Word and Nonword Repetition Test for Children in Kannada

PROJECT REPORT

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Dedicated to

All the sweet little ones and their parents who made this study possible

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CHAPTER I

INTRODUCTION

Typical language development and use requires some of the important cognitive processes including directing the attention to what others are saying, perceiving speech sounds, encoding or representing sounds as phonemes, storing the phonemes in a sequence, relating the sequence of sounds to words that have already been learned, planning a response, and executing a motor pattern. These cognitive processes shape the use of speech and language skills for communicative functions. Consequently cognition and language are closely related, and there are connections between cognitive development and language development. Cognition involves a wide range of mental processes such as attention, pattern recognition, memory, organization of knowledge, language, reasoning, problem solving, classification, concept and categorization (Best, 1999). These cognitive processes are interrelated with one another rather than existing in isolation.

Researchers have examined the role of several memory processes which are related to language learning in typically developing children. Performance on some memory protocols has been shown to be closely related to children's ability to learn new vocabulary and to read, suggesting that recall tasks tap into important language skills (Gathercole, 2006). Working memory (Baddeley & Hitch, 1974; Baddeley, 2003a, 2003b) is one such process that is reported to be involved in storage and processing of verbal information. The process within the working memory which is considered as highly specialized for language learning and which retains verbal information is called phonological working memory loop. The phonological loop consists of a phonological store, which holds phonological information for a short period, and rehearsal processes, in which sounds are repeated mentally in order to delay decay by keeping phonological representations active. The phonological loop's ability

to encode, store, and recall sequences of sounds appears to play an important role in language acquisition.

Any problem in the phonological working memory is considered to seriously hamper the child's acquisition of basic language and literacy skills during the early years of school which form the basic building for later scholastic achievements. Children with poor phonological working memory have particular difficulties with learning the sounds of new words, with the result that their vocabulary acquisition of the native language may be very slow. As vocabulary knowledge is itself the cornerstone of both spoken and written communication, the impact of inadequate phonological working memory skills in early childhood is a matter of great concern for the individual child, the family and the educators alike. Adequate phonological working memory is also required if a child has to pass easily through the early stages of reading acquisition, when he/she must be able to blend and build the component sounds of letters in unfamiliar words. Failure to master this strategy can lead to considerable delays in the child achieving reasonable levels of literacy.

For many years, researchers have tried to assess the capacity of the phonological working memory both in typically developing individuals and those with different communication disorders and the most widely used technique used for this purpose has been the nonword repetition task. Repetition is considered to be a simple task that even young preschool children can understand, and it is reported that repetition is informative about children's linguistic processing and representations. The nonword repetition task is thought to reflect some of the underlying cognitive difficulties, perhaps those concerned with working memory, phonological memory or long-term word knowledge (Gathercole, 1995). The repetition of single words (real words and nonwords) is shown to be highly correlated with a variety of language measures in typically and atypically developing children. The word/nonword repetition test requires the child to listen to a word/nonword, temporarily store

the phonological representation, and then produce it. Since repetition of words/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 deficits in phonological working memory. Moreover, nonword repetition tasks have a number of benefits not offered by other measures. Nonword repetition is culturally unbiased in that it is unrelated to maternal education level (Alloway, Gathercole, Willis, & Adams, 2004), or race (Campbell, Dollaghan, Needleman, & Janosky, 1997), intelligence quotient (Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000; Conti-Ramsden, Botting, & Faragher, 2001), culture (Dollaghan & Campbell, 1998; Burt, Holm, & Dodd, 1999; Ellis Weismer et al., 2000), and gender (Burt et al., 1999). These tasks are also quick and easy to administer (Gathercole & Baddeley, 1996) compared to other language measures. Several researchers have suggested that nonword repetition tasks would be useful as screening or diagnostic measures (have high sensitivity and specificity) when attempting to identify children with language impairment (Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Gray, 2003; Montgomery, 2003) and are good predictors of language test scores (Bishop, North, & Donlan, 1996; Bishop, Carlyon, & Deeks, 1999).

Poor performance on these memory tasks would help to identify the children who have language disorders or who are at risk for language delay. Studies suggest that children with language disorders may have difficulty focusing attention, representing and storing phonological information, allocating their mental energies to various memory processes, or retaining information over time.

Nonword repetition abilities have been shown to be reduced in children with different communication disorders, including children with specific language impairment (Kamhi & Catts, 1986; Kamhi, Catts, Mauer, Apel & Gentry, 1988; Gathercole & Baddeley, 1990; Edwards & Lahey, 1998; Sahlen, Wagner, Nettelbladt, & Radeborg, 1999; Ellis Weismer et

al., 2000; Gray, 2003; Marton & Schwartz, 2003; Montgomery, 2004; Archibald & Gathercole, 2006; Stokes, Wong, Fletcher, & Leonard, 2006; Girbau & Schwartz, 2008, De Bree, Rispens, & Gerrits, 2007; Prema, Prasitha, Savitha, Purushotham, Chitra, & Balaji, 2010; Shylaja & Swapna, 2010), stuttering (Hakim & Ratner, 2004), reading disability (Kamhi & Catts, 1986; Kamhi, et al., 1988), Down syndrome (Jarrold, Baddeley, & Hewes, 2000), Williams syndrome (Grant, Karmiloff-Smith, Gathercole, Paterson, Howlin, & Davies & Udwin, 1997), and autism (Kjelgaard & Tager-Flusberg, 2001). Some researchers also found nonword repetition test to be relatively a reliable indicator of specific language impairment (Bishop et al., 1996; Dollaghan & Campbell, 1998; Conti-Ramsden, et al., 2001). Many studies have also investigated repetition of nonwords and how this relates to other language skills in typically and atypically developing children. Studies of typically developing children aged 3-5years have found correlations with receptive vocabulary and indices of speech output, including repertoire of vocabulary, utterance length and grammatical complexity (Adams & Gathercole, 1995, 2000 etc).

In an effort to test the nonword repetition abilities, several tests of the same have been published. Two widely used published nonword repetition tests in the West are the Children's Test of Nonword Repetition (CNRep; Gathercole & Baddeley, 1996) and the Nonword Repetition Test (NRT; Dollaghan & Campbell, 1998). Archibald and Gathercole (2006) stated that the CNRep and the NRT may measure different abilities and that the NRT, particularly focused on measuring phonological working memory. The CNRep is used mostly in the United Kingdom, whereas the NRT is more commonly used in the United States (Archibald & Gathercole, 2006). The CNRep contains 40 nonwords that range from 2 to 5 syllables in length. Stimuli contain characteristics such as consonant clusters, weak syllables, reduced vowels, and lexical components and morphemes. Nonwords have a natural prosodic pattern. Scoring is done online, and each word is scored either as correct or incorrect. The

NRT, on the other hand, contains 16 nonwords that range from 1 to 4 syllables in length. Stimuli contain characteristics such as early-acquired phonemes, equal syllable stress, tense vowels, and no lexical components. Nonwords are scored according to percentage of correct phonemes correctly repeated. Archibald and Gathercole (2006) further explored the performance of children with SLI on the CNRep and the NRT. While the CNRep was better able to identify overall SLI deficits, several deficits measured extended beyond verbal working memory. The NRT, on the other hand, focused on measuring verbal working memory.

Consequently, several aspects of nonword design have been shown to affect repetition abilities. Nonwords are generally repeated more accurately when stimuli are word-like, containing common phoneme combinations, and when the child has greater vocabulary knowledge. When the nonwords of varying length are presented, the nonwords of shorter length are repeated more accurately. These components of nonword design, however, also affect whether lexical contributions or phonological contributions are being measured. Since nonwords are affected by several parameters, they are constructed in such a manner that the strings of letters or alphabets are devoid of lexicality effects and that are not predictable as a word (Gathercole, Frankish, Pickering, & Peaker, 1999). They are also 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. The segments of syllables used are within the repertoire of children in the age group under study to avoid articulatory constraints (Dollaghan & Campbell, 1998).

The focus of research in the recent past has been primarily on the repetition of nonwords. However, a recent study (Casalini, Brizzolara, Chilosi, Cipriani, Marcolini, Pecini, Ronoli, & Burani, 2007) investigated repetition of real words as well as nonwords,

and found that children with SLI had significantly lower scores on both real words and nonwords compared with age-matched controls.

Accordingly Seeff-Gabriel, Chiat, & Roy (2008) incorporated the word repetition also and constructed a test named the Early repetition Battery (ERB) which consisted of two tasks viz. The preschool Repetition test (PS Rep) and The sentence Imitation Test (SIT). The PSRep presents children with a set of real words and a set of nonwords which was designed to assess the phonological processing abilities of preschool children. Thus according to them, the real word repetition assesses the phonological processing abilities and the knowledge of lexical phonology in forms that are expected to be familiar and stored in the child's mental lexicon and the nonword repetition measures the phonological memory.

Since the tests especially the NRT and PSRep have been found to be effective in identifying the phonological working memory and phonological processing deficits in children with various communication disorders, are quick and easy to administer and have several other advantages as mentioned previously, it is essential to construct these tests in other languages. Such tests in the Indian context are limited. Hence this project was planned with the aim of developing a word and a nonword repetition test in Kannada language (along the lines of NRT and PSRep) for children in the age group of 4-6 years.

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. Normal language acquisition is mediated by intact pre-requisites like normal hearing, cognitive, sensory-motor abilities and an environment which provides language stimulation to the child. Learning a new word involves focusing attention on something that someone else is saying, listening to and remembering the sequences of sounds that are being said, associating the sequence of sounds that are being said, associating the sequences of sounds with possible meanings that are being expressed, and comparing the sound sequences and potential meaning to prior knowledge (words that already exist in long-term memory). If no match is found, language learners store the new phonological sequence along with additional information about the likely meaning, the event that was occurring when the word was heard, the other words that were spoken at the same time, the order the words were spoken in, and the role that the unknown word may have played in the utterance (subject, object, verb, modifier etc). Therefore, it is evident that, the learning of words relies on cognitive process such as attention and memory. Language and memory develops with age and they interact and depend on one another.

Role of memory in language learning

In the recent past, researchers have begun to examine the various cognitive linguistic processes specifically memory processes in depth which play a crucial role in language acquisition and its processing. In particular the potential role of working memory a cognitive process, in the language learning and processing in both typically and atypically developing children has received considerable attention (Gathercole & Baddeley, 1990a; Montgomery,

1995b; Montgomery 2000, 2002). Working memory is a temporary memory used in information processing. It 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. Working memory is considered to be the component of human memory that allows for problem solving and active retrieval from sensation and long term memory. The concept of working memory was introduced by Baddeley and Hitch (1974) and later updated by Baddeley (2007).

According to Baddeley's pholological loop model (Gathercole & Baddeley, 1993; Baddeley, 2007), working memory can be divided into four components (see Figure 1). The first component, known as the visuospatial sketchpad is responsible for visualizing images and retaining the information necessary to process visual and spatial dimensions. The second component is the phonological loop, responsible for processing and maintaining speech sound information. The third component is the central executive which supervises the use of the visual-spatial and phonological information in the sketchpad and phonological loop. Because the central executive is responsible for processing rather than storage, the fourth component—the episodic buffer—has been hypothesized to act as an interface between the central executive, sketchpad, phonological loop, and the long term memory. The episodic buffer provides the storage necessary to problem solve using the other components of working memory. Amongst these components the phonological loop is better understood and it includes a capacity-limited phonological short-term store and an articulatory control process (subvocal rehearsal) that acts to refresh and maintain speech material in the store for a brief period. The phonological 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).

