Nonword Repetition in Children with Language Impairment: An Exploratory Study

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DEDICATED TO……

…….MY DEAREST AMMA, APPA…….

……..MY SOURCE OF INSPIRATION IN MY LIFE, MY LOVING SIS SHALINI, who has always been with me……..

……..To my dearest BROTHER and BROTHER-IN-LAW…….

……..who have been close to my heart always…..

CERTIFICATE

This is to certify that this dissertation entitled **"Nonword Repetition in Children with Language Impairment: An Exploratory Study"** is a bonafide work submitted in part fulfilment for the degree of Master of Science (Speech Language Pathology) of the student Registration No. 08SLP030. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any Diploma or Degree.

Mysore

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CERTIFICATE

This is to certify that this dissertation entitled **"Nonword Repetition in Children with Language Impairment: An Exploratory Study"** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other university for the award of any Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Nonword Repetition in Children with Language Impairment: An Exploratory Study"** is the result of my own study under the guidance of Dr. Swapna. N, Lecturer in Speech Pathology, Department of Speech - Language Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other university for the award of any Diploma or Degree.

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Table of contents

List of Tables

List of Figures

Chapter I

Introduction

Over the years researchers and practitioners have identified children as language impaired if they demonstrated language skills that were far below those expected for their age. There are children who show significant language limitation in the absence of mental retardation, sensory deficits, frank neurological damage and serious emotional problems. This condition is widely known as Specific Language Impairment (SLI, Leonard, 1998) in which the acquisition of language in children is neither rapid nor effortless as is generally seen in typically developing children. This observation has aroused interest among researchers and practitioners who consider the condition of SLI as a challenge.

Children with SLI are significantly delayed in acquiring multiple aspects of language. Deficits including grammatical morphology, phonology, syntax, lexicon and pragmatic skills are observed in children with SLI (Joanisse & Seidenberg, 2003). Children with SLI exhibit other types of deficits also that extend beyond language including problem with working memory (Johnston & Weismer, 1983) and speech perception (Tallal & Piercy, 1974). They also exhibit limitations in central cognitive domains such as memory, attention, and executive functions; other cognitive functions such as problem solving, mental rotation, and mathematics; and in other neurological structure and function. They also have a relatively high incidence of dyslexia and other more global reading and writing disabilities. The nature of these limitations and their relation to SLI remain controversial.

There is a general debate among researchers on the underlying cause for language impairment in children with SLI. A few of the researchers claim that language impairment in children with SLI arises as a result of deficits in linguistic knowledge (Rice, Wexler & Cleave, 1995; Rice & Wexler, 1996; van der Lely & Stollwerck, 1997; van der Lely, 1998,

2005), typically attributed to delay in maturation or a deficient representation of language, while others explain SLI in terms of domain-general (with respect to language) or domain-specific cognitive-linguistic processes. These domain-specific cognitive-linguistic processing includes deficits in their general auditory perception, speech perception, working memory-phonological working memory, processing speed etc. (e.g., Tallal & Piercy, 1974; Gathercole & Baddeley, 1990; Leonard, 1989, 1998; Dollaghan & Campbell, 1998; Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000).

The researchers, who implicated a deficit in processing abilities, found that the children with SLI do not employ active processing strategies that use contextual information and stored knowledge. One of the language specific cognitive processing areas that have received much attention in the past is the Phonological Working Memory (PWM) (Dollaghan & Campbell, 1998; Marton & Schwartz, 2003; Gathercole, 2006). According to them a deficit in PWM means a decreased capacity to store phonological information which affects both the acquisition of new words (which demand the retention of new phonological sequences) and broader levels of language processing such as sentence comprehension that require the manipulation of phonological information (Briscoe, Bishop, & Norbury, 2001).

In the recent past, investigations regarding the assessment procedures of SLI have gained momentum and a better understanding of the symptom complex and the underlying perceptual base has been attempted. Specifically, the phonological working memory has been studied by a number of researchers using different methods and stimuli. One such diagnostic tool that has been recently researched upon is the use of nonword repetition as a clinical marker in children with SLI.

Nonword repetition task involves strings of letters or alphabets that are devoid of lexicality effects and that are not predictable as a word. This test requires the child to listen to

a nonword, temporarily store the novel phonological representation, and then produce it. Since repetition of nonwords calls for perception, storage and retrieval of its phonological constituents in a sequence, it is proposed as a potential task to identify the deficits related to phonological working memory in children with SLI (e.g., Bishop, North & Donlan 1996; Dollaghan & Campbell 1998; Botting & Conti-Ramsden 2001).

The nonword repetition (NWR) test has been found useful as a screening test since this involves shorter time for administration than the other measures (Gathercole & Baddeley, 1996). Campbell, Dollaghan, Needleman, & Janosky (1997) reported that norm-referenced tests are inherently biased against test-takers from minority backgrounds as these tests depend so heavily on experiential history and vocabulary knowledge, but the processing dependent measure like nonword repetition, which is of equal in familiarity to all test-takers regardless of their language knowledge, are less biased and offer a better way to distinguish between children whose poor performance reflects fundamental language processing deficits.

NWR has been extensively studied in English speaking children with SLI to assess their PWM. A number of investigations have documented that the children with language impairment are less proficient at nonword repetition than normal language peers there by indicating that they have an apparent deficit in their phonological working memory (PWM) (e.g., Bishop, North, & Donlan, 1996; Dollaghan & Campbell, 1998; Marton & Schwartz, 2003; Gathercole, 2006). An association has been found between nonword repetition and language skills in school-age children with both typical and atypical language development (Gathercole & Baddeley, 1990; Dollaghan & Campbell, 1998; Wiesmer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000; Montgomery, 2002). A number of studies on groups of typically developing children ranging from 3 to 5 years of age have revealed correlations between nonword repetition and children's receptive and

expressive vocabulary size. Associations have also been found between nonword repetition and indices of speech output including repertoire of vocabulary, utterance length, and grammatical complexity (Gathercole & Baddeley, 1989; Adams & Gathercole, 1995, 2000). Although there are no direct data yet, it has been argued that phonological working memory may also play an important role in children's grammatical and morphological learning (Nelson, 1987; Plunkett & Marchman, 1993).

Studies pertaining to NWR task have been also attempted in languages other than English too, such as Spanish, Cantonese, Dutch and Swedish. Sahlen, Wagner, Nettelbladt, and Radeborg (1999) explored the relationship between non-word repetition and different aspects of language comprehension (in 27 children with language impairment(LI) of Swedish. The results revealed that non-word repetition significantly correlated with all measures of language comprehension in the children with LI. They concluded that nonword repetition incorporates a range of processes necessary for language comprehension and production, and thus mirrors the general language status of the child.

Girbau and Schwartz (2008) found that phonological working memory abilities, as measured by nonword repetition, strongly correlated with comprehension and production skills in their native Spanish language. They concluded that the nonword repetition task following the phonotactic patterns of Spanish appears to be an accurate identifier of SLI and it has the potential to be an efficient screening test for SLI.

Stokes, Wong, Fletcher, and Leonard (2006), examined fourteen Cantonese-speaking children with SLI and 30 of their typically developing age matched (TDAM) and typically developing younger peers (TDY) were compared on nonword repetition task (NWR) and sentence repetition (SR) tasks. The results indicated that there was no limitation in phonological working memory in Cantonese-speaking children with SLI..

They attributed the poorer NWR for English-speaking children with SLI to the weaker use of redintegration strategy in word repetition. Thereby further cross-linguistic investigations of processing strategies are required.

de Bree, Rispens, and Gerrits (2007) investigated a group of Dutch preschool children with SLI and children at familial risk of dyslexia, as well as school-going groups of children with LI and dyslexic children on a nonword repetition task. The results showed that the children with SLI and the (at-risk of) dyslexia groups performed more poorly than the control children. Furthermore, with the exception of one child, all preschool children with SLI scored significantly below the mean of the preschool control group, suggesting that nonword repetition performance is a marker of SLI. The results showed that a non-word repetition deficit is attested early in life and underlies both dyslexia and SLI.

In the Indian context very limited number of studies has attempted to investigate the nonword repetition performance in children with SLI. One such study by Prema, Prasitha, Savitha, Purushotham, Chitra, & Balaji, (2010) was conducted in a subject with SLI who was a native speaker of Kannada, a South-Indian Dravidian language. They examined the performance of the subject with SLI on NWR task with the objective of checking the feasibility of using this task as a clinical marker for identification of children with SLI. The study was conducted by employing a comparative design using matched pair of subjects. The 14 year old male child diagnosed as SLI matched with a typically developing child on age, gender, language, socio-economic status and grade were selected for the study. The subject was administered with 15 nonwords of 3-syllable length each. They found that the subject with SLI had poor nonword repetition accuracy and hence, they suggested the possibility of inclusion of NWR task in the assessment battery of children with SLI who are native speakers of Kannada, provided further research with large sample size is undertaken to corroborate the results.

Need for the study

A look into the review of literature suggests that NWR has been studied extensively in English speaking children with SLI. Moreover, some research has also been carried out in other languages such as Swedish, Spanish, Dutch and Cantonese. The results of some of these studies are contradictory especially the study carried out in Cantonese SLI population (Stokes, Wong, Fletcher, & Leonard, 2006). Through this investigation it was found that although NWR is a sensitive test in Cantonese, with older children scoring higher than the younger children, there is no significant difference in performance between children with SLI and their age-matched typically developing (TDAM) peers. This calls for the question whether NWR is language dependent or processing dependent in English. The results of the study done in Cantonese suggested that NWR tests may depend on short-term memory and language abilities to varying degrees across the preschool period. The processing tasks are not independent of the language performance at 3 years of age but may be dependent by age 5. This study further attributed the poor NWR by children with SLI to the differences in prosodic properties, phonotactic structure and the phonetic inventory of the language. Thus, the performance on NWR tasks could depend on the linguistic and the paralinguistic aspects of the language.

Since the linguistic and paralinguistic aspects of the languages have an influence on the PWM, it is essential that such results be replicated in other languages to examine the same. Moreover in the Indian context, such studies are limited. Hence there is need to examine the effects of NWR in Kannada, a Dravidian language, on children with language impairment and thus the feasibility of using the same as a clinical marker in diagnosing children with language impairment.

Aims of the study

1. To examine the performance of Kannada speaking children with and without language impairment on nonword repetition task.
2. To determine the relationship between the nonword repetition accuracy and receptive vocabulary in Kannada speaking children with and without language impairment.

Chapter II

Review of Literature

The acquisition of language is, among the developmental milestones in an infant's life, that which perhaps receives the most attention in both parental regard and academic achievement endeavor. Although for the majority of children language development presents as a rapid, seemingly effortless task, some children fail to develop language normally despite there being no evidence of general intellectual impairment or physical, social or emotional problems. Such children are often classified as having specific language impairment (SLI).

Specific language impairment (SLI) is defined using exclusionary criteria, that is, a deficit in language in the absence of a number of other diagnostic features such as hearing loss, autism and cerebral palsy (Leonard, 1998). SLI is a condition in which the acquisition of language in children is neither rapid nor effortless as is generally seen in typically developing children. This observation has aroused interest among researchers and practitioners who consider the condition of SLI as a challenge.

Linguistic and non-linguistic abilities in children with SLI

Children with SLI are slower than their typically developing peers on many linguistic and non-linguistic tasks (Johnston & Weismer, 1983; Edwards & Lahey, 1996; Lahey & Edwards, 1996; Miller, Kail, Leonard, & Tomblin, 2001). Leonard (1998) pointed out that children with SLI have difficulty in both comprehension and production of language, and specified that these children acquire linguistic competence in delayed manner compared to peers. They may also exhibit an asynchronous pattern of language development, for e.g., the pragmatic language skills may be more advanced than syntactic and morphological skills. In addition to these language deficits, they also

have serious limitations in general auditory and speech perception, central cognitive domains such as memory, attention and execution function; deficits in other cognitive functions such as problem solving, mental rotation, mathematics and deviations in neurological structure and function (Schwartz, 2009). Thus children with SLI are a heterogeneous group, exhibiting different combination of deficiencies in various linguistic and non-linguistic aspects.

I. Linguistic ability in children with SLI

a. Comprehension:

Late talkers who exhibit receptive delays are more often diagnosed as having SLI than are late talkers who often seem to have normal receptive vocabulary development (Thal, Miller, Carlson, & Vega, 2005). Preschool children with SLI exhibit delays in receptive vocabulary (e.g., Clarke & Leonard, 1996) and sentence comprehension (Bishop & Edmundson, 1986). These children may also persist in overextending and underextending word meanings beyond the age of 3 years (Nelson, 1993). They have difficulty in understanding or producing abstract concepts such as metaphors, similes, idioms, and proverbs. Further, they may not understand or produce words expressing such concepts as size, shape color, quantity, and quality as readily as do typically developing children.

b. Morphological skills

In English, children with SLI have particular difficulty with verb morphology, functional morphemes that mark finiteness (i.e., tense, agreement), often producing bare stem verbs without third person singular or past tense endings. These deficits are part of a more general pattern of morphosyntactic deficits in English during the preschool years, with deficits in finite verb morphology becoming more pronounced

when the MLU reaches 3.50 and continuing to be prominent up to 8 years of age. They have difficulty in verb morphology, where they omit the past tense -ed (Rice, Wexler, & Cleave, 1995; van der Lely & Ullman, 2001), third-person singular -s (Leonard, Deevy, Miller, Charest, Kurtz, & Rauf, 2003), and the verb be (Leonard et al., 2003). Leonard (1998) suggested that children with SLI have difficulty with noun related morphology and verb related morphosyntax, grammatical functions and inflections.

c. Lexical ability

The children with SLI are delayed in the acquisition of first words (Clarke & Leonard, 1996); exhibit limited vocabularies, appear to have incomplete or underspecified phonological representations of words, have limited elaboration of the semantic underlying word, and atypical organization or access to their mental lexicon. The general course and speed of lexical development is delayed in them. Children with SLI are reported to have less lexical diversity than the age-matched peers, but may be similar to MLU-matched peers (Klee, 1992; Harber & Hollis, 1995; Leonard, Miller, & Gerber, 1999; Watkins, Kelly, Goffman, & Leonard, 2000). On fast mapping studies to examine early lexical abilities (Dollaghan, 1987; Rice, Buhr, & Nemeth, 1990; Rice, Buhr, & Oetting, 1992; Rice, Oetting, Marquis, & Bode, 1994), children with SLI acquired a novel object word in comprehension but not in expression with a single presentation; and they did more poorly than their peers even with five presentations embedded in a video story.

d. Phonological skills

Children with SLI exhibiting difficulty in morphosyntax and lexical skills during preschool years, almost invariably show weakness in phonology as well. A significant number of children with SLI have phonological impairments in production, perception,

and phonological awareness. According to the study by Shriberg, Tomblin, and McSweeny (1999), 11-15% of 6-year old children with speech delay had SLI and 5-8% of children with SLI had speech delay (Shriberg, Tomblin, & McSweeny, 1999).

