Abstract

THE EFFECTS OF PRESENTATION MODALITY ON LEARNING AND MEMORY PERFORMANCE IN CHILDREN WITH SPECIFIC LEARNING DISABILITIES IN THE AREA OF LANGUAGE

By Marijo F. O’Connell

This study investigated the learning and memory patterns in low-income, African-American children ages 9-13 with specific learning disabilities in the area of language (SLD/SLI) as compared to typically developing peers. All subjects (n=34) were administered the California Verbal Learning Test for Children (CVLT-C) and the experimental tasks. The experimental tasks measured supralist free recall under three presentation modalities; auditory, visual and simultaneous presentation of auditory and visual. Results indicate SLD/SLI children show significantly slower rates of learning than controls. Additionally, the visual presentation modality, with or without auditory information, demonstrates significantly better learning rates than the auditory modality alone. The results support the hypotheses stating that SLD/SLI children learn verbal information at a slower rate than typical children and the superiority of the visual presentation modality for verbal learning and memory.
Effect of Presentation Modality on Learning and Memory Performance in Children with Specific Learning Disabilities in the Area of Language

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CHAPTER ONE
Introduction
Specific Language Impairment

Statement of the Problem

Between 7 and 8% of kindergarten children are diagnosed with specific language impairment (SLI) (Tomblin et al., 1997). Research shows that children exhibiting early language deficits, in spite of grossly normal performance measures, are at risk for academic retention, academic failure, and academic attrition. Children who are identified with SLI at the second grade level, who also demonstrate reading-writing delays at that time, are likely to persist in those delays in later grades. (Catts et al., 2002; Catts, 1993; Rescorla, 2002).

Children are identified with SLI if their scores fall at least 1 standard deviation (SD) below the mean on a criterion-based language measure, in the absence of any evidence for mental retardation or neurological disorders that might account for the delay (Miller, 1991; Tallal, 1988; Weiss, 2001). SLI is known by a variety of names including developmental language disorder, language delay, or developmental dysphasia (Rice, 2002).

Conti-Ramsden and Botting (1999) have proposed a six-subgroup classification system of children with SLI. In their system, children tend to move across subgroups over time, with this classification remaining stable only in kindergarten and first grade. Guendourzi (2003) describes SLI as a generic category of language impairment that emerges from specific differences, and therefore he questions the validity of SLI as a designation for a multi-determined disability. A multi-determined disability is one that has a variety of different etiologies.

In the State of Ohio, where this study takes place, SLI is not an option when identifying children with disabilities. In Ohio, children with SLI are a subgroup of the classification specific learning disability (SLD). According to the Ohio Department of Education Operating Standards for Ohio’s Schools Serving Children with Disabilities, (2002), “Specific Learning Disability” means a “disorder in one or more of the basic psychological processes involved in the understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, read, write, spell, or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia.”
This experimental group, (SLD/SLI) was formed to exclude children with cognitive disorders or overall developmental delays. The Ohio Department of Education Operating Standards for Ohio’s Schools Serving Children with Disabilities, (2002), refers to a cognitive disability or mental retardation as significantly subaverage general intellectual functioning. This is clarified by an “intelligence quotient of seventy or below as determined through a measure of cognitive functioning administered by a school psychologist or a qualified psychologist using a test designed for individual administration. Based on a standard error of measurement and clinical judgement, a child may be determined to have significant subaverage general intellectual functioning with an intelligence quotient not to exceed seventy-five.”

Exact classification of these children varies from school system to school system based on each system’s special education eligibility criteria. Thus, for the purpose of this study, experimental subjects were those who demonstrated difficulties acquiring language without an obvious cause such as hearing loss or low intelligence quotient (IQ) (Rice, 2002, and Rice, 2000). They will be referred to as children with specific learning disabilities in the area of language (SLD/SLI).

A major identifying symptom of children with SLI is that they are “late talkers”, whereby the child’s gross overall development is apparently normal, and the child’s receptive language or comprehension also appears normal (Rescorla, 2002). Another major identifying characteristic of SLI children is that they consistently demonstrate a persistent impairment in grammatical comprehension and expression of language (van der Lely, 1993).

Later language development, (as seen in late talkers), has been associated with reading difficulties in higher grades (Rescorla, 2002; Catts et al., 2002). Stothard et al., (1998) reported adolescents with histories of speech and language problems are significantly less skillful than controls in phonological processing and literacy skills. Interestingly, the adolescents with speech-language difficulties did not have persistent vocabulary or language comprehension problems. Even though their difficulties resolved by the time they entered kindergarten, they demonstrated reading difficulties in adolescence. Therefore, while early identification and speech-language intervention in preschool years are necessary, research suggests that children with specific language impairment would benefit from long-term educational supports and planning. While rare, there are model programs delivered by speech-language pathologists
(SLP’s) which contribute to the success of high school students with language impairments (Ehren, 2002).

Education models designed to specifically address language learning could improve overall academic achievement for children with specific language impairment. Educational achievement is closely related to long-term personal stability and satisfaction, therefore improved models for language learning could yield lifelong benefits for students. Gill et al. (2003) implemented a systematic training protocol via rehearsal/visualization in children with SLI ages 6 to 12. Their findings suggest that this protocol was effective in improving their ability to follow verbal directions.

Stimulus modality has been investigated in other clinical groups with memory and learning deficits. In 1996, Constantinidou, Neils, Bouman, Lee and Shuren applied a multi-trial (e.g. repeated presentation) paradigm to investigate verbal learning preferences in individuals who sustained head injury and exhibited working memory deficits. Constantinidou et al. (1996) tested three stimulus presentation modalities: (a) auditory, (b) visual, and (c) auditory plus visual. The researchers found that subjects learned the greatest amount of information when verbal stimuli are presented visually, with or without the simultaneous auditory presentation of information, as compared with auditory information alone. Furthermore, the visual presentation modality was more resistant to declines after delays and interference.

The same multi-trial free recall paradigm was used to investigate the effects of modality presentation on verbal learning performance in normal aging adults (Constantinidou and Baker, 2002). Results of this research corresponded with the Constantinidou et al. (1996) study: Better learning, recall, and retrieval of information were obtained by visual presentation of objects, with or without the auditory stimulus, than the auditory presentation alone, and recall remained resistant to declines after delay and interference.

**Significance of the Problem**

Children with SLI demonstrate difficulty learning verbal information, therefore it is important to determine ways to maximize input to enhance verbal learning in these children. The effect of stimulus presentation on verbal learning in children with SLD/SLI has not been investigated in previous research. Understanding the effectiveness of stimulus modality for learning verbal information could have a significant impact on a child’s success at learning more
complex language. Additionally, broadening our knowledge about learning modality preferences and effectiveness will add to our ability to develop educational techniques and tools aimed at maximizing potential for learning.