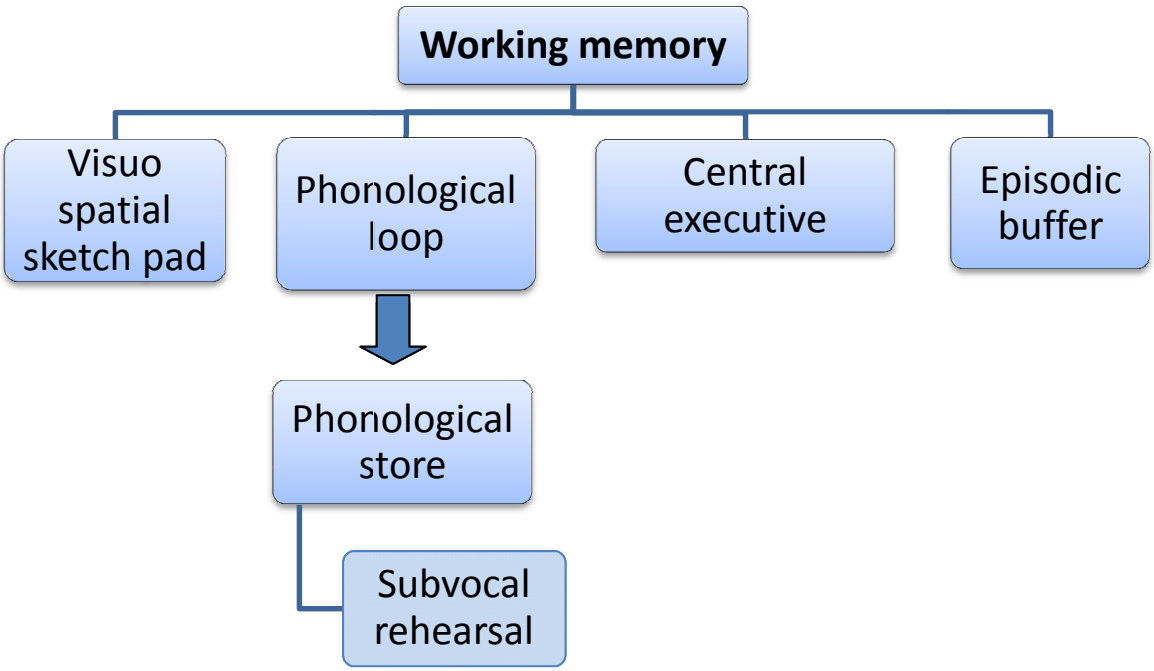

Figure 1: *Components of working memory.*

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). Research evidences points to extremely close links between the phonological loop and vocabulary acquisition, wherein phonological loop has been suggested to be evolved primarily as a vocabulary acquisition device, designed to support the long-term learning of the phonological structure of words within the native language (Baddeley et al., 1998). He has further suggested that PWM serves as a mnemonic window in which sequences of incoming words are held in serial order. 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 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). Therefore the linguistic knowledge and PWM work together and since they interact, deficits in PWM may produce difficulties in comprehension and language learning as the child will not be able to recall the linguistic information or to process it fast enough. 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, PWM has been evaluated in both typically and atypically developing children. Researchers have used a variety of tasks and stimuli including sentence recall/repetition, digit span, word span, and nonword repetition (NWR) (e.g., Gathercole, 1999; Archibald & Gathercole, 2006) to evaluate PWM. Among these, the NWR task has been widely used to assess the phonological working memory capacity in both typically and atypically developing children. Repetition is considered to be a simple task that even young preschool children can understand, and it is reported to be informative about children's linguistic processing and representations.

The nonword repetition test requires the child to listen to a nonword, temporarily store the 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 deficits in phonological working memory. Generally the nonwords are strings of letters or alphabets, that are devoid of lexicality effects and that are not predictable as a word (Gathercole, Frankish, Pickering, & Peaker, 1999). A better performance on NWR requires the subject to create an acoustic representation of the nonword robust enough to support subsequent articulation. Also, to learn a novel word, the child must create an acoustic representation robust enough to link to its real-world referent. Therefore successful repetition of a nonword includes good speech perception, encoding the phonemes/speech segments that can be stored in memory, creating a motor plan to assemble the phonological units, and articulation. Further, it involves exact representation of underlying speech units, and sufficient phonological short term memory capacity both to temporarily store and manipulate the novel phonological string as the task demands. That is NWR involves the phonological loop which is a specialized subsystem of working memory (Baddeley, 1986, 1996). Hence poor performance is thought to reflect some of the underlying cognitive difficulties, perhaps those concerned with working memory, phonological memory or long-term word knowledge (Gathercole, 1995).

NWR task is proposed to have many advantages over the other speech and language tests. They are culturally unbiased in that it is unrelated to maternal education level (Alloway, Gathercole, Willis, & Adams, 2004), race (Campbell, Dollaghan, Needleman, & Janosky, 1997), intelligence quotient (Conti-Ramsden, Botting, & Faragher, 2001; Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000), & gender (Burt, Holm, & Dodd, 1999). It has gained a great deal of acceptance in recent years as it correlates so well with standardized vocabulary measures in typical populations. Children who are better able to repeat nonwords after a single presentation tend to score higher on standardized vocabulary measures. Hence it is suggested to be related to underlying components common to both tasks.

Furthermore, NWR test has been found to be a useful screening test in children with language impairment, which requires a shorter administration time than other language measures (Gathercole & Baddeley, 1996). Campbell, Dollaghan, Needleman, and Janosky (1997) reported that norm-referenced tests are inherently biased against test-takers from minority backgrounds as these tests depend 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 in typically developing children

NWR has been used to study the phonological working memory skill which in turn helps in understanding the different aspects of typical language acquisition. One such study was conducted by Adams and Gathercole (1995) who studied the relationship between phonological memory and spoken language development in thirty eight children with normal language skills in the age range of 2.10-3.1years. The children were grouped into high- and low-phonological memory groups. They found that children in the high-phonological memory group (i.e., with better nonword repetition ability) produced longer, more grammatically complex sentences compared to the group with poorer nonword repetition abilities. Adams and Gathercole (2000) also examined the role of phonological working memory on grammatical complexity. They studied two groups of fifteen children with normal language aged 4.6 to 5.0years matched on nonverbal IQ, but differing in nonword repetition ability. Results revealed that children in the higher nonword repetition ability produced more grammatically complex sentences using a wider variety of lexical items compared to the children with lower nonword repetition abilities. Majority of such studies have been carried out to study the relationship between NWR and vocabulary development.

Relationship between NWR and vocabulary

Literature reveals several studies that have examined the phonological working memory using nonword repetition task and its relationship with language domains (vocabulary development) in typically developing children.

Gathercole and Baddeley (1989) examined the correlation of phonological memory with that of receptive vocabulary by assessing a total of hundred and four typically developing children. The children were in the age range of 4-5years and they were administered nonword repetition and digit span test twice i.e., at the beginning and end of the academic year. They found that the accuracy of repetition increased with age and decreased with the increase in nonword length and complexity. In addition they found that the accuracy at age four predicted the vocabulary skills of the children at age five that is, the children who scored highly on nonword repetition also typically performed well on a standardized test of vocabulary knowledge.

Gathercole, Willis, Emslie, and Baddeley (1992) conducted a longitudinal study to explore the nature of the developmental association between phonological memory and vocabulary knowledge. They administered measures of vocabulary, phonological memory, nonverbal intelligence, and reading in eighty children with normal language over a period of four years (at 4, 5, 6, and 8years of age). Comparisons of cross-lagged partial correlations revealed a significant shift in the causal underpinnings of the relationship between phonological memory and vocabulary development before and after 5 yrs of age. They reported that between 4 and 5 years, phonological memory skills appeared to exert a direct causal influence on vocabulary acquisition. Subsequently they concluded that, though, vocabulary knowledge became the major pacemaker in the developmental relationship, with the earlier influence of phonological memory on vocabulary development subsiding to a nonsignificant level.

Michas and Henry (1994) assessed the relationship between phonological memory and vocabulary, and also how phonological memory affects the acquisition of new words. The subjects were forty eight children with normal language in the chronological age range of 5.2- 6.2years. The results indicated that nonword repetition ability predicted the ability to learn new words providing direct evidence for the phonological memory-word learning link.

Service and collaborators in Finland, studying Finnish children learning English as a foreign language in secondary school, has also shown that nonword repetition ability is an extremely good predictor of a child's capacity to acquire foreign vocabulary (Service, 1992; Service & Kohonen, 1995).

Gathercole (1999) examined whether the link between nonword repetition and vocabulary arises from articulation or from encoding and memory. Eighteen children in 4-4.5yrs were selected for the study. The results revealed that nonword repetition taps phonological encoding and/ or memory skills rather than output variables such as articulation. They also tested 65 children with normal language in 5.1-6.3yrs of age and sixty adolescents with normal language aged 13.4-14.5yrs to study the relationship between phonological memory and vocabulary in older adolescents. They concluded that the link between phonological memory and vocabulary continues into adolescence.

Metsala (1999) conducted experiments to evaluate the changes in nonword repetition accuracy resulting from developmental changes in phonological representations. In the first experiment, thirty-two children with normal language in the age range of 3.11-4.11 years and twenty-nine children in 5.0-6.4year age group were selected. The second experiment involved a group of thirty-six children with normal language in the age range of 3.0-4.8years. The role of vocabulary growth in the development of two reading-related phonological processes was examined. In the experiments one and two, 4- and 5-year-olds and a sample of first graders

performed better on phonological awareness tasks for word versus pseudoword stimuli, and for highly familiar versus less familiar words. Three- and 4-year-olds in Experiment 3 performed better for words with many versus few similarly sounding items in a listener's lexicon. They reported that the vocabulary was strongly associated with nonword repetition scores for 3- to 5-year olds. They argued that the shared variance of the association was accounted for by phonological awareness measures and did not appear to be due to phonological short-term memory. They proposed that vocabulary growth, defined in terms of absolute size, word familiarity, and phonological similarity relations between word items, helped to explain individual differences in emerging phonological awareness and nonword repetition. Similarly several other earlier studies found correlation between receptive vocabulary and nonword repetition in typically developing children (Gathercole, Willis, & Baddeley, 1991a; Gathercole & Adams, 1993; Gathercole & Adams 1994; Bowey, 1996).

NWR and metalinguistic knowledge

Several studies have also examined the interrelationships between NWR and vocabulary indirectly, by looking at how the knowledge of words and sound patterns extracted from over the lexicon influences nonword repetition. A review of the relevant literature suggests that repetition accuracy depends on the degree to which a nonword overlaps with existing lexical entries. According to the study conducted by Bowey (2001), 'any manipulation that increases phonological complexity decreases nonword repetition performance' (p.443). Researchers have used a number of methods to manipulate phonological complexity, including presenting nonwords differing in the presence versus absence of consonant clusters, in adult ratings of subjective word-likeness, in the presence versus absence of embedded real words, in the presence versus absence of attested consonant sequences, and in the frequency of the component segments or combinations of segments.

These factors are all related to one another, and can be described in terms of phonotactics, or rules governing how speech sounds can be arranged within a given language.

Gathercole, Willis, Emslie, and Baddeley (1991) studied the correlation between phonological working memory and sensitivity with receptive vocabulary, and also the lexical influences on repetition accuracy. They evaluated the nonword repetition abilities of 103 children with normal language as they entered school at 4-5years age, then one year later, and again two years later. The results revealed no accuracy differences due to complexity. Further higher repetition accuracy was found for more word-like nonwords in comparison to the less word-like nonwords.

Dollaghan, Biber, and Campbell (1993) looked at the lexical effects on repetition accuracy by having eleven 9-12yrs old typically developing children repeat nonwords varying in the lexical status of stressed syllables. The results revealed that the nonwords containing real words, e.g., BATHesis, were repeated more accurately than those nonwords which did not contain embedded real words, e.g., FATHesis. That is they suggested that the normally achieving school-age children repeated nonsense words with lexical stressed syllables significantly more accurately than nonsense words with nonlexical stressed syllables. Further they concluded that the results suggest the need to control, at a minimum, the lexical status of constituent syllables in constructing nonsense-word stimuli.

Gathercole (1995) investigated the extent to which children's performance on tests of nonword repetition is constrained by phonological working memory and long-term lexical knowledge. They evaluated 70 children with normal language first at 4.1yrs of age and again at 5.3years of age to compare the phonological working memory and lexical knowledge influences on nonword repetition accuracy. At each time of testing, measures of nonword repetition, memory span, and vocabulary knowledge were administered. Reading ability was

also assessed at 5 years. They found that at both ages, repetition accuracy was greater for nonwords of high- rather than low-rated wordlikeness, and memory-span measures were more closely related to repetition accuracy for the low-word like than for the high-word like stimuli. They suggested that the nonword repetition for unword like stimuli was largely dependent on phonological memory, whereas repetition for word like items was also mediated by long-term lexical knowledge and was therefore less sensitive to phonological memory constraints. Further they observed that reading achievement was selectively linked with earlier repetition scores for low-word like nonwords, suggesting a phonological memory contribution in the early stages of reading development. They concluded that the vocabulary knowledge was associated with repetition accuracy for both low- and high-word like nonwords, consistent with the notion that lexical knowledge and nonword repetition share a reciprocal developmental relationship.

Beckman and Edwards (2000) evaluated sixteen children with normal language skills who were in the age range of 3.2-5.0 years. They also replicated the study with twenty-four children in 3.2-5.4years age. They studied the lexical effect on nonword repetition accuracy by comparing nonwords containing attested sequences to those containing unattested sequences. They found that children produced nonwords with attested consonant-vowel (CV) and consonant-consonant (CC) sequences more accurately (e.g. attested CC sequence [ft] occurs more often within the words such as after, fifty) compared to unattested sequences (e.g. unattested CC sequence [fk] occurs less frequently than [ft]). However they found no significant difference between attested and unattested vowel-consonant (VC) sequences.

Munson (2001) compared the accuracy and fluency of nonwords differing in phonological pattern frequency in nine children with normal language who were in the age range of 3.5-4.6yrs (preschool children) and in nine older typically developing children of

7.4-8.11yrs old (school-aged children) and also in adults. They analyzed the normal- and fast rate nonsense-word repetitions of the three groups of participants. Subjective ratings of the wordlikeness of nonsense words, percentage phonemes correctly repeated, mean duration, and durational variability were measured. In their first experiment, they found that the ratings of the wordlikeness of nonsense words correlated with the pattern frequency of sequences embedded in them. In their second analysis, it was found that children, but not adults, repeated infrequent sequences of phonemes less accurately than frequent sequences. In their third experiment, infrequent sequences were produced with longer durations than frequent ones, with children demonstrating a larger difference between frequent and infrequent sequences than adults. Further they observed that the phonological pattern frequency also influenced variability in duration: infrequent sequences of sounds were more variable than frequent ones. Hence they concluded that, there appears to be an influence of phonological pattern frequency on speech, and, for some measures, a larger effect of size was noted for children.

