessed: Declarative, active sentences (with coordination, prepositional phrase, negative, infinitival phrase, indirect and direct object, subordinate clause, and relative clause), passive, imperative sentences and interrogative (with prepositional phrase, passive with coordination, with infinitival phrase, and negative with direct and indirect object).

4. Sentence Structure

The **sentence structure** subtest assesses comprehension of sentences. It contains 26 sentences of the following syntactic categories: verb phrase, prepositional phrase, wh-interrogative, modification, indirect object, negative, passive, infinitive, relative clause, subordinate clause, and indirect request. The examiner presents the sentence and the child has to identify the correct picture illustrating the sentence from a plate of four pictures with only minimal distinguished differences.

3.3 Procedures

3.3.1 Administration

The **CELF-R** test was administered on an individual basis in a comfortable, quiet office, in a building adjacent to the school. Every effort was made to reduce distractions and encourage optimum performance.

On average, three 45 - minute sessions were needed to complete the administration of the test. For every subtest, a trial and a demonstration sentence proceeded the actual testing. Additional examples were provided if the child did not understand the instructions. The **recalling sentences** subtest is the seventh CELF-R subtest. It was usually administered on the second or third session, by which time the children were relaxed and at ease with the examiner.

3.3.2 Scoring

The scoring of **recalling sentences** was carried out as follows: correct repetition of the full sentence - 3 points; one word left out - 2 points; two words left out or distorted - 1 point; more than two words left out or distorted - 0 points.

The syntactic analysis of errors in **recalling sentences** was based on the "Item analysis for recalling sentences" table of the CELF-R (Semel and Wiig, 1987), which includes all the syntactic structures described above.

The scoring of the **formulated sentences** subtest was as follows: sentence correct syntactically and semantically = 3 points; adequate knowledge of the assessed structure but sentence incorrect syntactically or semantically = 2 points; incomplete sentence = 1 point; no use of the word provided in its actual morphological form = 0 points.

The analysis of the errors in the **formulated sentences** subtest was based on the "Item analysis for formulated sentences" table of the CELF-R. An additional category to those contained in the "Item analysis for formulated sentences" was added. This category, labeled **D**, included errors the children made when they were given two words for sentence construction. Formulation of sentences using two words is more complex than using one word. It was felt that recording these errors in a separate category would make the analysis of errors in the **formulated sentences** subtest and the subsequent statistical procedures more accurate.

The scoring of the **sentence assembly** subtest was as follows: 1 point if two of the sentence responses listed in the protocol were provided; 0 points for an incorrect or one sentence response; and NR for no response. Analysis of errors in the **sentence assembly** subtest was based entirely on the "Item analysis for sentence assembly" table of the CELF-R.

Scoring of the receptive **sentence structure** subtest was as follows: 1 point for a correct response; 0 points, for an incorrect response; and NR for no response. Analysis of errors in the **sentence structure** subtest was again according to the "Item analysis of sentence structure" table of the CELF-R.

The tables of "item analysis" for the scoring of the different subtests of the CELF-R are included in the protocols of the CELF-R.

3.3.3 Scores

Protocols were scored twice independently and error rate analysis determined 0.05% (95.5%) agreement. When differences were observed, the item was scored a third time and this third decision (not independent) was taken as the actual score.

3.4 Data Analysis

Data Analysis included the following steps.

1. Classification of the errors according to linguistic criteria (phonological, morphological, syntactic) as well as according to their type (omissions, substitutions, paraphrasing). Frequencies of the errors were computed using mainly descriptive statistics.

2. Regression analysis was performed to determine which of the errors contributed the most to the variance in **recalling sentences**. The Chi-square procedure was used to compare the subjects who scored above and those that scored below average (50th percentile) in the **recalling sentences** subtest.

3. Errors in **sentence formulation, sentence assembly and sentence structure** were classified according to the "item analysis tables" used by Semel and Wiig in scoring the different subtests. Kappa statistics were performed to find out whether there was agreement between the type of errors made in recalling sentences and the errors made in the other three subtests of the CELF-R mentioned above.

4. Correlation and multiple regression analyses were carried out to investigate the relationship between **reading decoding, reading comprehension** and the different **types of errors** made in recalling sentences.

5. To investigate how length and syntactic complexity affected sentence recall, sentences were classified according to the number of words and the nature of their syntactic structure. Frequency of occurrence of errors for the different sentence lengths and syntactic structures were computed. The Chi-square procedure was used to identify the

sentences that most clearly distinguished between the subjects who scored above and those who scored below the 50%ile in **recalling sentences**. These analyses may provide valuable information regarding the type of sentences that could be included in a pilot screening test, which could predict reading and language deficits.

CHAPTER IV

RESULTS

4.0 HYPOTHESIS I: Errors in Recalling Sentences

Hypothesis I stated that when repeating sentences, children with language deficits and reading impairment will spontaneously make the same type of errors that normal children and adults make when lure synonyms are used (Potter and Lombardi, 1990, 1992). That is, children with language deficits and reading impairment will substitute synonyms for target words and, when they replace a verb with a syntactically mismatched one, they will make syntactic changes to restore grammaticality.

The children's performance on the **recalling sentences** subtest was investigated and analysed statistically as described in the following two sections (Error Classification and Statistical Analyses).

4.1 Error Classification and Frequency of Occurrence

Error classification in the **recalling sentences** subtest was based on models of error classification used in studies of children's sentence repetition (Shankweiler et al., 1984), as well as that of agrammatic patients (Miceli et al., 1989) and deep dysphasic patients (Katz and Goodglass, 1990). New classification categories were added (e.g., phrase omissions and substitutions) to provide more accurate description of errors, as there is evidence in the literature that parsing in sentence processing is performed in phrasal units (Caplan, 1992).

Three broad error categories were distinguished - **omissions, substitutions** and **paraphrases** - which were further divided into the following subcategories: **content omissions (CO)**, omissions of nouns, verbs, adjectives, and adverbs (e.g., chased the **red ball** > chased the ball); **grammatical omissions (GO)**, omissions of verb tenses, auxiliary verbs and functive words (e.g., **had finished** dinner> finished dinner)[1] ; **phrase omissions (PO)**, omissions of phrases consisting of two to four words (e.g., who sits **on the bench**, next to the oak tree > who sits next to the oak tree); **grammatical substitutions (GS)**, substitutions of one grammatical morpheme for another (e.g., **has** the mouse...> **was** the mouse...); **content substitutions (CS)**, usually substitution of a synonym (e.g., **kind** > **nice**); **phrase substitutions (PS)** (e.g., **didn't show up** for practice> **missed** practice); and **paraphrases (P)** (e.g., **the children cut and pasted the pictures and hung them on the wall**> the children coloured the pictures and put them on the wall). No subcategories were created in the **paraphrases** category.

The subjects' errors in each of the above subcategories are shown in Appendix I. A summary of the errors presented in Appendix I, showing the frequency of each type of error and the percentage of subjects making each error, is found in Table 1. (next page)

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[1] Although functive words have lexical meaning, they were included under grammatical rather than content errors because as specifiers, complementizers, and prepositions, they mark grammatical structures. Furthermore, in Garret's (1984) model, functive words and bound morphemes are specified phonologically at the functional level while content words are specified at the positional level.

TABLE 1

RECALLING SENTENCES: Frequency of errors

Type of errors	Summed frequencies for 45 subjects	No. and (%) of subjects contributing to total errors
Omissions		
Grammatical	50	26 (57.8)
Content	111	39 (86.7)
Phrase	45	29 (64.4)
Total	206	
Substitutions		
Grammatical	38	22 (48.9)
Content	105	36 (80.0)
Phrase	20	15 (33.3)
Total	163	
Paraphrases	22	19 (42.2)
Content		
Omissions and substitutions	216	42 (93.3)
Grammatical		
Omissions and substitutions	88	32(71.1)
Phrase		
Omissions and substitutions	65	31 (68.9)

The most frequent errors were omissions (206), followed by substitutions (163) and paraphrases (22). Forty-three of the forty-five subjects, or 95.6%, made omission errors;

thirty-eight, or 84.4%, made substitution errors; and nineteen, or 42.2%, made paraphrasing errors.

4.1.1 Word errors

More subjects (93.3%) made content word errors than made grammatical word errors (71.1%). The sentences of the **recalling sentences** subtest contained 122 content words (i.e., nouns, verbs, adjectives, adverbs) and 149 grammatical words (i.e., prepositions, articles, pronouns, auxiliary verbs). Thus, the subjects had more opportunities to make grammatical word errors than content word errors. Nevertheless, when the results are viewed in terms of percentage of possible errors, they made three times as many content errors as grammatical errors (3.9% vs. 1.3%).

Errors in **recalling sentences** were also classified according to their morphological identity (i.e., nouns, verbs, pronouns etc.). A detailed description of the type of errors, the parts of speech they affected, and how frequently they occurred is shown in Table 2.

TABLE 2
Description of Errors in Recalling Sentences

Grammatical Omissions	**Number of errors**	**Most often omitted**
Auxiliary verbs	35	would, has
Functive words	15	and, even, the
Total:	50	
Content Omissions	**Number of errors**	**Most often omitted**
Verbs	44	labelled, bundled
Adverbs	22	away, very
Adjectives	19	red, heavy
Numerals	15	twelve
Nouns	11	oaks, trumpets
Total	111	
Phrase Omissions	**Number of errors**	**Most often omitted**
Phrases	45	in the house, on the bench
Grammatical Substitutions	**Number of errors**	**Most often substituted**
Functive verbs	29	who>that, and>but
Auxiliary verbs	9	has>was, were>was
Total	38	
Content Substitutions	**Number of errors**	**Most often substituted**
Nouns	45	woman>lady, children>kids
Adverbs	40	next to>beside, during>while
Verbs	13	delivered>mailed, sent>wrote
Adjectives	4	brown>red, big>large
Numerals	3	twelve>ten
Total	105	
Phrase substitutions	**Number of errors**	**Most often substituted**
Phrases	20	in the house>who lives, decided to go>went
Paraphrases	**Number of errors**	**Most often paraphrased**
Paraphrases	22	The boy who didn't show up for practice wasn't allowed to play on the team until a week later>The boy who came late wasn't allowed to play on the team until next week.

Most of the substitutions for content words were synonyms of the target word (e.g., **woman/lady, children/kids**). Only four words were replaced by words that were not synonyms: **hat/house, pasted/painted, sorted/spotted**, and **delivered/assailed**. The first three of these substitutions could have been due to mishearing. Furthermore, two of these substitutions seem to fit naturally into the sentence, and may have been more familiar to the children. For example, "The children cut and pasted the pictures" was replaced by "The children cut and painted the pictures". In the fourth case, the child was most likely unfamiliar with the target word, so he substituted a random word instead.

Most of the subjects' errors involved the same words. For instance, 16 children substituted synonyms for the word **woman**, and 13 for the adverb **next to**, while 10 omitted the adjective **red**. Nouns were most often substituted for, followed by adverbs. Additional comments about the parts of speech that were most often omitted or substituted will be made in the Discussion (see Chapter V).

4.1.2 Phrasal errors

The subjects made 20 phrase substitutions. Some of the substitutions were straightforward (e.g., had **finished dinner** was replaced by had **eaten their supper**). Others were complex (for instance, **the man in the house next door** was replaced by **the man who lived next door**). In this last example, deep sentence structure played a significant role. The elliptical clause **the man in the house next door** has as deep structure **the man who lives in the house next door**. The phrase **in the house** was deleted to produce **the man who lived next door**. These substitutions indicate processing in sentence repetition that goes beyond verbatim memory of the surface structure.

4.1.3 Paraphrases

In the **recalling sentences** subtest, the subjects spontaneously made 22 paraphrases. Most of the paraphrases (16/22) affected the longest sentence of the subtest, which contained 19 words. Five paraphrases involved a sentence containing 13 words and one a sentence of 16 words. Most of the paraphrasing errors were similar to those made by the subjects in the studies by Lombardi and Potter (1992). When a child substituted a verb that takes a noun phrase (NP) as object for a verb that takes a prepositional phrase (PP) as complement, its whole syntactic structure was changed to go with the new verb (e.g., **didn't show up for practice** was replaced by **missed practice**; **decided to go for a ride** was replaced by **took a drive**). In both examples, the prepositional phrase (PP) was replaced by a noun phrase (NP). Paraphrasing errors clearly show that sentence recall is not just verbatim recall of the surface structure; instead, the sentence is regenerated from a conceptual meaning, using normal mechanisms of sentence production.

4.2 Statistical Analyses

4.2.1 Regression analysis: Recalling sentences and all types of errors

Multiple regression analysis was performed to determine which errors accounted for the greatest proportion of variance in **recalling sentences**. Squared semipartial correlations were carried out to identify the unique variability accounted for by specific errors. The results were as follows:

TABLE 3

Summary of output from regression analyses in which recalling sentences (RS) test scores were predicted by substitution, omission, and paraphrasing errors, separately and in combination.

Predictor Variables	Variables in Prediction Equation	Multiple R-Square	Squared Semipartial Correlations*	Slope
<u>Omissions</u>		37.28		
Content (CO)	yes		13.99	negative
Phrase (PO)	yes		7.73	negative
Grammatical(GO)	no			
<u>Substitutions</u>		45.54		
Content (CS)	yes		16.06	negative
Phrase (PS)	no			
Grammatical(GS)	yes		15.59	negative
<u>Paraphrasing(P)</u>	yes	11.66	11.66	negative
<u>All errors</u>		60.33		
CO	yes		14.79	negative
PO	no			
GO	no			
CS	yes		13.76	negative
PS	no			
GS	yes		8.60	negative
P	no			

Based on the semipartial correlations, **grammatical substitutions (GS)**, **content substitutions (CS)**, and **content omissions (CO)** accounted for 60.3% (p<.0002) of the variance in **recalling sentences**. All three variables accounted for a substantial amount of unique variance in **recalling sentences**, with **content errors** accounting for more than **grammatical errors**.

As errors in recalling sentences are the focus of the present study, additional statistical computations were performed to find out whether any particular errors made distinct contributions to the subjects' performance.

4.2.2 Chi-square analysis: Errors in recalling sentences and performance above and below the 50%ile in RS.

To determine whether any of the errors distinguished between children who scored above average and those who scored below average, in the **recalling sentences** subtest, chi-square statistics were performed. As no children scored between the 25%ile and the 50%ile, statistic operations focused on two groups: those who scored above the 50%ile (19 subjects) and those who scored below the 50%ile (26 subjects). The results were as follows

TABLE 4

Relationship of specific errors in recalling sentences to the distinction of performance above and below the 50%ile in the recalling sentences subtest (chi-square analysis).

Errors	Significance
Grammatical Omissions (GO)	NS
Content Omissions (CO)	NS
Phrase Omissions (PO)	.01
Grammatical Substitutions (GS)	.0001
Content Substitutions (CS)	.01
Phrase Substitutions (PS)	.01
Paraphrasing (P)	NS

The errors that most clearly distinguished between the subjects who scored above and below average (50%) were grammatical substitutions (GS), $p<.001$. In fact, 75% of the children who scored below the 50%ile made **grammatical substitutions**, as compared to only 15% of those who scored above the 50%ile.

Nineteen of the 45 subjects scored average to above average in the **recalling sentences** subtest and 26 below (Appendix I). There were no qualitative differences between the errors made by the subjects who scored average or above average in the **recalling sentences** subtest and those who scored below average. The differences were only in the number of errors (quantitative).

Conclusion: The errors the subjects made in **recalling sentences** were similar to those made by normal children and adults in Potter and Lombardi's (1990) study: 97% of the content substitutions were synonyms of the target words. Furthermore, as in the 1992 Lombardi and Potter study, when the children replaced verbs with syntactically mismatched ones, they usually made syntactic changes to restore grammaticality. The frequency of errors was greater in the pathological population (80%) than in the normal population (53%). These findings are in accordance with Hypothesis I. **Grammatical substitutions**, **content omissions** and **content substitutions** made the most contribution to the variance in **recalling sentences**. **Grammatical substitutions** were the best distinguisher of whether the subjects would score above or below the 50%ile.

4.3 Hypothesis II: Grammatical Errors

Hypothesis II stated that subjects will make the same type of grammatical errors in the sentence structure, sentence assembly, and formulated sentences subtests of the clinical evaluation of language fundamentals - revised (CELF-R, Semel et al., 1987) as in the recalling sentences subtest.

and Welsh, 1973; Lombardi and Potter, 1992) is investigated indirectly in Hypothesis II. If the subjects have fundamental grammatical problems, there should be evidence in their regeneration of the stimuli in the **recalling sentences** task. As background for the investigation, a summary of the subjects' general performance on the CELF-R is presented in Appendix II A and B. The children's age, their percentile scores on 11 CELF-R subtests, and 2 CELF-R summary scores (Expressive Language and Receptive Language) are presented, as well as the means and standard deviations of these scores. The subjects as a group scored lower on the Expressive (x=33.96, SD=29.79) than on the Receptive (x=41.84, SD=28.06) subtests.

The subjects' performance on the four subtests of the CELF-R which assess grammatical and syntactic skills - **recalling sentences (RS), sentence structure (SS), sentence assembly (SA),** and **formulated sentences (FS)** - was thoroughly examined and analysed. Three of the subtests **(RS, SA, FS)** assess expressive grammatical skills, while the fourth **(SS)** assesses receptive skills. The subjects' comprehension of syntactic structures was within normal limits. Only two of the forty-five children scored below the 50%ile in the **sentence structure** subtest. For this reason, measurements of the **sentence structure** subtest were not used for further analyses or comparisons in the present study. The comparative work focused instead on the remaining three subtests: **recalling sentences, formulated sentences**, and **sentence assembly**. Appendix II, C through H, shows the errors made by the subjects in these three subtests, the frequency of errors, and the percentage of the subjects that contributed to these errors.

4.3.1 Syntactic errors in RS, SA and FS

Most of the errors in all three subtests involved **relative clauses, subordinate clauses**, and **coordination**. Appendix II I shows a breakdown of the errors in these structures. Relative absence from Appendix II I.

A summary of the errors with **subordinate clauses, relative clauses**, and **coordination** in the three expressive language subtests (**recalling sentences, sentence assembly**, and **formulated sentences**) is presented in Table 5. The number of sentences used to assess **subordinate clauses, relative clauses**, and **coordination** differed from subtest to subtest. To permit comparisons, the percentage of possible errors was calculated and included in Table 5, along with the percentage of the subjects who contributed to these errors.

TABLE 5

Summary of errors with subordinate clauses, relative clauses, and coordination, in Recalling Sentences, Sentence Assembly, and Formulated Sentences.

Recalling sentences	Subordinate Clauses	Coordination	Relative Clauses
Number of sentences	4	5	5
Total errors	57	38	95
% of possible errors	31.1	16.8	42.2
% of children contributing to total errors	64.4	62.2	88.9
SENTENCE ASSEMBLY			
Number of sentences	3	4	3
Total errors	47	30	75
% of possible errors	31.1	16.8	55.5
% of children contributing to total errors	64.4	40	88.9
FORMULATED SENTENCES			
Number of sentences	6	3	NA
Total errors	43	35	NA
% of possible errors	15.7	25.7	NA
% of children contributing to total errors	64.4	25.5	NA

There were similarities in the children's performance in the three subtests. The total number of errors in each of the structures tested **(subordinate clauses, relative clauses,** and **coordination**) were not very different. For instance, with **coordination**, 38 subjects made errors in **recalling sentences**, 35 in **sentence assembly**, and 30 in **formulated sentences.**

4.3.2 Kappa statistic analysis

Kappa analysis was performed to discover whether there was within-subject agreement in the errors made on specific structures in the three subtests. In other words, did the child who made errors in one syntactic structure (e.g., subordinate clauses) in **recalling sentences** make errors - beyond chance - in the same structure in **sentence assembly** and in **formulated sentences**?

Initial Kappa analysis indicated very low agreement between a child making an error in a particular syntactic structure in one subtest, and the child making the same error in another subtest. The closest agreement was between **sentence assembly relative clauses (SARC)** and **recalling sentences relative clauses (RSRC)**.

It is important to note that the cross-subtest comparisons were hampered by inconsistencies in test structures. The number of sentences in each broad syntactic category differed from subtest to subtest. For instance, there were 5 coordination sentences in the **recalling sentences** subtest, 4 in **sentence assembly**, and 3 in **formulated sentences**. Furthermore, the sentences differed both in length and in difficulty of vocabulary. In order to make the comparisons more accurate, further analyses were carried out. These analyses used the same number of sentences selected from each subtest, with structure and length as similar as possible. The following types of sentences were selected from each subtest (**SA, FS, RS**): two subordinate clauses, one containing the conjunction **although** and the other the conjunction **after**; one sentence with a relative clause; and one sentence with coordination. Appendix II J shows a comparison of errors in specific syntactic structures in **RS, SA** and **FS**.