Joanisse & Seidenberg (2003) propose (a) that SLI develops as a result of deficits in perception, which adversely affect the use of phonological information in working memory, leading to poor syntactic comprehension, or (b) that perceptual deficits give rise to grammatical deficits in those with SLI. Verbal learning and memory is appropriately explored when attempting to describe or explain processing difficulties of children with specific language impairment. Comparing the ability of children to learn verbal content under different stimulus modalities, specifically (a) auditory (b) visual, or (c) auditory plus visual will allow educators and researchers to further understand the nature of specific language delay and to develop educational tools that address the needs of these at-risk children.

This research used the three stimulus modalities described above to identify modality preferences of children with SLD/SLI. Results from this study will enhance our understanding of this population as well as provide clinical information to provide direction in designing effective educational practices.

Purpose of the Study

The purpose of this study is twofold: First, to investigate the effects of SLD/SLI on learning and recalling verbal information in school-aged children; and second, to investigate the effects of modality presentation on memory performance in children with SLD/SLI and in typically developing children.

Research Questions

1. Is there a significant difference between SLD/SLI children and typically developing children in memory performance as measured by formal verbal learning tests like the California Verbal Learning Test- Children’s Version (CVLT-C) (Delis et al., 1994)?

2. Is there a significant difference between SLD/SLI children and typically developing children in their ability to freely recall verbal information after a long delay as measured by the CVLT-C?
3. Is there a significant difference in verbal learning performance in SLD/SLI children and typically developing children when the presentation modality is auditory, visual, or auditory plus visual as measured by the experimental verbal learning tasks?

4. Is there a significant difference in the rate of learning between SLD/SLI children and typically developing children when the presentation modality is auditory, visual, or auditory plus visual during verbal learning tasks?

5. Is there a significant difference between SLD/SLI children and typically developing children in the amount of retroactive interference when stimulus modality is auditory, visually, or auditory plus visual?

**Null Hypotheses**

1. There is no significant difference between SLD/SLI children and typically developing children in memory performance as measured by formal verbal learning tests like the CVLT-C.

2. There is no significant difference between SLD/SLI children and typically developing children in their ability to freely recall verbal information after a long delay as measured by the CVLT-C.

3. There is no significant difference between verbal learning performance in SLD/SLI children and typically developing children when the stimulus presentation modality is auditory, visual or auditory plus visual as measured by the experimental verbal learning tasks.

4. There is no significant difference in the rate of learning of SLD/SLI children and typically developing children when the stimulus presentation modality is auditory, visual, or auditory plus visual during verbal learning tasks.

5. There is no significant difference between SLD/SLI children and typically developing children in the amount of retroactive interference when the stimulus presentation modality is auditory, visual, or auditory plus visual.
Research Hypotheses

1. Children with SLD/SLI will learn verbal information at a slower rate across all modalities than will typical children.

2. Learned verbal information will deteriorate to a greater degree in children with SLD/SLI after interference and time delay for all modalities as compared to control group.

3. The visual stimulus modality will continue to produce higher rates of verbal learning, as compared to the other stimulus modalities within and between subjects.
Chapter Two
Review of the Literature

*Characteristics of Children with Specific Language Impairment*

**Performance skills**

Several key features identify children with specific language impairment (SLI) or children whose linguistic skills are significantly weaker than their nonlinguistic or “performance” skills. Children with specific language delay perform as well as typically developing peers in other domains, specifically, visual-spatial skills, numerical skills, and general fine and gross motor development. Overall cognitive skills are comparable to typically developing peers. Language is the domain of weakness. Thus, children with SLI are differentiated from children with pervasive developmental delays or children who exhibit delays in varying degrees across multiple or all domains.

As discussed in Chapter 1, the first presenting feature of SLI is the late-talking toddler, who appears to understand language but is not talking, or who is exhibiting an expressive language delay. This characteristic of language development is normal to some degree and has long been discussed in the literature as language comprehension preceding language performance (Bates et al., 1988). It is also sometimes described as receptive language skills developing before expressive language skills, or dissociation between comprehension and production. For example, Bates et al. (1988) found this pattern in normal children between 13 and 28 months of age continuing into early grammar. However, studies show that as many as 40% of late talkers are later identified as children with SLI (Rescorla & Schwartz, 1990).

**Identifying late talkers.**

One consideration in any discussion of language development is acquisition as a result of experience. In her book on language acquisition in children younger than age 3, Bates (1976) presents an extensive overview of the difficulties of assessing language comprehension especially in a natural environment. Thus, children diagnosed with SLI are not necessarily SLI due to cognitive deficits, but may be identified as SLI due to lack of experience that could account for low vocabulary acquisition rates and, in turn, interfere with comprehension of more syntactically complex linguistic information. This is sometimes considered a slow processing
issue. Processing rates may then be due to “stalls” when there is too much ambiguity in the message and the meaning is unclear. This theory does not address how or if that interacts with the biological mechanism for learning language.

The difficulty in the natural environment is that once a researcher is injected into the child’s system, it creates a change in the environment, often associated with a change in the child’s behavior. Therefore, when a toddler is brought for an evaluation, the child typically produces far fewer words than parents report. On the other hand, a parent may confuse language comprehension with the child’s overall cognitive comprehension of a daily routine. In short, the child will anticipate what the parent wants and will do it as part of procedural memory. This does not necessarily mean that the child comprehended the linguistic input. Thus it is useful to consider that “late talking” is based upon parent recollection of their child’s language development.

Bates (1976) suggests that normal dissociation between comprehension and performance occurs between 18 and 26 months. The next 6 to 8 months have been discussed as earliest time frame in which normal and diminished skills can be distinguished. Thus, a child with persistent expressive deficits at 24 to 36 months old may have an enduring linguistic disability and, therefore, a higher likelihood of identification as a child with SLI.

In a sample of four children, ages 2 to 5, who had demonstrated very early language delays (before age 3), their language skills were relatively normal by 60 months or age 5. However, by age 8, three of the four children were reading delayed (Scarborough & Dobrich, 1990).

Although a young child’s expressive language deficits may be apparent, a toddler’s comprehension of linguistic input remains difficult to assess, especially for an untrained observer. When discussing late-talking as a predictor of SLI, one must consider that the description of late talking is based upon parent’s retrospective account of their child’s development. Although standardized and reliable measures exist for children under age 3, few parents seek a formal evaluation this early. Parental accounts of their child’s comprehension during the early years are unreliable. Researchers have found the widest gap between parent and teacher observations in kindergarten; by second grade parents and teachers agree more on behavior scales (Redmond & Rice, 2002).
Vocabulary development

Research on the preschool population regarding word-learning abilities in children with SLI compared to typically developing peers found that children with SLI have significantly reduced rates of learning new words, in both comprehension and production (Gray, S., 2003). Therefore, it appears that the child with SLI has a slower rate of understanding the meaning of new words and later using them as compared to children with typically developing language. In short, there appears to be some dispute that children with SLI do not have receptive vocabulary in addition to the more often stated syntactical deficits as infants and toddlers in expressive language. Dissociation between comprehension and performance seems to be normal for children between 18 and 26 months old. By age 2, late talkers whose receptive language skills are measurably normal do not go on to be identified as SLI (Thal et al., 1991). This would suggest that intervention needs to begin before age 2 for “at risk” toddlers.