Edwards, Beckman, and Munson (2004) examined the effect of vocabulary size and phonotactic frequency on nonword repetition accuracy. They assessed a total of twenty two-adults and hundred and four children with normal language. The children with normal language were divided into three groups where the first group included forty children with mean age of 4.2, the second group had thirty-eight children with mean age of 5.6yrs and the third group consisted of twenty-three children with mean age 8.1yrs. The results showed that all the children repeated nonwords with higher frequency phonological patterns more accurately than those with lower frequency, but suggested that the size of this effect decreases over development, as the lexicon increases in size. As explanation, they point out that phonological development is a process in which representations of the underlying speech units become increasingly abstract or context-independent. Younger children with smaller

lexicons should show larger phonotactic frequency effects because they may have reasonably abstract representations of more frequently occurring speech sounds and sound combinations, but they may not have encountered infrequently occurring sequences often enough to be able to extend them to novel phonetic contexts. Older children with larger lexicons are more likely to have encountered instances of infrequently occurring sequences, so they can more readily extend their abstracted representations to novel contexts. Hence they concluded that the repetition accuracy predicts subsequent vocabulary growth before age five, but that vocabulary after age 5 predicts subsequent repetition accuracy. This might suggest that these lexical effects in nonword repetition accuracy are not significant until after the age of five.

Zamuner, Gerken, and Hammond (2004) studied the influence of phonotactic frequency on repetition accuracy in a group of twenty-nine very young children who were in the age range of 1.8-2.4years. All the children had normal language abilities. As per their results it was found that children repeated coda consonants in CVC nonwords more accurately when they occurred in high phonotactic frequency nonwords (e.g., ged) compared to the same consonants in low phonotactic frequency nonwords (e.g., chud). This suggests that even very young children use knowledge extracted from over the lexicon to support non-word repetition. This is in contrast to the evidence found by Edwards et al. (2004) where they reported that the lexical effects in non-word repetition accuracy are not significant until after the age of five.

Coady and Aslin (2004) examined the lexical influences on nonword repetition accuracy by manipulating frequency of smaller and larger phonological units. They tested a total of twenty four children with normal language abilities who were in the age range of 2.4-3.8years and they were divided into three groups. They found that by the age of 2.6 years

children are sensitive to the frequency of individual segments, and sensitivity to all aspects of sound structure increase over development.

NWR in children with communication disorders

Amongst the atypically developing children NWR has been used to explore deficits experienced by children with Specific Language Impairment (SLI, e.g., Kamhi & Catts, 1986; Kamhi et al., 1988; Gathercole & Baddeley, 1990; Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Ellis Weismer et al., 2000; Gray, 2003; Marton & Schwartz, 2003; Montgomery, 2004; Archibald & Gathercole, 2006), children with reading difficulties (Brady, 1997), children with articulation/phonological disorders (Yoss & Darley, 1974), children with Williams syndrome (Grant, Karmiloff-Smith, Berthoud, & Christophe, 1996; Grant, Karmiloff-Smith, Gathercole, Paterson, Howlin, Davies, & Udwin, 1997), children with Down syndrome (Laws, 1998; Comblain, 1999), children with higher levels of lead exposure (Campbell, Needleman, Riess, & Tobin, 2001), children with cochlear implants (Carter, Dillon, & Pisoni, 2002), and children with fluency disorders (Hakim & Ratner, 2004). It has also been used to explore the PWM skills in the adults with acquired aphasia (e.g. McCarthy & Warrington 1984).

NWR and SLI

NWR tasks in children with SLI specifically have received maximum attention in the past years. This could probably be consequent to the momentum gained in assessment procedures of SLI that has lead to a better understanding of the symptom complex and the underlying linguistic base. Studies have revealed that these children have deficits in working memory that may underlie their language deficits. Children with SLI demonstrate slower linguistic and nonlinguistic processing on both expressive and receptive tasks than age matched typically developing children (Leonard, 1998; Windsor & Hwang, 1999; Miller,

Kail, Leonard, & Tomblin, 2001). They do not employ processing strategies that use contextual information and stored knowledge. 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). Hence the use of NWR in these children is suggested to be used as a clinical marker for language impairment (Bishop, North, & Donalan, 1996, Conti-Ramsden, Botting, & Farragher, 2001).

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.

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 an 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.

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. They had poorer performance on the CNRep because of the inclusion of consonant clusters in contrast to the NRT and this was reported to disadvantage their performance as the articulatory demands of the stimuli were particularly complex. 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.

NWR-Cross language studies

There have been studies carried out in languages other than English. 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 four 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 further cross-linguistic investigations of processing strategies.

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 nonword 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 nonwords 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 Nonword Repetition Task can be used as a valuable screening test for clinical and research purposes.

Girbau and Schwartz (2008) examined 11 Spanish-English bilingual children with SLI, in the age range of 8-10 yrs, using nonword repetition task. They found that the percentage of correct nonwords were significantly lower in children with SLI than in children with Typical Language Development (TLD). A length effect was found in 3-4-5syllable non-words, where children with SLI performed significantly poorer. Hence, nonword repetition task, differentiated children with SLI and age matched TLD children. They also found that phonological working memory abilities, as measured by nonword repetition, strongly correlated with comprehension and production skills in their native Spanish language. Consequently 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.

Prema, Prasitha, Savitha, Purushotham, Chitra, and 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. A 14 year old male child diagnosed as SLI matched with a typically developing child on age, gender, language, socio-economic status and grade was selected for the study. Fifteen nonwords from a set of nonwords were adapted for the study. All the nonwords 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 nonwords 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 nonwords 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 nonword repetition of the child with SLI. One significant observation was that, all the nonwords 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.

Shylaja and Swapna (2010) assessed the nonword repetition abilities and also the relationship between nonword repetition and receptive vocabulary measures. Nine Kannada speaking children with delayed speech and language who were in the age range of 4.5-7years were included in the study. All the children had a language age of 3-4years and they were matched on language age to ten typically developing children. All the children were administered with nonword repetition task in Kannada which had a total of 20 test items (5 items at each of 2-, 3-, 4-, and 5-syllable length) and 5 practice items. They were also 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. The results revealed that children with language impairment (CWLI) had lower accuracy of responses on nonword repetition task compared to children with normal language (CWNL) and suggested that the children with LI had 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 nonwords at 4- and 5-syllable lengths were found to differentiate the performance of the CWLI from CWNL and hence were better indicators of phonological working memory deficits found in children with SLI. 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 they found that there was no significant correlation between the nonword repetition accuracy and the receptive vocabulary.

NWR in clinical population other than SLI

Nonword repetition skills have also been examined in clinical population other than SLI as mentioned earlier. Laws (1998) studied the use of nonword repetition with 33 children and teenagers with Down syndrome aged from 5 to 18 years, and investigated the relationship between this test and other memory and language measures. Word repetition was also included as an indirect control for the perceptual and speech impairments often associated with this group. Words were repeated significantly more successfully than nonwords and both these tasks were sensitive to word length. The results suggested that the nonword repetition was significantly correlated with age, and when age and nonverbal cognitive ability were controlled, nonword repetition was significantly correlated with all other language-based memory measures, i.e. auditory digit span, word span, sentence repetition, and fluency, and also with memory for a sequence of hand movements, but not with memory for faces or a visual digit span task. Also a significant relationship between nonword repetition and receptive vocabulary, language comprehension, and reading was found. It was reported that when performance on the word repetition task was controlled in addition to age and nonverbal ability, significant correlations between nonword repetition and word span, sentence memory, hand movements, language comprehension, and reading remained. Association between digit span and the language and reading measures were not found. Results suggested that nonword repetition was a reliable measure of phonological memory in Down syndrome and can predict language comprehension and reading ability.

Hakim and Ratner (2004) carried out an exploratory study wherein they examined the nonword repetition skills in Children Who Stutter (CWS). They compared eight CWS (mean age 5:10, range 4:3–8:4) to eight normally developing children (ND) (mean age 5:9, range 4:1–8:4) in their ability to repeat the nonwords of the Children's Test of Nonword Repetition. They found that the CWS performed more poorly than ND on measures of Number of Words

Correct and Number of Phoneme Errors at all nonword lengths, although statistical differences were observed only for 3-syllable nonwords. In addition they observed that when lexical stress of the nonwords was varied to a non-English stress pattern, all participants repeated the stimuli with less accuracy, and the CWS again exhibited more errors than ND. Further fluency for the CWS group did not change systematically with increasing nonword length. They concluded that children who stutter may have diminished ability to remember and/or reproduce novel phonological sequences, and that further investigation into this possibility may shed light on the emergence and characteristics of childhood stuttering.

Munson, Edwards, and Beckman (2005) compared nonword repetitions by 40 young children with Phonological Disorders (PD) with those by 40 age peers with typical phonological development on a nonword repetition task in which the frequency of embedded diphone sequences was varied. They also examined the relationship between the frequency effect in the nonword repetition task and other measures of linguistic ability in these children. The results revealed that the children in both groups repeated low-frequency sequences less accurately than high-frequency sequences. They found that the children with PD were less accurate overall, but showed no larger disadvantage for the low frequency sequences than their age peers. Further across the group, the size of the frequency effect was correlated with vocabulary size, but it was independent of measures of speech perception and articulatory ability. Hence they suggested that their results supported the hypothesis that the production difficulty associated with low-frequency sequences is related primarily to vocabulary growth, rather than to developments in articulatory or perceptual ability. In addition they found that by contrast, production problems experienced by children with PD do not appear to result from difficulties in making abstractions over known lexical items. They concluded that instead they may be associated with difficulties in building representations in the primary sensory and motor domains. That is deficits seen in children with PD are associated with

difficulties forming robust representations of the auditory/acoustic and articulatory characteristics of speech.

deBree, 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 SLI and dyslexic children who 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 nonword repetition deficit is attested early in life and underlies both dyslexia and SLI and NWR is a marker of SLI.

Bakhtiar, Abad Ali, and Sadegh (2007) examined phonological encoding in young Persian native CWS and Children Who do Not Stutter (CWNS) (aged 5.1 to 7.10years), during a nonword repetition task. Results indicated that the CWS had a slightly poor performance in nonword repetition score than CWNS, though not significant. Also, differences between the bisyllabic and trisyllabic nonwords were significant for phonological errors but not for reaction times. It was concluded that CWS might not have a gross problem in phonological retrieval of the novel phonological context even with increase in syllable length. These authors also wanted to examine the Covert Repair Hypothesis (CRH; Kolk & Postma, 1997) which implicates that the phonological processing skills is a cause for disfluencies in individuals who stutter. But the predictions of CRH were not supported by them.

Somy and Geetha (2008) studied word and nonword repetition skills in 5-6 year old Kannada speaking children with stuttering (CWS) and in children who do not stutter (CWNS). The results revealed that the CWS had poor word/nonword repetition skills compared to CWNS. The CWS scored poorly than CWNS in the number of correct responses and in the number of phonemes correct and they have more difficulty in maintaining their

fluency. It was found that in general both the CWS and CWNS had difficulty on the nonword repetition task than the word repetition task. Further the tri-syllabic nonword repetition task was found to be a good indicator to differentiate CWS from CWNS as well as between the severities of stuttering.

Rispens and Parigger (2010) investigated the relationship between nonword repetition (NWR) and the presence of reading problems (RP) in Dutch speaking children with reading problems. They examined 15 typically developing (TD) children and 29 children with SLI on a NWR task that included nonwords of 2–5 syllables in length. Children with SLI without RP did not differ on any of the 4 syllable length conditions from the TD group, whereas the children with SLI plus RP scored more poorly on the 3-, 4-, and 5-syllable items compared to the TD group. They concluded that NWR is specifically affected in children with SLI plus RP who were learning to read and write in a transparent orthography. They suggested that literacy development and NWR performance are dependent on each other in children with SLI.

Tests to assess nonword repetition

Tests of nonword repetition have been developed by researchers in different languages considering its significance in identifying children with language impairment. Two of the widely used published nonword repetition tests in the West are the Children's Test of Nonword Repetition (CNRep; Gathercole & Baddeley, 1996) and the Nonword Repetition Test (NRT; Dollaghan & Campbell, 1998). Gathercole and Baddeley (1996) developed the Children's Test of Nonword Repetition (CNRep) which assesses the short term memory of children between four and eight years of age attending main stream schools, and older children with language related learning difficulties. This test is used mostly in the United Kingdom (Archibald & Gathercole, 2006). The test was standardized on a sample of 612

children attending primary schools in England. This test contains 40 nonwords, which includes 10 nonwords at each of the two-, three-, four-, and five-syllable length and each of which is presented on the accompanying audio cassette tape. Stimuli contain characteristics such as consonant clusters, weak syllables, reduced vowels, and lexical components and morphemes. Nonwords have a natural prosodic pattern. The child listens to each nonword and then is required to attempt to repeat it immediately, in the silent interval of 3seconds that follows the spoken presentation of the word on the tape. The duration of administration of the entire test requires 3minutes. Scoring is done online, and each word is scored either as correct or incorrect. The accuracy of responses is obtained by calculating the total number of correct responses out of 40nonwords and also at each of the syllable length. Along with the raw scores, standard scores and percentile ranks can also be obtained. Low scores on the test were observed in children with language impairment and children with learning difficulties. The test is rapid to administer, simple for young children to understand, and provides an effective indicator of a child's basic abilities to process and learn language.