Kappa statistics were performed and agreement was again low. The highest agreement,

subordinate clauses (SASC) and **recalling sentences subordinate clauses (RSSC)** with the conjunction **after**. The Kappa coefficient for these two variables was 0.32.

In psychiatry, where Kappa statistics are frequently used to evaluate agreement between two clinicians on patient diagnosis (Shrout et al., 1987), Kappa O.70 is considered acceptable for concordance between two raters. Kappa 0.32 in the above findings indicates weak within-subject agreement between **RSSC** and **SASC**.

Preliminary Conclusion: Hypothesis II, which predicted comparable performance in each of the three expressive language tests (**RS, SA, and FS)**, was not supported by the analyses of the data.

4.3.3 Reanalysis of errors in the formulated sentences subtest

As reported earlier, the agreement between the subjects' syntactic ability and their performance in sentence repetition was low. These findings are at variance with those reported in the literature. As noted in Chapter II, children usually have difficulty repeating sentences which contain syntactic structures that they have not yet mastered in their spontaneous speech (Menyuk, 1964; Schwartz and Daly, 1978, Berry-Luterman, 1971).

To understand this finding, the subject's testing protocols were rechecked and their performance on the three subtests was reexamined. A closer look at the errors in the **formulated sentences** subtest revealed that several errors (46%) did not involve the syntactic structure assessed, but were either semantic errors or syntactic errors affecting other than the assessed structure. For example, when asked to produce a sentence containing the word **or**, one of the children responded, "The man is choosing if he would have this lettuce or that". Another child created the following sentence using the word **after**: "The boy was the second after the first". Another child who was asked to formulate a sentence using the two words **if** and **before** came apparently mastered the syntactic structures being assessed, yet the sentences they produced were semantically anomalous and could earn a score of only 2 points, instead of 3 (see Methodology). Furthermore, children often made syntactic errors involving other than the target word. For example, the following sentence was produced using the word **if**: "If the school bus didn't come today then the kids will go home." These sentences also received a score of 2 rather than 3.

Although scoring of the **formulated sentences** subtest takes into consideration both the syntactic and semantic errors that the subjects make, this has an effect only on the total score. In the present study, where performance on specific syntactic structures is compared in the three expressive subtests (**recalling sentences**, **sentence assembly**, and **formulated sentences**), it is important to make more explicit the distinction between **syntactic** (**S**) errors (affecting the specific structure that is being assessed) and **other** (**O**) errors (semantic or syntactic affecting other than the targeted word). Reanalysis of the subjects' errors in the **formulated sentences** subtest, according to semantic versus syntactic criteria, is shown in Appendix II K.

When scoring was done according to the standardised procedures recommended in the CELF-R manual (see Methodology), 31 of the 45 subjects or 68.8%, scored below the 37%ile in the **formulated sentences** subtest. However, when the data were reanalysed, classifying the errors into syntactic (**S**) versus other (**O**) categories, only 20 of the 45 or 44.4% of the subjects exhibited syntactic disability. This new figure seems more accurate, as most of the subjects did not seem to present syntactic disability in spontaneous conversation, even to the trained (clinician's) ear.

4.3.4 Comparison of percentile scores in recalling sentences, sentence assembly and formulated sentences

Subjects who made predominantly semantic errors or errors affecting other than the targeted range. A comparison of the subjects' percentiles in the **recalling sentences, sentence assembly**, and **formulated sentences** subtest after reanalysis of the errors into syntactic (**S**) versus other (**O**) categories is shown in Appendix II L.

There was agreement in the performance of 21 or 46.6% of the children in the three subtests. Thirteen scored within the normal limits and 8 scored below average on all three subtests. When the 37%ile was appraised as above average or below average according to the scores in the other two subtests, the agreement was even higher at 64.4%. Of the remaining subjects, seven showed disability in **recalling sentences** only, one in **formulated sentences**, and one in **sentence assembly** only.

The subjects performed better on the **sentence assembly** subtest than on the **recalling sentences** or the **formulated sentences** subtests. Twenty seven of the 45 children scored above the 50%ile and 35 above the 37%ile. As explained in Methodology, the scrambled phrases in the **sentence assembly** subtest are presented both orally and in written form, which eliminates the memory impediment to recall and could explain the subjects' superior performance. When the errors in the **formulated sentences** subtest were divided into syntactic (**S**) versus other (**O**), 25 of the 45 subjects scored above the 37% ile. The lowest scores were in **recalling sentences**. In this subtest, only 19 of the subjects scored above the 37%. These findings suggest that syntactic disability was not the main cause of the subjects' very low scores in expressive language tasks.

As mentioned in the review of the literature in Chapter II, the relationship between sentence imitation and spontaneous speech production is not clear-cut (Connel and Myles-Zitzer, 1982). Short term memory seems to interfere (McDade et al, 1982), but its role is not clearly understood. It is difficult to know whether the findings of the present study indicate deficits in working memory or deficits in other linguistic or cognitive functions apart from syntactic ability. At this point, any suggestions will be speculative. Additional comments on these findings will be

Conclusion: Initial statistical analyses failed to support Hypothesis II: errors in **recalling sentences** did not reflect subjects' expressive grammatical deficits. The standard scoring of the **formulated sentences** subtest was found inadequate for the present investigation, as it did not clearly distinguish syntactic deficits for specific syntactic structures. After reclassification of the errors in the **formulated sentences** subtest according to semantic versus syntactic criteria, close agreement appeared among the percentile scores in all three expressive language subtests. This finding, together with the subjects' inferior performance in **recalling sentences** as compared to **sentence assembly** and **formulated sentences**, could indicate working memory or processing deficits rather than syntactic disability.

4.4 HYPOTHESIS III: Errors in Recalling Sentences and Reading Ability

Hypothesis III stated that specific errors in recalling sentences will predict impaired performance in reading decoding and reading comprehension. The relationship between the subjects' performance on the **recalling sentences** subtest of the **CELF-R** (Semel, Wiig, and Secord, 1987) and on the **reading decoding** and **reading comprehension** subtests of the Kaufman Test of Educational Achievement **(K-TEA)** (Kaufman and Kaufman, 1985) was investigated using the following statistical procedures:

4.4.1 Correlation analysis: Errors in recalling sentences, and reading decoding and reading comprehension

Table 6 shows the correlation coefficients and levels of significance between errors in **recalling sentences** and composite scores in **reading decoding** and **reading comprehension.**

TABLE 6

Correlations between errors in Recalling Sentences and composite scores in Reading Decoding and Reading Comprehension.

Errors	**RD**	**RC**
Grammatical omissions	.03	.17
Content omissions	.31	.48**
Phrase omissions	.01	.30
Grammatical substitutions	.33	.39*
Content substitutions	.22	.33
Phrase substitutions	.16	.03
Paraphrases	.16	.00

* $p<.01$
** $p<.001$

Of the seven types of errors the subjects made when repeating sentences, only **content omissions (CO)** ($p<.001$) and **grammatical substitutions (GS)** ($p<.01$) showed significant correlations with **reading comprehension.**

4.4.2 Multiple regression and stepwise regression analysis

i) Reading comprehension Results from the regression analysis (in which **reading comprehension** was predicted by omission, substitution, and paraphrasing errors, alone and in combination) are shown in Table 7.

TABLE 7

Summary of output from regression analyses in which Reading Comprehension test scores were predicted by substitution, omission and paraphrasing errors in the Recalling Sentences subtest of the CELF-R, separately and in combination.

Predictor Variables	Variables in Prediction Equation	Multiple R-Square	Squared Semipartial Correlations*	Slope**
Omissions		22.88		
Content(CO)	yes		22.88	negative
Phrase(PO)	no			
Grammatical(GO)	no			
Substitutions		14.87		
Content(CS)	no			
Phrase(PS)	no			
Grammatical(GS)	yes		14.87	negative
Paraphrasing(P)	no			
All Errors		44.23		
CO	yes		17.31	negative
PO	no			
GO	no			
CS	yes		6.54	negative
PS	no			
GS	yes		6.78	negative
P	yes		7.17	positive

*The relative size of the squared semipartial correlations indicates the strength of the relationship between the predictor variables and RC.
**The slope of the regression line indicates the direction between the predictor variable (type of error) and the variable being predicted (RC). A negative slope indicates that the children who made many errors tended to have lower RC scores and vice versa.

Content omissions, grammatical substitutions, and **paraphrases** accounted for 44.23% of the variance in reading comprehension. **Content omissions** contributed the most to the

grammatical substitutions, and fewer **paraphrases**[2] performed more poorly in reading comprehension.

ii) Reading decoding

Results from the regression analysis (in which **reading decoding** was predicted by omission, substitution, and paraphrasing errors, alone and in combination) are shown in Table 8.

[2] Although the inverse relationship appears paradoxical, it may be an artifact of the stimuli. The sentence which produced the greatest number of paraphrases may have

TABLE 8

Summary of output from regression analyses in which Reading Decoding test scores were predicted by substitution, omission and paraphrasing errors in the Recalling Sentences subtest of the CELF-R, separately and in combination.

Predictor Variables	Variables in Prediction Equation	Multiple R-Square	Squared Semipartial Correlations*	Slope**
Omissions		9.63		
Content (CO)	yes		9.63	negative
Phrase (PO)	no			
Grammatical (GO)	no			
Substitutions		19.43		
Content (CS)	no			
Phrase (PS)	yes		17.06	positive
Grammatical (GS)	yes		8.35	negative
Paraphrasing(P)	no	2.39	2.39	
All Errors		31.20		
CO	yes		10.43	negative
PO	no			
GO	no			
CS	no			
PS	yes		7.51	positive
GS	yes		12.18	negative
P	no			

* The relative size of the squared semipartial correlations indicates the strength of the relationship between the predictor variables and RD.

** The slope of the regression line indicates the direction between the predictor variable (type of error) and the variable being predicted(RD). A negative slope indicates that the children who made many errors tended to have lower RD scores and vice versa.

31.2% of the variance in **reading decoding** scores. Subjects making a greater number of **content omissions** and **grammatical substitutions**, and fewer **phrase substitutions**, performed more poorly in reading decoding.

<u>**Conclusion**</u>: **Content omissions** and **grammatical substitutions** were significantly associated with both **reading decoding** and **reading comprehension.**

In the Kotsopoulos et al. (1996) project, results showed that three variables - **digit span**, **recalling sentences**, and **sentence assembly** - accounted for a significant proportion of variance in **spelling** (29%), **reading decoding** (47%), and **reading comprehension** (63%). Each of the variables contributed an equitable proportion of unique variance, which suggests that these measures assess overlapping cognitive/language functions. For reasons outlined in the Methodology, the **recalling sentences** subtest was chosen to be the focus of the present study. However, as one of the goals of the study is to make suggestions for a screening test that would predict linguistic and reading deficits, it is important to include measures from **sentence assembly** (the second linguistic task that contributed to the variance of **reading decoding** and **comprehension** in the Kotsopoulos et al., 1996 project) in some of the statistical computations

4.5 Syntactic Errors in Recalling Sentences and Sentence Assembly, and Reading Decoding and Comprehension

The relationship between **reading decoding** and **comprehension** on the one hand and **syntactic errors** in **recalling sentences**, and **sentence assembly** on the other was investigated using the following statistical analyses.

4.5.1 Correlation analysis Table 9 presents the correlation coefficients and levels of significance between syntactic errors in **recalling sentences** and in **sentence assembly** on one hand, and **reading decoding** and **reading comprehension** on the other.

TABLE 9

Correlations between syntactic errors in Recalling Sentences and Sentence Assembly, and Reading Decoding and Reading Comprehension.

Syntactic Errors	RD	RC
Recalling Sentences Subordinate Clauses	.24	.40*
Recalling Sentences Relative Clauses	.44*	.62***
Recalling Sentences Coordination	.16	.32
Recalling Sentences Noun Modification	.20	.32
Recalling Sentences Conjunction Deletion	.15	.32
Recalling Sentences Elliptical	.29	.33
Sentence Assembly Subordinate Clauses	.43*	.50**
Sentence Assembly Relative Clauses	.11	.13
Sentence Assembly Coordination	.27	.40*
Sentence Assembly Indirect Object	.22	.31
Sentence Assembly Negation	.29	.33

***p<.01 **p<.001 ***p<.0001**

Errors with **relative clauses** in **recalling sentences** were significantly associated with **reading decoding** (p<.01) and with **reading comprehension** (p<.0001). **Subordinate clauses** in **sentence assembly** were significantly associated with both **reading decoding** (p<.01) and **reading comprehension** (p<.002), while **coordination clauses** in **sentence assembly** and **subordinate clauses** in **recalling sentences** showed correlations (p<.01) with **reading comprehension** only.

4.5.2 Regression analysis

Results from regression analyses in which **reading decoding** and **comprehension** were predicted by specific syntactic errors in **recalling sentences** and **sentence assembly** are shown in tables 10 and 11.

TABLE 10

Summary of output from regression analyses in which Reading Decoding scores were predicted by specific syntactic errors in RS and SA, separately and in combination.

Predictor Variables	Variables in Prediction Equation	Multiple R-Square	Squared Semipartial Correlations*	Slope**
Recalling Sentences		19.90		
Subordinate Clauses	no			
Relative Clauses	yes		19.90	Negative
Coordination	no			
Noun Modification	no			
Conjunction Deletion	no			
Sentence Assembly		19.03		
Subordinate Clauses	yes		19.03	Negative
Relative Clauses	no			
Coordination	no			
Indirect Object	no			
Negation	no			
All Errors		28.13		
Recalling Sentences				
Subordinate Clauses	no			
Relative Clauses	yes		9.10	Negative
Coordination	no			
Noun Modification	no			
Conjunc. Deletion	no			
Sentence Assembly				
Subordinate Clauses	yes		8.24	Negative
Coordination	no			
Relative Clauses	no			
Indirect Object	no			
Negation	no			

strength of the relationship between the type of errors and **RD**.

The slope of the regression line indicates the direction of the relationship between the type of errors and **RD. Negative means the children who made many errors tended to have lower **RD** scores and vice versa.

TABLE 11

Summary of output from regression analyses in which Reading comprehension scores were predicted by specific syntactic errors in RS and SA, separately and in combination.

Predictor Variables	Variables in Prediction Equation	Multiple R-Square	Squared Semipartial Correlations*	Slope**
Recalling Sentences		39.22		
Subordinate Clauses	no			
Relative Clauses	yes		39.22	Negative
Coordination	no			
Noun Modification	no			
Conjunction Deletion	no			
Sentence Assembly		24.35		
Subordinate Clauses	yes		24.35	Negative
Relative Clauses	no			
Coordination	no			
Indirect Object	no			
Negation	no			
All Errors		46.73		
Recalling Sentences				
Subordinate Clauses	no			
Relative Clauses	yes		22.38	Negative
Coordination	no			
Noun Modification	no			
Conjunc. Deletion	no			
Sentence Assembly				
Subordinate Clauses	yes		7.50	Negative
Coordination	no			
Relative Clauses	no			
Indirect Object	no			
Negation	no			

The slope of the regression line indicates the direction of the relationship between the type of errors and **RC. Negative means the children who made many errors tended to have lower **RC** scores and vice versa.

In **recalling sentences**, only errors with **relative clauses** accounted for a significant proportion of the variance in **reading decoding** (19.9%), and this relationship was even stronger for **reading comprehension** (39.2%). In **sentence assembly, subordinate clauses** accounted for 19.03% of the variance in **reading decoding**, and 24.35% in **reading comprehension**. Errors in both **recalling sentences** and **sentence assembly** accounted for 28.13% of the variance in **reading decoding**, and 46.73% in **reading comprehension**

4.6 Summary of overall results

Hypothesis I was supported. Behaviourally disturbed children exhibiting academic and language deficits made similar errors in **recalling sentences** to those reported by Potter and Lombardi (1990, 1992) for normal subjects. **Content omissions** and **grammatical substitutions** contributed the most to the variance in **recalling sentences**. **Grammatical substitutions** best distinguished between subjects who scored above and those who scored below the 50th percentile in the **recalling sentences** subtest.

Hypothesis II was not supported. When the subjects' performance in **recalling sentences**, **sentence assembly**, and **formulated sentences** was analysed following standard scoring procedures, no within-subject agreement was found in the three subtests. However, when the **formulated sentences** subtest was rescored, dividing errors into **syntactic** versus **other**, close agreement in the percentile scores in the three subtests was discovered in 64.4% of the children. The close agreement in the percentile scores rather than for the tested syntactic structures could indicate deficits in a more cognitive than syntactic ability, such as **working memory**. The children's superior performance on the **sentence assembly** and **formulated sentences** subtests, and their relatively poor performance on the **recalling sentences** subtest, could be an additional indication of working memory or processing deficits rather than structural syntactic disability.

Hypothesis III was supported. Two specific error types that subjects made when repeating sentences, **content omissions** and **grammatical substitutions**, contributed the most to the variance in **reading decoding** and **reading comprehension**. An additional analysis showed that, of the syntactic structures assessed, **relative clauses** in **recalling sentences** and **subordinate clauses** in **sentence assembly** contributed the most to the variance in **reading decoding** and **reading comprehension.**

CHAPTER V
INTERPRETATION OF RESULTS AND DISCUSSION

5.0 Introduction

The present study investigated sentence repetition in children with language deficits and reading impairment. The main goal of this study was to better understand the nature of sentence recall (e.g., the cognitive and linguistic processes involved, the type of errors that occur and the relationship of these errors to expressive grammatical deficits and academic impairment). Understanding the nature of sentence recall may have practical applications in the assessment and therapy of expressive language deficits and reading underachievement.

The main findings of the study were: in sentence recall by language disordered and academically delayed school age children, errors involving content words occurred more frequently than errors involving grammatical morphemes. Nouns and adverbs were affected the most. The majority of the content substitutions were synonyms to the target word. **Content omissions**, **content substitutions** and **grammatical substitutions** accounted for 60.3% (P= .002) of the variance in recalling sentences. Deficits in syntactic competence were not the main cause of the children's poor performance in expressive grammatical tasks. Disfunction in working memory or other linguistic processes could have been equally responsible. **Content omissions** and **grammatical substitutions** contributed the most to the variance in **reading decoding** and **reading comprehension**. Only errors in sentences containing relative clauses were associated with reading impairment.

The results of the study will be interpreted and discussed under the following headings. The results of Hypothesis I and II will be discussed under the headings **Content Omissions** and **Substitutions, Grammatical Errors,** and **Paraphrases**. The results of Hypothesis III will be interpreted and discussed under the heading of **Errors in Recalling Sentences, Reading Decoding** and **Comprehension**. Finally, some thoughts on the interplay of phonological and semantic memory in sentence recall will be discussed under the heading of **New Conceptualisation of Processes Involved in Sentence Repetition**. The chapter will conclude with **Suggestions for a Pilot Screening Test**, which may predict processing and reading deficits.

5.1 Hypothesis I: Content Omissions and Substitutions

To understand the relationship between **content omissions**, **content substitutions** and **grammatical substitutions** on the one hand, and **recalling sentences**, **expressive language deficits** and **reading impairment** on the other, an attempt will be made to answer the following questions: When do errors occur and under what conditions? Why do they occur? and What are the factors that affect their occurrence?

5.1.1 Content omissions

Most of the content omissions (76/111) occurred in sentences containing clusters of content words, usually in a list-like manner (e.g., "The woman has read the **twelve**, **big**, **heavy**, **brown** books"). Several omissions occurred in sentences containing unfamiliar vocabulary (e.g., "The **trumpets** and **violins** were played by the **musicians**"). There were also instances of combined enumeration and difficult/less common vocabulary (e.g., "The mailman **sorted**, **labelled**, **bundled** and delivered the magazines").

Sentences containing a high proportion of content words are liable to reduced recall. According to Romani and Martin (1993), when a content word is adjacent to the verb, that word is more easily integrated into the verb's syntactic structure. When a sentence has several content words (and therefore some of them are not next to the verb), they have to be kept in memory before they are integrated into the verb's syntactic structure and the larger meaning units. This extra step makes them vulnerable to loss and therefore more likely to be omitted in sentence recall.