Literacy and grammatical impairment

Chapter 1 describes late talking as a key identifying feature of children with specific language impairment. Many children benefit from early intervention and are dismissed from speech and language services only to find later their academic verbal skills are inadequate for successful classroom performance. These children demonstrate age-appropriate comprehension of concepts but find the reading and writing tasks at grade level challenging. Typical writing errors for children with specific language impairment include marked deficits on a measure of spelling and punctuation. Spelling errors are described as phonologically inaccurate when compared to younger children at a similar vocabulary level (Bishop & Clarkson, 2003).

Students with specific language impairment have demonstrable grammatical issues. Montgomery (2003) reviewed evidence suggesting that “The lexical-morphological learning and sentence comprehension-processing problems of many of these children are associated with deficient working memory functioning.” Windsor et al. (2000), found a high percentage of errors in units clarifying tense and plural markers, and that these errors in written language persisted well into adolescence.
Long term effects of specific language impairment

Although it may be critical to address a two-year-old child’s receptive language skills to resolve later expressive delays, a deficit at this age contributes to subsequent literacy delays. Specifically, children whose vocabulary and language comprehension delays appeared to be resolved by ages 5 and 6 performed significantly worse on phonological processing and literacy skills than children with normal language skills (Stothard et al., 1998).

In addition to literacy delays, social outcome is closely associated with poor pragmatic language skills. Deficient social communication skills lead to behavior problems which, in turn, interfere with academic success (Conti-Ramsden G., Botting N. 2004). Jerome et al. (2002) found that as children with SLI grew older (ages 6 to 11), they perceived themselves more negatively in academics, social acceptance, and behavioral conduct than did children with typical language.

Memory, a prerequisite to learning

Orientation to Memory

There are two major models for memory functions, the information processing model and the classical model. In terms of the informational processing model, researchers agree that memory skills advance along the following stages; attention, encoding, storage, and retrieval (Sohlberg & Mateer, 2001). The classical model of memory includes information processing concepts and adds the concepts of short-term, working memory, and long-term memory. The models are compatible with each other, and the literature utilizes terms from both models freely. As a result, it is worth clarifying the basic terms regarding memory.

Information processing model

With regard to the information processing model, attention forms the foundation of learning and memory. Attentional tasks are processed via the reticular activating system, at the level of the brain stem. Briefly, the reticular activating system sends sensory input from all of the senses to the thalamus, which sorts the information and directs it to the lobes of the brain for further processing. Generally, auditory information is directed to the temporal lobe, visual information is directed to the occipital lobe, and motor-sensory data is directed to the parietal lobe (Lyons, 2001).
Attentional skills form the basis of all verbal and nonverbal learning. At its most basic, attention requires the individual to be able to be alert or to be aroused. Attention-related tasks proceed to more difficult skills as sustained attention (being able to concentrate for periods of time), selective attention (maintaining a focus by resisting interference), alternating attention (being able to change focus from one task to another), and divided attention (being able to focus on two or more things at the same time).

Assuming the individual has attended to the stimuli, the next function in verbal learning is encoding. Encoding requires that the individual analyze the information. The next level of memory is storage, referring to the process of transferring information to a location in the brain to be accessed permanently. This long-term memory storage can be adversely affected by interference, whereby the “old” information is forgotten due to the effects of subsequently learned material.

The final level of memory is retrieval or the ability of an individual to remember previously learned material. This can be measured by recall or by recognition of previously learned material. Recall requires the individual to express what has been learned, and recognition requires that an individual be able to identify what has been learned. Because recognition is the easier task, recognition skills are superior to recall skills when exploring learning and memory.

Classical model

The classical model incorporates the concepts of short-term memory, working memory and long-term memory. Working memory and short-term memory are frequently used interchangeably, however, some researchers distinguish between the two concepts as follows: Short-term memory lasts only 15 to 30 seconds, and it can generally hold up to 7 items (+/- 2 items) before it goes to working memory. Working memory can be used for hours and provides the individual the ability to form lasting, long-term memories. Working memory requires extensive activation of the prefrontal cortex. Working memory, the aspect of memory involved in the present study places greater demands upon cognitive skills to manipulate information for storage and later retrieval. Both short term and working memory are temporary memory storage.

Temporary memory storage is examined by exploring the duration and capacity aspects of memory storage. Duration refers to the length of time information is stored and capacity
refers to the amount of information stored. Long term memory is described as permanent memory. Permanent memories are stored in sensory association areas.

**Baddeley’s model**

Baddeley (1974) proposed a theory of working memory that continues to be widely supported and discussed in the literature. He suggests that for information to be encoded for storage and later retrieval, two main processing pathways exist to the cortical areas. One pathway is dedicated to processing visual-spatial-sensory information, which proceeds to visual projection areas as well as association areas. Interpreting this information occurs at these association areas. The other major pathway is auditory and processes acoustic information, which proceeds to auditory projection areas and its association areas. These auditory association areas are well established in previous research and are known to be important in speech and language comprehension and production. Several language development researchers have proposed that part of the process of learning language is the individual developing a method of hearing a message and the ability to personally replicate the message orally that lays the groundwork for expressive oral speech and language. This is also referred to as the articulatory loop/route or the phonological loop in the literature which is based upon Baddeley’s original work of 1983.

Gathercole et al. (2004) support Baddeley’s version of working memory’s basic structure. Both view working memory developing in a linear order. While Baddeley’s model is based on adults, Gathercole’s work involves children ages 4-15, and concurs that the basic units needed to process information, e.g., the phonological system and the visual-spatial system are in place from at least age six and maybe earlier.

**Working memory**

Thompson et al. (1993) proposed a theory of skilled memory conjecturing three guiding principles: first, that information is encoded for memory storage utilizing pre-existing knowledge on the part of the individual; second, that retrieval of information is dependent upon a retrieval structure, which is deliberately attaching retrieval cues to the encoded material to enable efficient retrieval; and finally, that memory “speeds up” with greater practice, or, simply stated, memory skills increase when the material has been presented previously.
Another study that discusses the role of working memory in children with specific language disabilities focused on the role of the central executive functioning and its interaction with the phonological loop in complex working memory tasks. Subjects in this research demonstrated declining performance in tasks using increasingly complex syntax and longer word lengths. Marton and Schwartz (2003) found that children with specific language impairment exhibited larger processing and attentional capacity limitations than age-matched peers. They suggested a limitation in simultaneous processing rather than difficulty in encoding and analyzing the phonological structure of non-words. These tasks used non-word repetition tests and sentence comprehension by using sentences that differed in length and syntactic complexity.

Interestingly, the greatest decline in performance among children with SLI was in non-word repetition tests, which assess the phonological loop and bypasses semantic associations. According to this study, children with SLI may have language learning delays due to attention and phonological information processing difficulties. When SLI and hearing-impaired children are compared in their ability to learn novel words, hearing-impaired children outperform SLI, giving additional weight to the role of central executive functioning in learning (Hansson et al., 2004).