Dollaghan and Campbell (1998) developed the Nonword Repetition Test (NRT) which consists a total of 16 nonwords four at each of four syllable lengths (one, two, three, and four syllables). This test is more commonly used in the United States (Archibald & Gathercole, 2006). All nonwords begin and end with consonants (Cs); they contain no consonant clusters. The nonwords are constructed from a limited set of phonemes (11 consonants, 9 vowels) excluding late developing sounds. The nonwords follow an alternating Consonant-Vowel (CV) structure, and none of the syllables correspond to English lexical items. Only tense vowels are used, and therefore the stress patterns of the nonwords are unlike typical English words in that they have no weak syllables. The nonwords in the test were ensured not be affected by the subject's vocabulary knowledge wherein they were constructed such that none of their individual syllables (CV or CVC) corresponded to an

English word. Also no consonants or vowels occurred more than once in the stimuli to ensure the accurate repetition of nonwords by recalling each of its phonemes independently. The test stimuli consists of a recorded stimuli which is presented to the subject in an increasing order of difficulty that is from the shortest, one syllable, to the longest, four syllable, nonwords with an inter-stimulus interval of 3seconds. The duration of the entire task is 90seconds. The nonwords are presented to the subjects auditorily through headphones. The responses can be analyzed in terms of phoneme substitutions and omissions which are considered as incorrect. Further the test uses phoneme-by-phoneme scoring procedure and hence calculates the Percentage of Phonemes correct (PPC) score at each nonword length (1PPC, 2PPC, 3PPC, 4PPC), and for the entire set of nonwords (TOTPPC). The test is reported to be a useful screening measure for language impairment in children.

Archibald and Gathercole (2006) stated that the CNRep and the NRT may measure different abilities and that the NRT, particularly focused on measuring PWM. The CNRep may be more difficult for children with SLI who have lower vocabulary skills, since many of the stimuli on that test contain actual morphemes that can be accessed using existing vocabulary knowledge. The CNRep may also be more difficult due to the clustered consonants and later-developing phonemes. The NRT, on the other hand, also may be more difficult for children with SLI because fewer lexical aspects provide background and knowledge support compared to the CNRep. Archibald and Gathercole (2006) further explored the performance of children with SLI on the CNRep and the NRT. While the CNRep was better able to identify overall SLI deficits, several deficits measured extended beyond verbal working memory. The NRT, on the other hand, focused on measuring verbal working memory.

The focus of research in the recent past has been primarily on the repetition of nonwords. However, a recent study (Casalini, Brizzolara, Chilosi, Cipriani, Marcolini, Pecini, Ronoli, & Burani, 2007) investigated repetition of real words as well as nonwords, They investigated the effects of long-term memory (LTM) verbal knowledge on short-term memory (STM) verbal recall in a sample of Italian children affected by different subtypes of SLI. They aimed to evaluate if PWM abilities of children with SLI can be supported by LTM linguistic representations and if PWM performances can be differently affected in the various subtypes of SLI. They tested a sample of 54 children affected by Mixed Receptive-Expressive (RE), Expressive (Ex) and Phonological (Ph) SLI (DSM-IV - American Psychiatric Association, 1994) by means of a repetition task of words (W) and nonwords (NW) differing in morphemic structure [morphological nonwords (MNW), consisting of combinations of roots and affixes - and simple nonwords - with no morphological constituency]. They evaluated the effects of lexical and morpho-lexical LTM representations on STM recall by comparing the repetition accuracy across the three types of stimuli. They found that children with SLI had significantly lower scores on both real words and nonwords compared with age-matched controls. In addition although the children with SLI, as a group, showed lower repetition scores than controls, their performance was affected similarly to controls by the type of stimulus and the experimental manipulation of the nonwords (better repetition of W than MNW and NW, and of MNW than NW), confirming the recourse to LTM verbal representations to support STM recall. Further the influence of LTM verbal knowledge on STM recall in SLI improved with age and did not differ among the three types of SLI. However, the three types of SLI differed in the accuracy of their repetition performances (PMW abilities), with the phonological group showing the best scores.

Consequently Seef-Gabriel, Chiat, and Roy (2008) have developed Early Repetition Battery (ERB) in English which involves the Preschool Repetition Test (PSRep) and the

Sentence Imitation Test (SIT) as subtests. This test was developed and standardized by assessing a total of three-hundred and ninety six children in the age range of 2.0-5.11years. The PSRep subtest presents children with a set of real words and a set of nonwords, which evaluates the phonological processing abilities and the knowledge of lexical phonology in forms that are expected to be familiar and stored in the child's mental lexicon and the nonword repetition measures the phonological memory skills of preschool children. This consists of a total of 36 test items and 4 practice items, and requires approximately 10minutes to administer. The test items are 18 words and 18 nonwords, equally divided in length between one-, two-, and three-syllable items. Words and nonwords are of identical prosodic structure, and include a systematic range of prosodic patterns. They are phonologically matched where nonwords are created by altering the vowel of the one-syllable real words, and by transposing two or three consonants of the two or three-syllable real words. The children are individually tested by presenting the test and practice items auditorily and the child has to repeat them back as they hear. The responses of the child can be scored for accuracy in terms of lexical status and length. Also an error measure which examines the total number of syllables omitted/lost, according to the prosodic positions of the syllables is calculated. The test provides the mean scores for children of all the age ranges considered in the test. The mean score are provided for words, nonwords and total words and nonwords at each of the syllable lengths. In addition mean rate of syllable loss according to the prosodic position and item length for each age group are provided. Further the standard scores and percentile scores obtained by the children will denote whether the performance is within the normal limits or not. It also helps to assess the age-appropriateness of skills, identify difficulties, inform intervention targets and monitor progress over time. PSRep has been found useful in assessing the phonological processing and memory skills in children with

specific language impairment, general developmental delay or specific syndromes affecting language.

To summarize, several studies have reported poor phonological working memory in children with different communication disorders (Kamhi & Catts, 1986; Kamhi et al., 1988; Gathercole & Baddeley, 1990; Edwards & Lahey, 1998; Ellis Weismer et al., 2000; Gray, 2003; Marton & Schwartz, 2003; Montgomery, 2004; Archibald & Gathercole, 2006; Hakim & Ratner, 2004; Jarrold, Baddeley, & Hewes, 2000; Grant, Karmiloff-Smith, Gathercole, Paterson, Howlin, & Davies, 1997; Kjelgaard & Tager-Flusberg, 2001) . 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 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). 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. Further. studies using NWR task have also been replicated in a few other languages other than English such as Spanish (Girbau & Schwartz, 2008), Swedish (Sahlen, Wagner, Nettelbladt, & Radeborg, 1999), Dutch (De Bree, Rispens, & Gerrits, 2007) and Kannada (Prema, Prasitha, Savitha,

Purushotham, Chitra, & Balaji, 2010; Shylaja & Swapna, 2010). As the results of these studies carried out in Kannada, English and above mentioned other languages have also found that the children with SLI have deficits in phonological working memory and that the nonword repetition test can be used as a screening tool to identify these children, there is a need to develop such tests to detect deficits in PWM in languages other than English.

Several tests have been developed based on this premise especially, the NRT and PSRep which have been found to be effective in identifying the PWM and phonological processing deficits in children with various communication disorders. They are quick and easy to administer and have several other advantages as mentioned previously. However these are only appropriate for the Western population. Since such tests have proved to be beneficial, it is essential to construct these tests in other languages. Such tests in the Indian context are limited. Hence this project was planned with the aim of developing a word and a nonword repetition test in Kannada which is a South Indian Dravidian language, (along the lines of NRT and PSRep) for children in the age group of 4-6years.

CHAPTER III

METHOD

The aim of the present study was to develop a test of word and nonword repetition in Kannada.

Participants:

A total of one hundred and thirty eight typically developing Kannada speaking children with chronological age ranging between 4 to 6 years served as participants for the study. They were divided into two groups which included sixty six children (thirty four females and thirty two males) in 4-5years and seventy two children (forty two females and thirty males) in 5-6years age range. The children in both the groups were selected from around ten different schools in Mysore district of Karnataka and were learning English as their second language in school. They were divided into lower, mid, and higher socioeconomic status categories using Socio Economic Scale by Venkatesan (2009). In addition the WHO Ten-question disability screening checklist (Singhi, Kumar, Malhi, & Kumar, 2007) was administered to rule out any disability.

Participant selection criteria:

The participants were selected based on the following inclusionary criteria:

1. No evidence of sensory, neurological, oro-motor, social- emotional, cognitive, behavioral or learning deficits.
2. Age appropriate receptive and expressive language skills as revealed by standardized test of language viz. Kannada Language Test (Karanth, 1995) a diagnostic language tool.
3. No evidence of speech deficits.

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

The present study was carried out in three phases:

Phase I: Construction of the word and the nonword repetition test in Kannada

Phase II: Standardization of the word and nonword repetition test

Phase III: Establishment of the validity of the test

Phase I: Construction of the word and the nonword repetition test in Kannada

The real words of varying syllable lengths (2syllable, 3syllable, 4syllable and 5syllable length) were selected from Computerized Linguistic Protocol (in Kannada) for Screening Children (CLIPS) (Anitha & Prema, 2008), 'With a little bit of help-Early Language Training Manual' (Karanth, Manjula, Prema, & Geetha, 1999) and also from the Kannada text books of school children of 4-6years. The words selected were ensured to be within the vocabulary of 4-6years children. A total of 80 meaningful words were selected and different rules were applied to create 'nonwords'. The list of the nonwords was 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. The consonants of the original word were maintained.
5. 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 were as follows:

Rules used for preparation of 2-syllable length nonwords: The vowels of the original word were transposed or one of the vowels was replaced such that it formed a nonword in Kannada. For example, mane (word) to mena (nonword) or ni:li (word) to no:li (nonword) respectively.

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, chappali (word) to lippacha (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: malagide (word) to giladema (nonword), 5-syllable nonword: ma:vinamara (word) to ma:ravinama (nonword).

These 80 words and 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, ten 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/CVCCV, CVCVCV/CVCCVCV, CVCVCVCV/CVCCVCVCV, and CVCVCVCVCV/CVCVCVCCVCV/CVCCVCVCVCV respectively.

The final list of 40 words, 40 nonwords (test items) and 5 words & 5 nonwords as practice items were then audio-recorded by a female native speaker of Kannada using the "PRAAT" software (downloadable software for speech recording and analysis) using a Compaq Presario C 700 laptop system. The list of words and nonwords have been provided in Appendix I.

Phase II: Standardization of the word and nonword repetition test

Procedure: A pilot study was carried out by administering the initially developed list of 80 words and 80 nonwords to 10 children in each age group to evaluate which of the words and nonwords could be easily repeated. Further the first 40 nonwords which could be repeated easily out of the total 80 nonwords were selected and also the corresponding 40 words were included to the final list. The final list consisted of a total of 80 test items with 40 words, 40 nonwords and 10 practice items including 5 words and 5 nonwords.

Following this, the list of recorded words and nonwords along with 10 practice items were presented to the subjects selected for the study. These were presented as wave file through headphones auditorily at comfortable listening level to the individual participants, in a quiet listening environment. Each participant was given the instructions as following depending on the task: "You are going to hear some 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 you will be hearing the words only once. Here comes the first word." The list of practice items followed by the test items was presented. No prompting or cueing was presented regarding the accuracy of the child's

production during the testing. The words and nonwords were randomized and presented and their responses were audio recorded. The total time taken to complete the repetition test was 10 minutes. They were given tangible reinforcements as a token of appreciation for their efforts.

The reliability was established as a part of standardization. Test-retest reliability was established for 10% of the subjects selected for the study from each age group. They were tested within a span of one to two weeks. The inter-rater reliability was established by administering the entire test on 10% of the population wherein the responses were analyzed by two qualified speech-language pathologists.

Phase III*:* Establishment of validity

The validity of the test was established by administering the test to 10 other typically developing children and 5 children with specific language impairment (SLI) and learning disability (LD) in each age group who did not belong to the group selected for the study. The test administration was carried out in a similar manner as mentioned above.

Analysis:

The participants' responses which were audio recorded, were transcribed verbatim using broad phonetic transcriptions on to a score sheet provided in the Appendix II by the experimenter. The audio recorded responses were analyzed for the accuracy of the repetition and the type of errors.

a) Accuracy measure: This comprises the total number of items correctly repeated which is further broken down according to 1) Lexical status: Total number of words and total number of nonwords correct, 2) Length: Total number of two-syllable, three-syllable, four-syllable and five-syllable items correct and 3) Phonemes correct: total number and

percentage of vowels and consonants repeated correctly, where in 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.

Scoring:

- The first response to each item was considered, unless the child spontaneously self-corrected, in which case the self-corrected response was considered for scoring.
- In the column headed Word Score and Nonword Score,

  -Score '1' was given if the child repeated all the syllables in a word and a nonword, as matched to the target,

  -Score '0' was given if the child repeated the item incorrectly

  -Score 'No Response' was given if the child did not attempt the item.