Butterworth, Shallice, and Watson (1990) expressed a similar view in more detail. Using a number of short term memory tasks, they compared the performance of a female patient who had a meningioma removed from the vicinity of her angular gyrus at the age of 23 years with the performance of university-level psychology students. The tasks involved repetition of lists of words and repetition of sentences which incorporated the same lists of words. Recall was either immediate or after a 20 second delay. During the delay the subjects performed speeded addition by 1 from numbers presented on cards.

The researchers found that word lists were better remembered when embedded in sentences. Furthermore, they made the following observations regarding word omissions: In sentence repetition, a syntactic-semantic (S-S) structure is formed. This structure contains elements that are either adequately or inadequately supported. Although adequately supported elements make up the gist of the sentence, a formal definition of adequately and inadequately supported elements is difficult. The internal organization of the S-S usually determines the degree of support between elements. Most likely the elements that constitute the sentence's main structure (e.g., subject, verb, object) are adequately supported elements, while elaborations of well supported structures (e.g., adjectives, relative clauses) are inadequately supported. Thus words in a list-like manner are inadequately supported elements that lack distinctiveness in memory. The inadequately supported elements rely on phonological memory for retrieval, while the adequately supported ones can remain independent of phonological memory. Inadequately supported elements are more prone to loss when phonological memory is defective and often constitute omission errors.

The present study's findings are consistent with Butterworth et al.'s postulations. Most of the omissions were of unsupported elements. For example, in the sentence "The woman has read the twelve, big, heavy, brown books", **twelve** was omitted 15 times, followed by **heavy** 6, **big** 3, and **brown** 3 times.

TREE DIAGRAM

Tree — Diagram

"The woman has read <u>the *twelve big heavy brown* books</u> "

```
                      IP
                     /  \
           the woman     I'
                        /  \
                      I⁰    VP
                 has       /  \
                               V'
                              /  \
                            V⁰    NP
                       read      /  \
                               the   N'
                                    /  \
                              twelve    N'
                                       /  \
                                    big    N'
                                          /  \
                                     heavy    N'
                                             /  \
                                        brown    N⁰
                                                 books
```

As the tree diagram clearly shows, these words are adjectives (modifiers) in N-bar position. They are not NP-heads. Adjectival modifiers are attributes. According to Radford (1988), attributes are simply prenominal adjuncts. Like adjuncts, they recessively expand N-bar into N-bar position. Adjuncts do not need or receive **theta roles** (Baker, 1988), which means they are not as tied to the predicate as arguments are, and are therefore less supported syntactically and more susceptible to omissions in recall. Modifiers share the same X-bar status and this structural equality justifies the prediction that they would be equally liable to omissions. However the rate of omissions may increase if pragmatic and/or semantic factors are involved. This notion will be expanded later on.

Several omissions occurred in sentences containing less common vocabulary. For example in the sentence "The **trumpets** and **violins** were played by the **musicians**", **trumpets** and **violins** were omitted twice, and **musicians** once. Perhaps in processing, a certain amount of time is allocated for identifying and retrieving each word from semantic memory. Failure to identify a word within the time limit prevents its activation, thereby causing omission. Unfamiliar words would be more vulnerable, because more time is usually needed for their retrieval. This is what the omissions in the above sentence appear to indicate.

The sentence "The mailman sorted, labelled, bundled and delivered the magazines" combines clustering of content words and vocabulary unfamiliarity. The word **labelled** was omitted 13 times while **sorted** and **bundled** were omitted 10 times each. Once again the words under investigation have equal structural status as all of them are

VP-heads. Therefore they are expected to exhibit equal rates of omission. Registered differences should thus be attributed to additional factors, as discussed earlier.

The significance of the structural factor, however, should not be underestimated. Overall, only 13 of the 111 content omissions were syntactically well-supported structures. For example, in the sentence "The man in the house next door promised to water our flowers during our vacation", **promised** (a main verb in VP-head position) was omitted only twice.

Omission of phrases followed the same supported/unsupported pattern. The phrases that were most often omitted were elaborations of obligatory structures (e.g., "the man **in the house** next door"/"the man next door" and "who sits **on the bench** next to"/"who sits next to"). These constituted the majority of **phrase omissions** (35 out of 45). As expected, **phrase omissions** like individual word omissions are not affected by structural factors alone. Pragmatics also affected their occurrence as illustrated by the sentence immediately above. **On the bench** and **next to the oak tree** have equal syntactic weight, but, from a pragmatic perspective, sitting on a bench is often implied when you are sitting next to an oak tree, and could be omitted without changing the sentence's meaning. That is why only the former was omitted.

In general, omissions of content words and phrases did not happen indiscriminately: they appeared to follow patterns and to occur in only certain environments. Although it is not within the scope of the present study to evaluate which words are vulnerable to omissions, it seems that lack of syntactic support is a significant factor that contributes to their occurrence. Words that are **adjuncts**, that do not need or receive theta roles, are more liable to omission than **syntactic arguments**, whether subjects or complements. However, other factors such as semantics, pragmatics, prosodicity, etc. might influence their occurrence .

5.1.2 Content substitutions

When do content substitutions occur? This study showed that they occur in all types of sentences, independent of grammatical complexity and length. Many of the substitutions were **nouns** (45 out of 105), and most of the noun substitutions were either **subjects** (18) or **objects** (17). The majority of the substitutions occurred either at the beginning or the end of the sentence, or, in sentences containing a list of content words, at the beginning or the end of the list. Research has shown that words at the beginning or at the end of sentences are particularly vulnerable in recall. At the beginning of the sentence, there are no contextual restraints (Kolk, 1995); thus, according to connectionist theories, all the **associative words** of a particular word are equally activated. At the end of the sentence or phrase, context creates constraints and perhaps expectations for certain high-frequency or familiar words to occur. Several studies (e.g., Tobossi, 1988a; Gernsbacher, Varner and Foust (1990, as cited by Nelson et al., 1992) have shown that sentential context can influence the word that is constructed, particularly if the word appears later in the sentence.

Most of the content substitutions in the present study were synonyms or associative words; in fact only four substitutions were not synonyms (see Results). These findings are similar to those reported by Potter and Lombardi (1990) with normal subjects, both children and adults. Thirty-seven of the synonyms in the present study were strong synonyms (e.g., **woman/lady, dinner/supper**); the remaining ones were inferior synonyms or associative words (e.g., **railing/gate, lady/mother, trumpet/piano**). Most phrase substitutions were also phrase synonyms (e.g., **until a week later/ next week,** and **the man in the house next door/the man who lived next door**). The substitution of synonyms is understandable, since preserving meaning is very important in sentence repetition. If the word was substituted by an antonym or an unrelated word, the meaning of the whole sentence would have changed. Before proceeding into the exploration of factors that influence the occurrence of **content substitutions** and **omissions** in recalling sentences, we will review briefly previous studies of errors in recalling sentences.

5.1.3. Studies on errors in recalling sentences

Only one study in the available literature described in detail the errors children made when repeating sentences. Shankweiler, Smith, and Mann (1984), in a study of 35 good and poor readers in the third grade, assessed the children's ability to comprehend and repeat syntactically complex sentences containing reflexive pronouns (e.g., "The queen watched the witch pick herself a flower", "The queen watching the witch picked herself a flower"). In these sentences, pronoun reference is difficult to assign, particularly in the second sentence, where the centre-embedded relative clause modifies the subject of the main clause, thus causing the reflexive pronoun's referent to be the subject of the main clause. The researchers found that the children's comprehension of the sentences (as assessed by picture choice) was adequate. Poor and good readers, however, differed significantly in their ability to repeat the sentences: poor readers incorrectly recalled a larger number of sentences and made more **substitution, omission,** and **grammatical** errors than good readers. The greatest portion of errors occurred with **nouns** and **verbs**. **Substitutions** made up the greatest portion of errors, whereas intrusions rarely occurred. The proportion of omissions was comparable for each group. Correlation analysis showed that both the number of incorrectly recalled sentences and each type of error (**substitutions, omissions, grammatical errors**) in recalling sentences correlated ($p<.01$) with reading deficits, as assessed using the Iowa Test of Basic Skills (Hieronymous and Lindquist, 1978). Analysis of variance where type of sentences and reading groups were used as variables showed again that both number of incorrectly recalled sentences and number of word errors correlated with reading deficits.

Kirchner and Klatzky (1985) have reported errors by Specific Language Impaired (SLI) children in recalling lists of words (not sentences). In their study of 12 SLI children and 12 controls, the disordered subjects produced four times as many **intrusions** (substitutions) as the normal children. The **intrusions** were either **phonological** or **semantic**. The **semantic intrusions** included members of the same category (apple/pear), frequent associations (bread/butter) and conceptual similarities (tire/wheel). **Phonological intrusions** involved substitutions of new phonemes for given phonemes or clusters. The results showed that, compared to the control group, SLI children produced a substantially larger number of **semantic intrusions**, particularly those that were **categorically similar**. For **phonological intrusions**, however, there was not much difference between the two groups. These findings led Kirchner and Klatzky to propose that SLI children encode stimuli in a **semantic** rather than a **phonological** code.

Semantic errors in sentence recall were also reported by Wiig and Roach (1975), in a study involving 30 learning disabled adolescents. The substitutions, however, were not fully described, as they were not the focus of the study.

5.2 Factors Affecting Occurrence of Content Substitutions and Omissions

I was unable to locate any studies in the literature, on adults or children, which investigated the conditions or factors that lead to errors in sentence recall. To learn how omissions and substitutions occur, we will instead examine studies of children doing tasks similar to recalling sentences, such as **naming** and **reading** (Laine et al., 1990), and neurolinguistic studies on adults.

Semantic substitutions have often been reported in dyslexic children's reading, being in some cases the predominant symptom Siegel (1985, as cited by Snowling, 1987). They are also observed frequently in **naming** tasks, particularly in rapid naming, and they constitute the predominant symptom in adult neurological disorders such as **deep dysphasia** (Katz and Goodglass, 1990; Martin and Safran, 1992), and **deep dyslexia** (Coltheart 1980). Semantic substitutions of content words may occur for at least two reasons: 1) inferior semantic knowledge of the word, and 2) processing deficits, especially those associated with **timing**. In the remaining part of this section, the influence of **inferior semantic knowledge** of words and **processing** deficits on the occurrence of content substitutions and omissions will be discussed in detail, drawing information from research on both children and adults.

5.2.1 Inferior semantic knowledge of words

Replacement of a word by a synonym, and in particular by an inferior synonym, could mean substandard representation of the word in semantic memory. For instance, the child who substituted **gate** for **railing** most likely had a vague, unspecified, limited knowledge of the given word. According to Menyuk (1987), learning disabled as well as SLI children have problems with semantic skills. They exhibit limited **representations of lexical items**, develop lexical categorization with some difficulty, and have problems with synonyms, antonyms and figurative language. Inferior semantic knowledge of children with learning disabilities has also been reported by Wiig and Semel (1980) and Swanson (1988a, as cited by Gerber, 1993). These studies showed that learning disabled children exhibit inferior use of structural aspects of semantic knowledge (e.g., **organization, associations, elaborations**). As most of the children in the present study presented with reading deficits and language problems, at least some of their **content substitutions** very likely reflected deficits in their semantic knowledge.

Many of the errors, however, could not have been due to inferior knowledge of word meanings. For instance, 21 of the substitutions involved the words **woman** and **children**. These are simple words that we would expect school age children to have mastered.

Replacement of a word by a synonym, even an inferior one, does not necessarily indicate limited representation of the word in semantic memory. Studies with older subjects have shown that other factors could be equally responsible. Generating strong synonyms and providing adequate definitions for words are two of very few verbal skills to be affected by age (Botwinick and Storandt, 1974). Furthermore, adults at risk for Alzheimer's Disease experience similar problems (Houlihan et al., 1985, Mitrushina et al., 1989). Mitrushina et al. found that what distinguished patients at risk for developing AD (early stages of AD) from a control group, and an outlier group (subjects matched for vocabulary with the AD group but with no diagnosis of AD), was the at risk AD patient's performance on word associations (semantic fields). Patients at risk for developing AD provided inferior synonyms and definitions of the words than both the control group and the outlier group. The researchers suggested, however, that demented patient's deficits in lexical semantics are most likely in the processing mechanism rather than in the semantic representations.

The literature abounds with controversy as to the cause of the lexical-semantic deficits observed in older subjects and AD patients. Loss of word meanings, degradation of lexical-semantic knowledge, and **timing** deficits in processing are some of the explanations proposed. To test which of these explanations is correct, Smith et al. (1995) conducted a study involving eleven mildly demented AD patients and eleven elderly control individuals. The subjects were assessed using property (i.e., semantic features of concept) verification tasks, which tested the following abilities: **dominance ranking**, **typicality,** and judging whether the affected properties were **shared** with other associative words or were **distinctive**. Although the researchers found no loss of knowledge of lexical semantics in AD patients, nor any degradation of highly dominant properties of objects, they did find degradation for lower dominant properties. The strongest evidence for impaired lexical semantic representations in AD was the disproportionately **large amount**

of time required to access low dominant properties of objects. This deficit was even more pronounced in tasks that did not provide contextual support.

In the present study, most of the synonyms in content substitutions were inferior synonyms. Taken as a whole, however, the children showed adequate ability to generate word associations. They scored within the normal range (mean: 50.73 percentile) in the CELF-R's **word associations** subtest, which assesses ability to generate words of certain categories (e.g., animals, transportation, jobs) while being timed. Unfortunately, the categories assessed were relatively easy. It is difficult to predict how the children would have performed with more complex semantic categories. Nevertheless, the type of errors the children made in **recalling sentences**, their word association results, together with other evidence discussed below, suggest that the children's semantic representations were to a large extent intact and that their problems were most likely due to other causes (e.g., processing deficits).

In the following paragraphs, the contribution of deficits in processing and in particular deficits in **timing** to the occurrence of content substitutions and omissions will be explored.

5.2.2 Processing deficits

The studies by Potter and Lombardi (1990, 1992), as well as the present study demonstrate clearly that sentence repetition involves processing; that is, accessing of long term memory and regeneration of the sentence from its gist. Speedy word identification is very important in processing, as accessing of the words in the lexicon provide semantic as well as argument-structure and control information which facilitates parsing and comprehension of the sentence (Tanenhaus and Carlson, 1989). Furthermore, Dempster (1981) (see chapter II), in a critical review of 10 sources which account for differences in working memory, distinguished **item identification** (i.e., speed of word recognition) as the only source making a substantial contribution to differences and growth of working memory. Deficits in speedy word identification could affect processing and lead to errors.

Speedy word identification and retrieval is a skill that can distinguish between normally achieving students and students with reading deficits and language delays (Cornwall, 1992). Deficits in rapid naming (speedy recall) of familiar stimuli (e.g., digits, letters, colours, and objects) have been found to be a predominant problem in dyslexia (Denkla and Rudel, 1976; Fawcett and Nicolson, 1994).

Problems in rapid naming do not disappear with age (Korhonen, 1995; Wolf and Obregon, 1992). Wolf and Obregon conducted a 5-year longitudinal study that investigated word retrieval deficits in dyslexic children, the role of vocabulary development in these deficits, and the possible specificity of word retrieval deficits in dyslexia. They found that word retrieval problems continued throughout the primary grades and into middle childhood. These problems could not be explained by simple vocabulary deficits: comparison of performance between dyslexic children and poor but non-dyslexic readers functioning at the same level showed that word retrieval problems could be specific to dyslexia, in that dyslexic children can know the words but be unable to retrieve them, while poor readers may not know the words. Thus, this study provided evidence that dyslexic children have retrieval deficits that are specific to dyslexia and that endure over time.

In the present study, most of the children presented with severe academic problems and language deficits, so one could expect deficits in rapid naming of words. Sentence repetition resembles rapid naming because the sentence has to be remembered verbatim, which places considerable demands on phonological memory (the articulatory loop). Decay of the traces in phonological memory compels the subjects to produce the sentence quickly, and may lead to word substitutions and omissions. Furthermore, the endurance of deficits in rapid naming could explain why the children in the present study continued to have problems even at 12yrs. of age.

Speedy word identification and recall affects **timing** of processing.

5.2.2.1 Timing

Timing in sentence recall has two facets: timing of processing (i.e., accessing and retrieval of the words in semantic memory), and timing of word storage in the articulatory loop (one to two seconds, after which decay of traces takes place). Speed of word identification in semantic memory affects both processing and storage in the articulatory loop (decay of traces). The interplay between processing and storage timing could lead to errors. For instance, one child in the present study started to repeat the sentence "the children cut and pasted the pictures and hung them on the wall" correctly, then he stumbled on the word **pasted**, and started again, this time substituting **kids** for **children**. What might have happened is the following:

Synonyms may be represented in semantic memory with the same semantic features (e.g., **Children = kids = +human, +young, +males, +females, +males and females**. The subtle distinction between **children** and **kids** - that **kids** is a slightly more informal stylistic alternative - is most likely recorded in the encyclopedic knowledge associated with the word, rather than in semantic memory. In short, the principal distinction between the two words is their different phonological forms. When the phonological form of **children** has decayed in phonological memory, the longer lasting semantic features in semantic memory could apply to either **children** or **kids**. Thus either could be chosen. Maybe a word that is more familiar to the child is chosen. This idea will be expanded upon later on in this chapter.

Two of the most important factors that influence **timing** in processing are the **complexity of the word's structure** and **speech rate**.

5.2.2.2 Complexity of word structure.

The complexity of a word's structure (e.g., its imageability or familiarity) could affect **timing** and, consequently, processing.

a. Imageability

Imageability is the extent to which a word evokes an image. Imageable words tend to be concrete nouns or actions (e.g., **sun, umbrella, run**). According to Paivio, Yuile, and Madigan (1968, as cited by Kroll and Merves, 1986), highly imageable words are learned faster and remembered better than abstract words. They used a "dual code theory" to explain the advantage of concrete over abstract words. This theory claims that high imageable words are coded in memory both verbally and imaginally, making them easier to recall and more resistant to forgetting.

Several types of studies have tested imageability.These include **lexical decision** studies (in which subjects identify as quickly as possible whether a word is a real word or a pseudoword), **priming** studies (which test the influence of cueing on recall), and studies on neurological disorders, such as **deep dyslexia** and **dysphasia**. However, as with most psycholinguistic concepts, the literature exhibits controversy regarding the influence of imageability on certain linguistic tasks. James (1975) found that in lexical decision tasks, highly imageable words were identified as real words faster than abstract words were, but only when highly imageable words were of low frequency. In another lexical decision study, Kroll and Merves (1986) found that the effect of concreteness (high imageability) depended on the order of presentation of concrete versus abstract words: when blocks of concrete words were followed by blocks of abstract words, there was a noticeable advantage for the concrete words.

Studies of deep dyslexia (e.g., Coltheart, 1980) and deep dysphasia (Michel and Andreewsky, 1983; Katz and Goodglass, 1990; Martin and Safran, 1992; Martin, Safran and Dell, 1996) have also shown that highly imageable words affect recall, but with the following paradox: highly imageable words are easy to recall because they have stronger support, yet they are vulnerable to **semantic** errors, particularly in subjects with deficits in phonological memory. According to Plaut and Shallice (1993, as cited by Martin, Safran, and Dell, 1996), highly imageable words have richer semantic representations, containing semantic features that overlap with other words. It is this overlapping of features that makes imageable words vulnerable to errors in recall.

A word`s semantic representations are also known as its associative set size, and its effect on recall as its **target-set size effect** (Nelson and Schreiber, 1992). The target-set size effect predicts, counterintuitively, that recently activated words with a smaller number of associates will be recalled more accurately than recently activated words with a larger number of associates. This applies not only to single words, but also to words within sentences, and is more vigorous when the context lacks effective semantic constraints. The **target-set size effect** supports the paradox of highly imageable words with several associates being vulnerable to recall errors.

In the present study most of the **content substitutions** affected either highly imageable words (16 out of 33) (e.g., **children, magazine, woman**) or words with a large number of associates (18 out of 33) (e.g., **next to** the oak tree: beside, by, close, near; **during** our vacation: while, on, when). For the reasons outlined above, all these words are susceptible to semantic errors. Indeed, 70 out of the 105 substitutions involved just 7 words, each of which had a large number of associates, and 5 of which were highly imageable. In other words, the majority of content substitutions affected words with a large number of associates. These words are vulnerable to errors as their semantic features overlap with the semantic features of other words. It is not surprising that in the sentence "the woman has read the twelve, big, heavy, brown books" (referred to earlier) the word **woman**, which has a large number of associates, was most frequently substituted.

b. Word frequency and familiarity

Researchers have found that both young and old subjects name high- frequency words 450 msc. faster than low-frequency words (Fozard and Wough, 1977; Bowles and Poon, 1981). The speed advantage for high frequency words in recall has been attributed to various factors: **faster articulation**; **faster phonemic recognition**: and **familiarity** (Hulme et al., 1995). According to Goldstein et al. (1992), high frequency words that are also familiar may evoke additional visual, auditory, and tactile associations, thus making them easier to name.