Speed of processing

The speed of processing linguistic information has also been cited as a factor associated with SLI. Miller et al., (2001), was able to provide evidence of slower rates of learning on a variety of tasks as compared to typically developing peers in both verbal and non-verbal domains. In a study using the visual spatial attentional orienting response, the school aged subjects with SLI were found to have “a, slower visual processing, b, slower motor responses, but c. similar attentional orienting speed, relative to the control group”(Schul et al., 2004).

Typically developing children process information using both verbal and non-verbal domains more effectively than do children with SLI. Underlying processing constraints under dual presentation modalities confirm that typically developing children derive greater benefit than the children with SLI under conditions that enabled them to disperse processing efforts across all conditions. (Hoffman & Gillam, 2004).

Ullman (2003) proposes that language learning depends upon two distinct brain systems which together enable one to learn and remember. The first brain system is the
declarative/procedural model which depends on the temporal-lobe substrates of declarative memory which underlies the storage of facts and knowledge of events. The grammar necessary for mentally transforming lexical items into rule-governed complex structures depends on a different neural system, specifically, interconnected frontal/basal-ganglia, parietal and cerebellar structures. This second system is important in learning and executing procedural memory-like sequences. Ullman (2001) proposes that specific language impairment (as well as non-fluent and fluent aphasia) is a functional breakdown in one of these two systems.

Current researchers are utilizing event-related brain potentials (ERP) as a correlate to rate of verbal learning as well as other tasks (Shafer et al., 2001). Shafer et al. (2001) founded an ERP study upon research citing that deviant anatomical asymmetry is linked to SLI in children. Their results confirm ERP differences to language stimulation at the level of the basal ganglia to the cortex. They propose that children with SLI lack some contribution from a deep neural generator, possibly the hippocampus or basal ganglia. Specific cortical locations sited are T7 and T8, on the lateral surfaces of the temporal cortices were identified with high electrical activity. They specifically found depressed processing at the left temporal site and enhanced processing activity at the right temporal site which was reversed compared to the normal controls. It should be noted that these findings used spoken language as their auditory input, and both meaningful and non-meaningful language. Hugdahl, K., et al., (2004) add to these findings in functional magnetic resonating imaging (FMRI) brain studies that in family co-horts with specific language impairments, the control subjects had higher activation levels in the inferior frontal lobe in Broca’s Area (BA 44), an area critical to speech processing and phonological awareness.

**Evaluating verbal memory tasks in SLI**

Evaluating working memory has traditionally been based on the aim on quantifying capacity and rate. Capacity has been tested with digit span of numeric information, or, linguistic chunks of information, specifically single words, phrases, sentences etc. Non-sense words are sometimes used as stimuli in an attempt to separate phonological information from semantic associations. Gray (2003) verifies that using nonword repetition and digit span tasks are acceptably reliable for test-retest diagnostic accuracy in preschoolers with SLI. His aim is to
gain understanding and data regarding the processing components of the auditory channel for linguistic information, without visual/spatial cues or semantic cues.

Free recall is an assessment technique whereby the subject must demonstrate learning a list of words by saying them out loud without prompting. Repeated trials of the same lists provide opportunity for the subject to encode for later retrieval, which demonstrates the action of working memory. Another assessment tool, recognition is an indicator of working memory, however does not tax the subject by expecting retrieval (free recall) and expressive it orally. Thus, recognition is indicative of receptive skills, or comprehension.

A team of researchers have developed a computational model of prefrontal control in free recall, exploring strategic memory use in the California Verbal Learning Task. They theorize that the free recall model relies on controlled memory use that is influenced by self developed frontal control, and accounts for the interaction between the prefrontal control and the temporal lobe memory system (Becker & Lim, 2003).

O’Donnell et al. (1988) found that supraspan (12-15 items) lists of words were sensitive to distinguishing learning rate and capacity for young adults with learning disabilities and brain injury as compared to normal controls. Furthermore, he determined that the more severe the learning disability, the more decline in free recall performance. O’Donnell et al., (1988) explored verbal pairs in encoding and retrieval and discovered that this strategy proved useful in recalling verbal information, or memory skills. This research group looked at individuals with learning disabilities, head injuries and non-disabled, young adults. They theorized that one of the reasons for the differences in encoding and retrieval skills was the difference in the utilization of strategies, such as paired encoding. They consider the role of long term memory as a deficient part of the process of verbal learning in both head-injured and highly learning disabled young adults.
Chapter Three

Methods

Subjects

Two groups of subjects participated in this study (n = 34). All participants attended Cincinnati Public Schools. Group 1 consisted of 17 typically developing children between the ages of nine and thirteen. Group 2 consisted of 17 children with specific learning disabilities in the language domain (SLD/SLI) between the ages of nine and thirteen. All children in Group 2 were classified as specific learning disabled (SLD) according to the State of Ohio guidelines (2002). Every effort was made to match the subjects in the two groups for sex, age, and socio-economic status. The mean age for Group 1 was 11 years and 3 months, and the mean age for Group 2 was 11 years and 4 months. Group 1 had 7 males and 10 females, and Group 2 had 9 males and 8 females. All children in both groups lived in households earning less than $35,000 in annual income. All children were African-American.

It should be noted that in the State of Ohio there is no separate identification category of SLI. Rather, children with SLI are included in the category of SLD. In order to meet the strict criteria for SLI as described in the literature, there should be a difference of at least 15 points between the full scale IQ and the verbal IQ. This became a real challenge in the present study. Specifically, once subject recruitment began, it became clear that the 15 point difference was too stringent and would limit the number of experimental subjects. As a result, it was decided to modify the recruitment criteria to include children with learning disabilities with verbal scores weaker than performance scores and, a full scale IQ within normal limits as defined by the State of Ohio, which is currently 70 on a standardized IQ test. The verbal and performance IQ means for Group 1 was 100 and 96 respectively and the verbal and performance IQ means for Group 2 was 81 and 91 respectively. These scores were obtained by the Wechsler Abbreviated Scale of Intelligence (WASI) as part of the testing battery. Following are the inclusion and exclusion criteria for children in this study. 
**Group 1: Children without specific language impairment**

**Inclusion Criteria**
- Children with no known language impairment, as measured by the Receptive One Word Picture Vocabulary Test (ROWPVT) and the Expressive One Word Picture Vocabulary Test (EOWPVT). To be in the study, children required a standard score of 70 or greater on both measures.
- Children with normal intelligence as measured by the Wechsler Abbreviated Scale of Intelligence (WASI), with a standard score of 70 or greater
- Children attended Cincinnati Public Schools
- Ages 9 – 13 years
- English as a primary language

**Exclusion Criteria**
- Positive history of acquired or pervasive developmental delays/disorder, including autism and spectrum disorders, seizure disorders, history of disease or trauma to the brain, or genetic syndromes associated with neurological disorders
- Positive history of taking psychotropic medications.