There is substantial evidence that deficits in the production of morphosyntax and function words may be attributed to phonological factors (Gallon, Harris, & Van der Lely, 2007; Leonard, Davis, & Deevy, 2007; Marshall & Van der Lely, 2006, 2007). These children are less likely to produce past tense -ed overall in novel words but are even less likely to do so when the word stem was low in its phonotactic probability, whereas typically developing MLU-matched peers were not influenced by phonotactic probability (Leonard, Davis, & Deevy, 2007).

Other aspect of phonological deficits concerns phonological awareness. This includes tasks like segmentation, syllable-counting etc. Children with SLI exhibit mild deficits in phonological awareness, whereas children with dyslexia exhibit more severe deficits (Catts, Adolf, Hogan, & Weismer, 2005).

e. Syntactic abilities

Early in development, children with SLI exhibit delayed growth in the syntactic complexity, beginning as early as the onset of syntactic comprehension and production. They also exhibit persistent difficulty producing and comprehending syntactically complex sentences. In some instances, these difficulties appear to be related to poor linguistic knowledge, and in other instances, to inferior general processing abilities. They have difficulties comprehending sentences that involve long-distance dependencies, such as wh-questions (Hakansson & Hansson, 2000; Schuele & Tolbert, 2001; Deevy & Leonard, 2004; Hansson & Nettelbaldt, 2006; Novogrodsky & Friedmann, 2006; Marinis & Van der Lely, 2007). The sentence structure produced by

children with SLI is not appropriate to their age level and they have shorter MLU and produce less well formed sentences than typically developing children (Klee, Schaffer, May, Membrino, & Mougey, 1989; Grimm, & Weinert, 1990).

Deficits in the working memory (Montgomery, 2000 ; Deevy & Leonard, 2004), attention, control of attention, and processing speed (Leonard, Weismer, Miller, Francis, Tomblin, & Kail, 2007), in the children with SLI, has also been reported to cause the delay in acquisition, comprehension and production of complex syntactic structures.

They also have difficulties with passive sentences (Leonard, Wong, Deevy, Stokes, & Fletcher, 2006), finite complement clauses (Owen & Leonard, 2006), and have syntactic deficits in argument structure that affect production and comprehension (Loeb, Pye, Richardson, & Redmond, 1998; Grela & Leonard, 2000; Thordardottir & Weismer, 2002).

f. Pragmatic skills

Children with SLI are pragmatically impaired and do not form a homogeneous group (Adams & Bishop, 1989). Rapin and Allan (1983) reported normal or relatively intact grammar and phonology, but inadequate conversational skills, selecting inappropriate words and poor maintenance of topic. Their speech may be fluent and grammatically well formed, but the content of what they say has an odd quality and the way in which they use language in social interaction may be unusual (Tomblin, Zhang, Buckwalter, & O'Brien, 2003). Paul (1991) found that toddlers with SLI exhibited fewer interactions involving joint attention with their caregivers. Moreover there has been some evidence that children with SLI are more likely to initiate conversation with adults than they are with peers (Rice, Sell, & Hadley, 1991). In general they are

reluctant to initiate conversation, may initiate conversation at inappropriate times, or may interrupt or shout to gain attention before initiating conversation (Paul, 1991).

g. Narration ability

Even the simplest sentence cannot be constructed and produced without the coordination of lexical, morphosyntactic, phonological and pragmatic elements. Narratives require considerable skill in manipulation in language, whether they are in the form of telling a fictional story, providing an account of a previous experience, or retelling a story heard from someone else (Paul & Smith, 1993).

The evidence suggests that the children with SLI have the greatest problems like organizing an appropriate sequence of words (Clifford, Reilly, & Wulfeck, 1995). Paul & Smith (1993), reported difficulty of narrative skills in children with SLI, they pointed that language difficulty may be due to deficit beyond language, difficulty in encoding, organizing, linking proposition and retrieval of words.

h. Speech perception skills

Tallal (1976) reported that children with language impairment required longer intra-stimulus and inter-stimulus intervals to accurately discriminate between the consonant-vowel (CV) pairs, which lead to the poor performance in auditory discrimination task for consonants than vowels. Tallal, Stark, and Curtiss (1976) also reported that they have particular difficulty in discrimination of speech sounds distinguished by rapidly changing acoustic spectra.

Uwer, Albrecht and Von Suchodoletz, (2002); Rvachew, Ohberg, Grawburg, and Heyding (2003) suggested that children with SLI showed a specific deficit in automatic discrimination of CV syllables differing in place of articulation, whereas the processing of simple tone differences seems to be unimpaired.

i. Academic deficits

Numerous reports indicated that children who experience early language disorders often have difficulty learning to read and write during school years and beyond (Levi, Cappozzi, Fabrizi, & Sechi, 1982; Catts & Kamhi, 1999). Levi, Cappozzi, Fabrizi, and Sechi (1982) evaluated 18 children who had been diagnosed with SLI when they were four-year old. When children were eight-year old in the third grade, they were administered a battery of tests to examine language development and academic achievement. Their findings showed that children were having deficit in receptive and expressive language, as well as deficits in reading, spelling and mathematics.

II. Non-linguistic abilities in children with SLI

a. Cognitive skills

Although, children with SLI perform within normal limits on nonverbal intelligence task such as the Leiter International Performance Scale (Sharp, 1958) and Wechsler Intelligence Scale for children-Revised (Wechsler, 1974), they may also demonstrate cognitive impairments not exhibited on standard intelligence measures (Leonard, 1989; Kamhi, Minor, & Mauer, 1990).

The cognitive skills such as complex reasoning tasks, presumed information processing skills, interpreting rapidly sequenced auditory or visual stimuli, haptic (touch) perception, attentional deficits, tendency toward hyperactivity, and symbolic play activities. On most of these variables studied, the results are inconsistent and interpretation of positive findings is controversial.

1. Difficulties with complex reasoning tasks

In the studies designed to test reasoning task using visual-spatial skills, children with SLI performed more poorly i.e. they exhibited slower response rates or

incorrect responses than did children in normal comparison groups. Tasks tested have included asking the children to predict where the water level would be in a container tilted at various angles, to select objects that match forms as seen from different orientations, and to tell whether shapes presented at different rotations were the same or different (Camarata, Newhoff, & Rugg, 1981; Johnston & Ellis Wiesmer, 1983). Kamhi, Gentry, Mauer, and Gholson (1990) studied analogical reasoning by making use of problems such as the farmer's dilemma of how to get a fox, goose, and corn across the river with only a small boat at his disposal. The children with SLI had greater difficulty than the mental age controls on the original task only in the condition in which the description of the solution was not accompanied by demonstration. The two groups were comparable in their ability to apply the solution to the new situations.

2. Mental Representation

The symbolic play of children with SLI has been investigated as one of the mental representational task. Lovell, Hoyle, and Siddall (1968) examined symbolic play in children with SLI and found that the older children with SLI spent less time in symbolic play than the older age controls and also younger age controls differed from the younger children with SLI only in the amount of time they spent in play representing a transitional level between mere practice play and symbolic play. Similar results where the children with SLI displayed less developed symbolic play when compared with age controls has been reported by Morehead, 1972; Udwin and Yule, 1983). However, when compared with younger expressive language matched group, the children with SLI earned higher symbolic play scores (Terrell, Schwartz, Prelock, & Messick, 1984). In contrast, a study by Roth and Clark (1987) revealed that the MLU controls were observed to use higher levels of play than children with SLI.

Mental imagery is another form of representational ability studied in connection with SLI. It includes tasks such as predicting the direction of the level of water in a tilted glass, feel the geometrical shapes and then select the shapes corresponding to them, selecting the object that matches the form as seen by the examiner etc. The results of such tasks carried out on children with SLI revealed that they do not perform as well on imagery tasks as age controls do, whereas they perform better than younger language controls (e.g., Johnston & Ramstad, 1983; Kamhi, Catts, Koenig, & Lewis, 1984). Also, Johnston & Ellis Weismer (1983) found that the children with SLI had difficulty with image generation, maintenance, or interpretation rather than image transformation or mental rotation task.

3. Information processing skills

The children with SLI may process only the linguistic information or both linguistic and nonlinguistic information slowly than those with normal language skills. Kail (1994), proposed the generalized slowing hypothesis, which states that the underlying cause of SLI is a slower rate of response when various kinds of linguistic, visual, and spatial information is presented. Both verbal and nonverbal information processing is measured using reaction time (RT). The results of such studies have shown that the children with SLI are slower than those without SLI (Kail, 1994; Montgomery & Leonard, 1998; Windsor & Hwang, 1999; Windsor, Milbrath, Carney, & Rakowski, 2001; Miller, Kail, Leonard, & Tomblin, 2001) in both verbal and nonverbal RT.

Deficits in temporal processing in children with SLI has been proposed by Tallal, Stark, and Meltis, (1985) and Tallal, (1999). It is reported that these children have difficulty perceiving stimuli that are presented rapidly and executing tasks that require rapidity. In addition children with language impairment when compared to control

peers, required longer interval between the tones to discriminate the order in which they had occurred (Lowe & Campbell, 1965).

Holopainen, Korpilahti, Juottonen, Lang, and Sillanapaa (1997) used duration and frequency change MMN to investigate children with developmental dysphasia. They found that peak amplitude of frequency change MMN (500 Vs 555) was significantly attenuated in dysphasic children compared to healthy control children.

In search of a cause for SLI

The disorder of SLI has been explained to result from deficits in two different aspects: a) Linguistic knowledge, typically attributed to delayed maturation or deficient representation of language; b) Domain specific cognitive or cognitive-linguistic processes, which attributed to the problems seen in children with SLI due to deficits in auditory perception, speech perception, phonological working memory and processing speed.

Although many proposals have emerged over the last two decades in an attempt to explain SLI supporting the linguistic deficit hypothesis and the cognitive deficit hypothesis, they are not sufficiently comprehensive to account for all the deficits associated with SLI (Schwartz, 2009).

a. Linguistic Knowledge and computational based explanations (Linguistic deficit hypothesis)

Within the linguistic tradition, the difficulties of children with SLI are often constructed as arising from impairment to an innate grammatical module, hence allowing for the unimpaired development and functioning of other cognitive abilities (Gopnik & Cargo, 1991; van der Lely, 1994). The linguistic knowledge deficits in

children with SLI has been explained initially by extended optional infinitive (EOI) account proposed by Rice, Wexler, and Cleave, 1995: Rice & Wexler, 1996a, 1996b. According to the children with SLI extend a period that occurs in typically developing children during which tense is optionally marked on verbs that occur in main clauses, as a result they produce the finite verbs without tense markers and numbers.

The Representational Deficit for Dependent Relations (RDDR) by Van der Lely and Stollwerck (1997) and Van de Lely (1998) suggest that children with SLI lack the linguistic structural knowledge necessary to establish anaphoric relations between pronouns and their antecedents, or long-distance relations between nouns or pronouns, or as gaps in relative clauses and in wh-questions. van der Lely (2005) revised RDDR and named it as computational grammatical complexity hypothesis. According to this, children with SLI are impaired in the linguistic representation or computations that underlie hierarchical, structurally complex forms in one or more components of language (i.e., syntax, morphology, phonology).

These linguistic proposals provide detailed theoretical underpinnings of the language deficits of infrequently occurring subgroup of children with SLI. However, they do not address the full range of language deficits in children with SLI. Hence process based explanations have been put forth to explain some of the deficits in children with SLI.

b. Process based explanations (Cognitive deficit hypothesis)

A large body of evidence has revealed limitation in working memory and speed of processing as well as deficits in attention and various executive functions in children with SLI. These deficits in psychological processes have formed the basis of several accounts of SLI. These deficits could be general (domain general), affecting the

linguistic and nonlinguistic cognitive processing (e.g., motor movement), and specific to language (domain-specific) affecting the language (e.g., general auditory perception, speech perception, phonological working memory, processing speed etc). It is possible that these children have difficulty processing the information that is needed to acquire language adequately. That is, language itself may not be the problem; instead, processing limitations may significantly affect the child's ability to access language from the input and, once (finally) acquired, use it with facility. For example, some children may have no difficulty recognizing that a new word refers to a particular object. However, if the children are unable to retain the phonological sequence that makes up the word, they will probably require multiple encounters with that word before it can be adequately learned. Other children may be capable of hypothesizing that a grammatical inflection such as –ed refers to past tense but do not process the continuous speech stream quickly enough to identify this morpheme, hypothesize its grammatical function, and store the morpheme before attention must be directed to the portion of the speech stream that follows.

Kail and Salthouse (1994) noted that processing limitations can be considered from different perspectives. Viewed from the perspective of a spatial metaphor, processing limitations can be interpreted to mean that the computational region of memory is restricted; there is too little work space, that is limited processing capacity, which is revealed through the tasks of working memory capacity. And, viewed from the perspective of time, if the information is not processed quickly enough, it will be vulnerable to decay or interference from additional incoming information. The time perspective is often discussed in terms of processing speed. Processing speed uses Reaction Time (RT) as a dependent measure, whereas working memory uses accuracy, or more precisely, number of items correctly recalled.

Findings from Gillam and Ellis Weismer (1997) suggest that effects attributable to speed and those attributable to working memory may be separable. These investigators matched a group of school-age children with language impairment with a group of younger typically developing children on a working memory task. The children were given a task in which they had to memorize 12 target sentences and then verify whether a sentence was one they had actually studied. The children with LI were comparable to the younger TD children in their verification accuracy but were significantly slower than the younger TD children in responding to all sentence types.