Criteria for scoring responses as correct or incorrect:

A response was scored as correct if it contained all the target phonemes, in the correct order and if the meaning of the word remains unchanged, with the following allowances:

- Omissions and substitutions which were judged to be appropriate in the child's dialect and due to the influence of daily conversation, e.g., /tagijo:du/ for /tagijuvudu/; /no:dtidda:ne/ for /no:duttidda:ne/. In this example, though there is omission of a syllable/phoneme the meaning of the word remained the same and hence it was scored as correct. Another instance - /mi:nugolu/ for /mi:nugalu/ was scored as correct as this would be a correct response according to the child's dialect; consistent production of /s/ for /S/ by the typically developing child due to the rural influence on language was also scored as correct.

- Substitutions which were consistent due to the normal phonological processes such as fronting, stopping, gliding were scored as correct, e.g., /l/ for /L/ consistently as in /kannadigalu/ for /kannadigaLu/, /balegalu/ for /baLegaLu/ etc, /l/ for /r/ consistently as in /belaLu/ for /beraLu/, /mavinamala/ for /mavinamara/ etc., was scored as correct.
- Distortions of syllables were scored as correct responses.

This data obtained was averaged across subjects in two age groups.

b) Error analysis: The total number of different types of errors such as substitutions, omissions, and additions were noted and averaged across the different syllable lengths. The type and frequency of errors namely substitution, omission, and addition errors were calculated for each of the word and nonword repeated. The total percentage of different errors was also calculated in a similar manner to that of percentage of phonemes correct and computed for each subject, for the entire set of words and nonwords and also at each of the different syllable length.

Statistical analysis

The obtained data was 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 Mixed ANOVA, Repeated measure ANOVA, Boneferroni's pairwise comparison test, independent samples t-test, MANOVA, paired t-test and Cronbach's coefficient alpha were carried out to answer the research questions of the present study.

CHAPTER IV

RESULTS AND DISCUSSION

The present study investigated the performance of a total of 138 typically developing children in the age range of 4-6years on a word and nonword repetition task in Kannada. These children were divided into two groups which included sixty six children in the age-group of 4-5years and seventy- two children in the age group of 5-6years. Each child was tested individually. The word repetition task was administered followed by nonword repetition task. The stimuli were presented through headphones using a laptop and the responses of the children were audio recorded. Further their responses were transcribed verbatim, scored and subjected to the following statistical analysis using SPSS version 16.

- Descriptive statistical analysis was used to compute the mean and standard deviation for both the groups.
- Mixed ANOVA was used to examine the main effect and interaction effect among several variables.
- Independent samples t-test was used to find out significant difference 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 study if there was significant difference in the performance of children within each age group across pairs of different syllable lengths.
- MANOVA was used to find out the significant difference, if any 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, if any between percentage of vowels and consonants correct within groups.
- Cronbach's alpha test was used to calculate test-retest and inter-rater reliability.

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

1. Word and nonword repetition across different age groups and gender

The mean and standard deviation (SD) values were computed using descriptive statistics for the accuracy of repetition of words and nonwords at different syllable lengths for each of the two age groups and also for both the genders. These values have been depicted in Table 1. The mean values indicated that the accuracy of the repetition scores was better for words on the whole (overall) and at all syllable lengths compared to nonwords for both age groups and gender. Further the accuracy was better for shorter syllable length words compared to the longer syllable length words in both the age groups and also in both the genders, i.e. accuracy of the responses decreased with the increase in the length of the words as revealed by the mean scores.

Table 1. *Mean and Standard Deviation (SD) for words and nonwords across different syllable length, age and gender.*

Syllable length	Age group	Gender				Total	
		Males		Females			
		Mean	SD	Mean	SD	Mean	SD
	4-5yrs	9.84	0.37	9.85	0.36	9.85	0.36
WA2sy	5-6yrs	9.93	0.25	9.98	0.15	9.96	0.20
	Total	9.89	0.32	9.92	0.27	9.91	0.29
	4-5yrs	9.38	0.87	9.50	0.75	9.44	0.81
WA3sy	5-6yrs	9.63	0.67	9.81	0.46	9.74	0.56
	Total	9.50	0.78	9.67	0.62	9.59	0.70
	4-5yrs	9.38	1.07	9.47	0.83	9.42	0.95
WA4sy	5-6yrs	9.63	0.89	9.48	0.99	9.54	0.95
	Total	9.50	0.99	9.47	0.92	9.49	0.95
	4-5yrs	8.47	1.41	8.88	2.42	8.68	1.99
WA5sy	5-6yrs	9.13	1.17	9.14	1.26	9.14	1.21
	Total	8.79	1.33	9.03	1.86	8.92	1.64
	4-5yrs	36.56	4.03	37.41	2.38	37.00	3.29
WOA	5-6yrs	38.33	2.17	38.43	2.10	38.89	2.11
	Total	37.42	3.36	37.97	2.27	37.00	3.29
	4-5yrs	9.53	0.80	9.59	0.86	9.56	0.83
NWA2sy	5-6yrs	9.77	0.50	9.60	1.56	9.67	1.23
	Total	9.65	0.68	9.60	1.29	9.62	1.06
	4-5yrs	9.13	1.24	9.27	1.34	9.20	1.18
NWA3sy	5-6yrs	9.50	0.78	9.55	0.63	9.53	0.69
	Total	9.31	1.05	9.42	0.90	9.37	0.97
	4-5yrs	7.88	1.60	8.38	1.84	8.12	1.74
NWA4sy	5-6yrs	8.77	1.36	9.24	0.91	9.04	1.13
	Total	8.31	1.54	8.86	1.46	8.61	1.52
	4-5yrs	5.50	2.14	6.03	2.25	5.77	2.20
NWA5sy	5-6yrs	6.13	2.32	6.98	1.87	6.63	2.09
	Total	5.81	2.23	6.55	2.09	6.22	2.18
	4-5yrs	31.50	4.65	33.32	4.93	32.44	4.85
NWOA	5-6yrs	34.20	3.40	35.55	2.79	34.99	3.11
	Total	32.81	4.28	34.55	4.03	33.77	4.21

[W- words; NW- nonwords; A2sy-accuracy at 2-syllable length; A3sy-accuracy at 3-syllable length; A4sy- accuracy at 4-syllable length; A5sy-accuracy at syllable length; WOA - overall accuracy for words; NWOA - overall accuracy for nonwords]

Mixed ANOVA was used to examine the main effect and interaction effect of variables such as words, nonwords, syllable length, age and gender on the accuracy of the responses. The results indicated a significant main effect of words and nonwords, syllable length, and chronological age. A significant interaction effect was found between words, nonwords and syllable length. However there was no significant interaction found among words and nonwords with age, words and nonwords with gender, words and nonwords with age and gender, words and nonwords with syllable length and age, words and nonwords with syllable length and gender, syllable length with age, syllable length with gender, syllable length with age and gender, words and nonwords with syllable length, age and gender and also gender alone. The same has been depicted in the Table 2 below.

Table 2. *Main and interaction effect among the different variables.*

Variables	df	F values	p values
WNW	1,134	184.42	0.00*
WNW * CA		3.38	0.07
WNW * Gender		1.94	0.17
WNW * CA * Gender		0.19	0.67
Syllable Length	3,402	173.68	0.00*
Syllable Length * CA		2.24	0.08
Syllable Length * Gender		1.70	0.17
Syllable Length * CA * Gender		0.03	0.99
WNW * Syllable Length	3,402	98.09	0.00*
WNW * Syllable Length * CA		2.00	0.11
WNW * Syllable Length * Gender		1.90	0.13
WNW * Syllable Length * CA * Gender		0.85	0.47
CA	1,134	10.93	0.001*
Gender		2.80	0.10
CA * Gender		0.11	0.74

[*$p<0.05$; WNW- words and nonwords; CA- chronological age]

a. Comparison of accuracy on overall words and overall nonwords between the age groups:

The mean scores of the overall word task for the 4-5year old group was 37.00 and for the 5-6year old group was 38.89. The mean values of the overall nonwords for the 4-5year old group was 32.44 and for the 5-6year old group was 34.99. The mean scores when compared revealed that the older age group obtained higher mean scores compared to the younger age group. This has been depicted in Figure 2. This indicated that the children in the higher age group performed better than the children in the lower age group. The mean scores were subjected to independent t-test to compare the performance on the accuracy of overall words and overall nonwords between the age groups. The results indicated that there was a significant difference between 4-5year and 5-6year old children on the overall words at [t (136) = -2.98, $p<0.05$] and also on overall nonwords at [t (136) = -3.71, $p <0.001$]. Similar results were obtained by Baddeley and Hitch (1974), and Baddeley (2000). This shows that as children grow their phonological working memory also matures.

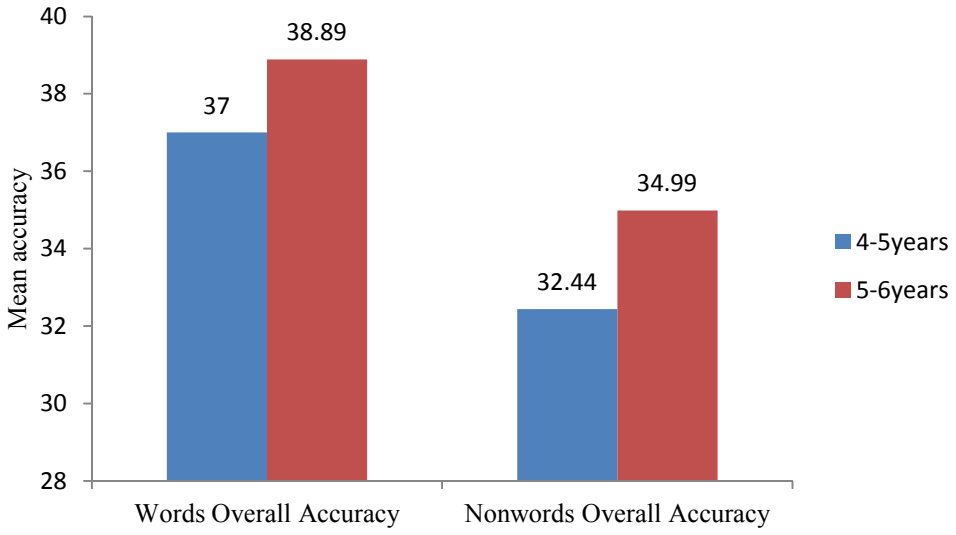

Figure 2. *Mean overall accuracy for repetition of words and nonwords in both the age groups.*

b. Comparison of accuracy between overall words and overall nonwords within each age group:

The mean and the standard deviation (SD) scores for the overall word and nonword task for both the age groups have been depicted in Table 3. A comparison of the mean scores revealed that both the younger group and the older group of children obtained higher scores on the word task than the nonword task. Paired t-test used to examine the difference in the accuracy between overall words and overall nonwords within each age group indicated a significant difference between overall words and nonwords within children of 4-5years age group at $t(65) = 8.02$, $p<0.01$ and within in 5-6years age group at $t(71) = 9.33$, $p<0.01$.

Table 3. *Mean and Standard Deviation (SD) values for overall word and nonwords accuracy in both the age groups.*

Age	**4-5years**		**5-6years**	
	Mean	**SD**	**Mean**	**SD**
WOA	37.00	3.29	38.89	2.11
NWOA	32.44	4.85	34.99	3.11

[WOA - overall accuracy for words;
NWOA - overall accuracy for nonwords]

The higher accuracy scores on the repetition of words compared to that of nonwords can be attributed to the effect of lexical status. The repetition of words requires the memory for the items which are familiar as they are learnt and stored in the mental lexicon of the children, which is easier when compared to the repetition of nonwords which are unfamiliar. Similar results were obtained by the study carried out by Chiat and Roy (2007).

c. Effect of syllable length on the accuracy of word repetition across age groups:

The mean scores for the word repetition task across both the age groups at all the syllable lengths have been depicted in Table 4. A comparison of mean values across the age groups revealed that the scores for the older age group were higher compared to the younger age group at all the syllable lengths. The same has been depicted in the Figure 3. MANOVA was used to compare the accuracy of responses at each syllable length in the word task between the two age groups and the results (F and p values depicted in Table 4) indicated that there was a significant difference between the performance of children of 4-5 and 5-6years age group on 2 and 3-syllable length words, however there was no significant difference between the performance of children on 4 and 5-syllable length words. The results showed that there was a greater development occurring between age groups at 2 and 3 syllable length word level compared to the 4 and 5 syllable length word level. This indicates that the task of learning and refining of repetition skills progresses in a step by step fashion from 2 and 3 syllable to 4 and 5 syllable level.