**Group 2: Children with specific language impairment**

**Inclusion Criteria**
- Subjects with specific learning disabilities as measured by the following:
- Full scale IQ was equal to or greater than 70 on a standardized IQ test
- Verbal IQ performance is lower than the performance IQ
- Children attended Cincinnati Public Schools
- Ages 9 -13 years
- English as a primary language

**Exclusion Criteria**
- Positive history for attention deficit disorder, or identified psychiatric disorder, or neurological disorder
- Positive history of acquired or pervasive developmental delays/disorder including autism and spectrum disorders, seizure disorders, history of disease
or trauma to the brain, or genetic syndromes associated with neurological disorders

• Positive history of taking psychotropic medications.

Recruitment and Selection of Subjects

The study protocol was approved by the Miami University’s Human Subjects Committee and by the legal department of Cincinnati Public Schools. All of the subjects attended Cincinnati Public Schools. Their participation was strictly on a volunteer basis. Permission to review student records was procured from the parent/guardian prior to selection of subjects. Prior to participation in the study, parent/guardian met with the examiner to review all procedures and signed the Informed Consent form. Each child gave verbal and written assent to participate in the study.

Recruiting for Group 2

In order to recruit subjects for Group 2, the examiner met with classes of learning disabled children of the appropriate ages and explained the study. Children who were interested in participating were given a packet of information for their parents. The packet included a letter from the examiner explaining the benefits of participating in the study. Additionally, a permission slip, called permission to review, was signed by a parent giving access to the examiner to their child’s cumulative record and for the examiner to contact the parents. After permission to review was obtained, potential subjects were selected for the study based upon the test scores cited in their most current multidisciplinary evaluation report as well as consideration of the other inclusion and exclusion criteria. The examiner identified students whose disability was established using a variety of psychological testing instruments, the most common being the Stanford-Binet Intelligence Scale or the Wechsler Intelligence Scale for Children. Other tests with standard scores that specifically measured a full scale IQ with verbal and performance subtests were acceptable for determining eligibility in the study. Subjects in the experimental group (Group 2) required a full scale IQ of 70 or above. Additionally, subjects in the experimental group were required to have lower verbal scores than their performance scores.
Once prospective subjects were identified, the parent/guardian, the child and the examiner held a meeting. At that time, the examiner explained the procedures in detail and responded to questions/concerns pertaining to the study. Following that, the subject and his/her guardian were asked to sign the Informed Consent Form provided that the child continued to want to participate. It was also explained to the child subject and guardian that he/she could withdraw from the study at any point without penalty.

Recruiting for Group 1

Typically developing children met separate criteria. For this study, students who were currently meeting classroom performance standards as reflected in passing rubric scores and not receiving intervention services for a medical, behavioral or truancy concern met the criteria for typically developing. Teacher assigned rubrics are aligned with state promotion standards and are based upon teacher tests and work samples. Teachers must be appropriately certified and/or licensed to be able to assign a teacher-certifiable rubric score.

After Group 2 (children with SLI) was formed, the researcher began recruiting participants for the normative sample (Group 1). The researcher met with classrooms of children who were the same age, grade, and socioeconomic status were told about the study and volunteers stepped forward. These students received a packet of information to take home to their parents explaining the benefits of the study, seeking permission to review cumulative records and to contact them about the study.

Once prospective subjects for Group 1 were identified, the parent/guardian, the child and the examiner set up a meeting. At that time, the examiner explained in detail and responded to any questions/concerns pertaining to the study. Following that, parent/guardian signed the Informed Consent Form provided that the child still wanted to participate. Additionally, the study was explained to the child and each child provided assent to participate. Both subject and guardian were informed that he/she could withdraw from the study at any point without penalty.

Hearing and vision screening

All participants were screened for normal hearing and vision as part of school procedures. The results are part of student cumulative record and were current for the school year. Children with
corrected vision were included in the study. Children with hearing impairment were not included in the study, even if they were fitted with hearing aids.

Research Procedures

Test Measures

The researcher administered the following test measures on the subjects in both groups in a single session. Each test was administered and scored according to procedures outlined in their respective manuals.

*The California Verbal Learning Task, Children’s version (CVLT-C)* (Delis et al., 1994) is a test measuring free recall of a list of items over five trials. Additionally the test provides scores for free and cued recall after a short and a long delay. A recognition score is also obtained, which is less demanding on the subject’s memory than free recall. One helpful clinical aspect of the CVLT-C is the fact that it provides information about the subject’s ability to use semantic relationships as a strategy for learning the list. The list is designed with common words ranging from one to several syllables that fall into three distinct semantic categories. This strategy is measured during the administration of the test by means of semantic clusters.

*The Wechsler Abbreviated Scale of Intelligence (WASI)* (Wechsler, 1999) is a screening intelligence test using four subtests that yield a verbal score, performance score as well as full scale IQ. This was administered to both groups, serving the purpose of providing a current IQ measurement that would be consistent among all participants.

*The Receptive One Word Picture Vocabulary Test-Revised (ROWPVT)* (Gardner, 2000) measures receptive vocabulary, requiring the subject to hear an item and then point to the appropriate choice from among a field of four pictures.
The Expressive One Word Picture Vocabulary Test (EOWPVT) (Gardner, 2000) measures expressive vocabulary requiring the subject to view a stimulus picture and then provide orally the correct name/label for the picture.

*The experimental task:* The experimental task developed by Constantinidou (1995) was administered to all participants as follows: each child was presented with 1 supralist of 12 words at a rate of 1 word per second. All words are one syllable nouns which are easily depicted in a black and white line art drawing. A list of 12 words was presented in a different stimulus condition, (a.) auditory only, i.e., spoken word, (b.) visual only, picture, or (c.) auditory plus visual, or the picture and the spoken word presented simultaneously, for a total of three different test lists. Each list condition (modality) was presented to the child over 7 trials. The participant/child used free recall to tell the examiner all of the words he/she could remember after every trial. The first five trials was the assigned experimental task list. The sixth trial was the interference list. (Participants used free recall on list B). The seventh trial was free recall after 30 minutes delay after the interference trial. During the time delay of 30 minutes, the participant completed a different study task with the examiner. The order of stimulus modality presentation was counterbalanced among subjects in order to avoid order effects. (Appendix D.)

**Data Gathering Instruments**

All of the above tasks were paper and pencil tasks. Therefore, data was gathered on the respective test forms. Due to the nature of some of the tasks, and in order to ensure correct scoring, subject responses were audiotaped. The tape was assigned the subject number and was erased immediately after scoring. All of the testing and data scoring was under the supervision of Dr. Fofi Constantinidou. All subjects were tested by Marijo F. O’Connell, B.S., a speech language pathologist licensed by the State of Ohio Board of Speech-Language Pathology and Audiology, employed by Cincinnati Public Schools with a professional teaching license from the Ohio Department of Education, and currently a speech pathology graduate student at Miami University.
Other Test Session Considerations

Each subject participated in one testing session lasting approximately 1 ½ hours for the experimental tasks plus 1 ½ hours for the CVLT-C, WASI, ROWPVT and EOWPVT. All subjects were provided two ten-minute breaks during the session. Testing took place in a quiet setting (e.g. therapy room in the school building, or another designated location in the school building). Measures were taken in order to safeguard the testing environment and avoid disruptions.