Phonological Working Memory

It has been almost 25years since researchers have begun to examine the potential role of working memory (WM) on the language learning and processing abilities of children with SLI (Gathercole & Baddeley, 1990a; Montgomery, 1995b; Montgomery 2000, 2002). Working memory is an active process that allows for access to a small number of items in conscious awareness. Incoming linguistic knowledge is held in working memory while the information is being processed. Children with SLI have deficits in working memory that may underlie their language deficits. These children do not employ processing strategies that use contextual information and stored knowledge. Children with SLI demonstrate slower linguistic and nonlinguistic processing on both expressive and receptive tasks than age matched typically developing children (Windsor & Hwang, 1999; Leonard, 1998; Miller, Kail, Leonard, & Tomblin, 2001). These characteristics suggest limitations in cognitive processing capacity. Limitations in cognitive processing ability and executive functions relative to working memory may interact with various modes of input and output to restrict information processing capacity (Hoffman & Gillam, 2004).

While there are two prominent models of working memory, the phonological loop model (Baddeley, 1986) and the capacity theory of comprehension (e.g., Just & Carpenter, 1992), much of the research with children, including children with SLI, has been dominated by Baddeley's phonological loop model.

Working memory according to Baddeley (1986) is a multicomponent, capacity-limited system that comprises a controlling ''central executive'' and an articulatory loop system. The central executive, the component that is not well understood, is thought to regulate information flow within working memory, retrieval of information from other memory systems, and the processing and storage of information. The articulatory loop, the better understood component, includes a capacity-limited phonological short-term store and an articulatory control process (verbal rehearsal) that acts to refresh and maintain speech material in the store for a brief period. The articulatory loop's function is to store verbal input temporarily, especially novel phonological input (Baddeley, Gathercole, & Papagno, 1998), while other cognitive tasks such as auditory comprehension take place. The ability to temporarily store novel material also allows the listener the opportunity to create long-term phonological representations of that material (Baddeley et al., 1998). This view of working memory is referred to as phonological working memory (PWM).

In Baddeley's model, PWM plays an important role in the learning of new words, whose unique phoneme sequences must be retained long enough to be assigned a semantic interpretation. Speech enters PWM automatically but will fade quickly if it is not immediately processed in some fashion. For example, temporarily holding speech in PWM presumably enables a listener to invoke the language system to immediately process that material (Baddeley, et al., 1998). He has further suggested that PWM serves as a mnemonic window in which sequences of incoming words are held. For

children with limited working memory capacities, comprehension of the language in the input would be only partial and lexical and grammatical representations would be built up only slowly. Thus poor phonological working memory (Gathercole & Baddeley, 1990a, 1990b; Montgomery, 1995). Leonard, Miller, & Finneran, (2009) means less capacity to store phonological information affects both the acquisition of new words (which demand the retention of new phonological sequences) and broader levels of language processing such as sentence comprehension that require the manipulation of phonological information (Briscoe, Bishop, & Norbury, 2001). Developmental research suggests that PWM capacity develops with age and asymptotes by about age 8 years or so (e.g., Gathercole, 1999).

Assessment of Phonological Working Memory

In the recent past, research on SLI has received much attention regarding the possible markers that can differentiate between individuals with and without language disorders. This is at least partly due to the dissatisfaction felt by both clinicians and researchers at the exclusionary criteria currently used to diagnose SLI (Fey ,Cleave , Ravida, Long, Dejmal, & Easton,1994) and the accumulating evidence that SLI is a disorder that can be persistent and thus can continue to affect children into adolescence and early adulthood (Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998; Snowling, Bishop, & Stothard, 2000). Hence, investigations regarding the assessment procedures of SLI have gained momentum and a better understanding of the symptom complex and the underlying linguistic base has been attempted.

The PWM has been studied by a number of researchers using different tasks and stimuli including sentence recall/repetition, digit span, word span, and nonword repetition (NWR) (e.g., Gathercole, 1999; Archibald & Gathercole, 2006). Among these, the NWR task has been widely used to assess the phonological working memory

capacity. Nonword involves strings of letters or alphabets that are devoid of lexicality effects and that are not predictable as a word (Gathercole, Frankish, Pickering, & Peaker, 1999). Nonwords are generally constructed from syllables that do not occur as true (real) word in the language but uses strings of letters or alphabets which follows the phonotactic rules of a given language. These segments of syllables should be the repertoire of children in the age group under study to avoid articulatory constraints (Dollaghan & Campbell, 1998). Furthermore, NWR is culturally unbiased in that is unrelated to maternal education level (Alloway, Gathercole, Willis, & Adams, 2004), or race (Campbell, Dollaghan, Needleman, & Janosky, 1997). This test requires the child to listen to a non-word, temporarily store the novel phonological representation, and then produce it. Since repetition of nonwords calls for perception, storage and retrieval of its phonological constituents in a sequence, it is proposed as a potential task to identify children with SLI (Bishop, North, & Donlan, 1996; Dollaghan & Campbell, 1998; Botting & Conti-Ramsden, 2001; Conti-Ramsden, Botting, & Faragher, 2001; Conti-Ramsden & Hesketh, 2003).

The NWR test has been found to be a useful screening test in children with language impairment, which involves a shorter time than other language measures (Gathercole & Baddeley, 1996). Campbell, Dollaghan, Needleman, & Janosky (1997) reported that norm-referenced tests are inherently biased against test-takers from minority backgrounds as these tests depend so heavily on experiential history and vocabulary knowledge, but the processing dependent measure like nonword repetition, which is of equal in familiarity to all test-takers regardless of their language knowledge, are less biased and offer a better way to distinguish between children whose poor performance reflects fundamental language processing deficits.

NWR involves the phonological loop which is a specialized subsystem of working memory (Baddeley, 1986, 1996). The NWR is thought to reflect some of the underlying cognitive difficulties of SLI, perhaps those concerned with working memory, phonological memory or long-term word knowledge (Gathercole, 1995). Some research is beginning to suggest that non-word repetition may be useful as a genetic marker for language impairment (Bishop et al. 1996, Conti-Ramsden et al. 2001c).However, relatively little work has been completed that directly analyses the language abilities of children who have good non-word performance compared with matched peers with poor scores.

Several studies have examined the nonword repetition skills in children with language impairment.

Kamhi, Catts, Mauer, Apel, and Gentry (1988) compared NWR skills in ten children with language impairment (LI) with mean age of 7.9years against 10 children with reading impairment (RI) and 10 typically developing peers. Each subject was administered eight tasks: four word repetition tasks (monosyllabic, monosyllabic presented in noise, three-item, and multisyllabic), rapid naming, syllable segmentation, paper folding, and form completion. The typically developing children performed significantly better than language impaired and reading impaired children on all the tasks, except on syllable segmentation task. Also the language impaired and reading impaired performed comparably on every task with the exception of the monosyllabic and multisyllabic word repetition task.

Gathercole and Baddeley (1990a) compared the NWR skills of 6 children with SLI (aged 8; 6) with those of 6 age-matched typically developing children (TDAM) and 6 typically developing younger (TDY) children. The children with SLI scored significantly lower than their TDAM and TDY peers on three- and four-syllable

nonwords. The mean performance of the children with SLI was approximately 4 years below their chronological age. They claimed that working memory deficits in these children were not attributable to language status, as the children performed worse than their TDY peers.

Montgomery (1995) examined the influence of phonological working memory on sentence comprehension in 14 children with SLI with mean age of 8.9years and 13 language-matched groups of children with the mean age of 6.9years through the use of two tasks. In the first task, a nonsense word repetition task was given and the subjects repeated nonsense words varying in length from one syllable to four. In the second task, the subjects listened to sentences under two conditions varying in linguistic redundancy (redundant, nonredundant). On the nonsense word repetition task, between- and within-group analyses revealed that subjects with SLI repeated significantly fewer 3-syllable and 4-syllable nonsense words. On the sentence comprehension task, between- and within-group analyses determined that subjects with SLI comprehended significantly fewer redundant (longer) sentences than nonredundant (shorter) sentences. A positive correlation was found between subjects' performance on the nonsense word repetition and sentence comprehension tasks. The results were interpreted to suggest that children with SLI have diminished phonological working memory capacity and that this capacity deficit compromises their sentence comprehension efforts.

Bishop, North, and Donlan (1996) used the task developed by Gathercole and Baddeley, and examined nonword repetition in twins who had participated in a genetic study of language impairment. They found that children with language impairment as well as those with resolved language impairment were significantly impaired in nonword repetition. Given their results, Bishop et al., suggested that deficits in

nonword repetition constitute a phenotypic marker of developmental language impairment.

Dollaghan and Campbell (1998) examined 40 children between the ages of 6 years and 9years, 9months, who were undergoing language intervention, using nonword repetition task. They found that children with SLI had difficulty in repeating nonwords and this difficulty increased as the length of the nonwords increased. They also reported that the nonword repetition distinguished between children independently identified as language impairment and children with normal language skills, with a high degree of accuracy (98%), by contrast with the traditional language test. They concluded that, nonword repetition may have considerable clinical utility as a screening measure for language impairment in children.

Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, and Jones, (2000) examined nonword repetition performance in a population-based sample of school-age children in the age range of 7-9yrs. A total of 581 second graders who were participating in a longitudinal, epidemiological investigation of specific language impairment (SLI) were administered the Nonword Repetition Task (NRT) developed by Dollaghan & Capmbell (1998). The performance was examined according to second-grade diagnostic category, presence/absence of language impairment, and treatment status. The results indicated that children with language impairment, as well as those in intervention, exhibited deficient nonword repetition skills compared to normal language controls. The findings also confirmed that the NRT is a culturally nonbiased measure of language processing. The results from likelihood ratio analyses indicated that NRT performance, though not sufficient on its own, may not provide a useful index to assist in ruling in or ruling out language disorder.

Botting and Conti-Ramsden (2001) examined nonword repetition and language development in children with SLI. They administered nonword repetition to a group of school age children with SLI at the age of 11 and then classified the children into two groups with the highest and lowest scores on nonword repetition. The authors then compared the language and literacy abilities of the two groups of children. The children were matched on the performance IQ tasks. The results indicated that, all linguistic measures namely, Past Tense Task (PTT), third person singular task (TPS), Clinical Evaluation of Language Fundamentals Revised-recalling sentences subtest (CELF-R), Test for Reception of Grammar (TROG), except for vocabulary assessment namely Expressive Vocabulary Test (EVT) and British Picture Vocabulary Scale (BPVS-II) showed significant differences between the groups. They suggested clear association between performance on a nonword repetition task and actual language ability. However, there was no clear association between nonword repetition and vocabulary measures at the age of 11 or 7 years in terms of progression of ability. The investigators concluded that more than a general working memory underlies the language difficulties.

Montgomery (2002) investigated the evidences suggesting that the lexical/morphological learning and sentence comprehension problems of many of these children are associated with deficient verbal working memory (VWM) abilities and reviewed for the possibility that deficient verbal working memory provides a clinical marker of SLI. By reviewing earlier studies which have highlighted the association between lexical/morphological learning and sentence comprehension problems with deficient verbal working memory abilities, the results of the study revealed that there is a connection between the verbal working memory deficits and language difficulties of children with SLI, or least many children with SLI. The author suggested that careful

observation of the performance of children with SLI as they attempt to solve different cognitive-linguistic challenges, will lead to better understanding of the nature of their language learning and language processing strengths and weaknesses.

Conti-Ramsden and Hesketh (2003) evaluated thirty-two, five-year-old children with SLI and 32 chronological age (CA) controls who completed four tasks that were considered potential positive markers for SLI. The tasks comprised of two linguistic tasks (past tense and noun plurals task) and two processing tasks (nonword repetition and digit recall). The nonword repetition and past tense marking yielded the best results in terms of sensitivity (between 52% and 71%), specificity (between 91% and 100%), and overall accuracy (between 80% and 83%) in the identification of SLI. These results corroborated the findings of particular difficulties of children with SLI with phonological short-term memory tasks such as nonword repetition (Bishop, North, & Donlan, 1996; Dollaghan & Campbell, 1998) and with linguistic information involving verb morphology (Rice & Wexler, 1996). They also suggested that neither nonword repetition nor past tense tasks were as good in discriminating between children with SLI and CA control children. The ROC curve analyses yielded relatively low sensitivity for these measures, with 59% for nonword repetition and 52% for past tense at the 16th percentile cut off point (i.e., less than one standard deviation below the mean), although specificity was excellent for both (100%). In the discriminant analyses, for nonword repetition, sensitivity approached more acceptable levels (78%) but this in turn resulted in loss of specificity (84%). A similar picture emerged for the past tense, with acceptable levels of sensitivity (81%) resulting in loss of specificity (81%). Thus, they suggested that these tasks are useful, but much research work is still needed to better tap the processing and linguistic abilities of children with SLI.

Marton and Schwartz (2003) examined the interaction between working memory and language comprehension in children with SLI, focusing on the function of the central executive component and its interaction with the phonological loop (Baddeley, 1986) in complex working memory tasks. Thirteen children with SLI in the age range of 7 to 10years and thirteen age-matched children with typical language development participated. The children were administered with nonword repetition task, nonword discrimination task and sentence comprehension by using sentences that differed in length and syntactic complexity. The results indicated that the mean percentage accuracy of NWR across the tasks was 46.36 for the children with SLI and 65.46 for the age matched group. It was evident from the results that the children with SLI exhibited larger processing and attentional capacity limitations than their age-matched peers. With the increase in word length and syntactic complexity there was a large performance decrease in nonword repetition in both groups. The results indicated difference in the error patterns between the groups where, of the errors made by the children with SLI were interference errors (65%), whereas most of the errors of the children with TLD were omissions (81%). Also the accuracy of the responses decreased significantly with the increase in syntactic complexity than with the increase in the sentence length. They concluded that the performance of the children with SLI in nonword repetition, across the different tasks, indicated a limitation in simultaneous processing rather than difficulty in encoding and analyzing the phonological structure of the nonwords.

Gray (2006) evaluated the diagnostic accuracy and test-retest reliability, where two forms of a nonword repetition task were administered to twenty two preschool

children with specific language impairment (SLI) and to twenty two age- and gender-matched children with normal language (NL). The results were compared with performance on a digit span task and norm-referenced test scores. The findings indicated that the nonword repetition scores provided excellent sensitivity and specificity for discriminating between groups. Scores on both nonword repetition and digit span tasks improved significantly from first to second administrations for both groups, but remained relatively stable at the third administration. The SLI group appeared to benefit more from repetition than the NL group. Acceptable levels of test-retest reliability were achieved for the digit span task, but not for the NL group on the nonword repetition task. The implication of the study was that the nonword repetition could be used as a promising diagnostic measure for SLI in preschool children with improvement in the test-retest reliability.