A closer look at the strong synonyms in the present study revealed the following: according to Thorndike and Lorge's (1952) teacher's book of 30,000 words, the synonyms that replaced the words in the present study had a lower frequency rate than the replaced words. Thorndike and Lorge's book, however, was first published in 1944 and norms might have changed since then. In my experience as a speech-language pathologist, and from informal discussions with my colleagues, the synonyms that the children substituted may be used more frequently in the Ottawa Valley than the target words (e.g., kids may be more common in this region than children). Also, 17 children substituted the word **lady** for woman in one sentence, while in a different sentence, only one child substituted **woman** for **lady**. This contrast provides further evidence that children were more familiar with the word **lady**.

5.2.2.3 Speech rate

Deficits in processing could affect not only identification of the word in the lexicon, but recall as well. As speech rate affects recall, a subject's speed of articulation could affect sentence recall. The effect of speech rate on recall has been investigated in several studies by Hulme and his collaborators over a number of years (Hulme, Muir, and Laurence, 1985; Hulme and Tordoff, 1989; Hulme et al., 1995). Hulme found that fast speed of articulation was associated with higher memory span scores, while slow rate of articulation was linked to deficits in recall and lower scores in memory span. These findings were consolidated in studies of children presenting with specific disabilities (Avons and Hanna, 1995).

In a study of 45 children ages 9.6 to 11 (15 with specific reading disability (SRD)), 15 controls with normal reading ability (CA), and 15 children matched for reading age with the specific reading disabled (RA)), Avons and Hanna found that SRD children showed a marked deficit in memory span compared to the age-matched group. Regression analysis showed that speech rate could be responsible for the deficits in memory span. This apparent relationship between speech rate and memory is not limited to children with reading disabilities, but is extended to young adults too. In a study of 17 dyslexic college students (ages 18.10 to 26 years), Catts (1989) found that the dyslexic students exhibited significant difficulties in rapidly repeating complex phrases, making more errors (**substitutions, omissions,** and **additions of phonemes**) than the control subjects. Although all subjects were able to articulate the phrases accurately in isolation, when they had to repeat them as quickly as possible 11 to 15 times, significant differences were observed between the controls and the dyslexic group. The dyslexic subjects made more errors and the rate of their speech was slower.

Similar results were obtained with language disordered children (Raine et al., 1991, as cited by Avons and Hanna, 1995); speech disordered children had markedly slower speech rates, which could explain their inferior memory span performance.

However, as the children in the present study did not present with obvious speech deficits (only two children had mild articulation difficulties), and the rate of their speech was not formally assessed, it is difficult to know whether their speed of production was impaired and how this might have influenced their sentence recall. Future studies on sentence repetition should include rate of speech in the assessment of their subjects.

In conclusion, **content omissions** and **substitutions** do not happen indiscriminately, but occur in certain sentence positions and affect certain types of words. Elements such as adjuncts (that do not need or receive **theta roles**) in sentences crowded with content words are susceptible to omissions, while syntactic arguments (subjects or objects) distributed at the beginning or the end of the sentences are liable to substitutions. **Timing** (speed of accessing the words in semantic memory and speed in the decay of the traces in phonological memory) appears to play a considerable role in the occurrence of word omissions and substitutions. **Imageability**, **complexity** and **familiarity** of the words, as well as **speech rate**, affect timing and may lead to word omissions and substitutions. Deficits in the semantic representations of words, particularly for low dominant properties, could be an additional reason for **content omissions and substitutions** in sentence recall. Needless to say, pragmatic and prosodic factors should also be taken into consideration.

This section of the chapter discussed the occurrence of **content omissions** and **substitutions** in sentence recall and the influence of **timing** in their occurrence, as they relate to word processing and storage. The next section will discuss **grammatical omissions** and **substitutions** and **timing** as they relate to sentence processing and storage, using information from the results of Hypothesis II.

5.3 HYPOTHESIS II: Grammatical Errors

5.3.0 Introduction

Hypothesis II predicted that grammatical errors in recalling sentences would reflect the children's grammatical disability. However, the investigation of this relationship showed negative results: no within-subject agreement was found in the errors made on specific structures in the three expressive language subtests (**recalling sentences** (**RS**), **sentence assembly** (**SA**), and **formulated sentences** (**FS**). In other words, a child who had difficulty with a specific grammatical structure in **recalling sentences** did not necessarily have problems with the same structure in the other two subtests.

As these results were at variance with the literature, the children's protocols were reexamined and the errors in **formulated sentences** were reanalysed according to semantic versus syntactic criteria (see Results). Following this reanalysis, the percentile scores in the three expressive language subtests were compared, revealing close agreement between the three subtests. The close agreement in the percentile scores, rather than in the particular syntactic structures assessed, could indicate a deficit in a more primitive skill, such as working memory, rather than in syntactic ability. This idea will be further explored in the paragraphs to follow.

5.3.1 Grammatical Errors

For the statistical investigation of hypothesis II, the measurements in the **recalling sentences** were not error specific. In other words, a sentence assessing a particular syntactic structure was scored incorrect even if the error was just a semantic substitution or word omission unrelated to the target syntactic structure.

However, the children's performance in **recalling sentences** also evidenced grammatical errors (**grammatical omissions** and **substitutions**). Some of the children made omissions only, others substitutions only and others both omissions and substitutions. Most of the **grammatical omissions** and **substitutions** affected <u>auxiliary verbs</u> (particularly the **perfective** aspect) and <u>functive words</u> (e.g., the disjunctive conjunctions **but**, **though**, and the pronoun **who**). A closer examination of these errors may provide valuable information about the nature of grammatical errors in **recalling sentences**, and enhance our understanding of the underlying factors that lead to grammatical deficits.

5.3.1.1 Auxiliary verbs

Auxiliaries are functional projections that participate in complex syntactic structures and express temporality, aspectuality, and modality. They are logical operators rather than core verbs. What distinguishes them from core verbs is that they do not assign **thematic roles**. There is a hierarchy in the position of auxiliaries. **Modals** occur in the outermost position from the main verb followed by **have** and **be**. When auxiliaries occur in strings (e.g., ... [would [have [been [main lexical verb ...]]]]) they resemble lists of content words and could therefore be susceptible to omissions. Omitting an auxiliary does not affect the meaning of the sentence to the same extent as omitting a core verb does.

In the present study, the sentence "If she **would have** baked some cookies they **would have been** eaten", which contains several auxiliaries, proved most difficult overall and showed many omissions and substitutions. Most of the omissions in this item involved the modal **would** (**11**). The auxiliary **have** was also omitted (4 times). Possible determining factors are discussed immediately below.

In a study of the acquisition of modal auxiliaries by children from kindergarten to third grade, it was found that the modals **can**, **could**, **will**, **would** and **should** were handled adequately by most children in most tasks (Major, 1974). Factors that affected the children's performance and led to errors included: age of the children, complexity of the task (tags, negation and inversion were always more difficult, particularly for the younger children), auxiliary expansion, and familiarity (e.g., items relatively rare in the language of adults were incorrectly used by the majority of the children). Third grade children in Major's study scored 90% correctly in handling expanded auxiliaries. In the present study, although the children were much older (mean: 10yrs. 3mon.), most of the omissions involved expanded auxiliaries and, in particular, the modal **would**.

There could be a number of reasons why **would** was most frequently omitted. First, future perfective is a difficult structure both semantically and syntactically and might not have been acquired by a number of children. As discussed earlier, the position of **would** (being the farthest from the main verb) could have affected its omission (Romani and

Martin, 1993). Furthermore, the **would** modal was embedded in a subordinate clause, which is syntactically a complex structure.

In summary, omissions of auxiliary verbs followed similar patterns as those of content words. Like adjuncts that are not assigned thematic roles and are thus less supported syntactically, auxiliary verbs do not assign thematic roles themselves. Also, expanded auxiliaries resemble lists of words (would, have, been). As reported earlier, **content omissions** occured most frequently in sentences crowded with content words presented in a list-like manner.

5.3.1.2 Functive words

Grammatical errors in **recalling sentences** also included omissions and substitutions of functive words, particularly those participating in the formation of relative clauses, subordinate clauses and coordination. Most of the children's errors in **recalling sentences** occurred in relative clauses. In addition, children who had difficulty with relative clauses in **recalling sentences** also had difficulty assembling relative clauses in the **sentence assembly** subtest (relative clauses were not included in the **formulated sentences** subtest). Furthermore, only errors with relative clauses accounted for a significant proportion of the children's deficits in **reading decoding** and **reading comprehension**. Below is a brief discussion of relative clauses that may help us understand the nature of these relationships.

5.3.1.3 Relative clauses

Relative clauses can be divided into four types according to the location of the gap (i.e., subject or object). Bar-Shalom et al. (1993) described the four types, giving the following examples of each.

a. Subject-Subject (SS): The dog who is pushing the ball with his nose is playful. **b. Object-Subject (OS)**: The girl is petting the puppy who is drinking milk. **c. Subject-Object (SO)**: The girl that the boy is hitting is crying and **d. Object-Object (OO)**: The man is bandaging the lady that the cat scratched.

Relative clauses are also distinguished as **medial** or **final**, according to placement of embedding. Sentences a and c are **medial**, while b and d are **final.**

Certain types of relative clauses are more difficult than others. Object medially embedded sentences (e.g., sentence c) are not mastered until the middle childhood years. In fact, 48% of 8-year-olds and 32% of 10-year-olds continue to experience difficulty with this type of relative clause (Quigley et al., 1974).

The CELF-R **recalling sentences** subtest contained five relative clause sentences: three SS and two OS. Although these sentence types are relatively easy to master, the children in this study continued to experience difficulty with them, even at the age of 12. Length of the sentence also affected their recall; for instance, 23 of the 45 children made errors in medial SS relative clauses in a 13-word sentence as compared to only 8 in a 9-word sentence. In a relative clause sentence containing 19 words, 36 children made errors. However this sentence also contained passive voice and negation, both of which further increased its complexity.

The relationship between deficits in processing (comprehension and production) of relative clauses on the one hand and reading impairment on the other is well accepted in the literature. Two theories attempt to explain this relationship (Bar-Shalom et al., 1993). One is the **Structural Lag Hypothesis (SLH)**, which claims that, since complex structures are acquired later, the difficulty that poor readers have comprehending and producing relative clauses is due to their general delay in language acquisition. The other theory is the **Processing Limitation Hypothesis (PLH)**, which claims that deficits in processing, in particular phonological processing, are the main cause of the problem.

Bar-Shalom et al. (1993) devised a study to decide between the **Structural Lag Hypothesis** and the **Processing Limitation Hypothesis**. The study involved 30 children, ages 7 to 8 years, and contained relative clauses of all four types. As a group, poor readers made significantly more errors than good readers in the comprehension of relative clauses. To determine whether this deficit was due to a structural lag or to processing problems, the researchers tested the children's ability to produce relative clauses. They found that both poor and good readers were able to produce relative clause sentences adequately. This finding indicates that the deficit lies in **processing** rather than in a **structural lag** leading to deficits in relative clause comprehension.

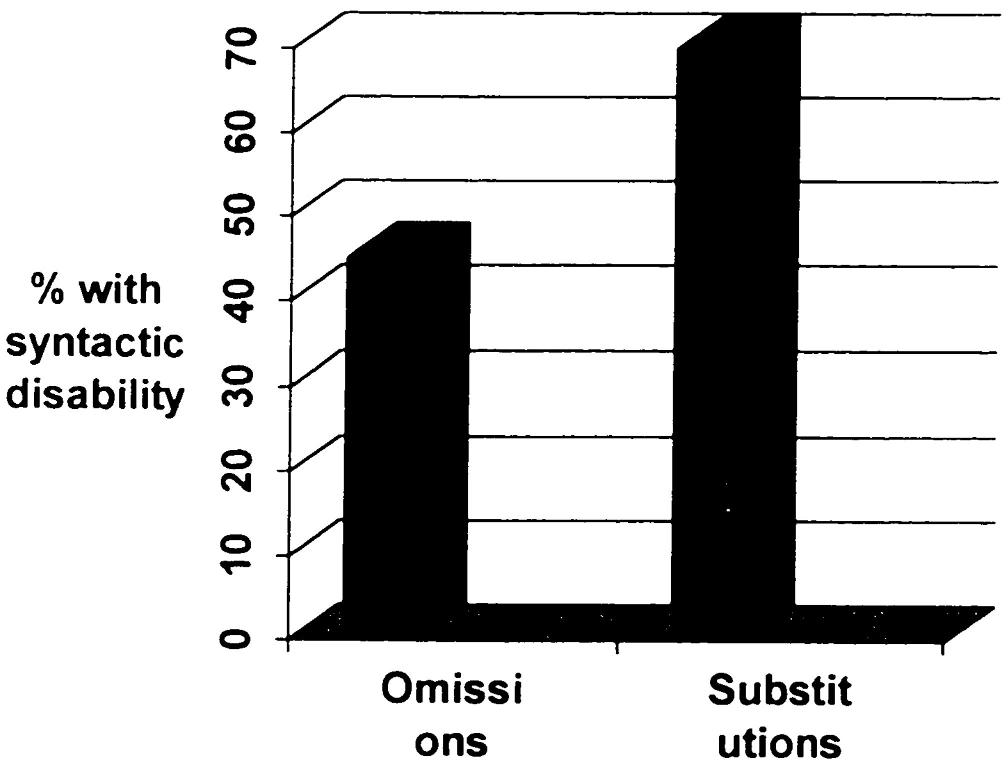
Relative clauses heavily tax working memory during processing. Even in relatively easy OS clauses such as the one included in the **recalling sentences** subtest (i.e., **The boy sent a letter to the lady, who moved away last year**), the action that is indicated by the relative clause often occurs chronologically before - but structurally after - the action in the main clause. In order to establish the actual chronology and fully comprehend the whole sentence, the reader must keep in memory the main clause, while processing the subordinate one. Furthermore, other factors such as the animacy/inanimacy of the object could affect processing in OS sentences. Thus the sentence " The boy ...." quoted above, which contained an animate object, proved difficult for the children in the present study. Processing of OS sentences with animate objects has been shown to be more difficult than that of sentences with inanimate objects (Goodluck and Tavakolian, 1982).

Goodluck and Tavakolian attributed this difficulty to failure of the object to c-command the relative clause. The animate object makes it harder to interpret the subject and object of the matrix sentence and the subject of the relative clause. This confusion is most likely due to overload in working memory. Building on Frasier and Fodor's (1978) two-stage model of processing, Goodluck and Tavakolian claim that an animate object delays processing of the relative clause until the second stage. While a relative clause can be correctly attached to an inanimate object head as early as the first parsing stage, this is not so with an animate object. When the matrix sentence enters the second parser before the relative clause is attached to the c-commanding NP, the children most likely attach the relative clause to the S-mode, thereby preventing the object from c-commanding. The only c-commanding NP is the sentential subject, which is not the proper antecedent for the relative clause. Thus confusion arises. Goodluck and Tavakolian concluded that the problems are in processing rather than in grammatical competence. Despite children's knowledge of the required syntactic structure of relative clauses, problems occurred vis-avis the animacy status of the antecedent of the relative clause. The findings of these studies suggest that the errors the children made in the **recalling sentences** subtest of the CELF-R in items with relative clauses were most likely due to processing deficits rather than to a structural lag in language development.

5.3.2 Grammatical Errors in Recalling Sentences and General Grammatical Ability

To determine whether any relationship existed between specific errors in **recalling sentences** and the children's general expressive grammatical skills, a comparative analysis was performed between **grammatical omissions** and **substitutions** in **recalling sentences** and the children's performance in the **formulated sentences** subtest. The subjects with percentile scores within the normal range on the **formulated sentences** were designated **N** (normal). Those whose percentile scores were below average were designated either **S** (when the errors were syntactic) or **O** (when the errors were semantic, or syntactic affecting other than the targeted structure). On the next page is a schematic illustration of these findings (Figure 1)

Figure 1 Omissions & Substitutions vs Syntactic Disability



It was found that 9 out of 20 or (45%) of the children who made **grammatical omissions** in the **recalling sentences** exhibited syntactic disability in the formulating sentences subtest, as compared to 7 out of 10 or 70% of those who made **grammatical substitutions**. Most of the children who made **grammatical omissions** in the **recalling sentences** subtest scored (**O**) or (**N**) in the **formulated sentences** subtest. This means that their grammatical disability in **recalling sentences** was most likely due to other than syntactic deficits (e.g., working memory, processing deficits etc.). However, the number of children in each group was small and the comparative analysis crude. Future studies are needed to further explore these findings, as the results might prove useful in providing information regarding the contribution of working memory to recall, and in distinguishing children with syntactic versus working memory or processing deficits.

5.3.3 Factors Affecting the Occurrence of Grammatical Omissions and Substitutions

Why do grammatical omissions and substitutions occur and under what conditions?

Most previous studies used sentence imitation to assess either grammatical development in younger children or to assess the grammatical skills of individual language disordered children. I was unable to locate in the literature any child-based studies on the causes of grammatical omissions and substitutions in sentence recall. Instead, I used information from neurolinguistic studies on aphasia, and in particular **agrammatism**, to understand the nature of **grammatical omissions** and **substitutions**.

Agrammatism is a type of aphasia characterised by telegrammatic speech, consisting mostly of content words and lacking in morphological structure. Grammatical omissions and substitutions are the cardinal symptom of agrammatism. In the past, agrammatism was divided into **agrammatism** and **paragrammatism** acccrding to whether challenged by Caramazza (1985) and by Kolk and Hofstede (1994, as cited by Kolk, 1995), who found that omissions and substitutions are not unrelated: when patients were asked to try to maintain the sentence's correct syntactical structure, omissions were usually replaced by substitutions.

Grammatical omissions and substitutions in agrammatism have been explained by Kolk (1995) as follows. In sentence production, activation of one element is necessary for the appropriate activation of the subsequent element. For instance, information about the subject of the sentence must be activated for the correct verb form to become activated. This is commonly known as subject-verb agreement. Between these two types of information, there must be synchronization. The availability of a syntactic slot must be synchronised with the delivery of a lexical filler. This integration is the crucial stage in sentence building. Slow activation or fast decay of the traces of one of the two elements leads to desynchronisation and subsequently to omissions. A slot that is part of a complex morphological structure requires more time to be computed and activated.

There is hierarchy in morphological complexity. Haarmann and Kolk (1992 as cited by Kolk, 1995), studied three types of inflectional morphology (plurals, adjectives in attributed positions and present tense verbs) and found an order of structural complexity; plural inflections were easier and required less computational time than adjectival inflections, which were in turn easier than verb inflections. Similar findings were reported for functive words; determiners were easier than prepositions, which were easier than auxiliary verbs. Complex morphological structures require more computational steps, and therefore more time. The resulting slowdown in processing can lead to desynchronisation of syntactic slots and lexical fillers, and subsequently to errors. In this respect, agrammatism can be viewed as a **timing** disorder. Kolk (1995) verified this notion by constructing a connectionist model (SYNCHRON) that produces agrammatic speech by memory.

In the present study, the grammatical elements most frequently omitted (35 out of 45) were auxiliary verbs, most particularly expanded auxiliaries, which (as mentioned earlier) are structurally complex. Also, the functive words **but, though,** and **who**, which the children most often omitted or replaced, are markers of subordinate clauses and relative clauses, which are complex syntactic structures requiring more computational steps and presumably more computing time than simple structures.

5.3.4 Conclusion

Although Hypothesis II was not supported by the findings of the present study, the children's inconsistent performance on the three expressive language subtests suggests processing deficits rather than structural ones. In other words, the children's grammatical errors with complex structures were not necessarily due to lack of knowledge of these structures, but could instead have been due to processing difficulties.

Grammatical complexity can affect the **timing** component of processing (slowing it down and thus desynchronizing syntactic slots with word fillers), as well as **timing** of storage in phonological memory. Deficits in processing and fast decay of phonological traces can each, separately and together, lead to grammatical errors in recall. Future studies, with better controlled testing material - matched sentences in the three expressive language subtests (**RS**, **SA**, and **FS**) - are needed to investigate Hypothesis II more accurately.