Table 4. *Comparison of accuracy on the word repetition task at different syllable lengths for both the age groups.*

Syllable length	**4-5years**		**5-6years**		**F values (1,136)**	**p values**
	Mean	**SD**	**Mean**	**SD**		
A2sy	9.85	0.36	9.96	0.20	4.98	0.03*
A3sy	9.44	0.81	9.74	0.56	6.42	0.01*
A4sy	9.42	0.95	9.54	0.95	0.53	0.47
A5y	8.68	1.99	9.14	1.21	2.696	0.10

[A2sy- accuracy at 2-syllable length; A3sy- accuracy at 3- syllable length; A4sy- accuracy at 4-syllable length; A5sy- accuracy at syllable length; *p<0.05]

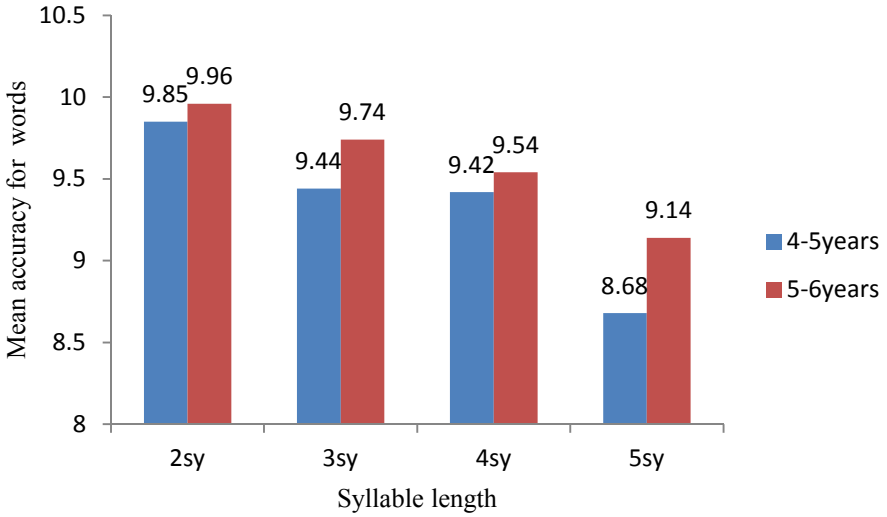

Figure 3. *Accuracy of repetition of words across syllable length in both the age groups.*

d. Accuracy of word repetition within each age group across syllable lengths:

Further repeated measure ANOVA used indicated that there was a significant difference in the performance of 4-5year old children in words at each of the different syllable length at [$F(3,195) = 13.52$, $p<0.05$] and in 5-6year old children at [$F(3,213) = 15.38$, $p<0.05$] respectively. Further Boneferroni's pairwise comparison test indicated that there was a significant difference in the performance of 4-5year old children at 2-syllable length words compared to the 3-, 4-, 5- syllable length words, that is, the 2-syllable length words had higher mean scores than 3, 4-, and 5-syllable length words ($p<0.01$), 5-syllable length words compared to 3-, and 4-syllable length words wherein 3- and 4-syllable length words had higher mean score than 5-syllable length words. However there was no significant difference in the performance of 4-5year old children at 3-syllable length words compared to 4-syllable length words ($p>0.05$). Similar results were obtained in the performance of 5-6year old children on the word repetition task.

Table 5. *Results of the Bonefferoni's test for each syllable length in words and nonwords.*

Syllable length		4-5yrs		5-6yrs	
		MD	**p values**	**MD**	**p values**
A2sy	**A3sy**	0.41	0.00**	0.22	0.01**
	A4sy	0.42	0.00**	0.42	0.00**
	A5sy	1.17	0.00**	0.82	0.00**
A3sy	**A4sy**	0.02	1.00	0.19	0.74
	A5sy	0.76	0.02*	0.61	0.001**
A4sy	**A5sy**	0.74	0.01**	0.40	0.03*

[MD – Mean difference; A2sy - accuracy at 2-syllable length; A3sy- accuracy at 3- syllable length; A4sy- accuracy at 4-syllable length; A5sy- accuracy at syllable length, *p<0.05; **p<0.01]

e. Effect of syllable length on accuracy of nonword repetition across age groups:

The mean scores for the nonword repetition task across both the age groups at all the syllable lengths have been depicted in Table 6. A comparison of mean values across the age groups revealed that the scores for the older age group were higher compared to the younger age group at all the syllable lengths. These results were similar to those obtained in the word repetition task. The same has been depicted in the Figure 4. MANOVA was used to compare the accuracy of responses in nonwords between the two age groups. The results (F & p values depicted in Table 6) indicated that there was a significant difference between the children of both age groups, on 3-, 4- and 5-syllable length nonwords, however children in both the age groups performed similarly on 2-syllable length nonwords. These results again showed that the children in both the age groups have greater phonological working memory for 2 syllable length nonwords. The younger group had lesser phonological working memory for the other longer syllable lengths. The children in 5-6 years age group obtained higher mean scores on 3-, 4-, and 5- syllable length nonwords than 4-5years old children and this indicated a better

developed phonological working memory capacity in the older children (5-6years) than the younger children (4-5years). Similar results were obtained by Baddeley & Hitch, (1974), and Baddeley (2000), who found better performance by the older children on the nonword repetition task when compared to the younger children suggesting a developmental progression in the efficiency of the phonological loop. Further Gathercole and Baddeley (1991) reported also that older children of 6 years performed better compared to 4-, and 5-years children on nonword repetition task and they attributed their better performance to the more proficient articulatory abilities and better subvocal rehearsal mechanism of the phonological loop which helps to actively maintain the to-be-repeated 'skeleton' of sub-lexical components (e.g., syllables, onsets-rimes) during the nonword repetition task.

Table 6. *Comparison of accuracy on the nonword repetition task at different syllable lengths for both the age groups.*

Syllable	**4-5years**		**5-6years**		**F values**	**p values**
length	**Mean**	**SD**	**Mean**	**SD**	**(1,136)**	
A2sy	9.56	0.83	9.67	1.23	0.35	0.56
A3sy	9.20	1.18	9.53	0.69	4.12	0.04*
A4sy	8.12	1.74	9.04	1.13	13.40	0.00*
A5sy	5.77	2.20	6.63	2.09	5.45	0.02*

[A2sy - accuracy at 2-syllable length; A3sy - accuracy at 3- syllable length; A4sy- accuracy at 4-syllable length; A5sy- accuracy at syllable length, *$p<0.05$].

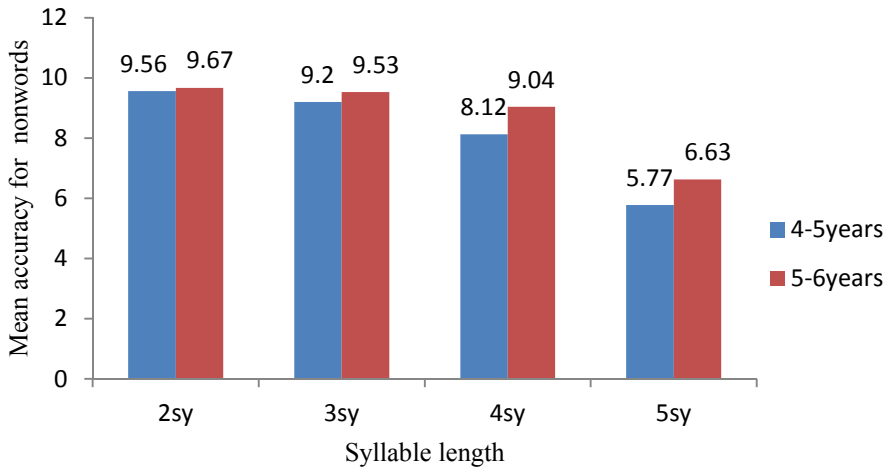

Figure 4. *Accuracy of nonword repetition across syllable length in both the age groups.*

f. Accuracy of nonword repetition within each age group across syllable lengths:

Repeated measure ANOVA was used to find the significant difference, if any, in the accuracy of responses across different syllable lengths in nonwords within each age group. The results indicated a significant difference in the performance of 4-5year old children on nonwords across different syllable lengths at [$F(3,195) = 124.35$, $p<0.01$]. A significant difference was also found in children of 5-6years age group at [$F(3,213) = 82.78$, $p<0.01$]. Boneferroni's pairwise comparison test indicated a significant difference in the performance of 4-5year old children on 2-syllable length nonwords compared to 4- and 5-syllable length nonwords, 3-syllable length nonwords compared to 4- and 5- syllable length nonwords and 5-syllable length nonwords compared to 4-syllable length nonwords at $p<0.01$. However there was no significant difference in the performance of 4-5year old children on 2- and 3-syllable length nonwords at $p>0.01$. Similar results were obtained in the performance of 5-6year old children on nonwords across different syllable lengths as found on Boneferroni's pairwise comparison test. The same has been depicted in Table 7.

Table 7. *Results of the Bonefferoni's test for each syllable length in nonwords.*

Syllable length		4-5yrs		5-6yrs	
		MD	**p values**	**MD**	**p values**
A2sy	A3sy	0.36	0.06	0.14	1.00
	A4sy	1.42	0.00**	0.63	0.01*
	A5sy	3.79	0.00**	3.04	0.00**
A3sy	A4sy	1.06	0.00**	0.49	0.01*
	A5sy	3.42	0.00**	2.20	0.00**
A4sy	A5sy	2.36	0.00**	2.42	0.00**

[MD- Mean difference; A2sy- accuracy at 2-syllable length; A3sy- accuracy at 3- syllable length; A4sy- accuracy at 4-syllable length; A5sy- accuracy at syllable length, *p<0.05, **p<0.01]

In general, the children in both the age groups performed better on the 2- and 3-syllable length nonwords than on 4- and 5-syllable length nonwords. The performance of the typically developing children in this study was similar to the findings of earlier studies in which it was reported that the typically developing children performed 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). Similar results in terms of the effect of length was also found in the several studies carried out with monolingual English-speaking children (e.g., Gathercole & Baddeley, 1989; Gathercole & Adams, 1994), monolingual Spanish-speaking children (Girbau & Schwartz, 2007, 2008), and bilingual Spanish-English language users (Calderon & Gutierrez-Clellen, 2003). They reported that the accuracy advantage for shorter length over longer length stimuli suggests the dependence on a "time- or capacity-limited phonological memory system" (Gathercole, Willis, Emslie, & Baddeley, 1991). They proposed that the longer the stimulus item, the greater are the demands on the storage and rehearsal functions

of the loop (Baddeley & Hitch, 1974; Baddeley, 2002). The longer length stimuli would tax the storage and rehearsal functions of the loop very much, which would lead to less complete and precise short-term representations and further less accurate repetitions of novel phonological forms.

On the other hand, it was reported that the decay in the memory traces of the longer syllable length nonwords would be more specifically related to the simultaneous processes of retrieving and sequentially ordering the nonword constituents. Gupta (2005) advocated that demands on an individual's short term memory to serially repeat long lists of sublexical chunks (i.e., onsets and rimes) results in more repetition errors.

Further in the present study it can be observed that the mean score for accuracy at 4-syllable (mean = 8.86) and especially at 5-syllable length nonwords (mean = 6.55) is significantly lesser compared to the 2- syllable length nonwords (mean = 9.60), and 3-syllable length nonwords (mean = 9.42). This might be attributed to the lesser frequency of exposure of the children at this age to longer syllable length words. Similar observations were mentioned by Gupta (2005) who suggested that the increase in errors for the longer nonwords may also illustrate the effect of practice using language units. The short words tend to be more prevalent in early vocabulary learning contexts. Gupta hypothesized that similar processes are utilized in the repetition of real words and nonwords. Hence it might be possible that the children repeated more accurately shorter nonwords because they are more frequently encountered lexical forms that resembled these nonwords in length. Similarly, longer nonwords (4- and 5-syllable length) could have elicited more errors due to unfamiliarity or insufficient practice with long words.

g. Comparison of accuracy of words and nonwords:

The mean scores for the accuracy of words and nonwords at each of the syllable length for each age group shown in Table 8 indicated that, the children in both the age groups performed better on the words at each of the syllable length compared to the nonwords of the corresponding syllable length. Further paired t-test was used to compare the performance on the accuracy of words with that of the nonwords in children within each age group across at each syllable length. There was a significant difference in the performance of the 4-5year old children on 2-, 4-, 5-syllable length words and nonwords, however they performed almost similarly on 3-syllable length words and nonwords. There was a significant difference between words and nonwords of 3-, 4-, 5-syllable length in the 5-6 year age group, however their performance was similar on the 2-syllable length words and nonwords. The t-values and the p values have been represented in Table 8.

Table 8. *Mean for words and nonwords, t and p values for accuracy of repetition between words and nonwords in each age group.*

Pairs	**4-5 years**				**5-6 years**			
	Mean (W)	**Mean (NW)**	**t values (65)**	**p values**	**Mean (W)**	**Mean (NW)**	**t values (71)**	**p values**
WA2sy-NWA2sy	9.85	9.56	3.16	0.00**	9.96	9.67	1.10	0.05
WA3sy-NWA3sy	9.44	9.20	1.59	0.12	9.74	9.53	2.15	0.04*
WA4sy-NWA4sy	9.42	8.12	6.10	0.00**	9.54	9.04	3.61	0.00**
WA5sy-NWA5sy	8.68	5.77	10.12	0.00**	9.14	6.63	10.63	0.00**

[W- words; NW- nonwords; A2sy - accuracy at 2-syllable length; A3sy - accuracy at 3- syllable length; A4sy- accuracy at 4-syllable length; A5sy - accuracy at syllable length, **p<0.01; *p<0.05]

2. Comparison of performance of children across different socioeconomic status (SES):

Kruskal Wallis test was used to compare the performance of children from different SES on both words and nonwords at each of the syllable lengths. The results indicated that there was no significant difference in the performance of 4-5yrs children on the basis of SES on both words and nonwords at any of the syllable lengths. The same results were found in the performance of children of 5-6yrs. The mean and the standard deviation values have been depicted in Table 9 and the chisquare and level of significance values have been depicted in Table 10.