In recent years, researchers have also suggested that NWR could be used as an indicator of early language delay. Roy and Chiat (2004), examined word and nonword repetition in sixty-six children between 2 and 4 years of age. The stimuli consisted of 18 words and 18 matched nonwords that were systematically manipulated for length and prosodic structure. In addition, an assessment of receptive vocabulary was undertaken. The results indicated that there was increase in the total scores as well as word and nonword scores with the increase in the age. Lexical status and item length affected performance regardless of age, where words were repeated more accurately than nonwords, and 1-syllable item were repeated more accurately than 2-syllable items, which were in turn repeated more accurately than 3-syllable items. The effect of prosodic structure was also significant. Whole syllable errors were almost exclusive to unstressed syllables, with those preceding stress being most vulnerable. Performance on the repetition task was significantly correlated with performance on the receptive

vocabulary test. This repetition task effectively elicited responses from most of the 2- to 4-year-old participants, tapped developmental change in their repetition skills, and revealed patterns in their performance; and thus it has the potential to identify deficits in very early repetition skills that may be indicative of wider language difficulties.

Thal, Miller, Carlson, and Vega (2005) examined the usefulness of the Nonword Repetition Test (NRT) (Dollaghan & Campbell, 1998) with 4-year-old children and the relationship among the NRT, language, and other aspects of mental processing. The NRT was administered to 64 children at 4 years of age; 44 had a history of typical language development (HTD), and 20 had a history of language delay (HLD) at 16 months of age. Although all children had normal language abilities at the time of the study, (and several aspects of language and mental processing), the NRT differentiated between HTD and HLD. They also indicated that non-word repetition alone is not a sufficient index of weak language abilities, a finding consistent with that of Weismer et al. (2000) for older children with specific language impairment.

Archibald and Gathercole (2006) compared performance of children on two tests of nonword repetition, namely the Children' Test of Nonword Repetition (CNRep) (Gathercole & Baddeley, 1996) and the Nonword Repetition test (NRT) (Dollaghan & Campbell, 1998), to investigate the factors that may contribute to the well-documented nonword repetition deficit in specific language impairment (SLI). Twelve children with SLI age 7 to 11 years, 12 age-matched control children, and 12 control children matched for language ability completed two tests of nonword repetition. The results indicated that the children with SLI performed significantly more poorly on both tests than typically developing children of the same age. The SLI group was impaired on the CNRep but not the NRT relative to younger children with similar language abilities

when adjustments were made for differences in general cognitive ability. The children with SLI repeated the lengthiest nonwords and the nonwords containing consonant clusters significantly less accurately than the control groups. The authors suggested that the nonword repetition deficit in SLI may arise from a number of factors, including verbal short-term memory, lexical knowledge, and output processes.

Archibald and Gathercole (2007) examined the possible role of phonological short-term memory in the nonword repetition deficit of children with SLI by comparing serial recall and nonword repetition of sequences of auditorily presented CV syllables. They included 13 children with SLI (8 males, 5 females), and 16 typically developing children of the same age, all of whom were native English speakers. The results indicated that the children with SLI showed impairments in both serial recall and nonword repetition relative to typically developing children of the same age, however the SLI deficit in nonword repetition was greater and persisted even when differences on an independent measure of short-term memory were taken into account. They concluded that the deficits could not be explained in terms of a sole deficit in short-term memory, and whereas they attributed the findings to differences between the serial recall and nonword repetition paradigms as potential factors contributing to this disorder of learning.

Graf-Estes, Evans, and Else-Quest (2007) explored the size of the NWR deficit in children with specific language impairment (SLI) by screening 60 published and unpublished studies for possible inclusion in a meta-analysis of NWR performance in children with and without SLI. Their meta-analysis of the 23 studies that met their inclusion criteria revealed that children with SLI, on average, performed at 1.27 standard deviations below the mean score of children without SLI. However, they also

reported that four different versions of NWR tests yielded different effect sizes in group comparisons and were thus not interchangeable. Nonetheless, there was no relationship between effect size and the age of the children with SLI, and children with SLI were significantly worse than both their age-matched peers and younger language-matched children at repeating even one-syllable nonwords, not just longer strings of syllables. These findings of statistically significant differences in mean scores for groups identified as SLI and TD have led researchers to suggest that NWR could be used as a clinical marker of SLI.

Montgomery and Windsor (2007) investigated the effects of processing speed and phonological short-term memory (PSTM) on children's language performance. They included fourty-eight school-age children with specific language impairment (SLI) with the mean age of 8.9years and age peers with the mean age of 8.8years. Both the groups completed auditory detection reaction time (RT) and nonword repetition tasks, the Clinical Evaluation of Language Fundamentals—Revised (CELF–R; Semel, Wiig, & Secord, 2003) and a word recognition RT task. The results indicated that the children with SLI were outperformed by age peers on each task. Auditory detection RT was correlated with nonword repetition (NWR) in each group. However, both variables covaried with age, and auditory detection RT did not contribute unique variance to NWR in either group. For the SLI group, NWR predicted unique variance in CELF–R performance (about 15%); auditory detection RT predicted a smaller amount of unique variance in the word recognition RT task (about 9%). They concluded that processing speed and PSTM measures covaried with chronological age. Processing speed was associated with offline language performance only through association with PSTM. Processing speed contributed to online language performance, suggesting that speed is associated with processing more familiar language material (i.e., lexical content and

structure) than less familiar material (e.g., various content on the CELF–R).

Thordardottir (2008) examined the effect of task demands on language production in children with SLI cross-linguistically. The participants were a total of forty-two children from Icelandic- and English-speaking school-age children with SLI and normal language (NL) peers. They were administered measures of verbal working memory which included tests of nonword repetition and listening span. Spontaneous language samples were collected in contexts that vary in task demands: conversation, narration, and expository discourse. The effect of the context-related task demands on the accuracy of grammatical inflections was examined. The results indicated that the children with SLI in both language groups scored significantly lower than their NL peers in verbal working memory. Nonword repetition scores correlated with morphological accuracy that is it correlated with inflectional accuracy in both languages, suggesting an association between morphological accuracy and processing ability. In both languages, mean length of utterance (MLU) varied systematically across sampling contexts. Context exerted a significant effect on the accuracy of grammatical inflection in English only. Error rates were higher overall in English than in Icelandic, but whether the difference was significant depended on the sampling context. Errors in Icelandic involved verb and noun phrase inflection to a similar extent. They concluded that production of grammatical morphology appears to be more taxing for children with SLI who speak English than for those who speak Icelandic. Although children with SLI in both language groups evidence deficits in language processing, cross-linguistic differences are seen in which linguistic structures are vulnerable when processing load is increased. Future research should carefully consider the effect of context on children's language performance.

Archibald and Joanisse (2009) examined the utility of two measures proposed as markers of specific language impairment (SLI) in identifying specific impairments in language or working memory in school-age children. They included a group of 400 school-age children who completed a 5-min screening consisting of nonword repetition and sentence recall. The results indicated that approximately equal numbers of children were identified with specific impairments in either language or working memory. A group about twice as large had deficits in both language and working memory. Sensitivity of the screening measure for both SLI and specific working memory impairments was 84% or greater, although specificity was closer to 50%. Sentence recall performance below the 10th percentile was associated with sensitivity and specificity values above 80% for SLI. Hence they concluded that the developmental deficits may be specific to language or working memory, or include impairments in both areas. They suggested sentence recall as a useful clinical marker of SLI and combined language and working memory impairments.

Montgomery and Evans (2009) investigated the association of two mechanisms of working memory (phonological short-term memory [PSTM] and attentional resource capacity/allocation) with the sentence comprehension of school-age children with specific language impairment (SLI) and 2 groups of control children. They included twenty-four children with SLI with the mean age of 9years, 18 age-matched (CA) children with mean age of 9years, and 16 language- and memory-matched (LMM) children with the age of 6.3years and they completed nonword repetition task (PSTM), the competing language processing task (CLPT; resource capacity/allocation), and a sentence comprehension task comprising complex and simple sentences. The results indicated that the SLI group performed worse than the CA group on each memory task; all three groups showed comparable simple sentence comprehension, but for complex

sentences, the SLI and LMM groups performed worse than the CA group. For the SLI group, (a) CLPT correlated with complex sentence comprehension, and (b) nonword repetition correlated with simple sentence comprehension; for CA children, neither memory variable correlated with either sentence type; and for LMM children, only CLPT correlated with complex sentences. They concluded that the comprehension of both complex and simple grammar by school-age children with SLI is a mentally demanding activity, requiring significant working memory resources.

Studies assessing the phonological working memory in children with SLI have also been done languages other than English.

Sahlen, Wagner, Nettelbladt, and Radeborg (1999) explored the relationship between non-word repetition and different aspects of language comprehension (comprehension of words, sentences and fables) in 27 children with language impairment(LI). The results showed that non-word repetition significantly correlated with all measures of language comprehension in the children with LI. Partial correlations revealed a weaker relationship between vocabulary comprehension, comprehension of fables and non-word repetition than between non-word repetition and comprehension of grammar. A possible explanation for the findings may be that the tests assessing comprehension of grammar strained language processing and storage more than the other tests. They concluded that non-word repetition cannot be considered to be a single, reliable index of phonological memory in pre-school children with LI. Non-word repetition incorporates a range of processes necessary for language comprehension and production and mirrors the general language status of the child.

Stokes, Wong, Fletcher, and Leonard (2006) examined fourteen Cantonese-speaking children with SLI and 30 typically developing age matched (TDAM) and

typically developing younger peers (TDY) on nonword repetition task (NWR) and sentence repetition (SR) tasks. NWR of IN nonwords (CV combinations attested in the language) and OUT nonwords (CV combinations unattested in the language) were compared. SR performance was compared using 4 different scoring methods. The results indicated that the SLI group did not score significantly lower than the TDAM group on the test of NWR (overall results were TDAM = SLI > TDY). There were nonsignificant group differences on IN syllables but not on OUT syllables. The results indicated that there was no limitation in phonological working memory in Cantonese-speaking children with SLI. The SR task discriminated between children and their TDAM peers but not between children with SLI and their TDY peers matched for mean length of utterance. They concluded that SR but not NWR discriminates between children with SLI and their TDAM peers. Poorer NWR for English-speaking children with SLI in comparison to TDAM might be attributable to weaker use of the redintegration strategy in word repetition, where they lack the ability to relate the target nonwords to the long-term memory language store and used lexical and phonotactic information to "fill in the blanks" of the skeletal score (the CVC pattern), creating either an accurate response or a close approximation to the target nonword. They recommended that further cross-linguistic investigations of processing strategies are required.

Girbau and Schwartz (2007) examined the repetition of nonwords that are consistent with the phonotactic patterns of Spanish in eleven Spanish-speaking children with SLI and 11 age-matched children with typical language development aged 7.6-10.10 years. The study also examined the relationship between non-word repetition performance and other language measures. The children with SLI performed more poorly on almost all measures of accuracy, but particularly in their production of three-,

four-, and five-syllable non-words. Substitutions were the most frequent error type for both groups. Likelihood ratios indicated that non-word repetition performance is a highly accurate identifier of language status in these preselected groups. The children's non-word repetition was highly correlated with three of the four subtest of the Illinois Test of Pyscholinguistic Abilities (ITPA), namely auditory association subtest, grammatical integration subtest, and with that of auditory comprehension subtest of the standardized language measures that were administered to the children. They concluded that repetition of non-words consistent with Spanish phonotactics reveals word-length effects and error patterns similar to those found in previous studies and they also extended these findings to older school-age Spanish-speaking children with Specific Language Impairment. They concluded that among the limited choices for instruments that can be used to identify children with SLI, a Spanish Non-word Repetition Task can be used as a valuable screening test for clinical and research purposes.

de Bree, Rispens, and Gerrits (2007) investigated a group of Dutch preschool SLI children and children at familial risk of dyslexia, as well as school-going groups of SLI and dyslexic children were presented with a nonword repetition task. The results indicated that the SLI and the (at-risk of) dyslexia groups performed more poorly than the control children and they concluded that non-word repetition deficit is attested early in life and underlies both dyslexia and SLI and NWR is a marker of SLI.

Prema, Prasitha, Savitha, Purushotham , Chitra,& Balaji (2010) conducted a study to examine the performance on NWR task by children with SLI in Kannada, a South-Indian Dravidian language with the objective of checking the feasibility of using this task as a clinical marker for identification of children with SLI. The study was conducted by employing a comparative design using matched pair of subjects. 14 year old male child

diagnosed as SLI matched with a typically developing child on age, gender, language, socio-economic status and grade were selected for the study. Fifteen nonwords from a set of nonwords were adapted for the study. All the non-words had been formed with the syllables from the Kannada syllabary. The nonwords were of 3-syllable length each. 21 year old female Kannada speaker recorded the nonwords in an audio cassette. The subjects were asked to repeat the non words presented through a cassette player under headset. Their responses were transcribed verbatim using broad phonetic transcription. The transcribed samples were analyzed for accuracy of response and the nature of incorrect responses. The results suggested that there was 93.3% accuracy in the repetition of non words by typically developing child as against 46.6% for the child with SLI. The error analysis included the analysis of the phonological processes and an examination of the productive error patterns in the children's responses. Consistent error patterns such as additions, devoicing, omission, and liquid gliding were observed in the non word repetition of the child with SLI. One significant observation was that, all the non words that had liquids were incorrectly produced and backing, the phonological process which is generally not observed in normal children was also predominant. These findings suggested a probable processing decrement for the production of liquids. They suggested the possibility of inclusion of NWR task in the assessment of children with SLI who are native speakers of Kannada provided further research with large sample size is undertaken to corroborate the results.