Confidentiality Provisions

All of the subjects were assigned a code, so that the testing data was not connected to an individual subject’s name. Additionally, the audiotapes were erased as soon as the data scoring was completed. The data was stored until the completion of the data analyses and then were shredded.

Experimental Design:
This study is a multi-variate mixed model design, with between groups and within groups analysis. The experimental design is shown in Appendix C. An alpha level was set at .05.
CHAPTER FOUR

Results

The present study compares verbal learning performance between children with specific language impairment to typically developing children on a variety of learning and memory tasks. Table 1 provides group means, standard deviations and range of scores for IQ and vocabulary tests used to describe the groups.

Table 1: IQ and vocabulary means, standard deviations and range of scores for Group 1 and Group 2.

<table>
<thead>
<tr>
<th></th>
<th>IQ full 4 WASI</th>
<th>IQ full 2 WASI</th>
<th>IQ Verbal WASI</th>
<th>IQ Performance WASI</th>
<th>ROWPVT</th>
<th>EOWPVT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical</td>
<td>M 97.70</td>
<td>99.65</td>
<td>100.12</td>
<td>95.70</td>
<td>96.82</td>
<td>94.29</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD 6.11</td>
<td>6.92</td>
<td>6.89</td>
<td>7.67</td>
<td>11.16</td>
<td>9.44</td>
</tr>
<tr>
<td></td>
<td>Range 86-109</td>
<td>88-118</td>
<td>86-108</td>
<td>77-112</td>
<td>80-117</td>
<td>81-110</td>
</tr>
<tr>
<td>SLD/SLI</td>
<td>M 84.94</td>
<td>88.12</td>
<td>80.76</td>
<td>91.35</td>
<td>79.71</td>
<td>77.47</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD 8.27</td>
<td>8.42</td>
<td>6.51</td>
<td>10.85</td>
<td>4.87</td>
<td>5.54</td>
</tr>
<tr>
<td></td>
<td>Range 69-100</td>
<td>76-102</td>
<td>70-91</td>
<td>74-118</td>
<td>72-87</td>
<td>67-87</td>
</tr>
</tbody>
</table>

This results section will first report results on the CVLT-C and then report results on the experimental tasks.
CVLT Performance

Research Question 1: Is there a significant difference between SLD/SLI children and typically developing children in memory performance as measured by formal verbal learning tests like the CVLT-C?

Table 2 displays the group results for each of the learning trials of the CVLT-C.

Table 2. CVLT-C means and standard deviations by trials for Group 1 and Group 2.

<table>
<thead>
<tr>
<th>CVLT-C Trials</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total (1-5)</th>
<th>6 (List B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical</td>
<td>M</td>
<td>5.82</td>
<td>8.76</td>
<td>10.00</td>
<td>11.24</td>
<td>11.82</td>
<td>47.64</td>
</tr>
<tr>
<td>n = 17</td>
<td>SD</td>
<td>2.10</td>
<td>1.68</td>
<td>1.37</td>
<td>1.64</td>
<td>1.38</td>
<td>8.17</td>
</tr>
<tr>
<td>SLD/SLI</td>
<td>M</td>
<td>5.47</td>
<td>7.65</td>
<td>9.65</td>
<td>10.12</td>
<td>10.35</td>
<td>43.24</td>
</tr>
<tr>
<td>n = 17</td>
<td>SD</td>
<td>2.21</td>
<td>3.10</td>
<td>2.37</td>
<td>2.37</td>
<td>2.76</td>
<td>12.81</td>
</tr>
</tbody>
</table>

The multivariate analysis of variance (a = .05) compared the 2 groups of children on the CVLT-C performance across the 5 learning trials. The results indicate a significant trials effect for both groups. This indicates that subjects benefited from the five learning trials and learned significantly more words across time, \( F(4,29) = 81.33 \) and \( p = .0001 \). There was no significant difference between SLD/SLI children and typically developing children in the total number of words learned where \( F(1, 32) = 2.162 \) and \( p = .151 \), or on the rate of learning across the 5 learning trials where \( F(4, 29) = 1.244 \) and \( p = .314 \). Figure 1 is the graphic plot of the 5 trials for each group.
Research Question 2: Is there a significant difference between SLD/SLI children and typically developing children in their ability to freely recall verbal information after a short and long delay as measured by the CVLT-C?

In order to determine the decline in performance as a result of short (Trial 6) and long delay (Trial 7) the difference scores were obtained by subtracting the short delay score from the Trial 5 score and the long delay score from the Trial 5 score. Table 3 displays the delay scores per group.
Table 3. CVLT-C means and standard deviations after short and long delays for Group 1 and Group 2.

<table>
<thead>
<tr>
<th></th>
<th>Short-delay</th>
<th>Long-delay</th>
<th>Derived short-delay</th>
<th>Derived long-delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical</td>
<td>M</td>
<td>10.06</td>
<td>9.82</td>
<td>-1.76</td>
</tr>
<tr>
<td>n = 17</td>
<td>SD</td>
<td>1.63</td>
<td>1.81</td>
<td>1.09</td>
</tr>
<tr>
<td>SLD/SLI</td>
<td>M</td>
<td>9.53</td>
<td>9.12</td>
<td>-0.82</td>
</tr>
<tr>
<td>n = 17</td>
<td>SD</td>
<td>1.74</td>
<td>1.96</td>
<td>2.86</td>
</tr>
</tbody>
</table>

While the difference scores of the typical group were somewhat smaller, the MANOVA did not result in significant differences between groups, where F (1, 32) = 1.389 and p = .247.

The experimental tasks—overall learning performance

Research question 3: Is there a significant difference in verbal learning performance in SLD/SLI children and typically developing children when the presentation modality is auditory, visual, or auditory plus visual as measured by the experimental verbal learning tasks?