5.4 Paraphrases

The paraphrasing errors made by the subjects in repeating sentences provide strong memory of the surface structure but involves accessing long term memory and regeneration of the sentence from a gist of its meaning.

When a sentence was long and syntactically complex, the children usually paraphrased it. Sixteen out of the twenty-two paraphrases affected the longest sentence in the **recalling sentences** subtest, which contained 19 words and was syntactically complex. The paraphrases were of three types:

.intact gist of the sentence but modification of the surface structure.

.slight changes of parts of the gist.

.major changes in the gist of the sentence.

For example, in the sentence "**the boy who didn't show up for practice wasn't allowed to play on the team until a week later**", these elements constitute the gist of the sentence: **not go**, **not let play**, **until later**. In 4 of the 16 paraphrases, the gist of the sentence remained intact (e.g., "The boy who didn't go for practice wasn't allowed to play until a week later."). In 7 attempts, part of the gist was altered (e.g., "the boy **who was late** for practice wasn't allowed to play on the team until next week".). In the remaining 5, the gist was considerably changed (e.g., "The boy who didn't practice played a week later").

The same pattern was observed in other sentences. For instance, the sentence "**The children cut and pasted the pictures and hung them on the wall**" was paraphrased as "The boys and girls cut up some pictures and hung them on the wall" (in which the gist of the sentence remained intact), and "The children coloured the pictures and put them on the wall" (in which part of the essential meaning was changed). Most of the substitutions in paraphrasing were synonyms of the targeted word or phrase. Familiar, frequently used expressions usually replaced the target phrase (e.g., "didn't show up for practice" > "was late for practice"). In most of the paraphrases, the basic syntactic replaced by another verb that took a different syntactic structure, the structure of the entire phrase was changed to accommodate the new verb. For example, "didn't show up for practice" became "missed practice": the change of verb led to the prepositional phrase ("for practice") being replaced by a noun phrase ("practice").

Pragmatic knowledge and expectations may also have contributed to sentence reconstruction. There were at least two instances where pragmatic information was probably employed: **team** was expanded to **soccer team** and **wasn't allowed to play on the team** became **didn't make the team**. These changes perhaps indicate the influence of the children's personal experiences in recall.

The paraphrasing errors in **recalling sentences** clearly show that repetition of sentences is not simply based on verbatim memory of the surface structure but involves accessing long term memory and creating the sentence from a gist of its meaning. Future studies are needed to explore ways of classifying paraphrases in a more accurate way and to investigate the conditions under which paraphrases occur.

5.5 Hypothesis III: Errors in Recalling Sentences and Reading Decoding and Comprehension

5.5.1 Introduction

Statistical investigation of the relationship between specific errors in **recalling sentences** and **reading decoding** and **comprehension** showed that **content omissions** and **grammatical substitutions** accounted for a significant portion of the variance in **reading comprehension** and **reading decoding**. We will now proceed to examine the nature of this relationship.

Unfortunately, some types of errors which would have been of interest in this study are not recorded in the **K-TEA** protocols. Thus, this discussion is based on the general

comprehension, and on information about the children's errors from informal communication with the psychometrist who administered the **K-TEA**. These data, along with an analysis of the stimuli used to assess **reading decoding** and **comprehension** are sufficient to allow comparisons between errors in **recalling sentences** and **reading performance**, and to trigger questions to be addressed in future studies.

We will begin with a comparison of the linguistic structures of the stimuli used in the **recalling sentences** subtest of the **CELF-R** and the **reading decoding** and **reading comprehension** subtests of the **K-TEA**.

5.5.2 Sentence Structure in the Reading Decoding Subtest of the K-TEA, and the Recalling Sentences Subtest of the CELF-R

The Reading decoding tasks in the **K-TEA** include identifying letters (grade one), decoding functive words (grade two), decoding simple, mostly one-syllable words (grade three), reading two and three syllable words containing clusters (grade four), and decoding orthographically difficult vocabulary (grades five and six).

Considering the subject's tendency to make semantic substitutions when recalling sentences, one might have expected them to make semantic substitutions when decoding words as well. This was not, however, the case. When decoding words, the subjects did not make any semantic substitutions (personal communication with the psychometrist, K. Beggs, who administered the **K-TEA**). However, an examination of the **reading decoding** subtest's vocabulary showed that the words contained in the list were not particularly susceptible to semantic substitutions. Most of the decoding list words had very few associatives (e.g., deep, ceiling, whistle, microscope). Nor did their associatives have high frequency or high familiarity rates (see Appendix IIIM).

5.5.3 Sentence Structure in the Reading Comprehension Subtest of the K-TEA and the Recalling Sentences Subtest of the CELF-R.

The **K-TEA** contains two **reading comprehension** tasks: reading of sentences and executing their commands by gestures (i.e., eat, open your mouth, show me how you drink a glass of water), and comprehension of passages, usually containing 2 to 4 sentences, at a grade one to grade twelve level.

The sentences and passages in the **K-TEA reading comprehension** subtest and the sentences in the **CELF-R recalling sentences** subtest are of similar structural composition and length. The **reading comprehension sentences** ranged from 1 to 18 words, and the **recalling sentences** ones ranged from 5 to 19. The longest passage at the grade six level contained 28 words. The passages contained several grammatical structures that the children had difficulty repeating in the **recalling sentences** subtest (i.e., past modal, perfect tense, and the conjunctions "but", "and", "if"). Also, the longer passages were crowded with content words, including many unsupported elements, mostly adjuncts. (e.g., a little squirrel with a big bushy tail). Considering the structural similarity between the sentences in the **CELF-R** and the **K-TEA** subtests, similar kinds of errors in both of these tasks are predicted. According to the psychometrist who administered the **K-TEA** (K. Beggs, personal communication) when reading the passages in the **K-TEA reading comprehension** subtest aloud, the children did make semantic errors. These errors were not recorded in the protocols as this is not required in the administration of the **K-TEA**. In future studies, errors in reading the passages aloud should be fully recorded.

5.5.4 Semantic Errors in Reading: An Explanation

Semantic errors in reading can be explained using the arguments Laine et al. (1990) used is most likely abolished in deep dyslexia, thus preventing phonological coding from backing up recall. Recall then relies on semantic codes. Errors could be due to either a disordered semantic code or to problems in lexical retrieval. A disordered semantic code would occasionally cause activation of a semantically related word instead of the target word. If this happens, the patient would be unaware of the semantic error. On the other hand, if the problem lies in lexical retrieval, the correct lexical semantic representation would be accessed, but the phonological form would not be retrieved. In this case, the patient would usually be aware of the error and try to correct it.

To test whether the problem was in word retrieval or in disordered semantic code, Laine et al. asked their patient to read a word aloud and then draw a picture of the object named. It was clearly shown that the problem lay in the correct lexical retrieval (phonological code) rather than in the semantic code, because, although the patient read the word **scissors** as **knife**, he drew a picture of scissors. The patient also had difficulty in naming pictures and repeating simple phrases: He made 35 semantic errors in the naming of 103 pictures and he made semantic errors when repeating simple three-word phrases. The patient's semantic errors in all three tasks indicate that **reading, naming**, and **repetition** share common brain functions (Laine et al., 1990).

Errors in reading decoding can also be explained using other types of hypotheses and theories. Below is a brief review of some of these theories.

5.5.5 Short Term Memory and Reading Decoding

As reported in the review of the literature, numerous studies have shown a significant association between **short term memory (articulatory loop)** and **reading ability**, particularly **reading decoding**. The association between short term memory and reading decoding has been attributed to the phonological code that they share (Wagner et al., maintaining individual sounds so as to blend them to form words) can help the child acquire reading. Likewise, because English orthography lacks a one-to-one correspondence between a grapheme and a segment of the acoustic signal, the child must keep the signal in memory to be able to map it onto the orthographic lexicon. Disturbances in the phonological code, either in the representation of the phonemes or in their activation, can cause impairment in reading decoding.

However, this explanation of the relationship between short term memory and reading decoding has been challenged by McDougal et al. (1994). Their study investigated the relationship between short term memory, rate of speech, reading ability, and phonological awareness skills in poor, average, and good readers. The researchers found that phonological awareness skills distinguished between good, average and poor readers, while short term memory in itself did not have much effect on learning to read. What accounted for the relationship between reading decoding and short term memory was primarily **speech rate**. Speech rate was significantly associated with single word decoding. Furthermore, additional statistical analyses indicated that speech rate is not tapping purely the same phonological skills as those that are assessed by measures of phonological awareness. McDougal et al. (1994) concluded that short term memory skills are important as predictors of reading ability because they tap individual differences in **speech rate**, not because of the phonological code that phonological awareness and short term memory share.

5.5.6 Specific Errors in Recalling Sentences and Reading Decoding

Speech rate affects the **timing** of processing. A slow rate of processing in sentence repetition could lead to the omission of certain words (see earlier discussion). Similarly, a slow rate in the processing of letters in reading decoding could lead to the omission of are indeed common errors in reading decoding, and are usually recorded in detail in the scoring of reading tests, including the **K-TEA**. In other words, **timing** could explain the relationship of **content omissions** with **reading decoding** Lack of detailed information on the errors the subjects made in **reading decoding** and **comprehension** prevent us from making stronger suggestions regarding the underlying factors that lead to these errors. Future research studies should investigate these findings in more detail (see chapter VI).

The correlation between **grammatical substitutions** in **recalling sentences** and deficits **in reading decoding** is difficult to explain. In most of the **grammatical substitutions** in **recalling sentences**, the substituted morphemes were simpler than the target morphemes. This tendency towards simplification indicates immaturity in the subjects' grammatical skills. Immaturity could perhaps be another reason for their reading disability. Furthermore, the vocabulary in the **reading decoding** subtest (grade two level) contained some functive words. Functive words constituted a substantial number of **grammatical substitutions** in the **recalling sentences** subtest. Perhaps the children who experienced difficulty in recalling functive words had difficulty decoding these words as well.

5.5.7 Reading Comprehension: Brief Review of Studies on the Relationship of Sentence Repetition and Reading Comprehension

So far, the results of the present study have supported Lombardi and Potter's (1992) position that repetition of a sentence entails comprehension of the sentence and regeneration of its structure from the gist of its meaning. If this is so, then the relationship between reading comprehension and sentence repetition may be understood in terms of their mutual reliance on the comprehension of the sentence.

Studies of the relationship between sentence repetition and reading comprehension

comprehension and repetition of sentences was by Kotsopoulos et al. (1996). Swanson (1994) found a relationship between repetition of sentences and reading comprehension in learning disabled individuals, but her statistical analyses combined measurements from both single word repetitions and sentence repetitions.

Most studies on the relationship between reading comprehension and sentence repetition have used tasks more complex than sentence repetition in measuring working memory. The most frequently used task has been **memory span** (see review of the literature in chapter II for a brief review of these studies).

Only one study has used a task similar to the **recalling sentences** of the CELF-R. Daneman and Blennerhassett (1984) used a **listening span** test as one of the tests in the investigation of sentence repetition and listening comprehension of passages. They also looked (indirectly) at reading. The **listening span** test required the children to repeat clusters of sentences, starting with two sentences and progressing to three, four and five sentences. In this way, it is similar to the more complex items in the **recalling sentences** subtest, which contain clusters of clauses.

Daneman and Blennerhassett`s subjects were 44 preschool children ages 3years 2months to 5years 2months. Two experiments were conducted using three listening tasks: 1. **Listening span** test (see above). 2. **Word span** test, which required the children to repeat sets of unrelated words. 3. **Listening comprehension** test, which consisted of a story (**"The Circus"**) made up of 25 connected segments. After hearing the story read aloud, the child had to decide which one of three pictures best described a given story segment.

Results indicated that **listening span** was significantly associated with listening comprehension. Furthermore, the **listening span** task, which taxes processing as well as storage functions, was found to be a better index of preschooler`s listening skills than a

1.8 sentences. Three of the children in the experiment had already started to read, and their memory spans were the highest (between 2.5 and 3 sentences). Daneman and Blennerhassett (1984) concluded that the **listening span** test has the potential to be an invaluable educational tool: perhaps children who cannot repeat two sentences are not ready to begin learning to read.

5.5.8 Studies not Supporting the Relationship of Recalling Sentences and Reading Ability

One study (Cornwall, 1992) failed to show a relationship between sentence repetition and reading ability. Fifty-four children with severe reading disabilities (mean age: 9.7 years) were assessed using various tests of academic performance, intelligence, memory and phonetic analysis skills. Regression analysis showed that **verbal comprehension** (WISC-R), **speed naming** and **phonological awareness** scores were all significantly associated with reading ability. Age and socioeconomic status were also predictors of achievement, but the **sentence repetition** test was not a significant predictor of reading ability.

The differing results of Cornwall's study and the present one could be due to the different tests of sentence repetition employed. Cornwall's study used Knight and Norwood's (1980) sentence repetition test, in which the child is asked to repeat sentences of increasing length. This test is not available on the market and does not appear to be published. However, Cornwall's description suggests that it is most likely similar to the **sentence imitation** subtest of the Detroit Test of Language Assessment (**DTLA**). The sentence imitation subtest of the **DTLA** differs from the **CELF-R recalling sentences** subtest in that the former is composed of syntactically simple sentences differing mostly in length, while the latter is composed of sentences that differ in both length and complex ones, several with relative clauses. As we saw earlier, it is mostly processing of syntactically complex sentences, and of relative clauses in particular, that is associated with reading ability.

5.5.9 Relationship of Specific Errors in Recalling Sentences and Reading Comprehension.

As mentioned earlier, lack of detailed information on the errors the children made in **reading decoding** and **comprehension** did not allow statistical investigation of the relationship between specific errors in **recalling sentences** and specific errors in **reading decoding** and **comprehension**. The following are some ideas on the association between **content omissions** and **substitutions** in **recalling sentences** and **reading comprehension** . These are more speculations at this stage and in need of substantial theoretical and experimental backing.

In **recalling sentences**, several **content omissions** occurred in sentences containing complex vocabulary. Moreover, most of the **content substitutions** were inferior synonyms of the target word. Both of these findings could indicate deficits in the children's knowledge of advanced vocabulary. A child who has not yet mastered difficult vocabulary would probably also have difficulty comprehending complex passages. Furthermore, we speculated that deficits in processing, particularly **timing** deficits, resulted in **content omissions** and **substitutions** in the **recalling sentences** subtest, as well as impaired comprehension of complex sentences (e.g., relative clauses). Timing deficits in processing could also account for impairment in the comprehension of reading passages.

The relationship of **grammatical substitutions** in **recalling sentences** and **reading comprehension** is easier to understand: A child who has not yet mastered complex structures containing these morphemes. Also, a child who replaces difficult morphemes with simpler ones will have difficulty understanding the subtle aspects of meaning in sentences and passages containing these morphemes. The linguistic similarity in the structures of the sentences in the **recalling sentences** subtest and the passages in **reading comprehension** make these claims reasonable.

In conclusion, the association between **reading decoding** and **reading comprehension** on the one hand, and **content** and **grammatical omissions** and **substitutions** in **recalling sentences** on the other, could be due to at least three factors: similarity in the structure and length of the sentences in both the **reading** and the **recalling sentences** subtests; processing deficits, particularly deficits in **timing** and **lack of familiarity** with difficult vocabulary and complex grammatical structures. Processing deficits or unfamiliarity with complex vocabulary could each separately or both together account for the relationship of specific errors in **recalling sentences** and reading ability. Future studies are needed to investigate this relationship in more detail (see Chapter VI for recommendations).

5.6 New Conceptualisation of Memory Involved in Sentence Repetition

The results of the present study, together with an extensive literature review, allow a revised interpretation of Baddeley's (1986) model of sentence repetition. Some of the concept realizations presented below are speculative and in need of testing, but the majority of the ideas are well-supported in the literature.

Sentence repetition involves processing, that is comprehension and production of the sentence (Slobin and Welsh, 1973; Butterworth et al., 1990; Lombardi and Potter, 1990, 1992). To understand the mechanisms and processes involved in sentence repetition, two models of sentence processing will be presented that portray the theories

(1993, 94) represents distinct levels of processing, that is, processing through different levels of language representation that are separate and do not interact. The second by Dell (1986) represents parallel processing, that is simultaneous interaction between the different levels of language representation. These models will be used as a framework for the development of new arguments regarding the processes involved in sentence repetition.

5.6.1 Patel's model

Patel (1993, 1994) has adapted concepts from other models to build up a new model of language comprehension and production that blends satisfactorily most of the main ideas of distinct level models of processing. Patel's model presents a global view of the cognitive and linguistic processes involved in the comprehension and production of language and is one of very few models that incorporates both the **articulatory loop** and the **central executive** in the functions involved in language processing.

5.6.1.1 Language comprehension

According to Patel, the memory systems that are involved in language comprehension are **working memory** (which is temporary), **episodic memory** (used in learning new information) and **semantic memory** (permanent memory of word and phrasal meanings). **Lexical access** and **parsing** are the two major processes in verbal comprehension.

After the initial activation of the phonemes in phonological memory, the message is stored in the articulatory rehearsal loop of working memory, which handles information in phrasal units. Grammatical analysis of the message (parsing) and lexical activation are the next steps in processing. Lexical activation includes activation of the conceptual, phonological, and orthographic representations of the word. The **central executive** of semantic memory. After the syntactic analysis (parsing) and the lexical access in semantic memory, the stage of inferential processing begins. This is more cognitive than linguistic in nature. **Inferences, presuppositions** and **implicatures** (non-demonstrative inferences) take place at this level to assist in the comprehension of the message. Comprehension is also facilitated by knowledge of **pragmatics** (social-interaction use of language) and our **encyclopedic knowledge** of the world.

Below is a summary of the processes involved in language comprehension (Patel, 1993).

Processing Steps in Language Comprehension

Working memory - Episodic memory - Semantic memory

Working memory: Articulatory Loop: Phrasal meanings

Working memory: Central Processing Unit: Episodic Encoding

Consolidation and Linking with Semantic Memory

Lexical Access: Lexicon

Parsing: Grammar

Relational Processing: Meaning Postulates

Inferential Processing: Presuppositions and Implicatures

Sociocultural Pragmatics

5.6.1.2 Language Production

In language production, **episodic, semantic** and **procedural** memory are involved. Procedural memory is memory for habits that are used automatically in appropriate situations, mostly social interactions. The first stage in sentence production uses both the linguistic and the cognitive systems. **Knowledge of the world, pragmatic information**, and **inferences** are employed to formulate ideas (i.e., propositions). The next stage involves

Huijbers (1983, as cited by Patel, 1994), lexical selection is performed in two stages: selection of the semantic form **(lemma)** followed by the lexical-phonological form or **lexeme**. The **central executive** of working memory helps in the transfer of schemas to linguistic concepts. The syntactic frames, together with the lexemes, are rearranged according to the word order rules of a particular language. Scanning mechanisms maintain the syllabic-lexemic-syntactic organization within the phrasal units. The phrasal units are kept in the **articulatory loop** and are then translated into articulatory movements. The processes involved in language production are summarised below (Patel, 1994).

Processing Steps in Sentence Production

Procedural- Episodic- Semantic Memory Systems

Conceptual and Pragmatic Inferential Processes

Propositions

Working memory: Central Processing Unit

Syntactic frames: Categories

Lemmas: Phonological Form

Grammatical Morphemes

Phrasal Units in Segmental- Metrical- Prosodic Form

Phonetic Form

Working Memory: Articulatory Rehearsal Loop

Articulatory Execution

5.6.2 Connectionist Models

Distinct level models of processing (Garrett, 1984; Caplan, 1990; Patel, 1993, 1994; etc.), although adequate in demonstrating the general mechanisms and processes linguistic performance of language disordered patients, particularly their semantic and phonological errors. The models that are perhaps more suitable for explaining abnormal linguistic behaviour and that could assist us in understanding the semantic errors made by the children in the present study are those that stress parallel processing (e.g., connectionist models). The main idea of connectionism is that processing occurs in complex networks, which are composed of single units that are joined together. Most models contain two layers of networks: the **input** and the **output**. Often between them is a layer of hidden "weights". As energy or activation spreads along the connections, the rate of spreading is controlled by "weights" which are either **positive** (boosting up activation) or **negative** (inhibiting activation).