To summarize, poor phonological working memory affects both the acquisition of new words (which demand the retention of new phonological sequences) and broader levels of language processing such as sentence comprehension that require the manipulation of phonological information (Briscoe, Bishop, & Norbury, 2001) and thereby leading to delay in language learning in children with language impairment. It has also been consistently shown that English speaking children with SLI have an

apparent deficit in Phonological Working Memory (PWM) and score significantly lower than their age-matched typically developing peers and also language-matched typically developing peers in nonword repetition (NWR) tasks, particularly as the length of the nonwords increases (Dollaghan & Campbell, 1998; Marton & Schwartz, 2003; Gathercole, 2006). The typical pattern is that children have no difficulty repeating one and two syllable items but by three syllables, repetition accuracy begins to decrease, reflecting the capacity-limited nature of the phonological store. Children with 'greater' phonological working memory capacity than those with less capacity show better accuracy for longer items. The logic behind the task is that poor performance reflects a basic language-related processing ability that should be critical to the processing and learning of language. Indeed, many studies report a positive relation between children's phonological working memory and word learning (Gathercole & Baddeley, 1989, 1990b; Gathercole, Willis, Emslie, & Baddeley, 1992; Gathercole, Service, Hitch, & Martin, 1997; Avons, Wragg, Cupples, & Lovegrove, 1998) and expressive skills (Adams & Gathercole, 1995).

An association has also been found between nonword repetition and language skills in school-age children with both typical and atypical language development (Gathercole & Baddeley, 1990; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Montgomery, 2002). A number of studies on groups of typically developing children ranging from 3 to 5 years of age have revealed correlations between nonword repetition and children's receptive and expressive vocabulary size. Associations have also been found between nonword repetition and indices of speech output including repertoire of vocabulary, utterance length, and grammatical complexity (Gathercole & Baddeley, 1989; Adams & Gathercole, 1995, 2000). Although there are no direct data yet, it has been argued that PWM may also play an important role in children's

grammatical and morphological learning (Nelson, 1987; Plunkett & Marchman, 1993).

Such studies using NWR task has been replicated in a few other languages other than English such as Spanish (Girbau & Schwartz, 2009), Cantonese (Stokes, Wong, Fletcher, & Leonard, 2006), Swedish (Sahlen, Wagner, Nettelbladt, & Radeborg, 1999), Dutch (De Bree, Rispens, & Gerrits, 2007) and Kannada (Prema, Prasitha, Savitha, Purushotham , Chitra,& Balaji, 2010). These studies and the other studies carried out in English speaking children varied in sample sizes and the inclusion of control group (age-matched group or language matched group and sometimes both). Some of these studies have yielded mixed results, suggesting that children with SLI speaking other languages may not have a deficit in the NWR tasks. This could be attributed to the possible prosodic (temporal & sequential) influences on the NWR (Marshall, Ebbels, Harris, & van der Lely, 2002). Other reasons that could lead to such mixed findings is the phonotactic structure of language, the complex syllable structures and timing patterns of some languages, or superior redintegration skills of typically developing age-matched children (Stokes, Wong, Fletcher, & Leonard, 2006). Though non-word repetition has been put forward as a powerful indicator of presence of language impairment, there are cross-linguistic differences questioning its effectiveness in identifying children with SLI. Moreover such studies in the Indian context are also limited. Since there is lack of data with respect to the nonword repetition abilities in children with SLI and its relationship to aspects of language, this study was planned with the aim of investigating the differences in phonological working memory in Kannada speaking children with SLI and typically developing language matched controls through the use of a nonword repetition task and to examine the relationship between nonword repetition abilities and the receptive vocabulary in these children.

CHAPTER III

METHOD

The present study investigated the nonword repetition abilities of Kannada speaking children with language impairment and also examined whether their nonword repetition abilities correlated with some language measures.

Subjects:

A total of nineteen Kannada speaking children with chronological age ranging between 3 to 7 years served as subjects for the study. The clinical group consisted of nine children in the age range of 4.5 to 7 years diagnosed as Delayed speech and Language (language impairment) by a qualified team of professionals including speech-language pathologist and psychologist. They were matched for language to the control group by determining their language age with the help of a standardized test of language viz. Kannada Language Test (Karanth, 1995) a diagnostic language tool. All the children had average intelligence quotient. The control group consisted of ten typically developing children with normal hearing and normal receptive and expressive language skills, matched for language age and socioeconomic status. The language age of all the children ranged from 3-4 years which was again determined by using Kannada Language Test. They were mainly recruited through nursery and kindergartens.

The children included in both the groups had no history of sensory, intellectual, neurological, medical, oro-motor, emotional, or behavioral disturbances. In addition the WHO Ten-question disability screening checklist (Singhi, Kumar, Malhi & Kumar, 2007) was used to rule out any disability for the children in the control group. All the children had

attended speech-language therapy for an average duration of one week (demonstration therapy) and were advised to continue to train the child at home.

Subject selection criteria:

The subjects in the clinical group were selected based on the following inclusionary criteria:

1. The receptive age and expressive age being 6 months or more below the chronological age, but with the overall language age (receptive and expressive) of at least 3 years, as revealed by the Kannada Language Test.
2. Subjects with known minimal consistent articulatory errors, whose speech can be easily understood, as evaluated by Kannada articulation test (Babu, Rathna & Bettageri, 1972). Subjects with more number of consistent or inconsistent articulatory errors and with phonological processes inappropriate for their chronological age and who had poor speech intelligibility were excluded from the study.
3. No evidence of fluency problem in the speech of the children.

Ethical standards used in the study: Ethical procedures were used to select the participants. The parents were explained the purpose and the procedures of the study and an informed verbal and /or written consent were taken.

The present study was carried out in two phases: Phase 1 involved the preparation of the list of nonwords and phase 2 involved the administration of the nonword repetition task and the assessment of their receptive vocabulary.

Phase 1: Preparation list of nonwords:

The nonwords used in the study were constructed by selecting meaningful words from Computerized Linguistic Protocol (in Kannada) for Screening Children (CLIPS) (Anitha & Prema, 2008) and words from 'With a little bit of help-Early Language Training Manual' (Karanth, Manjula, Prema & Geetha, 1999). A total of 52 meaningful words were selected and different rules were applied to create 'nonwords'. The list of the nonwords were developed based on the following criteria.

1. The nonwords constructed were such that none of their individual syllables (CV or CVC) corresponded to a Kannada word. This was done to ensure that the nonwords included were not affected by a subject's vocabulary knowledge.
2. The nonwords contained sounds that were within the phonetic inventory of the children selected.
3. The nonwords did not include consonant clusters.
4. No consonants occurred more than once within a given nonword.
5. The consonants of the original word were maintained.
6. The nonwords developed followed the phonotactic rules of the Kannada language.

The rules used to construct the nonwords differed for the words of different syllable length and are as follows:

Rules used for preparation of 2-syllable length nonwords: The vowels of the original word were transposed such that it formed a nonword in Kannada. For example, na:ji (word) to nija: (nonword).

Rules used for preparation of 3-syllable length nonwords: The position of one of the syllable of the word was maintained and the other two syllables of the word were transposed, such that it formed a nonword in Kannada. For example, kiṭaki (word) to ṭakiki (nonword).

Rules used for preparation of 4-syllable and 5-syllable length nonwords: Three or four syllables were transposed in 4-syllable words and four or five syllables were transposed in five-syllable words to form a nonword in Kannada. For example, 4-syllable nonword: d ḏoḍḍavanu (word) to nuḍḍaḏova (nonword), 5-syllable nonword: nɛgɛjuvuḏu (word) to gɛḏujunɛvu (nonword).

These 52 nonwords prepared were subjected to a judgement on word-likeliness on a 4-point rating scale by five adult native speakers of Kannada, with '3' denoting the highest degree (100%) of word-likeliness and '0' denoting least degree (not at all similar to any meaningful Kannada word) of word-likeliness. The words which were rated with a point of '0' or '1' were included in the final list of nonwords, five at each of the 2-syllable length, 3-syllable length, 4-syllable length and 5-syllable length. All the stimuli began with a consonant and ended with a vowel. The syllable structure for the two-, three- four- and five-syllable nonwords were CVCV, CVCVCV, CVCVCVCV, CVCVCVCVCV.

The final list contained a total of 25 nonwords, with 20 nonwords as the test items (5 under each of the syllable lengths used) and 5 nonwords as the practice items. The 20 nonwords recorded consisted of a total of 70 syllables. The list of nonwords have been provided in the appendix. The prepared list of nonwords were then audio-recorded by a female native speaker of Kannada, using the "PRAAT" software (downloadable software for speech recording and analysis) loaded in the Compaq Presario C 700 laptop system and then loaded into DMDX software to maintain a constant inter-stimulus interval of 4msec. A pilot study was carried out to ensure that the nonwords can be repeated by 3-4 year old group of

normal children with ease and to check whether the interstimulus interval was adequate or not to repeat the nonwords.

Phase 2: Administration of the nonword repetition task to evaluate the phonological working memory capacity and assessment of receptive vocabulary skills.

Procedure:

The list of recorded nonwords along with five practice items were presented using DMDX software, through headphones auditorily at the comfortable listening level to the individual participants, in a quiet listening environment. Each participant was given the recoded instructions in Kannada through headphones as following: “I am going to say some funny made-up words. Your job is to say them back to me, exactly the way you hear them. Some of the words will be short, and others will be longer. Listen carefully, because I will be saying the words only once. Here comes the first word.” The list of five practice items were presented first followed by the test items. The responses were audio recorded directly into the DMDX software. No prompting or cueing were presented regarding the accuracy of the child’s production during the testing. No feedback was given on the test items, but encouragement was given as required. The nonwords were presented in the order of increasing difficulty (all two-syllable non words, followed by three-syllable nonwords etc.)

In addition, the subjects were evaluated for their receptive vocabulary using KPVT- A Screening Picture Vocabulary Test in Kannada (Sreedevi, 2002). The test consisted of thirty pictures. The subject was instructed to point to the appropriate picture named by the experimenter from a set of four pictures. The total time taken to complete the nonword repetition task and vocabulary assessment task was approximately 30minutes.

Analysis:

The participants' productions were audio recorded and were transcribed verbatim using broad phonetic transcriptions by the experimenter. The audio recorded responses were analyzed for the accuracy of the repetition and the type of errors. The accuracy of each of the individuals' responses was calculated as follows:

Accuracy of the response: This was calculated as the whole word correct or incorrect. Exact repetition of all the syllables in a nonword, as matched to the target nonword was considered as correct and assigned a score of '1'. Any syllable substitutions, omissions, and additions were considered as incorrect and scored '0'. The distortions of a syllable and segmental substitutions based on normal phonological processes were counted as correct. The exact repetition of the target nonword was scored, and incorrect repetition of the nonword with any of the errors mentioned above was scored as '0'. The total number of nonwords correct out of the 20 nonwords were calculated and tabulated in the score sheet.

Error analysis: The total number of vowels and consonants repeated correctly and the total number of different types of errors such as substitutions, omissions, and additions were averaged across the different syllable lengths. The total percentage of vowels correct, total percentage of consonants correct and the type and frequency of errors namely, substitution, omission, and addition errors were calculated for each of the nonword repeated from the raw scores. The percentage of vowels/consonants correct was obtained by dividing the number of vowels/consonants correct by the total number of vowels/consonants multiplied by 100.

$$\text{Percentage of vowels/consonants correct} = \frac{\text{Number of vowels/consonants correct}}{\text{Total number of vowels/consonants}} \times 100$$

The total percentage of different errors was also computed in a similar manner for each subject for the entire set of nonwords and also at each of the different syllable length.

Receptive vocabulary score: The subject's vocabulary score was computed from the KPVT. A correct response received a score of '1'and an incorrect response was scored '0'. The total number of pictures identified correctly was determined and the total score was computed.

Statistical analysis:

The obtained data were appropriately tabulated and subjected to statistical measures. SPSS software (version 16.0) package was used for statistical analysis. Descriptive statistics was used to compute the mean and standard deviation. Other statistical procedures such as Repeated measure ANOVA, Boneferroni's pairwise comparison test, independent samples t-test, Karl Pearson's correlation coefficient, MANOVA and paired t-test was carried out to answer the research questions of the present study.

Chapter IV

Results and Discussion

The present study investigated whether children with language impairment (CWLI) had difficulty in nonword repetition task as compared to the children with normal language skills (CWNL) and also examined whether any relationship existed between nonword repetition and their receptive vocabulary. Nine CWLI (clinical group) with language age of 3-4years were compared against language age matched ten typically developing children (control group). Two tasks were administered to children in both the groups. The first was a nonword repetition task in which all the children were presented with a total of twenty nonwords which consisted of five nonwords at four syllable lengths viz. two-syllable, three-syllable, four-syllable and five-syllable length. The second task involved the administration of Kannada Picture Vocabulary Test (Sreedevi, 2002), to assess their receptive vocabulary. All the subjects were tested individually and the recorded nonwords were presented through headphones one at a time and the responses were automatically recorded into the DMDX software. Then the nonwords were scored and the total number of correct responses was calculated for all the children. The scores of both the tests were tabulated and subjected to the following statistical analytical procedures using SPSS version 16.

- Descriptive statistical analysis was used to compute the mean and standard deviation scores for the both the groups individually.
- Independent samples t-test was used to find out significant different between groups.
- Repeated Measure ANOVA was used to examine whether significant difference existed within the groups across different syllable lengths.

- Boneferroni's Pairwise comparison test was used to find out the pairs of syllable lengths on which there was significant difference in the performance of children with in the groups.
- MANOVA was used to find out the significant difference in the performance between the groups on the aspects such as percent of vowels/consonants/syllables correct and percent of syllable substitution/omission/additions.
- Paired t-test was used to find out the significant difference between percentage of vowels and consonants correct within groups.
- Karl Pearson's Correlation Coefficient was used to find out the relationship between nonword repetition accuracy and receptive vocabulary.

The results of the statistical analysis for both groups on both the tasks have been discussed under the following sections:

I. Overall accuracy of responses
II. Accuracy across the syllable length
III. Error analysis in the nonword repetition task
IV. Relationship between the accuracy of nonword repetition task and receptive vocabulary skill

I. Overall accuracy of responses

The accuracy of the responses was determined by calculating the total number of nonwords repeated correctly. Descriptive statistics was used to compute the mean and standard deviations and the values for both the groups are depicted in the table 1.

Table 1:

Mean and standard deviations (SD), and t-values of scores for accuracy of responses on nonword repetition task in CWLI and CWNL.