Table 4 presents the group means and standard deviations for modalities for all trials and is below.
Table 4. Experimental tasks means and standard deviations by trial and modality for Group 1 and Group 2.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total (1-5)</th>
<th>6 (List B)</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auditory Trials</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>M</td>
<td>4.47</td>
<td>6.18</td>
<td>7.71</td>
<td>8.35</td>
<td>8.94</td>
<td>35.65</td>
<td>3.76</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD</td>
<td>1.18</td>
<td>1.29</td>
<td>1.99</td>
<td>1.22</td>
<td>1.56</td>
<td>7.24</td>
<td>1.03</td>
</tr>
<tr>
<td>SLD/SLI</td>
<td>M</td>
<td>3.94</td>
<td>5.82</td>
<td>6.29</td>
<td>7.00</td>
<td>7.29</td>
<td>30.34</td>
<td>3.82</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD</td>
<td>1.48</td>
<td>1.94</td>
<td>1.96</td>
<td>1.58</td>
<td>2.05</td>
<td>9.01</td>
<td>2.13</td>
</tr>
<tr>
<td><strong>Visual Trials</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>M</td>
<td>6.06</td>
<td>7.76</td>
<td>8.35</td>
<td>9.82</td>
<td>10.41</td>
<td>42.40</td>
<td>4.12</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD</td>
<td>1.48</td>
<td>1.20</td>
<td>1.00</td>
<td>1.24</td>
<td>0.87</td>
<td>5.79</td>
<td>1.45</td>
</tr>
<tr>
<td>SLD/SLI</td>
<td>M</td>
<td>5.41</td>
<td>7.41</td>
<td>8.06</td>
<td>9.06</td>
<td>9.29</td>
<td>39.23</td>
<td>4.06</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD</td>
<td>2.09</td>
<td>2.74</td>
<td>1.81</td>
<td>2.28</td>
<td>2.02</td>
<td>10.94</td>
<td>1.78</td>
</tr>
<tr>
<td><strong>Auditory + Visual Trials</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>M</td>
<td>5.35</td>
<td>7.88</td>
<td>9.18</td>
<td>9.53</td>
<td>10.11</td>
<td>42.05</td>
<td>4.41</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD</td>
<td>1.54</td>
<td>1.17</td>
<td>1.54</td>
<td>1.18</td>
<td>1.17</td>
<td>6.60</td>
<td>1.28</td>
</tr>
<tr>
<td>SLD/SLI</td>
<td>M</td>
<td>6.00</td>
<td>7.94</td>
<td>8.88</td>
<td>9.24</td>
<td>9.82</td>
<td>41.88</td>
<td>4.53</td>
</tr>
<tr>
<td></td>
<td>n = 17 SD</td>
<td>1.46</td>
<td>1.56</td>
<td>1.73</td>
<td>1.71</td>
<td>1.42</td>
<td>7.88</td>
<td>1.42</td>
</tr>
</tbody>
</table>
A significant trials effect was demonstrated by both groups on the experimental tasks, where $F(4, 29) = 111.036$ and $p = .0001$ indicating improved performance with repeated presentations. However, there was no significant difference between typical children and SLI children in total number of words learned, where $F(1, 32) = 2.792$ and $p = .104$.

Research question 4: Is there a significant difference in the rate of learning between SLD/SLI children and typically developing children when the presentation modality is auditory, visual, or auditory plus visual during verbal learning tasks?

On the experimental task Trials 1-5, typically developing children demonstrated a significantly faster rate of learning than SLD/SLI children, as demonstrated by the interaction effect, where $F(4,128) = 2.565$ and $p = .041$.

Figure 2 is a graphic display of the group by trials interaction effect.

\[
\text{Figure 2.}
\]

Trials by Group Effects on Experimental Tasks
Modality effects

The MANOVA resulted in an overall significant modality effect, where $F(2,31) = 29.311$ and $p = .0001$. Pairwise Helmert contrasts followed significant multivariate results. There was a significant difference between the visual and simultaneous auditory and visual presentation as compared to the auditory presentation alone, where $F(1,32) = 60.196$ and $p = .0001$. However, there was no significant difference between the visual and simultaneous auditory and visual modalities, where $F(1,32) = 1.229$ and $p = .276$. This is graphically presented in Figure 3 and Figure 4.

Figure 3.
Interference effects

Research question 5: Is there a significant difference between SLD/SLI children and typically developing children in the amount of retroactive interference when stimulus modality is auditory, visual, or, auditory plus visual?

In order to determine the effects of retroactive interference (RI) the difference scores were obtained from the last learning trial (Trial 5) and the Trial 6 score (recall of List A after
presentation and recall of List B). Group means of derived interference effects are listed in Table 5.

Table 5. Experimental tasks interference means and standard deviations by modality for Group 1 and Group 2.

<table>
<thead>
<tr>
<th></th>
<th>Derived Auditory Interference</th>
<th>Derived Visual Interference</th>
<th>Derived Auditory + Visual Interference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical</strong></td>
<td>M</td>
<td>-.71</td>
<td>-.71</td>
</tr>
<tr>
<td>n = 17</td>
<td>SD</td>
<td>1.26</td>
<td>1.26</td>
</tr>
<tr>
<td><strong>SLD/SLI</strong></td>
<td>M</td>
<td>-.53</td>
<td>-.53</td>
</tr>
<tr>
<td>n = 17</td>
<td>SD</td>
<td>1.84</td>
<td>1.84</td>
</tr>
</tbody>
</table>

The MANOVA compared the 2 groups on the degree of RI across modalities. There was no significant difference between the 2 groups, where $F (1,32) = .002$ and $p = .964$. 
CHAPTER FIVE
Discussion

Implications

The purpose of this study was to investigate verbal learning abilities in children with SLD/SLI. The present results indicate that children with SLD/SLI are able to learn new information with repeated presentations. However, their rate of learning is much slower across the 5 learning trials than that of typical children. This information could be helpful when trying to meet the educational needs of children with SLI/SLD. The present finding supports Thompson’s 1993 theory that verbal learning increases with more practice and that children with SLI demonstrate a slower rate of learning (Miller et al., 2001; Schul et al., 2004).

In the present study, while children with SLI/SLD demonstrate a slower rate of learning, the total number of words learned was not significantly different between groups for either the CVLT-C or the experimental tasks. One possible explanation for this lack of difference may be the repetitive nature of the tasks. The multitrial paradigm may provide enough support for children with SLI/SLD and facilitated their working memory performance. These results support the notion that rehearsal and visualization strategies can be a helpful tool to foster learning (Gill et al., 2003).

While children with SLI/SLD learned words at a slower rate during the experimental tasks, their rate of learning was not slower than that of typically developing children on the CVLT. This discrepancy could be attributed to differences in the nature of the tasks. The CVLT-C list is designed so that the entire 15 words on the list fit clearly into one of three semantic categories, whereby, the experimental task is not designed around three semantic categories. During the experimental task, a subject can formulate paired associates to facilitate learning the lists, however, these associations could range beyond three categories (as on the CVLT-C) and would not be obviously apparent to the subject. The fact that SLD/SLI children learned at the same rate and learned as much as typically developing children on the CVLT-C task indicates that they effectively used the semantic categories as a working memory strategy to learn and later recall the verbal information, in addition to the benefits of repeated trials. Therefore, the CVLT-C inherently provides more support for verbal learning than the experimental task.
One of the primary objectives of the present study was to investigate stimulus modality preferences in children with SLI/SLD as compared to typically developing children. The visual stimulus presentation modality enabled both groups of children to learn the lists of words faster than the auditory modality for concrete single syllable words. The present study supports the hypothesis that pictorial information can be incorporated during verbal memory tasks to enhance verbal learning attainment in school-age children.

In the present study, the auditory plus visual modality did not result in significantly better performance compared to the visual condition alone. It is possible that the presentation of pictures was adequate for dual coding or semantic processing. In other words, the semantic processing elicited by the pictures enhanced the subject's learning to the extent that hearing the name of the picture did not add anything more. These findings are consistent with previous studies that demonstrate pictorial superiority in verbal learning tasks in patients with brain injuries and also normal older adults who demonstrate decline in working memory abilities (Constantinidou et al, 1996; Constantinidou & Baker, 2002).