One of the first connectionist models was developed by Dell (1986). In Dell's model, concepts are connected to the word nodes in the lexical network. Activation of a concept at a higher level spreads to lexical nodes at a lower level, and from there to phonological nodes at the final lower level. Activation can also proceed from lower to higher levels, but there are rules that regulate such flow. Activation also spreads to associative nodes of the target node, which become its competitors. The node whose activation is the strongest is selected. At the final level of processing, phonemes are activated. When subjects formulate the final output, they are helped to keep the right order by comparing the output with a skeleton of the word, which indicates the number of syllables and the order of the phonemes (e.g., CVC, CVCC, CCVC). Phonological errors happen when the wrong phonemes are more active than the correct ones. Phonological errors can be caused by anticipation (e.g., **deal back** > **beal back**), perseveration (e.g., deal back > **deal dack**) and exchange (anticipation + perseveration) (e.g., deal back > **beal dack**).

In Dell's (1986) model, information floats both ways: from higher to lower, and from

(1996)}, information floats only downwards. Still other models combine both: downwards from semantic to lexical and both downwards and upwards between the lexical and the phonological levels (Harley, 1995).

There are models that differ either in their architecture (e.g., number of units, type of connections) or in the algorithmic processes that govern their behaviour (e.g., back propagation, Hebbian learning). There are simple models. There are models that can learn - some with constant outside supervision, some without explicit "teaching". The most commonly used learning model works by repeatedly comparing the network's output with the desired target, until they match.

Most recently, models have been developed which can simulate abnormal speech using data from neurologically disordered patients, mostly aphasics. This is achieved by lesioning the connectionist networks either by adding noise at different locations, by removing certain nodes and connections, or by increasing or decreasing the decaying rate of activation. Models have been developed that can simulate deep dyslexia (Hinton and Shallice, 1991), deep dysphasia (Martin et al., 1996), and agrammatic speech (Kolk, 1995). Burges and Hitch (1992) have developed a model that simulates the articulatory loop in working memory. This model shows good agreement with human performance in memory span, exhibiting sensitivity to phonemic similarity and word length, and making errors similar to those made by human subjects.

Recently, models have been developed that simulate recovery from neurological disorders. Relearning is achieved by retraining lesioned models. Plaut (1992, as cited by Harley, 1996) lesioned Hinton and Shallice's (1991) model of deep dyslexia, then retrained it using the back propagation algorithm. Plaut found that relearning is easier than learning. He also found that lesioning in the semantic sites was followed by speedier recovery than lesioning in the orthographic ones. Martin et al. (1994) developed a model dysphasia. By manipulating **decay of activation**, they successfully demonstrated spontaneous recovery.

Some researchers have criticised the way model networks simulate brain function. Small (1991, as cited by Harley, 1996), for example, considers the way model functions imitate brain damage to be biologically impossible. Nevertheless, these models have enhanced our knowledge of processing and may prove useful in diagnosing and rehabilitating people with language disorders.

Keeping these processing models in mind, let us turn to a new interpretation of the mechanisms and processes involved in sentence recall.

5.6.3 New Interpretation of Processes Involved in Sentence Recall. Interplay of Phonological and Semantic Memory.

In sentence repetition, two functions of language processing, phonological and semantic memory, seem to play a prominent role. The contribution of phonological and semantic memory to sentence recall has in recent years been recognised by a number of authors. Butterworth et al. (1990) distinguish two stores, a phonological one (A) and one with long-term memory (LTM) characteristics (B) that are involved in sentence recall. Squire and Butters, 1992 (as cited by Bayles et al., 1996), claim that the ability to repeat depends in part on the integrity of semantic memory. Furthermore, Hulme et al. (1991, 1995) recognise the contribution of LTM (both semantic and phonological) to STM memory. In the following paragraphs, a revised version of the interplay of phonological and semantic memory in sentence repetition is developed.

5.6.3.1 Articulatory loop and central executive

In both general processing and in sentence repetition tasks, after the phonetic input has activated, the appropriate phonemes have been realised and the appropriate lexical forms (**lexemes**) identified, the phonological traces begin to decay. There seems to be no storage of the activated phonemes, and **no articulatory loop**. If there were a separate storage component for the phonological constituent of the sentence, **timing** would not be important and rehearsal not necessary. The one-to-two second span (described as STM) is most likely the duration of activation of the phonemes in phonological memory or the lexemes in the lexicon. It is only through rehearsal (reactivation of the appropriate phonemes or lexemes) that duration can last longer than one to two seconds. The activation of the meaning of the lexeme in semantic memory, the so called **lema**, begins early. Potter (1993) claims that very early in processing, meaningful stimuli activate conceptual information that constitute a form of very short-term memory (CSTM) that is closely linked to LTM. The nature of CSTM is not fully understood. It is not clear whether it is an activated part of LTM or a separate representation that passes information to and from LTM. The gist of the sentence which is used to regenerate the sentence in sentence recall is most likely formed from the activated elements in CSTM. The gist of the sentence lasts in memory longer than 20 seconds (Butterworth et al. 1990). The different timing of activation and duration of the elements in phonological and semantic memory (or the phonological and semantic properties of the word in the lexicon) make it extremely difficult to distinguish their contribution to recall as separate units.

To prolong duration of the activated phonemes in phonological memory, **the central executive** (CE) triggers rehearsal. Rather than being a part of automatic processing rehearsal is conscious (i.e., controlled). It is a continuous process going from phonological input lexicon to phonological output lexicon or, in cases of pathologically limited duration of activation, from lexical semantics to phonological output (see Caplan's 1992 model of word repetition in the review of related literature in chapter II, page 151, The **central executive's** role in working memory is not clearly understood. The central executive has been described as attention, conscious awareness, and metacognition. Baddeley (1994b) is probably correct in identifying the central executive with conscious awareness. It seems that the central executive is aware (receives feedback) from the different levels of processing (e.g., phonological, lexical, semantic). It "understands and uses" different codes, regulates the flow of information of the different processing levels, and decides what type of processing to trigger. For instance, it is most likely the central executive that activates rehearsal when verbatim recall is needed. Conversely, when the sentence is obviously too long for verbatim recall, the CE activates script processing, resulting in paraphrasing of the sentences.

5.6.4 Timing in sentence recall

Timing in sentence recall has two facets: timing of processing of the sentence (i.e., accessing and retrieval of the words in semantic memory), and timing of storage (duration) in both the phonological and semantic memory.

5.6.4.1 Timing of sentence processing

Timing of sentence processing is influenced by the following factors (as discussed earlier): 1. **Complexity**: This includes **grammatical complexity** that requires more computational processing, **vocabulary complexity** that prolongs searching and **complexity of word structure** (imageability, frequency and familiarity) that affects activation of the correct word in semantic memory and extends processing time. 2. **Rate of speech**: This is affected by longer words, and by phonemically similar words, which slow down processing and recall in particular.

5.6.4.2 Timing of storage

Our knowledge of timing of storage (duration of activation) in both the **phonological** and the **semantic** memory is limited. Phonological activation appears to last between one and two seconds. It can be affected in pathological cases by incomplete development of phonological skills (i.e., developmental speech disorders), by disturbances in phonological representations (i.e., in some types of aphasia), or attention deficits (i.e., attention deficit disorders with or without hyperactivity).

Storage in semantic memory lasts longer, possibly as long as 20 seconds. Our knowledge of **timing** in semantic memory (duration of activation and storage of gist) is even more restricted, as research studies on the topic are scarce. It is clear, however, that elapsing of time leads to decay of traces in both the phonological and semantic memory. Below are some thoughts regarding timing and decay on traces in semantic memory and on the interplay of phonological and semantic memory.

5.6.4.3 Timing in Semantic Memory

Maintaining the meaning of the sentences is very important in sentence repetition. Preservation of meaning takes place in semantic memory, where word meanings are activated. According to connectionist theories, all of a word's properties (semantic features) are activated in semantic memory. For example: for the word **woman** the following features could be activated **+human, +adult, +female, -relative**. However, in a child's semantic memory, **lady** may have the same semantic features as **woman**, the two words differing only in their phonological form. As a result, when the phonological traces disappear, only the semantic representations common to **lady** and **woman** remain. At this stage, greater familiarity with one of the two words may add "extra weight" to that word, leading to its activation. Otherwise the choice is a matter of chance.

a concepts' semantic features. Most likely, the features that fade first are those that distinguish between words such as woman and lady (distinctive properties). For instance, given the word **woman**, once the traces in phonological memory have decayed, the word **lady** could be chosen instead. When the feature **+adult** decays, **girl** could be substituted. When **-relative** decays, **mother** could result. These were indeed the substitutions the children made for the word **woman**.

For the word **children=kids**, the following features are activated: **-adult**, **+ males and females**, **+ males**, **+ females**. When the traces in phonological memory decay, the synonym **kids** could be chosen. When **-adult** decays, **boys and girls** could occur. When **+males and females** fades, **boys** could be chosen and when **+males** decays, **girls** is produced. These were exactly the substitutions made by the children in the present study.

When processing is slowed due to task complexity or slow speech rate, the phonological traces in phonological memory and the semantic traces in semantic memory decay. If the decay is limited to phonological memory, the target word may be replaced by strong synonyms. Decay in both semantic and phonological traces leads to substitution of inferior synonyms. Inferior synonyms could also result from incomplete specification or vague knowledge of the word, as in developmental language disorders.

Perseveration provides additional evidence that traces in semantic memory decay more slowly than those in phonological memory. In the present study, one of the children, when repeating a sentence containing the word **woman**, substituted the word **children** for **woman**. Although children was the subject of the previous sentence, twenty-three words and three pauses intervened between that word and the start of recall for the sentence containing **woman** in the next sentence. This elapsed time far exceeds phonological memory capacity, making it seemingly impossible for **children** to override **woman**. If, however, the word is "stored" in semantic memory with its longer duration of

In the final stage of sentence recall, synchronization in the integration of a syntactic slot with a lexical filler is crucial. Both grammatical complexity and lexical complexity can affect processing timing, resulting in desynchronization of syntactic slots with lexical fillers. Also, slowdown in processing results in decay of traces in phonological memory, stripping semantic memory of support. Desynchronization in the integration of a syntactic slot with a lexical filler and decay of traces in phonological memory could lead to errors in sentence recall (see earlier sections).

The importance of **timing** in verbal memory is increasingly being recognised and more studies are demonstrating its importance in language and learning disorders. The following are some of the studies that have already been mentioned in different sections of the thesis.

In a critical review of studies on 10 different sources of differences in memory span, Dempster (1981) found **speedy word recognition** the only source to make a substantial difference in memory growth.

Kail (1992) and Kevin Hall (1994) stress the importance of processing speed in memory, naming and reading.

Deficits in rapid naming can distinguish normal subjects from language and reading underachievers (Denkla and Rudel, 1976, Cornwall, 1992, Fawcet and Nickolson, 1994).

A faster articulation rate distinguishes children with normal verbal memory skills (Hulmes et al., 1995), while a slow rate of speech often characterises children with speech and language deficits (Avon and Hanna, 1995) and reading impairment (McDougal et al., 1994).

Bishop (1992) claims that one possible cause of Specific Language Impairment is a slower rate of information processing.

Tallal (1985, 1996), not only recognises timing deficits in processing as a very therapy programs that have so far been used successfuly in the remediation of these deficits.

The results of the present study clearly demonstrate that sentence repetition is not a simple task. It involves the comprehension and reproduction of the sentence from its gist using the individual's internal grammar. Specific errors in recalling sentences were found to be associated with linguistic deficits and reading impairment. It thus seems reasonable that a sentence repetition test could be devised to predict processing deficits and reading disability. In the following section the type of sentences that might be included in a screening test are explored.

5.7 Suggestions for a Pilot Screening Test

As reported in the results the majority of the errors occured in syntactically complex sentences (e.g., subordinate clauses, coordination, and, most frequently in relative clauses). To identify the kinds of sentences that would be most suitable for a pilot screening test, descriptive statistics as well as correlation and regression analyses were performed.

The statistical analyses were carried out in two steps. In step one, the relationship between **length** and **complexity** of the sentence and performance in **recalling sentences** was investigated, while in step two the relationship of sentence **length** and **complexity** with **reading decoding** and **comprehension** was explored.

5.7.1 Step One

5.7.1.1 Sentence length and recalling sentences skills.

The sentences were divided according to the number of words they contained, which ranged from 5 to 19. No errors were made with sentences containing 5 to 8 words. The sentences with which the subjects most often made errors were the following:

TABLE 12

Subjects making errors as related to sentence length

Sentence Length	Subjects Making Errors
9 words	55.6%
10 words	53.3%
13 words	53.3%
16 words	51.1%
19 words	80.0%

Not surprisingly, most children (80%) made errors with the sentence containing 19 words.

However, the second greatest number of subjects (55.6%) made errors with sentences containing only 9 words. These figures suggest that sentence length alone was not the key factor affecting the children's performance; complexity may be as important as length in affecting error rates.

5.7.1.2 Chi-square statistics: Sentence length and performance above and below the 50%ile in RS.

Table 13 summarizes the relationship between sentence length and performance above and below the 50% in RS.

TABLE 13

Relationship of sentence length to the distinction of performance above and below the 50%ile in the recalling sentences subtest (chi-square analyses).

Sentence length (No. of words)	Item #	Significance
5	(1)	NS
6	(2)	NS
7	(2)	NS
8	(5)	NS
9	(3)	.01
10	(2)	.01
11	(2)	NS
12	(2)	NS
13	(2)	NS
15	(3)	.000
16	(1)	.000
19	(1)	.01

The sentences that most clearly distinguished between those children who scored above and those who scored below the 50%ile in the **recalling sentences** subtest were those containing 15 ($p<.0001$) and 16 words ($p<.0001$). Sentences containing 9, 10, and 19 words also made small but significant contributions.

The **recalling sentences** subtest contained 3 sentences with 15 words, 1 with 16, 3 with 9, 2 with 10, and 1 with 19 words. To determine which of these sentences contributed most to the distinction between above-average and below-average performance in the **recalling sentences** subtest, as well as which of the syntactic structures contributed most to this distinction, chi-square statistics were used.

5.7.1.3 Chi-square statistics: Individual sentences and performance above and below the 50%ile in RS.

Table 14 summarizes the finding of Chi-square analysis.

TABLE 14

Relationship of RS items to the distinction of performance above and below the 50%ile in the recalling sentences subtest (chi-square analyses).

Items	# Words	Significance
S8	8	NS
S9	8	NS
S10	11	NS
S11	11	NS
S12	9	NS
S13	10	NS
S14	12	NS
S15	8	NS
S16	15	NS
S17	9	.01
S18	12	NS
S19	13	NS
S20	13	NS
S21	10	NS
S22	15	.001
S23	16	.001
S24	19	NS
S25	9	NS
S26	15	.01

As expected, children made errors more frequently with more complex syntactic structures. The sentences that contributed the most to the distinction between children who scored above and those who scored below the 50%ile were the following: sentence **22** (a **relative clause** containing 15 words, p<.001), and sentence **23** (a **subordinate**

clause containing 16 words, $p<.001$). Sentences 17 (a **passive** with **coordination**) containing 9 words and 26 (an **elliptical relative clause**) containing 15 words also made small but significant contributions ($p<.01$). The sentence which contributed the most to the distinction was **23**.

5.7.2 Step Two

5.7.2.1 Sentence Length and Complexity with Reading Decoding and Comprehension

The relationship between sentence length and **reading decoding** and **comprehension** was investigated using the following statistical analyses:

5.7.2.2 Correlation analysis

Table 15 presents summarized results of the correlation analysis between length of the sentence in the **CELF-R recalling sentences** subtest and **reading decoding** and **reading comprehension** as measured by the **K-TEA.**

TABLE 15
Relations between Length of the Sentence in the Recalling Sentences subtest and Reading Decoding and Reading Comprehension.

Length of sentences (no. of words)	Reading Decoding	Reading Comprehension
6	.16	.12
8	-.05	.09
9	-.30	-.53***
10	-.19	-.35
11	.005	.01
12	-.32	-.21
13	-.30	-.52***
15	-.25	-.51***
16	-.30	-.51***
19	-.39*	-.40*

***p<.01**

*****p<.00**

Only the sentence containing 19 words was found to have a significant association with both **reading decoding** ($p<.01$) and **reading comprehension** ($p<.01$). Sentences containing 9, 13, 15, and 16 words showed significant correlations ($p<.0001$) with only **reading comprehension.**

5.7.2.3 Regression analysis

The **Recalling Sentences** item containing 19 words and 2 items containing 12 words were found to account for a small but significant proportion of the variance (14.7% and 22.5% respectively) in **reading decoding. Recalling Sentences** items containing 9 words and 13 words accounted for a significant proportion of variance ($p<.001$ for each) in **reading**

comprehension.

Two sentences contained 13 words (one with a **relative clause** and one with **coordination**), two contained 12 words (one with a **relative clause** and one with a **subordinate clause**), three contained 9 words (one with a **relative clause**, one with **coordination** and one with **conjunction deletion**), and one with a **relative clause** contained 19 words.

To discover which individual sentences contributed a significant proportion of the variance in **reading decoding** and **reading comprehension**, the following statistical procedures were used.

5.7.2.4 Correlation analysis: Individual sentences with reading decoding and comprehension

Table 16 presents the results of a correlation analysis between measures in individual sentences of **recalling sentences**, **reading decoding** and **comprehension**.

TABLE 16

Correlations between errors in RS items with Reading Decoding and Reading Comprehension.

RS Items	RD	RC
8	.16	.12
9	-.10	-.10
10	-.02	-.02
11	.03	.05
12	-.13	-.18
13	.09	-.05
14	-.28	-.20
15	-.07	-.10
16	-.07	-.35
17	-.07	-.35
18	-.20	-.12
19	-.16	-.40*
20	-.14	-.20
21	-.18	-.29
22	-.20	-.40*
23	-.30	-.51**
24	-.23	-.24
25	-.23	-.42*
26	-.29	-.30

***$p<.01$**
****$p<.001$**

Significant correlations were found between **reading comprehension** and three **Recalling Sentences** items - sentence 19 (**relative clause** containing 13 words, $p<.01$), sentence 22 (**relative clause** containing 15 words, $p<.01$), and sentence 23 (**subordinate clause** containing 16 words, p<.001).

5.7.2.5 Regression analysis

Only sentence 23 accounted for a small but significant proportion of the variance in **reading decoding** (p<.05) and a significant proportion in **reading comprehension** (p<.003). Sentence 25 accounted for a smaller but significant proportion (p<.03) of the variance in **reading comprehension** only.

5.7.3 Conclusion:

Most of the sentences associated with performance both in recalling sentences and in reading decoding and comprehension were relative clauses. Sentences containing 9, 13, 15, 16, and 19 words distinguished between children who scored above and below the 50th percentile in the **recalling sentences** subtest and accounted for a significant proportion of the variance in **reading decoding** and **comprehension**. Sentence 23, a **subordinate clause** containing 16 words, best distinguished between those children who scored above and below the 50th percentile in the **recalling sentences** subtest, and contributed the most to the variance in **reading decoding** and **comprehension**.

5.7.4 Grammatical analysis of the sentences most associated with performance in RS and Reading.

The sentences that most distinguished the children who scored above the 50%

percentile in the **recalling sentences** subtest and those who scored below it were a subordinate clause containing 16 words and a relative clause containing 15 words. The same sentences were also highly correlated with reading comprehension, and one of them, the subordinate clause, with reading decoding as well. Furthermore, a relative clause containing 19 words and two coordinate clauses each containing 9 words distinguished between children who scored above and below the 50%ile, and also correlated with reading ability.

To determine what type of sentences should be included in the pilot screening test, the grammatical and lexical structure of the above-mentioned sentences was analysed:

1. " **After the family had finished dinner they decided to go for a ride in the country**".

Grammatical Complexity: subordinate clause, heavy start (left adjoined sentential adjunct), past perfect, after (time concept)

Vocabulary: words with numerous associatives (e.g., finish, dinner, ride.)

Length: 16 words; borderline capacity for sentence recall (average 15 words)

2. " **The man who sits on the bench next to the oak tree is our major**".

Grammatical Complexity: SS relative clause

Vocabulary: unfamiliar words (i.e., (bench), (oak), (major))

high number of associates of **next to**

Length: 15 words (average capacity for sentence recall)

3. " **The boy who didn`t show up for practice wasn`t allowed to play on the team until a week later".**

Grammatical Complexity: SS relative clause, passive voice, negation, (until)

Vocabulary: phrases with a high number of associatives (i.e., (show up), (a week later))

Length: 19 words. The longest sentence.