Accuracy of responses	**Group**	**Mean**	**SD**	**t-values (17)**
A2s	CWLI	3.56	1.42	1.41
	CWNL	4.30	0.82	
A3s	CWLI	3.22	1.30	1.75
	CWNL	4.20	1.14	
A4s	CWLI	2.00	1.00	4.58*
	CWNL	4.10	0.99	
A5s	CWLI	1.00	1.32	2.65*
	CWNL	2.40	0.96	
Overall Accuracy	CWLI	9.78	4.41	3.45*
	CWNL	15.20	2.20	

[A2s- accuracy at 2-syllable length nonwords; A3s-accuracy at 3-syllable length nonwords; A4s- accuracy at 4-syllable length nonwords; A5s-accuracy at syllable length nonwords, *$p<0.05$].

The overall mean score for accuracy for the nonword repetition task in the CWNL group was 15.2 (SD= 2.20), which is greater than the mean for the CWLI group which was 9.78 (SD=4.40). This indicates that the CWLI had lower accuracy than the CWNL for the nonword repetition task. The following figure 1 below depicts the same.

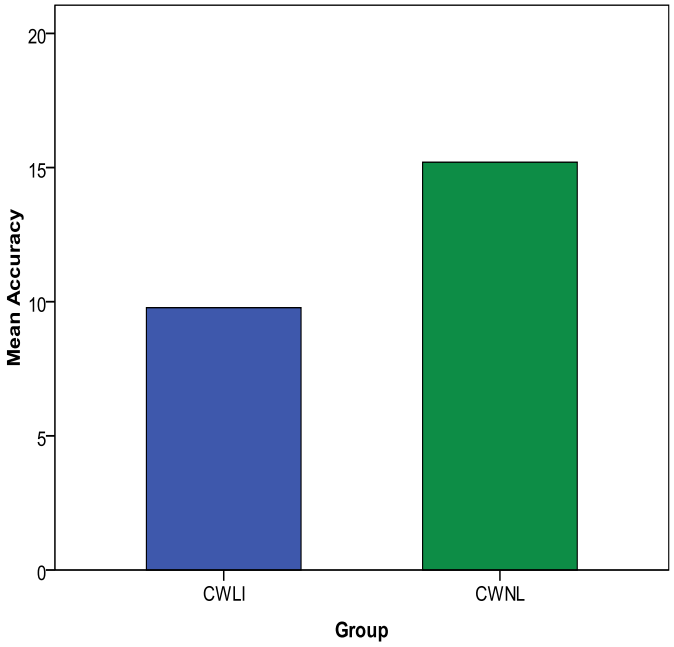

Figure 1: Mean accuracy of the responses on nonword repetition task in CWLI and CWNL group.

To determine whether any significant difference existed between the performance of both the groups as a whole, independent t-test was administered and the results revealed that the performance of the CWLI was significantly poorer than that of the CWNL. On specific examination of the performance of the two groups at across different syllable length, it was seen that there was no statistically significant difference in the performance on 2- and 3-syllable length nonwords between the groups ($p>0.05$). But there was a significant difference in the performance between groups on the repetition of 4- and 5-syllable length nonwords.

The results of the present study replicates the results of the earlier studies which indicated poorer performance of the children with SLI on nonword repetition compared to the typically developing children (Kamhi, Catts, Mauer, Apel, & Gentry, 1988; Gathercole & Baddeley, 1990; Montgomery, 1995; Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000; Conti- Ramsden, 2003 ; Conti-Ramsden & Hesketh 2003; Gray, 2003; Archibald & Gathercole, 2006b; de Bree,

Rispens & Gerrits, 2007; Girbau & Schwartz, 2007; Conti-Ramsden &Durkin, 2007). They suggested that the children with SLI have a deficit in phonological working memory capacity that is they have reduced capacity to process and store phonological information. This deficit plays a causal role in their language impairment, according to them leading to their poorer performance on nonword repetition task (Gathercole & Baddeley, 1990). Also the cognitive complexity of a nonword repetition task overtaxes the general processing resources of children with SLI, thereby hindering their ability to create and thus store accurate phonological representations of unfamiliar input and hence poor performance on nonword repetition task (Edwards & Lahey, 1998).

However, these results are in contrast to the study by Stokes, Wong, Fletcher & Leonard (2006) who found that Cantonese speaking children with SLI performed at par with the typically-developing age matched children. They concluded that the NWR task in Cantonese does not tax the working memory in the same way that nonwords do in other languages such as English and Swedish. This difference could be attributed to the complex phonotactic structures, variable stress patterns, prosodic (temporal and sequential properties) and difficult-to-articulate consonants in English and Swedish compared to the Cantonese language. They also suggested that the other possible factors contributing to the better performance of English speaking typically developing age-matched children on nonword repetition task, was that the target nonwords in their test stimuli had items which were more similar to the real words, though was not claimed so. And hence they suggested that the normal children could relate the target nonwords to the long-term memory language store and used lexical and phonotactic information to "fill in the blanks" of the skeletal score (the CVC pattern), creating either an accurate response or a close approximation to the target nonword. This process used by the children with typical language development was termed as redintegration which was reported to be lacking in the children with SLI due to deficient

language skills. Hence the results of the present study with respect to the accuracy of responses in nonword repetition task seemed to follow the same pattern as in English, Spanish, Dutch and Swedish.

The finding that there was a significant difference between the groups at the 4 and 5 syllable levels are in consonance with the study done in Dutch where they reported that there was a sharp decrease in the accuracy of the responses at a target length of 4-syllable nonwords in children with SLI (de Bree, Rispens, & Gerrits, 2007).

However, studies done in English and Spanish languages suggest that the children with SLI have difficulty in repeating nonwords of 3-syllable length and above (Dollaghan & Campbell, 1998; Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000; Girbau & Schwartz, 2007). This could be attributed to the differences in the complexity of the syllable structure between the Kannada and English languages. It has been reported according to the rhythm class hypothesis by Abercrombie (1967) that English has relatively complex syllabic structure, for e.g., CCV and CCCVCC and is classified as stress-timed language and Kannada is a syllable-timed language considered to be having relatively simple syllabic structure, for e.g., CVCVCV pattern.

The results of the present study suggests that 4- and 5-syllable nonwords were better in differentiating CWLI and CWNL on nonword repetition performance and hence can be considered as a good indicator of phonological working memory deficit in CWLI and this was in consonance with the results of the earlier studies (e.g., Bishop, North, & Donlan, 1996; Bishop, 2002; Girbau & Schwartz, 2008).

II. Accuracy across syllable length

The mean values of accuracy for both the groups across the syllable length showed a decreasing trend with the increase in the syllable length. The mean values depicted in table 1 represent the decrease in the accuracy of the responses with the syllable length in both the groups. The same has been depicted in figure 2.

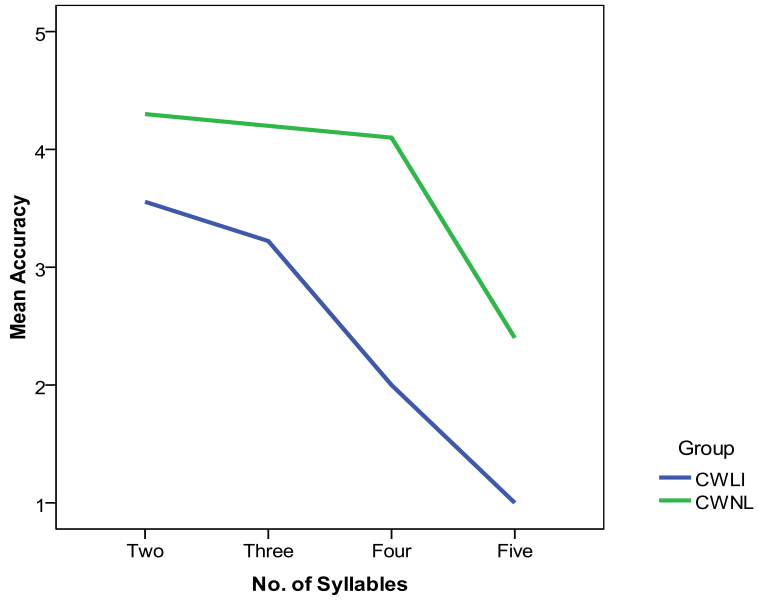

Figure 2: Mean accuracy of the nonword repetition task at different syllable lengths in both CWLI and CWNL.

a. Performance of CWNL:

Repeated Measure ANOVA was used to examine if any significant difference existed across each syllable length in the CWNL group. The results indicated that there was a significant difference in the performance of CWNL across the syllable length [$F(3, 27) = 10.50$, $p < 0.001$)]. In order to determine, which two pairs are significantly different from each other, Bonefferoni's pairwise comparison test was used and the results are shown in table 2.

Table 2:

Pairwise comparison of the syllable lengths in the CWNL group

Syllable length		**Mean Difference**	**Level of significance**
2s	3s	0.10	1.00
	4s	0.20	1.00
	5s	**1.90**	**0.01**
3s	4s	0.10	1.00
	5s	**1.80**	**0.05**
4s	5s	**1.70**	**0.001**

[2s- accuracy at 2-syllable length nonwords; 3s-accuracy at 3-syllable length nonwords; 4s- accuracy at 4-syllable length nonwords; 5s-accuracy at syllable length nonwords].

The analysis indicated that the CWNL performed with accuracy which was not significantly different on the 2-syllable, 3-syllable and 4-syllable nonwords ($p>0.05$). However, the performance of the CWNL was significantly different on the 5-syllable nonwords compared to 2-, 3- and 4-syllable length nonwords ($p<0.05$).

The performance of CWNL in this study was similar to the earlier studies where it was reported that the typically developing children perform better on shorter syllable length nonwords than longer syllable length nonwords because of the limited capacity nature of phonological short-term memory (e.g., Gathercole & Baddeley, 1989; Gathercole, 1999, 2006).

b. Performance of CWLI:

In a similar manner, the performance of CWLI was analysed to determine the accuracy of the nonword repetition across the syllable length. The means and standard deviations as shown in the table 1 indicated that there was decrease in the accuracy of the responses with the increase in the syllable length. To determine whether there was any significant difference in the accuracy of the responses across the syllable length, Repeated Measure ANOVA was used. The results indicated that there was significant difference in the performance of CWLI across the syllable length [F (3, 24) =23.03, p<0.001)]. Following this, Bonefferoni's pairwise comparison test was used to determine which two pairs significantly differed from each other and the results of this procedure is depicted in table 3.

Table 3:

Pairwise comparison of the syllable length in the CWLI group

Syllable length		**Mean Difference**	**Level of significance**
2s	3s	0.33	1.00
	4s	**1.56**	**0.02**
	5s	**2.56**	**0.001**
3s	4s	**1.22**	**0.01**
	5s	**2.22**	**0.00**
4s	5s	1.00	0.10

[2s- accuracy at 2-syllable length nonwords; 3s-accuracy at 3-syllable length nonwords; 4s- accuracy at 4-syllable length nonwords; 5s-accuracy at syllable length nonwords]

The results indicated that there was no significant difference in the performance of the CWLI on the 2-syllable nonwords compared to 3-syllable nonwords and, 4-syllables compared to 5-syllable nonwords ($p>0.05$). However, there was a statistically significant difference in the performance of the CWLI between 4-syllable nonwords compared to 2- and 3-syllables and also 5-syllable nonwords compared to 2- &3-syllable length ($p<0.05$).

The decrease in the accuracy of the nonword repetition with the increase in the length of the nonwords obtained in the present study is in consonance with the results of earlier studies (Kamhi, Catts, Mauer, Apel, & Gentry, 1988; Gathercole & Baddeley, 1990a; Montgomery, 1995a; Montgomery, 1995b; Dollaghan & Campbell, 1998; Marton and Schwartz, 2003; Archibald & Gathercole, 2007) .The decrease in repetition accuracy for memory sequences that have lengthy articulatory durations is suggested to be hallmark of verbal short-term memory deficit and is typically attributed to temporal decay of the phonological representations in a short-term store (Baddeley, Thomson, & Buchana, 1975; Cowan, Saults, Winterowd, & Sherk, 1991). The greater repetition decrement for lengthier nonwords in children with SLI could arise either from accelerated rates of decay before output or from inadequate encoding in the short-term store. Also the unfamiliarity of phonological structure of nonwords forces participants to rely heavily on temporary phonological representations to support their repetition attempt, preventing the reliance on activated lexical representations that arises in memory tasks using familiar verbal stimuli (e.g., Hulme, Maughan, & Brown, 1991).

However this result is not in consonance with the study by Graf-Estes, Evans, and Else-Quest (2007) where the children with SLI had deficit repeating even one- and two-syllable item. Hence they suggested that one-syllable novel word may not be sufficient to overwhelm working memory capacity; children who fail to accurately encode or represent the sound sequence may have trouble repeating it. Longer nonwords may produce compounding

effects for children with SLI if they lack support from the initial phonological representations or from associations with lexical knowledge, and the nonwords overwhelm phonological working memory capacity as well.

The results of the accuracy of the responses across the syllable length indicated that the CWNL had poorer repetition accuracy in nonword repetition at only 5-syllable nonwords, where as the CWLI had poorer repetition accuracy at both 4- and 5-syllable nonwords. This decrease in the repetition accuracy is suggested to be due to the increase in demand on working memory capacity requirements for both groups This indicates a more limited capacity of the phonological loop function in children with SLI than in children with typical language development, similar to the results of the study by Marton and Schwartz (2003).

III. Error analysis in the nonword repetition task

a. Percentage of vowels correct

The mean and standard deviation values for overall Percentage of Vowels correct (PVC) for the total nonwords repetition task and the PVC at each syllable length for both the groups are shown in table 4.

Table 4:

Mean, standard deviation (SD) and F-values indicating the percentage of vowels correct at different syllable lengths on the nonword repetition task for both the groups.

Percentage of vowels correct	**Group**	**Mean**	**SD**	**F(1,17)**	**Level of significance**
PVC2s	CWLI	92.22	10.93	0.16	0.70
	CWNL	94.00	8.43		
	Total	93.16	9.46		
PVC3s	CWLI	88.89	12.01	**4.55**	**0.05**
	CWNL	97.34	3.44		
	Total	93.34	9.43		
PVC4s	CWLI	78.34	25.86	3.30	0.09
	CWNL	94.10	8.43		
	Total	86.58	19.93		
PVC5s	CWLI	63.56	25.49	**6.53**	**0.02**
	CWNL	85.20	8.01		
	Total	74.95	21.07		
TPVC for 20nonwords	CWLI	77.30	18.20	**5.78**	**0.03**
	CWNL	91.57	4.54		
	Total	84.81	14.53		

[PVC - percentage of vowels correct; 2s- 2-syllable nonwords, 3s- 3-syllable nonwords; 4s-4-syllable nonwords; 5s- 5-syllable nonwords; TPVC- Total percentage of vowels correct on the overall nonword repetition task]

The overall mean scores of PVC for the CWNL group and the mean values at 2-syllable, 3-syllable, 4-syllable and 5-syllable is higher than the CWLI group. The PVC also decreased from 2-syllable nonwords to 5-syllable nonwords, that is, the errors increased from shorter syllable length to the longer syllable length nonwords in the CWLI group. In the CWNL group the PVC for 4 & 5-syllable length is lesser than that of the 2 & 3-syllable length.