**Limitations**

The limited number of subjects in this study, (n=34) may have adversely affected the overall results, particularly finding significant differences between groups as far as rate of learning on the CVLT-C. It is apparent that when looking at the plotted means that the data trend would indicate that there are differences between groups and a larger subject pool may have been necessary to demonstrate this.

Another limitation of the study was inclusion/exclusion criteria for the subjects in the experimental group. As noted in the methods section, the original criteria of finding subjects with full scale IQ of 85 or better and verbal subtests 15 points lower proved to be too stringent for both the full scale IQ score and the difference spread. Meeting the strict SLI criteria for this study was based on an independent, multi-factored evaluation. The reports for the volunteers who stepped forward were of various degrees of completeness, and used a variety of versions of a variety of standardized IQ tests. Additionally, in order to meet placement criteria for special educational services school psychologists consider confidence levels and often provide a range of numbers. This was not clear until the researcher had access to the students’ cumulative
records. This might have been anticipated since language delay is already known to be multi-determined and was the point of Guendouzi, (2003) and Conti-Ramsden et al. (1999).

Consequently, the SLD/SLI experimental group was composed of three types of children all of whom have language delays, but have varying co-present performance deficits and/or cognitive deficits. The first subgroup (sn=3) consists of children meeting the strict criteria of SLI with performance subtests scores of 85 or better and language subtests scores at least 15 points lower than performance scores. The second subgroup (sn=7) has both performance and verbal subtests scores between 70 and 85 and a fifteen point spread between scores. The third subgroup (sn=7) have minor differences between verbal and performance subtest scores, (not the full 15 point discrepancy) and ROWPVT and EOWPVT scores less than 85.

This is consistent with issues surrounding the subject of identifying children with disabilities, particularly minority children from low-income households. All children in the study were African-American and all were from households of less than $35,000 annual income. It is well documented that children with these characteristics lag behind more affluent peers. Standardized IQ test manuals generally describe a cultural bias in these tests, with African-American children typically scoring one standard deviation below the mean on established norms. The point is that classifying non-affluent, African-American children as SLD, or SLI, or cognitive disorder (CD) is fraught with a myriad of complications (which are not the subject of this paper), and could have affected the ability of the researcher to assemble an experimental group with clear and distinct deficits that were significantly manifested in the area of language alone.

Nonetheless, the children in the experimental group who were selected from the total pool of possibilities had significant deficits in verbal skills as compared to the typically developing children. When looking at group means for full scale IQ and verbal subtests, it is clear that the two groups differ in their overall abilities as shown in Table 1 of Results.

*Future research*

This study would benefit from more subjects overall, and, it would make sense to explore modality preference differences between the subgroups as discussed above. This would help to examine the role of IQ performance skills as an independent variable in verbal learning.
Future studies could modify the experimental tasks by developing lists that can be analyzed for semantic clusters or categories. This would provide information about the effects of modality preferences, semantic clustering, and possible interactions between these two variables in respect to working memory.

Future studies should also include a more ethnically diverse subject pool. While all of the stimuli implemented in this project are common nouns, future studies need to ensure that all stimuli are ethnically appropriate.

Another direction for future studies is to explore modality preference with more grammatically complicated verbal stimuli. This study used one-syllable, concrete, common nouns on the experimental task. Additionally, the subjects were not learning the meaning of the words, as it was presumed that they already knew the meaning of the words. Since children with SLI have demonstrated weaknesses in acquiring and/or mastery of complex grammatical structures, it seems logical to investigate if stimulus modality effects interact with more complex verbal information in the same way. For example, does the auditory component dominate working memory effectiveness once the verbal stimulus becomes less concrete by the influx of function words and grammatical morphemes? Perhaps it is at this level of language sophistication that the child must rely solely on the weaker auditory channel for those phonologic tidbits of verbal information. How does one form a mental picture of and, to, of, ed, etc.? It is worthy of study to determine if there is a more severe breakdown in any modality between SLD/SLI children and typically developing children using more complex language.

Further research is indicated regarding the educational challenge of developing appropriate educational strategies for SLD/SLI children. The first is that repeated exposure to the verbal information will increase learning. The second is that a visual component to verbal stimuli increases the ability of working memory to encode for later retrieval. The third is that SLD/SLI children demonstrate an ability to utilize semantic categories as a strategy for enhancing working memory. All of these areas can be incorporated into the development of educational techniques and educational materials. Additionally, while development of semantic units of study is not a new technique, this study lends credence to the importance of refining this technique to a data-driven educational practice. Considering that the SLD/SLI group effectively used semantic clusters to facilitate their free recall, this strategy may be an especially important key to learning across the curriculum, or accessing the curriculum for special needs children.
References


Research: JSLHR, 47, 145-61.


Guendouzi, J., (2003). ‘SLI’, a generic category of language impairment that emerges
from specific differences: a case study of two individual linguistic profiles. 
*Clinical linguistics and phonetics*, 17, 135-52.


delay. *Journal of Speech and Hearing Research, 33*, 70-83.


The Psychological Corporation.


Appendix A:

Experimental task stimuli: List A

Order 1:
1. book
2. door
3. boat
4. ear
5. bed
6. car
7. rock
8. sun
9. neck
10. head
11. ring
12. dog

Order 2:
13. house
14. coat
15. feet
16. watch
17. egg
18. bear
19. ball
20. hand
21. tree
22. girl
23. mouth
24. glass

Order 3:
25. saw
26. face
27. heart
28. fly
29. roof
30. cup
31. fish
32. bird
33. shoe
34. chair
35. hair
36. tie
Appendix B: Permission to Review

Parents: Please sign and return to the front office at school. Mrs. O’Connell will call you soon with more information. Please call 631-5698 if you have any questions. Thanks.

Permission to Review Records
For Learning Profile/Memory Study ONLY

I give Marijo F. O’Connell permission to read my child’s Educational Record. This record review will determine if my child qualifies for this study and the learning profile.

No child will be tested without informed written consent by parent. All information is confidential.

Mrs. O’Connell will call me on the telephone to explain and answer my questions. I can choose at that time if I want my child to continue to participate in the study and receive the professional learning profile.

We will make an appointment to do the learning/memory tests. I know that testing permission will be required at that time. I am volunteering my child to participate in this project and my child has the right to not participate.

Name of Child: __________________________________________

Name of Parent: (PRINT)__________________________________

Parent Signature: ________________________________________

Parent Phone numbers: List 2 if possible: _____________________  ___________________

A yellow return envelope is enclosed. Thank you very much.
Appendix C

Experimental Design

<table>
<thead>
<tr>
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<th>WASI Full scale IQ</th>
<th>ROWPVT</th>
<th>EOWPVT</th>
<th>CVLT-C Trials 1-5 Short Delay Long Delay</th>
<th>Experimental Tasks 3 modalities Trials 1-5 Post interference</th>
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<td>✓</td>
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<tr>
<td>Group 2 (typical children)</td>
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### Appendix D: Experimental Tasks – Order of Conditions

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<th>A (Auditory)</th>
<th>B (Visual)</th>
<th>C (Auditory + Visual)</th>
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<tbody>
<tr>
<td>B</td>
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<tr>
<td>C</td>
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