4. " **The trumpets and violins were played by the musicians".**

Grammatical Complexity: passive with coordination, high proportion of content words

Vocabulary: unfamiliar words

length: 9 words

5." **The mailman sorted, labelled, bundled, and delivered the magazines"**.

Grammatical complexity: active with conjunction deletion, high proportion of content words in a list-like manner

Vocabulary: unfamiliar, difficult words

length: 9 words

5.7.5 Recommendations.

It is recommended that the pilot screening test, which would be tested with school age behaviouraly disturbed children, include relative, subordinate, and coordinate clauses. As most of the errors occurred in **relative clauses**, there should be proportionately more more of these. The pilot screening test should contain sentences of the following types: 1.

Sentences of 15 or 16 words combining grammatical complexity and high imageable words with numerous associatives; 2. Sentences of 9 or 10 words with a high proportion of complex content words presented in a list--like manner; 3. Sentences of 9 to 15 words with unfamiliar vocabulary;and 4. Longer sentences (15 to 19 words) containing phrases with a high number of associatives.

CHAPTER VI
CONCLUSIONS

6.1 Background

The present study was an offshoot of a larger project which investigated the relationship between psychiatric disorders and academic delay. **Reading decoding**, **reading comprehension**, and **spelling** were the dependent variables of the project's investigations, while **behaviour**, **socioeconomic**, **intelligence**, and **language** measures were the independent variables. Hierarchical multiple regression analyses showed that only **digit span**, **sentence assembly**, and **recalling sentences** accounted for a large proportion of the variance in reading decoding, reading comprehension, and spelling.

Digit span, **sentence assembly**, and **recalling sentences** probably assess cognitive or linguistic functions that overlap. In the present study, the relationship between one of these variables, **recalling sentences**, and **reading decoding** and **comprehension** was investigated. The subjects were 45 of the 50 children who participated in the first project. Most of the children were diagnosed as suffering from attention deficit and hyperactivity disorder, often associated with aggressive behaviour, while a smaller proportion of them presented with adjustment and anxiety disorders. The children`s ages ranged from 8 to 13 years (mean: 10 years 3 months).

Recalling sentences was chosen as the focus of this study for several reasons identified in the Methodology. This proved to be a wise choice, as both the prevailing literature and the results of the present study indicate that **recalling sentences** involves both storage and processing of information. Of the two other measures that partially accounted for the variance in reading scores, **digit span** involves mostly storage, and **sentence assembly**, given that it was administered to the present population using both the visual and the auditory channels, involves mostly processing.

The primary goal of the present study was to investigate the nature of deficits in **recalling sentences**. The focus was on errors; what type occur, where they occur, why they occur, and what factors contribute to their occurrence? The second goal was to study the relationship of specific errors in **recalling sentences** with, first, reading ability (**reading decoding** and **comprehension**), and, second, **expressive grammatical** skills. The third goal was to make suggestions for the design of a pilot screening test that could predict processing and reading deficits.

6.2 Conclusions

6.2.1 Errors in recalling sentences

Errors involving content words occurred more frequently than errors involving grammatical morphemes. Nouns and adverbs were the most frequently affected. **Content** and **phrase omissions** affected mostly syntactically unsupported elements (e.g., adjuncts), while **content substitutions** mostly arguments (e.g., subjects or complements). Both **content** and **grammatical omissions** were usually words that do not assign thematic roles or have thematic roles asssigned to them. Most of the substituted words were synonyms of the target words; the majority were associatives, but several were strong synonyms. As no studies were found in the literature that investigated the factors leading to omissions and substitutions in sentence recall, information from studies addressing similar tasks (such as **naming** in both children and adults) was used. Deficits in processing and, in particular, **timing** deficits were recognised as possible contributors to the occurrence of omissions and substitutions in **recalling sentences**. Inadequate representation of the meaning of unfamiliar words in semantic memory (particularly for low dominant properties) was another factor that may have contributed to errors, and in particular to **content substitutions**. **Word complexity** (e.g., imageability, frequency in spontaneous speech, familiarity) and **speech rate** were identified as some of the factors that affect **timing** and processing in general.

6.2.2 Grammatical errors

Grammatical errors occurred in syntactically complex sentences (e.g., relative clauses, subordinate clauses, and coordination). They affected functive words used to express these syntactic relationships (e.g., who, and, but, although), as well as auxiliary verbs, in particular auxiliary expansions that included modals.

Some of the grammatical errors were probably due to deficiency in the children's acquisition of complex structures. Nonetheless the majority of grammatical errors were most likely due to processing deficits, as there was inconsistency and lack of within-subjects agreement in the children's performance in the **recalling sentences, formulating sentences**, and **sentence assembly** subtests of the CELF-R, which assess expressive grammatical skills. **Grammatical omissions** were particularly indicative of processing deficits.

6.2.3 Specific errors in recalling sentences and reading ability

In the present study, **content omissions** and **grammatical substitutions** in **recalling sentences** accounted for a significant portion of the variance in **reading comprehension** and **reading decoding**, as assessed using the K-TEA reading test. Of all the syntactic structures assessed, the **relative clause** was the only syntactic structure that contributed to the variance of **reading decoding** and **reading comprehension.**

Three factors were proposed as possible contributors to the relationship between **recalling sentences** and **reading decoding** and **comprehension**. These were: (1) similarity in sentence structure and sentence length in the **reading** and the **recalling sentences** subtests, (2) processing deficits, particularly deficits in **timing**, and (3) deficiency in the acquisition of unfamiliar vocabulary and complex grammatical structures.

6.2.4 Pilot screening test

The literature review and the findings of the present study have clearly shown that repetition of sentences is a complex task which involves processing and verbal memory, and that it has the potential to be used as a screening test to predict processing deficits and reading disability. The importance of sentence repetition in predicting reading ability has been suggested by at least one more study: Deneman and Blennerhassett (1984) claimed that perhaps children who can repeat two sentences as a cluster are ready to begin learning to read.

A pilot screening test to predict processing and reading deficits should contain complex syntactic sentences (e.g., relative clauses, subordinate clauses, and coordinating clauses) with a proportionally larger number of relative clauses. The following types of sentences should be included: (1) sentences combining grammatically complex structures and high imageable words that have numerous associatives, (2) sentences containing a high proportion of content words in a list-like manner, (3) sentences that include unfamiliar vocabulary, and (4) sentences containing phrases with a high number of associates.

6.3 Limitations of the present study

6.3.1 Isolation of the effects of the variables.

As mentioned in Chapter III, one goal of the larger project was to determine whether disruptive behaviour affected children's performance on three academic variables (**reading decoding, reading comprehension**, and **spelling**). As no statistically significant differences were found, the present study makes no distinction between children with and those without disruptive behaviours.

In the present study, precautions were taken to minimise the effect of psychiatric disorder on the children's testing performance. The testing conditions were close to ideal; the clinician had extensive experience handling behaviourally disturbed children and the crucial subtests of the CELF-R were presented later in the testing order, allowing the child to adjust to the testing experience. Nevertheless, the influence of specific factors (e.g., attention deficits, destructiveness and medication) in individual cases on certain days cannot be overlooked. Also, the age range of the children (8 to 13 years) added to the difficulty in isolating the factors that influenced performance. Different kinds of classes and schools attended by the children in the past, different types of teaching methods used, and the children's sensitivity to failure on certain tasks were but a few of the factors that might have influenced their performance.

6.3.2 Methodological limitations

The following limitations in methodology were identified.

The speech rate of the children was not formally assessed, thus preventing its use as a variable in the statistical analyses of the relationship between **recalling sentences** and **reading ability.**

The three expressive language subtests (**recalling sentences**, **formulated sentences** and **sentence assembly**) did not assess exactly the same syntactic structures and the sentences they contained were not matched for vocabulary or length.

More information was needed on the errors the children made in the **reading decoding** and the **reading comprehension** subtests. Some of the information was not provided by the test; other types of information would have required the full participation of a psychometrist in the present study.

6.3.3 Literature Limitations

Although there are numerous research studies on short term memory and working memory from a number of disciplinary perspectives, studies on the specific topic of this thesis (errors in recalling sentences, and their relationship to grammatical skills and reading ability), particularly with children, are relatively scarce. It was therefore necessary to rely on information from studies employing tasks **similar** to **recalling sentences**, performed mostly by adults. The application of such information to understanding and explaining children's performance on the **recalling sentences** subtest should be viewed with caution.

6.4 Suggestions for future studies

Future research is needed to confirm the findings of the present study. The study should of course be replicated with psychiatrically disordered children of the same age as those in the present study, and in a similar type of therapeutic set-up. As most of the children presented with psychiatric problems, as well as with reading impairment and language deficits, it would be interesting to compare groups of children with either predominantly language impairment, predominantly learning disability or predominantly psychiatric disturbance.

Hulme's (1992) studies with developmentally delayed (Down's syndrome) children showed that the children's ability to repeat words and sentences was severely impaired and that it was even lagging behind their IQ growth. As the testing tasks in the present study are easy to perform, the study should be repeated with mild to moderate developmentally delayed children, to explore whether these children exhibit a different pattern of errors in recalling sentences.

The comparison of errors in **recalling sentences** with those in **formulated sentences** and **sentence assembly** (Hypothesis II) needs refinement. The sentences in the three expressive language subtests should be structurally similar, if not the same. Also, the **formulated sentences** subtest should be scored according to syntactic versus semantic criteria. It is recommended that **grammatical omissions** and **substitutions** in **recalling sentences** be compared with errors in both the **formulated sentences** and **sentence assembly** subtests, thus permitting a better understanding of structural versus processing deficits.

The finding concerning the vulnerability of certain content words and phrases to omission and substitution should be investigated in normal children ages 8 to 13 years, as well as in younger children ages 4 to 8 years. The test should include the following types of sentences: sentences containing highly imageable words with a large number of associatives, sentences containing a high proportion of content words in a list-like manner, and sentences with unfamiliar vocabulary. These sentences should be matched with analogous sentences containing words with few associatives, those with a high number of syntactically well supported content words, and simple sentences with unfamiliar words.

Content substitutions and **omissions** may be studied in recalling sentences tasks by different groups of disordered children (e.g., developmentally delayed, autistic, children with specific language impairment etc.). Differences or similarities in the children's performance could enhance our understanding of the contribution of phonological versus semantic memory to recall.

As mentioned earlier, the investigation of hypothesis III was incomplete because it lacked detailed information on the children's errors in reading decoding and comprehension. Future studies on the relationship of specific errors in **recalling sentences** and **reading decoding** and **comprehension** should be planned carefully. Decoding tests should include words vulnerable to substitutions (e.g., words with high numbers of associatives), which could then be compared with the decoding of words with few associatives. The reading passages should be formulated to contain sentences combining content words and grammatical morphemes liable to omissions and substitutions. Furthermore, two types of reading passages should be contrasted: those with sentence structure and length similar to the ones used in the **recalling sentences** subtest, and those that are different. Comparing the children`s performance on the different decoding and comrehension tasks may provide us with interesting information on the factors contributing to errors in reading. Also the comparison of the structures of stimulus sentences in the **recalling sentences** subtest and the **reading decoding** and **reading comprehension** subtests of different reading tests could enhance our understanding of the relationship between the nature of testing materials and the assessment of reading ability.

Paraphrasing errors were rather neglected in the present study. In future studies, paraphrasing errors should be classified into a larger number of subcategories, taking into consideration changes in the gist of the sentence as well as in its surface structure. Possible errors might include intact gist but modification of the surface structure, slight changes in the gist, radical changes in the gist, etc.

The proposal that **grammatical omissions** indicate processing deficits rather than syntactic disability should be investigated further, using a larger number of subjects. In any future studies, the **recalling sentences** subtest and the **formulated sentences** subtest should be modified to include sentences of matching syntactic complexity.

6.5 Clinical applications

6.5.1 Testing

The findings of the present study could be used to develop a screening test to predict processing and reading deficits in older school-age children presenting with psychiatric disorders.

6.5.2 Therapy

Better understanding of the mechanisms involved in recalling sentences and of the facto leading to errors could help therapists plan language therapy in a more focused and systematic manner. The findings of the present study could also aid in the planning of reading remediation. Decoding words should be controlled, starting with those less vulnerable to errors and gradually proceeding to harder ones. Furthermore, passages read for comprehension should be better controlled not only for vocabulary and grammatical complexity but for word structure as well.

A P P E N D I X

APPENDIX I
RECALLING SENTENCES: Raw Errors by Category

S	Age	PS	P	GS	PO	GO	CS	CO	PR
1	12.6	0	0	0	0	0	0	0	99
2	11.8	0	0	0	0	1	0	0	98
3	8.10	0	0	0	1	0	0	1	91
4	11.5	0	0	0	0	0	0	1	84
5	9.11	0	1	0	0	0	4	1	84
6	12.1	0	0	1	0	1	2	0	75
7	11.2	0	0	1	0	1	0	1	75
8	12.8	0	0	0	0	0	0	0	63
9	10.2	0	1	0	1	1	3	0	63
10	10.7	0	1	0	1	0	1	1	63
11	10.10	0	0	0	0	2	0	2	63
12	9.9	0	0	0	1	1	2	1	63
13	12.5	0	0	0	0	0	2	3	50
14	11.7	0	1	0	0	0	3	1	50
15	12.3	0	1	0	0	0	2	1	50
16	12.4	0	0	0	2	1	1	5	50
17	10.0	2	0	0	0	0	2	1	50
18	8.9	0	0	0	1	0	0	5	50
19	8.5	1	0	1	1	1	2	4	50
20	12.5	0	0	1	2	0	4	2	25
21	11.10	1	0	1	2	0	3	3	25
22	12.4	0	0	1	0	1	1	5	25
23	11.5	0	0	0	0	2	1	3	25
24	10.7	1	1	1	3	3	2	4	25
25	9.6	1	1	2	1	1	4	3	25
26	12.8	1	0	1	2	1	2	3	16
27	12.6	1	0	0	2	0	4	0	16
28	10.7	0	2	0	1	3	2	3	16
29	8.3	1	0	1	0	0	1	1	16
30	10.11	1	1	2	1	2	3	4	09
31	9.11	1	2	0	2	3	3	7	09
32	12.6	0	0	0	1	0	3	2	09
33	10.2	0	1	3	1	0	4	5	09
34	10 11	0	0	1	1	2	5	4	09
35	9.11	2	1	5	1	0	5	2	09
36	11.8	0	1	0	3	2	3	3	05
37	11.5	1	0	1	2	1	7	2	05
38	11.11	0	1	0	2	1	7	3	05
39	11.4	0	1	2	1	2	5	1	05
40	9.10	1	1	2	1	5	3	7	05
41	10.6	1	0	1	3	5	2	5	05
42	13.0	0	1	3	2	2	3	4	02
43	9.2	0	2	4	0	2	1	3	02
44	10.6	0	0	1	1	1	0	2	02
45	9.11	4	1	2	2	2	3	2	02
		20	**22**	**38**	**45**	**50**	**105**	**111**	

S=Subject, Age:Yrs.mon., PS= Phrase Substitutions, P=Paraphrases, GS=Grammatical Substitutions, PO= Phrase Omissions, GO= Grammatical Omissions, CS=Content Substitutions, CO= Content Omissions.

APPENDIX II A
Language Assessment Percentile Scores on the CELF-R (Semel et al., 1987): All 45 Subjects

S	Age	OD	WC	SR	RL	SA	EL	LP	WA	LC	SS	WS	RS	FS
1	12.6	75	91	95	95	75	92	75	50	x	75	84	99	50
2	12.5	37	37	63	45	37	18	84	05	75	50	75	25	16
3	12.5	50	50	50	47	37	32	09	50	75	75	91	50	25
4	11.7	95	37	50	70	84	53	75	75	75	91	91	50	25
5	12.8	50	09	09	13	09	05	16	09	75	75	63	16	09
6	11.10	95	63	63	84	63	47	25	16	75	84	84	25	63
7	11.5	16	37	37	23	63	18	75	37	09	91	75	05	25
8	12.3	75	25	50	47	37	32	50	75	75	84	75	50	25
9	11.11	09	37	37	19	98	42	37	91	50	91	91	05	25
10	12.8	75	50	09	37	50	12	75	37	75	91	91	63	0
11	12.6	50	37	16	27	75	32	50	50	75	75	91	16	25
12	12.1	91	50	63	75	75	70	37	75	75	91	84	75	50
13	11.8	37	37	50	37	91	92	75	50	37	91	75	98	37
14	12.4	75	09	16	23	37	14	02	37	09	91	63	25	09
15	11.5	75	75	91	87	84	88	91	84	75	91	91	84	75
16	11.2	16	16	75	27	09	27	02	50	37	75	50	75	25
17	12.4	50	09	50	27	37	37	02	16	75	50	84	50	37
18	11.8	09	37	25	16	25	03	37	16	37	75	75	05	02
19	11.5	75	37	37	50	37	10	37	91	16	91	50	25	05
20	13.0	50	16	09	16	63	04	63	25	75	91	91	02	0
21	11.4	25	37	50	32	37	05	63	x	75	75	91	05	05
22	12.6	75	05	37	27	98	42	50	50	16	37	91	09	16
23	10.7	84	75	99	75	75	95	50	63	75	91	91	63	99
24	10.7	09	16	16	07	09	05	09	09	37	75	91	16	09
25	10.2	16	09	25	09	63	12	37	05	75	50	37	09	05
26	9.10	37	25	84	50	91	37	84	63	63	75	84	05	16
27	10.2	63	75	63	68	50	42	84	84	25	50	75	63	25
28	9.2	05	37	05	05	50	05	25	63	84	37	25	02	05
29	10.10	95	99	84	99	91	75	84	50	63	91	91	63	50
30	9.11	25	05	63	19	63	18	37	50	50	50	63	02	25
31	10.11	37	37	37	32	16	04	84	50	25	84	16	09	05
32	9.11	63	09	50	32	63	32	91	37	84	91	91	09	84
33	9.9	63	75	84	79	63	37	63	98	50	75	91	63	09
34	10.6	16	05	50	13	16	03	37	09	02	50	84	02	09
35	10.11	37	37	09	19	37	09	09	75	75	75	63	09	09
36	10.00	84	50	75	75	84	61	x	75	37	91	84	50	37
37	9.11	91	75	95	95	99	97	25	84	84	91	91	84	75
38	10.6	37	05	09	07	02	01	50	37	16	91	91	05	02
39	9.6	50	91	37	63	63	37	63	91	84	75	37	25	37
40	9.11	91	25	37	53	25	12	09	84	50	84	84	09	16
41	10.7	16	05	16	05	50	27	16	25	02	50	63	25	25
42	8.9	16	50	63	37	16	09	75	50	37	75	63	50	02
43	8.10	50	63	75	63	91	92	63	50	91	91	91	91	63
44	8.3	09	05	0	01	05	01	37	16	25	50	50	16	01
45	8.5	75	50	37	53	50	42	63	75	50	91	75	50	37

x = skipped   0 = unable to handle

S=Subject, Age=Yrs.mon, OD=Oral Directions, WC=Word Classes, SR=Semantic Relationships, RL=Receptive Language, SA=Sentence Assembly, EL=Expressive Language, LP=Listening to Paragraphs, WA=Word Associations, LC=Linguistic Concepts, SS=Sentence Structure, WS=Word Structure, RS=Recalling Sentences, FS=Formulated Sentences

APPENDIX II B

Summary of CELF-R Subtest Scores: Percentiles

	Percentiles	
Variable	$\bar{x}$	SD
Receptive		
Oral Directions	50.53	28.95
Word Classes	38.31	26.54
Semantic Relationships	45.12	27.86
Receptive Language Score	41.84	28.06
Expressive		
Formulated Sentences	27.77	24.46
Recalling Sentences	36.04	30.09
Sentence Assembly	53.18	28.62
Expressive Language Score	33.96	29.79
Supplementary Subtests		
Listening to Paragraphs	48.30	27.68
Word Associations	50.73	27.29
Linguistic Concepts	53.86	26.55
Sentence Structure	75.80	17.54
Word Structure	75.27	19.43