To determine whether any significant difference between both the groups on total PVC and PVC at each of the different syllable lengths, MANOVA was used instead of independent-t-test due to presence of more number of dependent variables and the F-values are indicated in the table 4. The results of MANOVA indicated a significant group difference in the total PVC for the overall nonword repetition task, at the 3-syllable length and 5-syllable nonword repetition, where the CWNL had higher percentage of the vowels correct than CWLI ($p<0.05$).

The results of the present study are in consonance with the study done by Girbau & Schwartz (2008), who found that the children with SLI aged 8.10years, though scored higher on vowels compared to consonants, they did not perform on par with the children with typical language development who had almost 100% score on the percentage of vowels correct. In addition, the age-matched children with typical language development achieved nearly 100% scores on the vowels, with only six children scoring 95% score. They found that children with SLI did not approach the ceiling scores, despite the fact that all participants produced vowels more accurately than consonants. They suggested that the performance of the SLI children reflected the limited vowel inventory of Spanish (five vowels) and the fact that vowels are fully acquired earlier in development than the complete consonant inventory.

b. Percentage of Consonants Correct

Similar to PVC, the mean and standard deviation values for overall percentage of consonants correct (PCC) for the nonword repetition task and the PCC at each of the different syllable lengths for both the groups are shown in table 5. The overall mean of PCC and the mean at different syllable lengths revealed similar pattern as that of percentage of vowels correct, where the PCC was higher in CWNL than in the CWLI group. In addition, the PCC was least at the 5-syllable nonwords for the CWLI group.

Table 5:

Mean, standard deviation (SD) and F-values indicating the percentage of consonants correct at different syllable lengths on the nonword repetition task for both the groups.

Percentage of consonants correct	**Group**	**Mean**	**SD**	**F(1,17)**	**Level of significance**
PCC2s	CWLI	73.33	26.46	1.65	0.22
	CWNL	85.00	10.80		
	Total	79.47	20.13		
PCC3s	CWLI	86.67	21.60	1.45	0.25
	CWNL	95.33	7.06		
	Total	91.23	15.88		
PCC4s	CWLI	73.33	22.36	4.32	0.05
	CWNL	89.50	9.85		
	Total	81.84	18.43		
PCC5s	CWLI	58.22	27.21	**9.94**	**0.006**
	CWNL	87.60	10.91		
	Total	73.68	24.81		
TPCC for 20 nonwords	CWLI	70.00	22.45	**7.06**	**0.02**
	CWNL	89.43	5.48		
	Total	80.23	18.40		

[PCC - percentage of consonants correct; 2s- 2-syllable nonwords, 3s- 3-syllable nonwords; 4s-4-syllable nonwords; 5s- 5-syllable nonwords; TPCC- Total percentage of consonants correct on the overall nonword repetition task]

Analysis done using MANOVA indicated that there was significant difference between both the groups in the total PCC for the overall nonword repetition task and also at the 5-syllable length nonwords, where the CWNL performed better than the CWLI ($p<0.05$). The results of the present study are in consonance with the study done by Marton and Schwartz (2003) and Girbau and Schwartz (2008). They reported that the children with SLI made more consonant errors overall and in the 3-, 4-, and 5 -syllable nonwords.

c. Comparison between total PVC and PCC in the CWNL group

To determine whether CWNL group had greater difficulty in the production of vowels or consonants during the nonword repetition task, the mean and standard deviation scores for total PVC and the total PCC were calculated. The mean values indicated that the CWNL group had higher PVC (Mean = 91.57, SD = 4.54) than PCC (Mean = 89.43, SD = 5.48). Paired t-test was used to determine the significant difference between the total PVC and total PCC in the CWNL group. The results indicated that there was significant difference between total PVC and PCC at [$t(9) = 2.764$, $p<0.05$].

d. Comparison between total PVC and PCC in the CWLI group

To determine whether CWLI group had greater difficulty in the production of vowels or consonants during the nonword repetition task, the mean and standard deviation scores for total PVC and the total PCC were computed. The mean values indicated that the CWLI group had higher PVC (Mean = 77.30, SD = 18.20), than on total PCC (Mean = 70.00, SD = 22.4). Paired t-test indicated that there was significant difference in the total PVC and PCC in the CWLI group at [$t(8) = 3.68$, $p<0.05$]. That is the CWLI had more difficulty in repeating

consonants, than vowels similar to the results obtained in CWNL group. The average percentage of vowels and consonants correct has been depicted in figure 3.

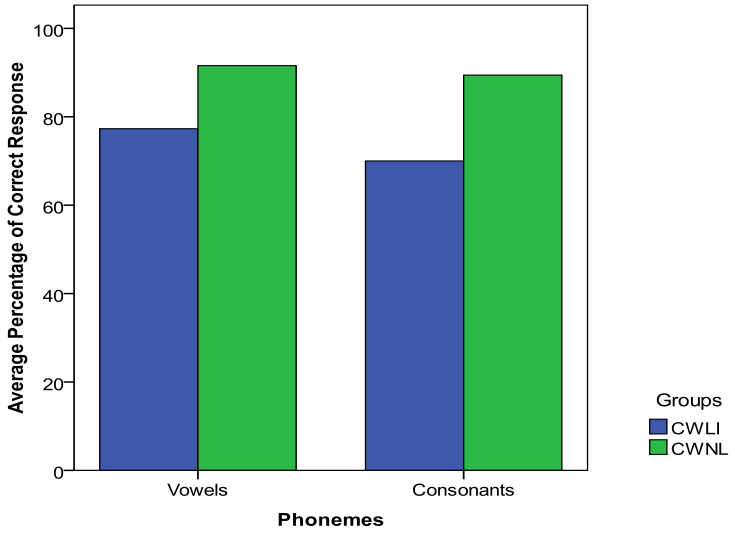

Figure 3: Representation of the average percentage of the phonemes correct in the CWNL and CWLI group.

The results of the present study are in consonance with the study done by Girbau and Schwartz (2008). They concluded that vowels are preferentially preserved in the phonological working memory task in children with SLI and children with typical language development.

e. Percent syllable substitution (PSS)

The mean and standard deviation scores for percentage of syllables substituted (PSS) were calculated for each of the different syllable length nonwords and also for the overall nonword repetition task are shown in the table 6. These values indicate that the CWLI had higher PSS than CWNL overall and at each syllable length.

The results of MANOVA indicated that there was a significant difference in the PSS only at the 5-syllable length where CWLI had higher PSS indicating more errors than CWNL ($p<0.05$). The results of the present study are similar to the studies by Marton and Schwartz

(2003) and Girbau and Schwartz (2008). They found that the children with SLI produced more percentage of substitutions than children with typical language development overall and in the 3-4-and 5-syllable nonwords.

Table 6:

Mean, standard deviation and F-values indicating the PSS across different syllable lengths in CWNL and CWLI.

Percentage of syllables substituted	**Group**	**Mean**	**SD**	**F(1,17)**	**Level of significance**
PSS2s	CWLI	20.00	11.18	1.29	0.27
	CWNL	14.00	11.74		
	Total	16.84	11.57		
PSS3s	CWLI	12.59	16.81	2.26	0.15
	CWNL	4.00	6.44		
	Total	8.07	12.88		
PSS4s	CWLI	21.67	14.14	3.27	0.09
	CWNL	10.50	12.79		
	Total	15.79	14.27		
PSS5s	CWLI	31.11	22.78	**5.84**	**0.03**
	CWNL	12.80	7.254		
	Total	21.47	18.58		
TPSS for 20 nonwords	CWLI	20.64	14.64	4.30	0.05
	CWNL	10.57	4.477		
	Total	15.34	11.49		

[PSS - percentage of syllable substituted; 2s- 2-syllable nonwords, 3s- 3-syllable nonwords; 4s-4-syllable nonwords; 5s- 5-syllable nonwords; TPSS- Total percentage of syllable substituted on the overall nonword repetition task]

f. Percentage of Syllable Addition

The mean and standard deviation scores for percentage of syllables addition (PSA) were calculated for each of the different syllable length nonwords and also for the overall nonword repetition task and are shown in the table 7. These values indicate that the CWLI had higher PSA than CWNL in total and also at each of the different syllable lengths.

Table 7:

Mean, standard deviation and F-values indicating the PSA across different syllable lengths in CWNL and CWLI.

Percentage of syllable additions	**Group**	**Mean**	**SD**	**F(1,17)**	**Level of significance**
PSA2s	CWLI	2.22	4.41	0.49	0.49
	CWNL	1.00	3.16		
	Total	1.58	3.75		
PSA3s	CWLI	0.74	2.22	0.27	0.62
	CWNL	1.33	2.81		
	Total	1.05	2.50		
PSA4s	CWLI	3.33	8.30	1.63	0.22
	CWNL	0.00	0.00		
	Total	1.58	5.79		
PSA5s	CWLI	0.89	2.67	1.12	0.30
	CWNL	0.00	0.00		
	Total	0.42	1.84		
TPSA for 20 nonwords	CWLI	1.75	3.18	1.64	0.22
	CWNL	0.43	0.69		
	Total	1.05	2.28		

[PSA - percentage of syllable additions; 2s- 2-syllable nonwords, 3s- 3-syllable nonwords; 4s-4-syllable nonwords; 5s- 5-syllable nonwords; TPSA-Total percentage of syllable additions on the overall nonword repetition task]

The results of MANOVA indicated that there was no significant difference in the percentage of syllable addition between the groups ($p>0.05$). The results of the present study replicated the findings of the earlier study by Girbau and Schwartz (2008). They found that there was no difference in the percentage of syllable additions on the overall nonword repetition task and also for the 3-4-and 5 -syllable nonwords between the children with SLI and children with typical language development.

g. Percentage of Syllable Omission

The mean and standard deviation scores for percentage of syllables omission (PSO) were calculated for each of the different syllable length nonwords and also for the overall nonword repetition task and are shown in the table 8. These values indicate that the CWLI had higher PSO than CWNL overall and at each syllable length.

Though the percentage of syllable omissions was greater in CWLI than in CWNL on the overall nonword repetition task and at each of the different syllables, there was no statistically significant difference between the groups on these measures as determined by MANOVA ($p>0.05$). These results are not in consonance with the earlier study by Girbau and Schwartz (2008), where they found that children with SLI had higher percentage of the syllable omissions on overall nonword repetition task and for the 3-4-5 syllable nonwords.

Table 8:

Mean, standard deviation and F-values indicating the PSA across different syllable lengths in CWNL and CWLI.

Percentage of syllable omission	**Group**	**Mean**	**SD**	**F(1,17)**	**Level of significance**
PSO2s	CWLI	8.89	20.28	1.94	0.18
	CWNL	0.00	0.00		
	Total	4.21	14.27		
PSO3s	CWLI	5.19	13.24	1.54	0.23
	CWNL	0.00	0.00		
	Total	2.46	9.22		
PSO4s	CWLI	12.22	25.99	1.51	0.24
	CWNL	2.00	4.22		
	Total	6.84	18.35		
PSO5s	CWLI	19.56	27.67	2.74	0.12
	CWNL	4.80	5.59		
	Total	11.79	20.33		
TPSO for 20nonwords	CWLI	12.86	19.74	2.83	0.11
	CWNL	2.29	2.63		
	Total	7.29	14.36		

[PSA - percentage of syllable omission; 2s- 2-syllable nonwords, 3s- 3-syllable nonwords; 4s-4-syllable nonwords; 5s- 5-syllable nonwords; TPSO-Total percentage of syllable omission on the overall nonword repetition task]

h. Predominantly occurring errors

The mean and standard deviations were compared for the total percent of syllable substitution (PSS), the total percent of syllable addition (PSA) and the total percent of syllable omission (PSO) for both the groups. It was found that both the groups had higher percent of syllable substitution error compared to the other types of errors as shown in table 9. The CWLI group had higher PSO than the CWNL group. The same has been depicted in the figure 4.

Table 9:

Mean and standard deviations of different types of error

Types of errors*	**Group**	**Mean**	**Std. Deviation**
TPSS	CWLI	20.64	14.64
	CWNL	10.57	4.48
TPSA	CWLI	1.75	3.18
	CWNL	0.43	0.69
TPSO	CWLI	12.86	19.74
	CWNL	2.29	2.63

[*TPSS- Total percent of syllable substitution, TPSA- Total percent of syllable addition, TPSO- Total percent of syllable omission]

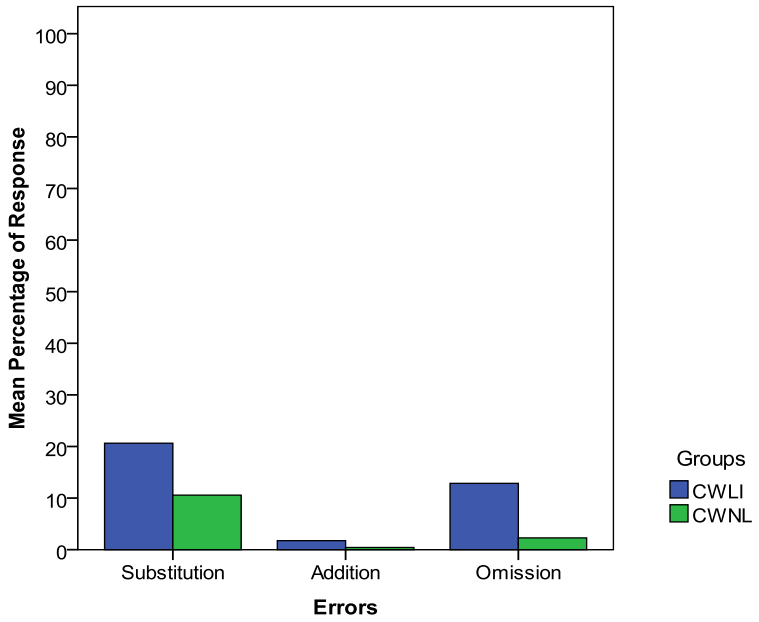

Figure 4: Representation of the errors types in the CWLI and CWNL group.