Similar results were obtained by earlier studies where the repetition performance was not affected by the variables like gender and SES (Burt, Holm, & Dodd, 1999; Ellis Weismer et al., 2000; Chiat & Roy, 2004, 2007).

Table 9. *Mean and Standard Deviation (SD) values for word and nonword accuracy at each syllable length for children from different SES.*

Syllable length	SES	4-5yrs		5-6yrs	
		Mean	SD	Mean	SD
WA2sy	1	9.93	0.26	10.00	0.00
	2	9.78	0.42	9.91	0.29
	3	9.82	0.41	9.97	0.18
WA3sy	1	9.39	0.88	9.74	0.56
	2	9.41	0.80	9.57	0.73
	3	9.64	0.67	9.87	0.35
WA4sy	1	9.61	0.88	9.69	0.67
	2	9.30	1.07	9.70	0.47
	3	9.27	0.79	9.33	1.30
WA5sy	1	8.96	2.63	9.37	0.60
	2	8.37	1.45	9.30	0.88
	3	8.73	1.10	8.87	1.63
OWA	1	37.54	2.59	38.90	1.10
	2	36.26	4.10	38.44	1.76
	3	37.46	2.42	38.03	2.75
NWA2sy	1	9.71	0.54	9.21	2.28
	2	9.44	0.89	9.74	0.54
	3	9.46	1.21	9.90	0.31
NWA3sy	1	9.36	0.91	9.63	0.50
	2	9.15	1.29	9.39	0.78
	3	8.91	1.51	9.57	0.73
NWA4sy	1	8.00	1.61	8.95	1.03
	2	8.26	1.68	9.13	0.97
	3	8.18	2.27	9.03	1.33
NWA5sy	1	5.50	2.05	6.53	2.22
	2	5.96	2.30	6.87	2.24
	3	6.00	2.45	6.50	1.943
ONWA	1	32.12	4.26	34.84	2.99
	2	32.74	4.72	35.22	3.07
	3	32.55	6.70	34.90	3.29

[W- words; NW- nonwords; 1- children of lower socioeconomic status; 2- children of middle socioeconomic status; 3- children of higher socioeconomic status; A2sy - accuracy at 2-syllable length; A3sy - accuracy at 3- syllable length; A4sy - accuracy at 4-syllable length; A5sy - accuracy at syllable length; OWA - overall accuracy for the entire words; ONWA - overall accuracy for the entire nonwords]

Table 10. *Chisquare and level of significance values for word and nonword accuracy at each syllable length for both the age groups.*

Syllable length	4-5years		5-6years	
	Chisquare, (df, 2)	p values	Chisquare, (df, 2)	p values
WA2sy	2.49	0.29	2.03	0.36
WA3sy	0.81	0.67	2.74	0.25
WA4sy	3.54	0.17	0.62	0.73
WA5sy	0.76	0.69	0.32	0.85
OWA	2.28	0.32	0.27	0.87
NWA2sy	0.88	0.65	3.68	0.16
NWA3sy	0.42	0.42	1.08	0.58
NWA4sy	1.01	1.01	0.61	0.74
NWA5sy	0.99	0.99	0.51	0.77
ONWA	1.31	1.31	0.89	0.96

[W- words; NW- nonwords; A2s - accuracy at 2-syllable length; A3s - accuracy at 3- syllable length; A4s - accuracy at 4-syllable length; A5s - accuracy at syllable length, OWA - overall accuracy for the entire words; ONWA - overall accuracy for the entire nonwords; df – degree of freedom].

3. Accuracy for words and nonwords combined:

The mean and standard deviation (SD) values were computed for the accuracy of words and nonwords combined at each syllable length and for the accuracy for entire set of words and nonwords. The mean and SD values depicted in Table 11 indicated that the accuracy for words and nonwords combined was high at shorter syllable lengths compared to longer syllable length. Further the mean values indicated slightly higher accuracy scores for

5-6year old children compared to 4-5year old children as shown in Figure 5. Similar results were obtained by Chiat and Roy (2007).

Table 11. *Mean and Standard Deviation (SD) values for word and nonword accuracy combined at each syllable length for both the groups across gender.*

Syllable length	Age group	Females		Males		Total	
		Mean	SD	Mean	SD	Mean	SD
WNWA2sy	4-5yrs	19.44	1.08	19.38	1.01	19.41	1.04
	5-6yrs	19.79	0.42	19.70	0.54	19.75	0.47
	Total	19.63	0.80	19.53	0.82	19.59	0.81
WNWA3sy	4-5yrs	18.77	1.67	18.53	1.55	18.65	1.60
	5-6yrs	19.36	0.76	19.13	1.17	19.26	0.95
	Total	19.09	1.28	18.82	1.40	18.97	1.33
WNWA4sy	4-5yrs	17.82	2.34	17.25	2.02	17.55	2.19
	5-6yrs	18.74	1.53	18.40	1.98	18.60	1.73
	Total	18.33	1.98	17.81	2.06	18.09	2.03
WNWA5sy	4-5yrs	14.65	3.19	14.00	3.10	14.33	3.14
	5-6yrs	15.91	3.28	15.27	2.94	15.64	3.13
	Total	15.34	3.28	14.61	3.06	15.02	3.19
TWNWA	4-5yrs	70.62	6.68	68.75	6.08	69.71	6.42
	5-6yrs	73.12	6.97	72.07	5.04	72.68	6.22
	Total	72.00	6.91	70.36	5.80	71.26	6.47

[WNW- words and nonwords combined; A2sy - accuracy at 2-syllable length; A3sy - accuracy at 3-syllable length; A4sy - accuracy at 4-syllable length; A5sy - accuracy at syllable length, TWNWA- accuracy for the entire words and nonwords combined]

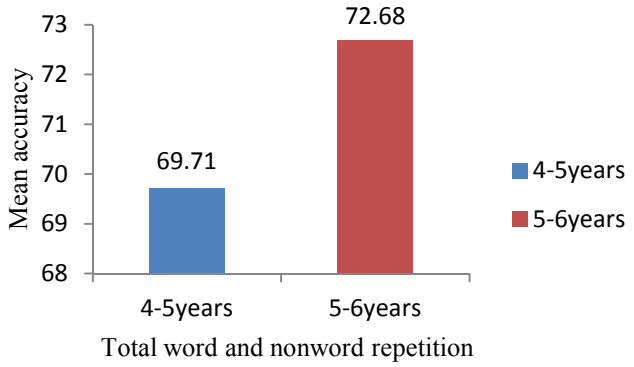

Figure 5. *Mean accuracy for words and nonwords combined for both the age groups.*

Mixed ANOVA was done to examine the main and interaction effect of syllable length, age and gender on the word and nonword combined accuracy of the responses. The results indicated a significant main effect of syllable length and chronological age at $p<0.01$. However, no significant main effect was found for gender, between syllable length and chronological age, syllable length and gender, syllable length, chronological age and gender and chronological age and gender ($P>0.05$) as shown in the Table 12 below .

Table 12. *Main and interaction effect among variables.*

Variables	df	F values	p values
Syllable	3	197.70	0.00*
syllable * CA	3	2.06	0.11
syllable * Gender	3	0.73	0.53
syllable * CA * Gender	3	0.04	0.99
CA	1	11.912	0.001*
Gender	1	2.252	0.12
CA * Gender	1	0.016	0.90

[CA - chronological age; *p<0.01]

Boneferroni's pairwise comparison test was used to examine the significant difference in the accuracy of words and nonwords combined across different syllable lengths. The results suggested a significant difference in the accuracy of total words and nonwords at each syllable length as shown in the Table 13 below.

Table 13. *Results of the Bonefferoni's test for accuracy between each of the syllable lengths.*

Syllable length		Mean Difference	p values
WNWA2sy	**WNWA3sy**	0.63	0.00*
	WNWA4sy	1.52	0.00*
	WNWA5sy	4.62	0.00*
WNWA3sy	**WNWA4sy**	0.89	0.00*
	WNWA5sy	3.99	0.00*
WNWA4sy	**WNWA5sy**	3.10	0.00*

[WNW- words and nonwords combined; A2sy - accuracy at 2-syllable length; A3sy - accuracy at 3-syllable length; A4sy - accuracy at 4-syllable length; A5sy - accuracy at syllable length; *- $p<0.01$]

MANOVA was done to compare the accuracy of total words and nonwords between the two age groups. The results showed that there was a significant difference in the accuracy of total words and nonwords at each of the syllable lengths between the age groups at $p<0.05$. Table 14 represents the F and p values. The accuracy of the words and nonwords combined at each of the syllable length was higher for 5-6year old children than that of 4-5year old children as mentioned earlier. The following Figure 6 indicates the same.

Table 14. *Comparison of accuracy of words and nonwords combined between the two age groups.*

Syllable length	F values (1,136)	4-5years		5-6years		p values
		Mean	SD	Mean	SD	
WNWA2sy	6.37	19.41	1.04	19.75	0.47	0.013*
WNWA3sy	7.60	18.65	1.60	19.26	0.95	0.007*
WNWA4sy	9.89	17.55	2.19	18.60	1.73	0.002*
WNWA5sy	5.97	14.33	3.14	15.64	3.13	0.02*

[WNW- words and nonwords combined; A2sy - accuracy at 2-syllable length; A3sy - accuracy at 3-syllable length; A4sy - accuracy at 4-syllable length; A5sy - accuracy at syllable length; * - p<0.05]

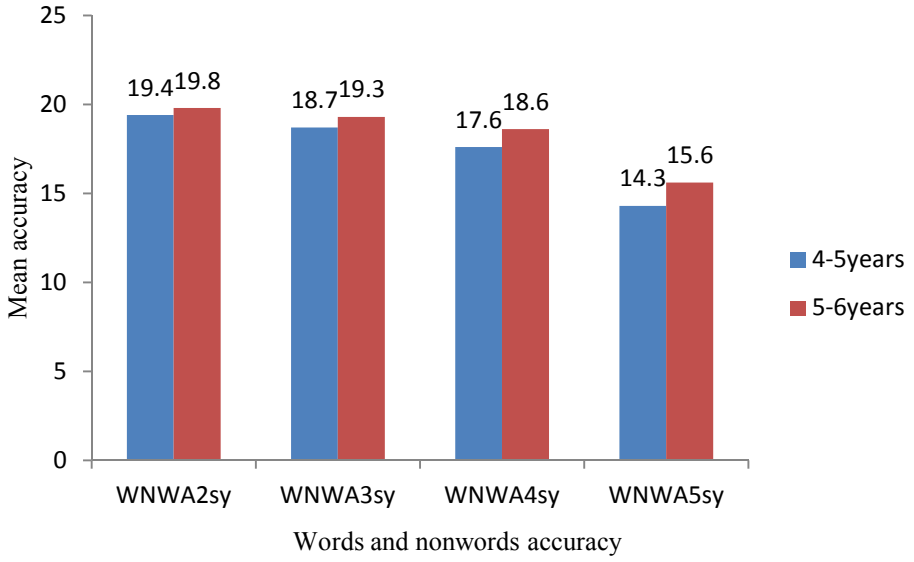

Figure 6. *Mean accuracy of word and nonword combined across syllable length for both the age groups.*

Repeated measure ANOVA was done to find out whether significant difference existed in the accuracy of total words and nonwords combined between the different syllable lengths in the performance of children of 4-5years and also in 5-6years group. The results revealed a significant difference in the accuracy scores between different syllable lengths in

4-5years age group at F (3,195) = 120.16, p<0.01and in 5-6years age group at [F (3,213) = 82.64, p<0.01].

Boneferroni's pairwise comparison test indicated a significant difference in the accuracy of total word and nonword scores between each syllable length in the children of both 4-5 and 5-6years age group. Furthermore the accuracy of the words and nonwords combined were higher at 2-syllable length compared to the 3-, 4-, and 5-syllable length in both the age groups. The same is represented in Table 15.

Table 15. *Results of the Bonefferoni's test for accuracy of total words and nonwords combined at different syllable lengths.*

Pairwise comparison of accuracy of total words and nonwords at different syllable lengths		**4-5years**		**5-6years**	
		Mean difference	**p values**	**Mean difference**	**p values**
WNWA2sy	**WNWA3sy**	0.76	0.00*	0.47	0.00*
	WNWA4sy	1.86	0.00*	1.15	0.00*
	WNWA5sy	5.08	0.00*	4.11	0.00*
WNWA3sy	**WNWA4sy**	1.11	0.00*	0.67	0.02*
	WNWA5sy	4.32	0.00*	3.63	0.00*
WNWA4sy	**WNWA5sy**	3.21	0.00*	2.96	0.00*

[WNW- words and nonwords combined; A2sy - accuracy at 2-syllable length; A3sy - accuracy at 3-syllable length; A4sy - accuracy at 4-syllable length; A5sy - accuracy at syllable length; *p<0.01]

Two-way ANOVA carried out revealed a significant main effect in the chronological age alone for the word and nonword total accuracy scores as shown in Table 16.