APPENDIX II C
RECALLING SENTENCES: Breakdown of Syntactic Errors

S	Age	SC	RC	C	NM	CD	E	PR
1	12.6	0	0	0	0	0	0	99
2	11.8	1	0	0	0	0	0	98
3	8.10	0	1	0	1	1	1	91
4	11.5	0	0	0	0	1	1	84
5	9.11	1	1	1	0	1	1	84
6	12.1	1	2	1	0	0	0	75
7	11.2	1	2	0	0	1	0	75
8	12.8	0	0	1	0	1	0	63
9	10.2	0	1	0	1	1	0	63
10	10.7	2	2	1	0	1	0	63
11	10.10	1	0	0	0	1	1	63
12	9.9	0	1	0	0	1	1	63
13	12.5	0	3	0	1	1	1	50
14	11.7	0	1	1	1	0	1	50
15	12.3	0	1	1	1	1	1	50
16	12.4	0	2	0	0	1	1	50
17	10.00	0	2	0	0	1	1	50
18	8.9	2	2	0	1	1	1	50
19	8.5	2	1	0	1	1	1	50
20	12.5	0	2	1	0	1	0	25
21	11.10	0	2	1	1	1	1	25
22	12.4	0	2	0	1	1	1	25
23	11.5	2	2	1	1	1	1	25
24	10.7	1	2	1	1	1	1	25
25	9.6	2	2	0	1	1	1	25
26	12.8	2	2	1	0	1	1	16
27	12.6	1	2	1	1	1	1	16
28	10.7	2	3	1	1	1	1	16
29	8.3	1	4	2	1	1	1	16
30	10.11	2	3	1	1	1	1	09
31	9.11	2	4	2	2	1	1	09
32	12.6	0	2	0	2	1	1	09
33	10.2	2	5	0	2	1	1	09
34	10.11	0	2	1	1	1	1	09
35	9.11	3	3	2	1	1	1	09
36	11.8	2	4	2	0	1	1	05
37	11.5	3	2	2	2	1	1	05
38	11.11	2	4	1	1	1	1	05
39	11.4	3	2	2	1	1	1	05
40	9.10	3	2	2	1	1	1	05
41	10.6	2	3	1	1	1	1	05
42	13.0	3	4	1	1	1	1	02
43	9.2	4	4	1	1	1	1	02
44	10.6	2	3	2	2	1	1	02
45	9.11	2	3	3	2	1	1	02

S=Subject, Age=Yrs.mon. SC=Subordinate Clauses, RC=Relative Clauses, C=Coordination, NM=Noun Modification, CD=Conjunction Deletion, E=Elliptical, PR=Percentile Ranking

APPENDIX II D

RECALLING SENTENCES: Frequency of Syntactic Errors

Type of Errors	Number of Errors	% of Children
Relative Clauses	95	88.9
Subordinate Clauses	57	64.4
Coordination	38	62.2
Noun Modification	36	66.7
Conjunction Deletion	41	91
Elliptical Relative Clause	37	82.2

Subjects

Percentile > 50 = 19
Percentile < 50 = 26

APPENDIX II E
SENTENCE ASSEMBLY: Breakdown of Errors

S	Age	RC	SC	IO	NG	C	PR
1	9.11	0	0	0	0	0	99
2	12.6	0	1	0	0	0	98
3	11.11	0	0	0	0	0	98
4	11.8	1	0	0	0	0	91
5	8.10	2	0	0	1	0	91
6	10.10	0	1	0	0	0	91
7	9.10	2	0	0	0	0	91
8	11.7	1	0	1	0	0	84
9	11.5	2	0	0	0	0	84
10	10.00	2	0	0	0	0	84
11	12.6	2	0	0	0	0	75
12	12.6	1	0	1	1	0	75
13	12.1	2	0	0	0	0	75
14	10.7	1	1	1	0	0	75
15	9.11	2	2	0	0	0	75
16	9.9	1	2	1	1	0	63
17	9.11	0	1	1	2	1	63
18	11.10	2	0	1	1	0	63
19	13.	1	0	1	1	0	63
20	10.2	1	2	1	0	0	63
21	9.6	2	1	1	1	1	63
22	11.5	2	1	1	0	0	63
23	10.7	1	1	1	1	1	50
24	12.8	2	0	1	0	1	50
25	10.2	2	1	1	1	0	50
26	9.2	2	1	1	1	0	50
27	8.5	3	1	0	1	2	50
28	12.5	2	0	2	0	0	37
29	12.5	1	0	1	1	1	37
30	12.3	2	1	1	1	0	37
31	12.4	3	2	1	1	0	37
32	12.4	2	1	1	0	1	37
33	11.5	2	2	0	1	1	37
34	11.4	2	2	0	1	1	37
35	10.11	2	2	0	0	0	37
36	11.8	1	1	1	2	1	25
37	9.11	2	1	1	1	1	25
38	10.6	2	2	1	1	2	25
39	10.11	1	3	1	2	2	16
40	8.9	3	2	1	2	3	16
41	12.8	2	2	1	2	0	09
42	11.2	2	2	0	0	2	09
43	10.7	3	2	1	2	3	09
44	8.3	3	3	1	2	3	05
45	10.6	3	3	2	2	3	02

S=Subject, Age=Yrs.mon., RC=Relative Clause, SC=Subordinate Clause, IO=Indirect Object, NG=Negation, C=Co-ordination, PR=Percentiles.

APPENDIX II F

SENTENCE ASSEMBLY: Frequency of Errors

Type of Errors	Number of Errors	% of Children
Relative Clauses	75	88.9
Subordinate Clauses	47	64.4
Coordination	30	40.0
Indirect Object	30	62.2
Negation	33	55.5

Subjects

Percentile > 50 = 27
Percentile < 50 = 18

APPENDIX II G

FORMULATED SENTENCES: Breakdown of Errors

S	Age	N	V	M	C	SC	CL	D	PR
1	10.7	0	0	0	0	0	0	2	99
2	9.11	0	0	0	0	0	0	2	84
3	9.11	0	0	0	0	0	1	1	75
4	11.5	0	0	0	2	0	0	0	75
5	8.10	0	0	0	1	0	1	2	63
6	11.10	0	0	0	2	0	0	2	63
7	10.10	0	0	0	0	0	2	3	50
8	12.6	0	0	0	0	0	1	1	50
9	12.1	0	0	0	0	1	1	2	50
10	10.00	0	0	0	0	2	1	4	37
11	9.6	0	0	0	0	1	1	3	37
12	11.8	0	0	0	1	1	0	3	37
13	8.5	0	0	0	1	1	2	2	37
14	12.4	0	0	0	0	1	2	1	37
15	11.11	0	0	0	0	1	1	2	25
16	11.7	0	0	0	1	1	1	2	25
17	12.6	0	0	0	0	0	1	2	25
18	11.5	0	0	0	1	0	1	3	25
19	9.11	0	0	0	1	0	1	3	25
20	10.2	0	0	0	0	0	1	3	25
21	10.7	0	0	0	0	2	1	4	25
22	12.5	0	0	0	1	1	1	2	25
23	12.3	0	0	0	1	1	0	4	25
24	11.2	0	0	0	0	1	1	2	25
25	12.6	0	0	0	0	0	1	4	16
26	9.10	0	0	0	0	1	2	3	16
27	12.5	0	1	0	1	1	1	1	16
28	9.11	0	0	0	1	0	1	6	16
29	9.9	0	0	0	1	0	2	5	09
30	12.4	0	0	0	0	1	0	4	09
31	10.11	0	0	0	0	0	2	4	09
32	10.6	0	0	0	2	1	1	6	09
33	12.8	0	0	0	1	1	2	5	09
34	10.7	0	0	0	1	1	1	5	09
35	9.2	0	0	0	1	3	2	5	05
36	11.5	0	0	0	0	1	1	4	05
37	11.4	0	0	0	2	1	1	3	05
38	10.11	0	0	0	3	2	1	6	05
39	10.2	0	0	0	1	3	1	5	05
40	8.9	0	0	0	3	1	2	x	02
41	11.8	0	0	0	1	3	1	4	02
42	10.6	0	0	0	1	2	2	5	02
43	12.8	0	0	0	0	1	0	x	x
44	8.3	0	0	0	3	5	2	x	01
45	13.00	0	0	0	1	1	1	x	x

S=Subject, Age=yrs.mon., N=Noun, V=Verb, M=Modifier, C=Coordination, SC=Subordinate Clauses, CL=Correlation, D=Double-Word Sentence Formulation, PR=Percentile Ranking

APPENDIX II H

FORMULATED SENTENCES: Frequency of Errors

Type of Errors		Frequency	% of Children
Coordination			
but		19	42.2
and		6	13.5
or		10	22.2
	Total:	**35**	**55.6**
Subordination			
although		16	35.5
before		5	11.1
because		5	11.1
after		2	4.4
if		10	13.5
when		5	11.1
	Total:	**43**	**64.4**
Correlation			
either		31	68.8
neither		17	37.7
	Total:	**48**	**82.2**
Double-Word Sentences			
	Total:	**130**	

Subjects

Percentile > 50 = 9
Percentile < 50 = 36

APPENDIX II I

Breakdown of errors in Recalling Sentences, Sentence Assembly, and Formulated Sentences of CELF-R.

S	Age	RSSC	SASC	FSSC	RSRC	SARC	RSC	SAC	FSC
1	12.6	0	0	0	0	2	0	0	0
2	12.5	0	0	1	2	2	1	0	1
3	12.5	0	0	1	3	1	0	1	1
4	11.7	0	0	1	1	1	1	0	1
5	12.8	2	2	1	2	2	1	0	1
6	11.10	0	0	0	2	2	1	0	2
7	11.5	3	1	0	2	2	2	0	1
8	12.3	0	1	1	1	2	1	0	1
9	11.11	2	0	1	4	0	1	0	0
10	12.8	0	0	1	0	2	1	1	0
11	12.6	1	0	0	2	1	1	0	0
12	12.1	1	0	1	2	2	1	0	0
13	11.8	1	0	1	0	1	0	0	1
14	12.4	0	2	1	2	3	0	0	0
15	11.5	0	0	0	0	2	0	0	2
16	11.2	1	2	1	2	2	0	2	0
17	12.4	0	1	1	2	2	0	1	0
18	11.8	2	1	3	4	1	2	1	1
19	11.5	2	2	1	2	2	1	1	0
20	13.0	3	0	1	4	1	1	0	1
21	11.4	3	2	1	2	2	2	1	2
22	12.6	0	1	0	2	0	0	0	0
23	10.7	2	1	0	2	1	1	0	0
24	10.7	2	2	1	3	3	1	3	1
25	10.2	2	2	3	5	1	C	0	1
26	09.10	3	0	1	2	2	2	0	0
27	10.2	0	1	0	1	2	0	0	0
28	09.2	4	1	3	4	2	1	0	1
29	10.10	1	1	0	0	0	0	0	0
30	9.11	2	1	0	3	0	3	1	1
31	10.11	2	3	2	3	1	1	2	3
32	9.11	2	2	0	4	2	2	0	0
33	9.9	0	2	0	1	1	0	0	1
34	10.6	2	2	1	3	2	2	2	2
35	10.11	0	2	0	2	2	1	0	0
36	10.00	0	0	2	2	0	0	0	0
37	10.11	1	2	0	2	3	1	0	0
38	11.6	2	0	2	2	2	1	3	1
39	9.6	2	3	1	2	2	0	1	0
40	9.11	3	1	0	3	2	2	1	1
41	10.7	1	1	2	2	1	1	1	0
42	8 9	2	2	1	2	3	0	3	3
43	8.10	0	0	0	1	2	0	0	1
44	8.3	1	3	5	4	3	2	3	3
45	8.5	2	1	1	1	3	0	2	1

S=Subject, Age=Yrs.mon., RSSC=Recalling Sentences Subordinate Clauses, SASC=Sentence Assembly Subordinate Clauses, FSSC=Formulated Sentences Subordinate Clauses, RSRC=Recalling Sentences Relative Clauses, SARC=Sentence Assembly Relative Clauses, FSRC=Formulated Sentences Relative Clauses, RSC=Recalling Sentences Coordination, SAC=Sentence Assembly Coordination, FSC=Formulated Sentences Coordination

APPENDIX II J

Comparison of specific syntactic structures in Recalling Sentences, Sentence Assembly, and Formulated Sentences.

S	Age	Al	Af	Al	Af	Al	Af	RSRC	SARC	RSC	SAC	FSC
1	12.6	0	0	0	0	0	0	0	1	0	0	0
2	12.5	0	0	0	0	1	0	1	1	0	0	0
3	12.5	0	0	0	0	0	0	1	1	0	1	0
4	11.7	0	0	0	0	1	0	1	1	0	0	0
5	12.8	0	1	1	1	1	0	0	1	1	0	0
6	11.10	0	0	0	0	0	0	1	1	0	0	1
7	11.5	1	1	0	0	0	0	1	1	1	0	0
8	12.3	0	0	0	1	0	0	1	1	0	0	0
9	11.11	1	1	0	0	0	0	1	0	0	0	0
10	12.8	0	0	0	0	0	0	0	1	0	0	0
11	12.6	0	1	0	0	0	0	1	0	0	0	0
12	12.1	0	0	0	0	0	1	0	1	0	0	0
13	11.8	0	0	0	0	1	0	0	1	0	0	0
14	12.4	0	0	1	1	1	0	1	1	0	0	0
15	11.5	0	0	0	0	0	0	0	1	0	0	0
16	11.2	0	1	1	1	1	0	1	1	0	0	0
17	12.4	0	0	0	1	0	0	0	1	0	0	0
18	11.8	0	1	0	1	1	0	1	0	0	0	0
19	11.5	1	1	1	1	1	0	1	1	0	0	0
20	13.	1	1	0	0	0	0	1	1	0	0	0
21	11.4	1	1	1	1	0	0	1	1	0	0	1
22	12.6	0	0	0	0	0	0	1	0	0	0	0
23	10.7	0	0	0	1	0	0	1	0	0	0	0
24	10.7	0	1	1	1	0	0	1	1	0	1	0
25	12.2	1	1	1	1	1	0	1	1	0	0	0
26	9.10	0	1	0	0	1	0	1	1	1	0	0
27	10.2	0	0	1	0	0	0	1	0	0	0	0
28	9.2	1	1	0	1	1	0	1	1	0	0	0
29	10.10	0	0	1	0	0	0	0	0	0	0	0
30	9.11	0	1	0	1	0	0	1	0	1	1	0
31	10.11	0	1	1	1	0	0	1	0	0	1	0
32	9.11	0	1	1	1	0	0	1	1	1	0	1
33	9.9	0	0	1	1	0	0	1	0	0	0	0
34	10.6	1	1	1	1	0	0	1	1	0	1	0
35	10.11	0	0	1	1	0	0	1	1	0	0	1
36	10.00	0	0	0	0	0	0	1	1	0	0	0
37	9.11	1	1	0	0	0	0	1	0	0	0	0
38	10.6	1	1	1	1	1	0	1	1	0	0	0
39	9.6	0	1	0	1	0	0	1	1	0	1	0
40	9.11	0	1	0	0	0	0	1	1	0	1	0
41	10.7	0	0	0	1	1	0	1	0	0	0	0
42	8.9	0	1	1	1	1	0	1	1	0	1	1
43	8.10	0	0	0	0	0	0	0	1	0	0	0
44	8.3	0	1	1	0	1	1	1	1	0	0	1
45	8.5	0	1	0	0	1	0	1	1	0	1	0

S=Subject, Age=Yrs.mon., Al=although, Af=after, RSRC=Recalling Sentences Relative Clauses, SARC=Sentence Assembly Relative

Clauses, RSC=Recalling Sentences Coordination, SAC=Sentence Assembly Coordination, FSC=Formulated Sentences Coordination.

APPENDIX II K
FORMULATED SENTENCES: Breakdown of Errors (syntactic/other)

S	AGE	C. S	C. SM	Sub. S	Sub. SM	Cor. S	Cor. SM	Double S	Double SM	Grm. Dis.	PR
1	12.06					1		1		N	50
2	12.05	1		1			1		1	O	16
3	12.05		1		1	1			2	O	25
4	11.07		1		1	1			2	O	25
5	12.08		1		1	2		1	4	S	9
6	11.10		2					1	1	N	63
7	11.05		1				1	1	2	O	25
8	12.03		1		1				4	O	25
9	11.11				1		1	1	1	O	25
10	12.08				1					O	IN
11	12.06						1	2		O	25
12	12.01				1		1		2	O	50
13	11.08		1		1			1	2	O	37
14	12.04			1				3	1	S	9
15	11.05		2							N	75
16	11.02			1			1		2	O	25
17	12.04				1		2		1	O	37
18	11.08		1	2	1		1	3	1	S	2
19	11.05			1		1		4		S	5
20	13.00	1		1		1				S	IN
21	11.04	2		1		1		3		S	5
22	12.06					1		2	2	S	16
23	10.07							2		N	99
24	10.07		1		1		1	3	2	S	9
25	10.02		1	2	1	1		4	1	S	5
26	09.10			1		2		1	2	S	16
27	10.02						1	2	1	O	25
28	09.02	1		3			2	4	1	S	5
29	10.10					1	1		3	O	50
30	09.11		1	0		1		2	1	S	25
31	10.11	2	1	1	1	1		6		S	5
32	9.11							1	1	N	84
33	9.09	1				2		4	1	S	9
34	10.06	2		1		1		2	4	S	9
35	10.11					2		2	2	S	9
36	10.00				2	1		1	3	O	37
37	9.11						1	1		N	75
38	10.06		1	1	1		2	4	1	S	2
39	9.06				1	1		1	2	0	37
40	9.11		1				1	4	2	S	16
41	10.07				2		1	2	2	0	25
42	8.09	3		1		1	1			S	2
43	8.10		1			1		1	1	N	63
44	8.03	3		3	2	2				S	01
45	8.05	1		1		2		1	1	0	37
TOTAL		**17**	**18**	**22**	**21**	**28**	**20**	**71**	**59**		

Sj=Subjects, Age=Yrs.mon., C=Coordination, Sub.=Subordination, Cor.=Correlation, Double=Formulation of Sentences Using Two Words, S=Syntactic, O=Other, N=Normal, Grm. Dis.=Grammatical Disability, PR=Percentile Rank.

APPENDIX II L

Comparison of percentile scores in RS, SA, and FS subtests after reanalysis of FS into S/O errors.

S	Age	Grm.Dis.	RS	SA
1	12.06	N	99	75
2	12.05	O	25	37
3	12.05	O	50	37
4	11.07	O	50	84
5	12.08	S	16	09
6	11.10	N	25	63
7	11.05	O	06	63
8	12.03	O	50	37
9	11.11	0	05	98
10	12.08	0	63	50
11	12.06	0	16	75
12	12 00	0	75	75
13	11.08	0	98	91
14	12.04	S	25	37
15	11.05	N	84	84
16	11.02	0	75	09
17	12.04	0	50	37
18	11.08	S	50	25
19	11.05	S	25	37
20	13.00	S	02	63
21	11.04	S	05	37
22	12.06	S	09	98
23	10.07	N	63	75
24	10.07	S	16	09
25	10.02	S	09	63
26	9.10	S	05	91
27	10.02	0	63	50
28	9.02	S	02	50
29	10.10	0	63	91
30	9.11	S	02	63
31	10.11	S	09	16
32	9.11	N	09	63
33	9.09	S	63	63
34	10.06	S	02	16
35	10.11	S	09	37
36	10.00	0	50	84
37	9.11	N	84	99
38	10.06	S	05	02
39	9.06	0	25	63
40	9.11	S	09	25
41	10.07	0	25	50
42	8.09	S	50	16
43	8.10	N	91	91
44	8.03	S	16	05
45	8.05	0	50	50

S=Subject, Age:Yrs.mon., Grm.Dis.= Grammatic Disability, FS=Formulated Sentences, RS=Recalling Sentences, SA=Sentence Assembly, N=Normal, O=Other, S=Syntactic.

APPENDIX III M
K-TEA: READING DECODING SUBTEST

Grade 1

s, A, n, e, b

Grade 2

to, in , here, four, apple

Grade 3

Open, take, new, deep, hello

Grade 4

Teacher, sorry, breakfast, knife, twenty

Grade 5, 6

Special, powder, whistle, straight, couple

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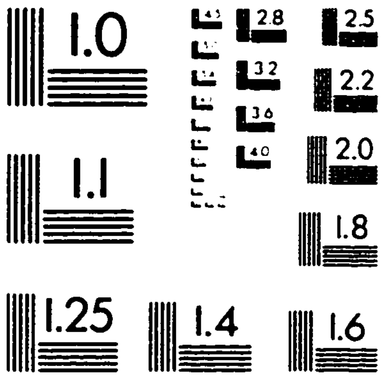
IMAGE EVALUATION TEST TARGET (QA-3)



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