Repeated measure ANOVA was administered to determine any significant difference in the error type in both the groups and the results indicated that there was a significant difference in the type of error in both CWNL group [$F(2, 18) = 53.29$, $p<0.05$] and CWLI group [$F(2, 16) = 4.366$, $p<0.05$]. To determine which two pairs are significantly different in the CWNL group, Boneferroni's pairwise comparison test was used. The results indicated that there was significant difference between the PSS and the other two types of errors indicating that the PSS was higher in CWNL ($p<0.05$). In the CWLI group, using Boneferroni's pairwise comparison test, that there was significant difference only between the PSS and the PSA ($p<0.05$). These results are depicted in table 10.

Table 10:

Results of Boneferroni's pairwise comparison test for the different types of errors in both the groups

Pairwise comparison of error types		**CWNL**		**CWLI**	
		Mean Difference	**Level of significance**	**Mean Difference**	**Level of significance**
PSS	PSA	**10.14**	**0.00**	**18.89**	**.007**
	PSO	**8.29**	**0.00**	7.78	1.00
PSA	PSO	1.86	0.12	11.11	0.36

[PSS- percentage of syllable substitution; PSA-percentage of syllable addition; PSO - percentage of syllable omission]

The result of the present study is in consonance with the results of the earlier studies done by Marton and Schwartz (2003) and Girbau and Schwartz (2008) who found that consonant substitutions were the most frequent type of error found in the nonword repetition task in both the children with typical language development and children with SLI on the entire nonword repetition task and also at 3-, 4- and 5-syllable nonwords. The errors in children with SLI were attributed to the some underlying weakness in phonological knowledge or memory for phonological information, including the nature of phonological representations in working memory (Edwards & Lahey, 1998; Ellis Weismer & Edwards, 2006).

IV. Relationship between accuracy of the nonword repetition and receptive vocabulary

The receptive vocabulary of both the CWNL and CWLI was assessed using KPVT- A Screening Picture Vocabulary Test in Kannada (Sreedevi, 2002). The number of correct responses was calculated for each child in both the groups. The mean scores indicated better performance of the CWNL group (Mean= 17.40, SD=2.41) compared to the CWLI group

(Mean= 14.33, SD=2.12). Further analysis using independent samples t-test revealed a significant difference in the performance between the groups on the vocabulary test [t (17) = 2.93, p<0.05].

Karl Pearson's correlation coefficient was used to determine the relationship between nonword repetition accuracy and receptive vocabulary scores. The results indicated that there was no significant correlation between these two measures in both CWLI (r= 0.109, p>0.05) and CWNL (r=0.249, p>0.05) group. The same is depicted in the figure 5.

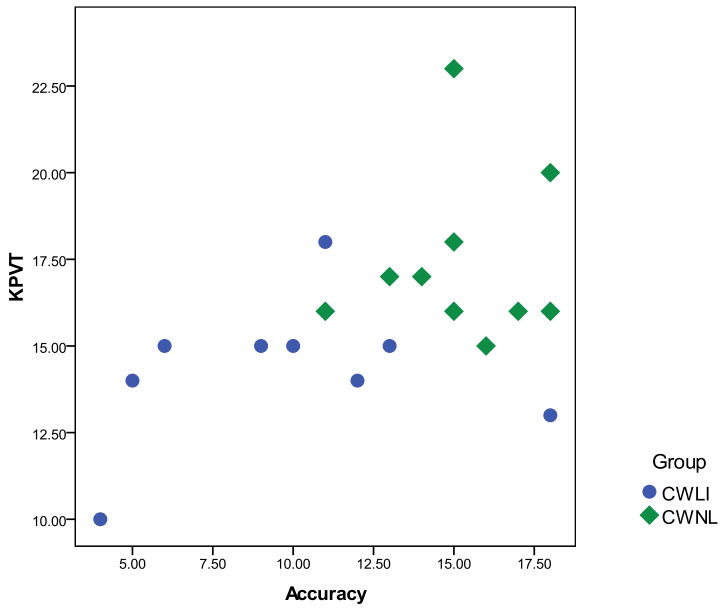

Figure 5: Scatter plot between the nonword repetition scores and receptive vocabulary scores

The above results are in consonance with the results obtained by Metsala (1999) and Sahlen, Wagner, Nettelbladt, and Radeborg (1999). Sahlen et al. (1999) evaluated the relationship between nonword repetition and tests of comprehension of grammar, vocabulary comprehension, and comprehension of words, sentences and fables. They found that there was a weaker correlation between vocabulary and fable comprehension and non-word repetition than between non-word repetition and comprehension of grammar. Hence, they

concluded that tests assessing the comprehension of grammar strained language processing and storage more than the other tests.

The result of the present study is in contrast to the earlier studies where significant correlation was found between nonword repetition accuracy and receptive vocabulary in normal children (Gathercole & Adams, 1993, 1994; Gathercole, Service, Hitch, Adams, & Martin, 1999; Bowey, 2001; Roy & Chiat, 2004). The possible factors contributing to the lack of correlation between the nonword repetition and receptive vocabulary scores in the CWNL in the present study was the inappropriate and lack of clear representation of the target words in the picture form in the KPVT. In addition, few of the target word stimuli were inappropriate and unfamiliar to the present day children as these words are rarely used due to modernization. Hence the children with age appropriate language skills also obtained poorer scores in the receptive vocabulary test. Thereby it is recommended that fresh norms be obtained for the test.

In summary, the results of the present study revealed that the performance of the children with language impairment was poorer on nonword repetition task compared to the typically developing children. It was observed that as the syllable length increased, there was a simultaneous increase in errors during repetition in both the groups. The CWLI had a significant difficulty in repeating nonwords of 4 and 5 syllables, while the control group had significant difficulty only at the 5 syllable level. The CWLI group had a higher percentage of vowel and consonant errors compared to the CWNL. The percentage of syllable substitution and syllable omissions were found to be higher in CWLI than CWNL in nonword repetition task. Further, there was no significant relationship between the receptive vocabulary and nonword repetition accuracy in both CWNL and CWLI groups.

CHAPTER V

SUMMARY AND CONCLUSIONS

Children with SLI are significantly delayed in acquiring multiple aspects of language. Deficits including grammatical morphology, phonology, syntax, lexicon and pragmatic skills are observed in children with SLI (Joanisse & Seidenberg, 2003). Many theories have been put forth to explain the different underlying cause for the language impairment in these children. Phonological working memory (PWM) deficit is one of the underlying causes reported leading to delay in language acquisition in children with SLI (Briscoe, Bishop, & Norbury, 2001). Many tools have been devised to examine the PWM; amongst them nonword repetition is reported to be one of the efficient tools to identify the PWM deficit in children with SLI (Bishop, North, & Donlan 1996; Dollaghan & Campbell 1998; Tager- Flusberg & Cooper 1999; Botting & Conti-Ramsden 2001; Conti-Ramsden, Botting, & Faragher 2001; Conti-Ramsden & Hesketh 2003). Many studies have reported that English speaking children with SLI have deficits in nonword repetition task and nonword repetition has been considered as a clinical marker in children with SLI (Bishop, North, & Donlan, 1996; Dollaghan & Gathercole, 1998; Marton & Schwartz, 2003; Gathercole, 2006a, 2006b). Similar results have been obtained in few other languages such as Spanish, Swedish, and Dutch. However, nonword repetition task has not been found to differentiate children with SLI from the age-matched typically developing children in Cantonese language in a study done by Stokes, Wong, Fletcher, and Leonard (2006). Hence literature suggests cross-linguistic differences in the performance of children with SLI on nonword repetition task. In the Indian context there are limited number of studies investigating the performance of the children with SLI on nonword repetition task. Chitra, Balaji, and Prema (2007) investigated the performance of a fourteen year old subject with SLI on nonword repetition task. On account of the poorer performance of the subject on nonword repetition task, they suggested the inclusion of the

nonword repetition task in the assessment battery for the children with SLI, with further investigation of the nonword repetition task on a larger population in children with SLI. Hence there is dearth of research in the Indian context pertaining to the investigation of the performance of the children with SLI on nonword repetition task.

Thus the present study investigated the nonword repetition abilities of Kannada speaking children with language impairment and also examined whether their nonword repetition abilities correlated with some language measures. A total of nineteen Kannada speaking children with chronological age ranging between 3 to 7 years served as subjects for the study. The clinical group consisted of nine children in the age range of 4.5 to 7 years diagnosed as Delayed speech and Language (language impairment) by a qualified team of professionals including speech-language pathologist and psychologist. They were matched for language to the control group by determining their language age with the help of a standardized test of language viz. Kannada Language Test (Karanth, 1995), a diagnostic language tool. All the children had average intelligence quotient. The children with only minimal consistent articulatory errors and good speech intelligibility as revealed by the administration of Kannada Articulation Test (Babu, Rathna & Bettageri, 1972) were included as subjects in the clinical group. The control group consisted of ten typically developing children with normal hearing and normal receptive and expressive language skills, matched for language age and socioeconomic status. The language age of all the children ranged from 3-4 years which was again determined by using Kannada Language Test. It was ensured that control group had no inappropriate phonological process and articulatory errors with respect to their age as screened with Kannada articulation test for any age. The children included in both the groups had no history of sensory, intellectual, neurological, medical, oro-motor, emotional, or behavioral disturbances. In addition the WHO Ten-question disability screening checklist (Singhi, Kumar, Malhi, & Kumar, 2007) was used to rule out any disability for the

children in the control group. The children in both the groups were administered with nonword repetition task which had a list of 20 nonwords at four different syllable lengths- 2-, 3-, 4-, and 5-syllable length. The accuracy of the responses was calculated across different syllable lengths and also on the overall nonword repetition task. All the children were administered with KPVT- A Screening Picture Vocabulary Test in Kannada (Sreedevi, 2002) to examine their receptive vocabulary in order to study the relationship between nonword repetition and receptive vocabulary scores. Appropriate statistical analysis was carried out using SPSS version 16.

The results revealed that the children with language impairment (CWLI) had lower accuracy of responses on nonword repetition task compared to children with normal language (CWNL) in the present study, indicating a deficit in phonological working memory capacity as indicated by several other studies. The accuracy of the responses decreased with the increase in word length in both groups. The CWNL had difficulty in repeating nonwords at 5-syllsble length, whereas the CWLI had difficulty in both 4- and 5-syllable nonwords repetition. The nonwords at 4- and 5-syllable were found to differentiate the performance of the CWLI and CWNL in the present study, and hence found to be better indicator of the children with SLI, as in consonance to earlier studies (e.g., Bishop, North, & Donlan, 1996; Bishop, 2002; Girbau & Schwartz, 2008). The error analysis revealed that the CWLI repeated lesser percentage of vowels and consonants correct than CWNL and they had greater errors on consonants than the vowels. In addition, it was also found that percentage of syllable substitutions, percentage of syllable additions and percentage of syllable omissions were higher in CWLI than CWNL and the percentage of syllable substitutions was significantly higher than the other types of errors in both the groups. Further there was no significant correlation between the nonword repetition accuracy and the receptive vocabulary.

To conclude, Kannada speaking children with language impairment have a deficit in the phonological working memory which is revealed through their poor performance on the nonword repetition task. The longer syllable nonwords (4- and 5-syllable nonwords) were found to be better indicators of phonological working memory deficit in CWLI. Hence is recommended that the nonword repetition test be included in the routine clinical assessment procedures. Further the lack of relationship between nonword repetition accuracy and receptive vocabulary scores in both CWNL and CWLI indicates that the KPVT did not strain language processing and storage.

Implications of the study

Cautions must be taken while drawing inferences from this study given the small number of participants and reliance on correlation analysis, which does not clarify causal relations. Nevertheless, this study has important implications for early childhood assessment and intervention. This study provides an insight into the phonological working memory skills in children with language impairment and the children with normal language skills. In addition, assessing phonological working memory skills using nonwords in children with language impairment may help us to predict whether the children might be at risk for specific language impairment and further have greater language and literacy deficits. This study has implications in intervention as along with teaching language, clinicians can also incorporate tasks which require mental manipulation of language thus, incorporating successful intervention methods dual language-memory approach. To promote better phonological working memory abilities having them repeat nonsense words in a game-like situation may facilitate their ability to abstract the phonological properties of novel input, which may also improve their ability to phonologically encode and represent novel material and nonlanguage material which would in turn improve the overall processing abilities. The findings of such

research might contribute to theories related to underlying causes of language impairment in children with SLI as well as assist clinicians in designing accurate screening procedures.

Future Directions

Further research can be done in the Indian scenario on:

- Developmental norms for the nonword repetition ability.
- Nonword repetition skills in the children with language impairment across different age groups.
- Relationship between the nonword repetition accuracy and the language related measures like expressive vocabulary, sentence comprehension, mean length of utterance, grammatical complexity in different age groups etc.
- Comparison of the nonword repetition task and other processing related measures like sentence recall, digit recall etc.
- Evaluating the clinical utility of the nonword repetition task in comparison to the standardized language measures.
- Nonword repetition abilities in children with language impairment across different Indian languages.
- Nonword repetition abilities in children with different communication disorders.

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Appendix

Nonword List

Practice Items:

Syllable lengths	Nonwords
2-syllable	bussa
3-syllable	lana:gɛ
4-syllable	kaḍannaka
4 -syllable	ḏuno:vuḍu
5-syllable	ṯɛnka:ginaji

Test Items:

Syllable lengths	**Nonwords**				
2-syllable	nija:	mɛna	nuga	bija:	t̪ɛla
3-syllable	ṭakiki	t̪ipa:tʃa	lɛt̪t̪aka	ku:lud̪a	lippatʃa
4-syllable	nuḍḍad̪ova	vakkatʃinu	d̪unnuvut̪i	ginna:d̪ɛtʃɛ	d̪uvuḍuko
5-syllable	gɛd̪ujunɛvu	jut̪avud̪ugi	nɛmagid̪d̪a:la	kod̪d̪a:t̪t̪iḍunɛ	d̪ujuvuḍiku