Table 16. *Interaction among the variables.*

Source	F values	p values
CA	7.20	0.01*
Gender	1.81	0.18
CA * Gender	0.14	0.71

[CA - chronological age; *p<0.05]

The responses of the children were analyzed in terms of percentage of phonemes correct with respect to vowels and consonants and also the type of errors exhibited by the children during the repetition task.

1. Percentage of Vowels Correct (PVC):

The mean and the standard deviation (SD) values for the PVC at each syllable length in both words and nonwords were computed according to the chronological age and gender using descriptive statistics and the same has been shown in Table 17. The mean values indicated that the PVC was highest for words compared to nonwords for both the age groups and gender. Further it was seen that the PVC decreased with the increase in the syllable length, i.e. decreased from 2-syllable length words to 5-syllable length words in both the age groups and the same has been depicted in Figure 7. Similar results were also found on the nonwords as shown in Figure 8.

Since the accuracy for the words repeated were higher compared to that of the nonwords, the PVC was also higher in words than nonwords. Greater number of vowel errors were seen in nonwords than in words as the nonwords contained more unfamiliar phonological forms. Furthermore, larger the syllable length, greater were the errors that occurred, that is, PVC was lesser in 5-syllable length nonwords compared to shorter syllable length nonwords which indicates less complete and precise short-term representations and less accurate repetitions of novel phonological forms.

Table 17. *Mean and standard deviation (SD) values for PVC in both words and nonwords at different syllable lengths for both the age groups.*

W/NW different syllable lengths	CA	Females		Males		Total	
		Mean	SD	Mean	SD	Mean	SD
	4-5yrs	100.00	0.00	100.00	0.00	100.00	0.00
WPVC2sy	5-6yrs	100.00	0.00	99.83	0.91	99.93	0.59
	Total	100.00	0.00	99.92	0.64	99.96	0.43
	4-5yrs	99.90	0.57	99.38	2.15	99.65	1.56
WPVC3sy	5-6yrs	100.00	0.00	99.78	0.85	99.91	0.55
	Total	99.96	0.38	99.57	1.65	99.78	1.15
	4-5yrs	99.71	0.82	99.61	0.92	99.66	0.87
WPVC4sy	5-6yrs	99.58	1.65	99.92	0.46	99.72	1.30
	Total	99.64	1.34	99.76	0.75	99.69	1.12
	4-5yrs	98.00	4.85	98.69	2.36	98.33	3.84
WPVC5sy	5-6yrs	99.67	0.98	99.47	1.28	99.58	1.11
	Total	98.92	3.40	99.07	1.94	98.99	2.83
	4-5yrs	99.37	0.976	99.29	1.32	99.33	1.15
WTPVC	5-6yrs	99.76	0.58	99.67	0.72	99.72	0.64
	Total	99.59	0.80	99.47	1.08	99.53	0.94
	4-5yrs	100.00	0.00	100.00	0.00	100.00	0.00
NWPVC2sy	5-6yrs	99.88	0.77	99.67	1.27	99.79	1.01
	Total	99.93	0.574	99.84	0.89	99.89	0.73
	4-5yrs	99.71	0.96	99.69	0.99	99.70	0.97
NWPVC3sy	5-6yrs	99.68	0.99	99.67	1.017	99.68	0.99
	Total	99.69	0.97	99.68	0.99	99.69	0.98
	4-5yrs	98.82	2.24	98.60	1.79	98.71	2.02
NWPVC4sy	5-6yrs	99.23	1.61	99.50	1.02	99.34	1.39
	Total	99.05	1.91	99.03	1.53	99.04	1.74
	4-5yrs	95.94	3.67	96.00	3.09	95.97	3.37
NWPVC5sy	5-6yrs	96.57	2.77	95.80	4.28	96.25	3.47
	Total	96.29	3.20	95.90	3.68	96.12	3.41
	4-5yrs	98.13	1.72	97.81	1.80	97.98	1.75
NWTPVC	5-6yrs	98.54	1.23	98.24	1.70	98.41	1.44
	Total	98.36	1.48	98.02	1.75	98.20	1.61

[W - words; NW - nonwords; CA- Chronological age, PVC - percentage of vowels correct; TPVC - total percentage of vowels correct; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length]

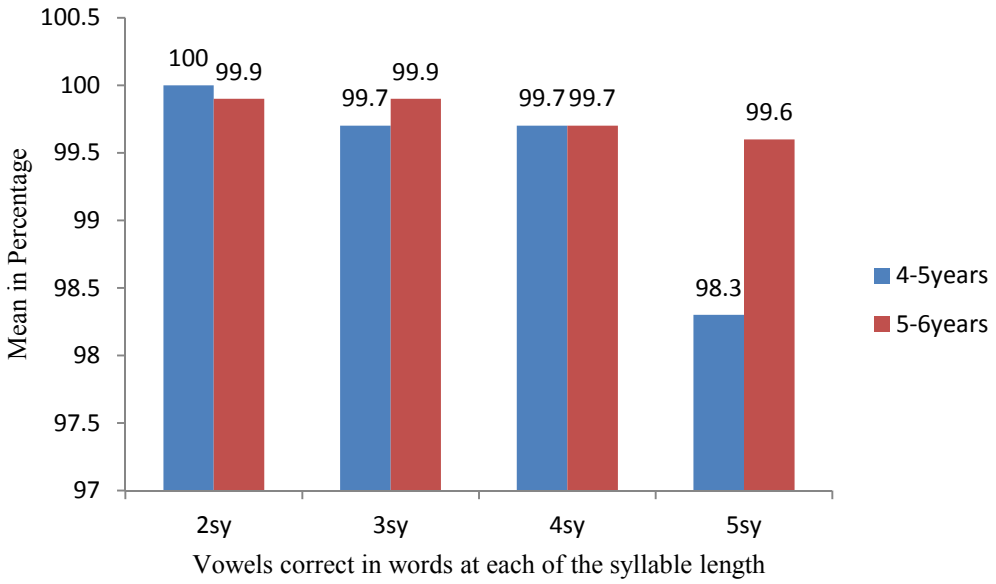

Figure 7. *Percentage of vowels correct in word repetition across syllable length in both the age groups.*

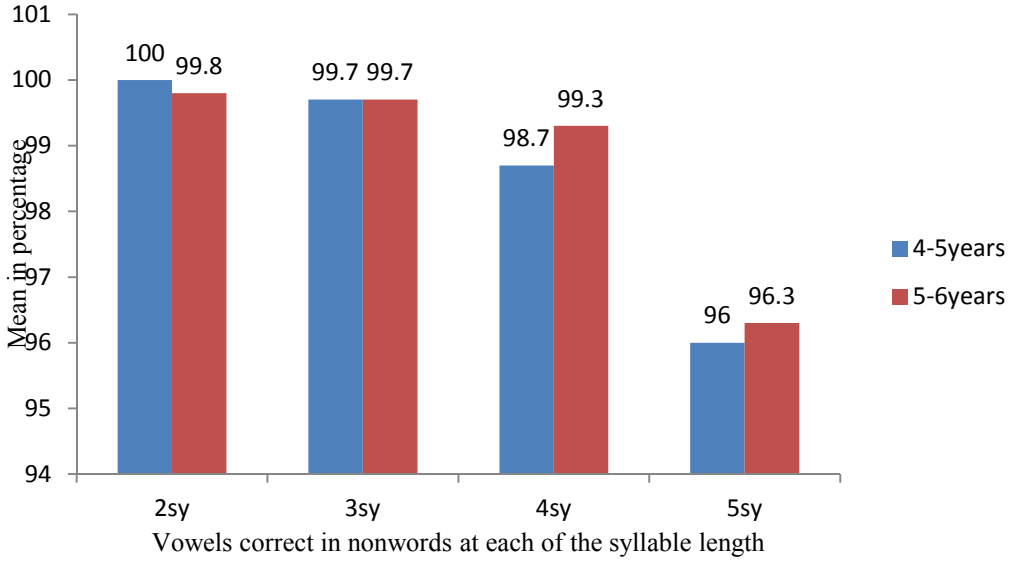

Figure 8. *Percentage of vowels correct in nonword repetition across syllable length in both the age groups.*

Mixed ANOVA was used to examine the variation of PVC due to the effect of variables like words, nonwords, syllable length, chronological age, and gender. The results

indicated a significant main effect between words and nonwords, syllable length, chronological age and a significant interaction effect on syllables with chronological age and words and nonwords with syllable length. There was no significant main effect found in gender alone and also no significant interaction between words and nonwords with chronological age, words and nonwords with gender, syllables with gender, syllables with chronological age and gender, words and nonwords with syllables and chronological age, words and nonwords with syllables and gender and words and nonwords with syllables, chronological age and gender. The same has been shown in the Table 18 below.

Table 18. *Interaction among the different variables.*

Variables	df	F values	p values
WNW	1,134	58.21	0.00**
WNW * CA	1,134	0.80	0.38
WNW * Gender	1,134	0.14	0.71
WNW * CA * Gender	1,134	0.01	0.91
Syllables	3,402	114.96	0.00**
syllables * CA	3,402	3.29	0.02*
syllables * Gender	3,402	0.29	0.84
syllables * CA * Gender	3,402	1.91	0.13
WNW * syllables	3,402	38.46	0.00**
WNW * syllables * CA	3,402	2.24	0.08
WNW * syllables * Gender	3,402	0.84	0.47
WNW * syllables * CA * Gender	3,402	0.04	0.99
CA	1,134	3.92	0.049*
Gender	1,134	0.27	0.60
CA * Gender	1,134	0.16	0.69

[**p<0.01; *p<0.05; WNW- words and nonwords; CA- chronological age]

The PVC was compared across the different syllable lengths using Boneferroni's pairwise comparison test. The results indicated that there was a significant difference in the PVC between different syllable lengths as shown in Table 19.

Table 19. *Results of the Bonefferoni's test for PVC at different syllable lengths.*

Pairwise comparison of PVC at different syllable lengths		**Mean difference**	**p values**
PVC2sy	PVC3sy	0.20	0.04*
	PVC4sy	0.55	0.00**
	PVC5sy	2.41	0.00**
PVC3sy	PVC4sy	0.36	0.01*
	PVC5sy	2.21	0.00**
PVC4sy	PVC5sy	1.85	0.00*

[PVC - percentage of vowels correct; 2s - 2-syllable length, 3s - 3-syllable length; 4s - 4-syllable length; 5s - 5-syllable length; **- $p<0.01$;*-$p<0.05$]

a. Comparison of total PVC in words and nonwords:

Mixed ANOVA was done to compare the total PVC in words (mean = 99.53, SD = 0.94) and total PVC in nonwords (mean = 98.20, SD = 1.61). The results indicated that there was a significant main effect between the total PVC in words and nonwords at [$F(1,134) = 83.03$, $P<0.01$] and also on chronological age at [$F(1, 134) = 5.3$, $p<0.05$]. However no significant main effect was found on gender. Furthermore no significant interaction was found between total PVC for words, total PVC for nonwords and chronological age, total PVC for words, total PVC for nonwords and gender, total PVC for words, total PVC for nonwords, chronological age and gender, total PVC for words and total PVC for nonwords and chronological age and gender ($P>0.05$).

b. Comparison of total PVC in words and nonwords between the age groups:

The mean values for the total PVC in words (4-5years, mean = 99.33; 5-6years, mean = 99.72) and for the total PVC in nonwords (4-5years, mean = 97.98; 5-6years, mean = 98.41), between the age groups indicated a better performance of the children in the 5-6years. This has been depicted in Figure 9. Independent-t test revealed that both the groups obtained significantly different scores on the total PVC in words at [t (136) = -2.51, P<0.05], however, no significant difference was found between the groups in total PVC in nonwords, (P>0.05).

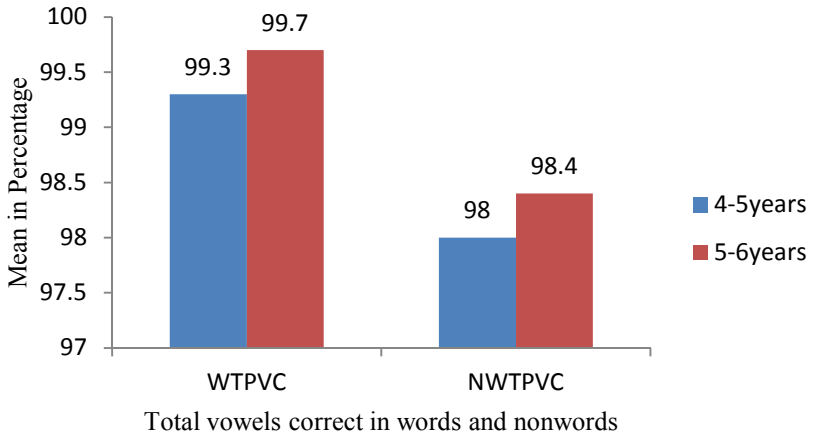

Figure 9. *Percentage of total PVC on the word and nonword repetition task across age groups.*

c. Effect of syllable length on the PVC in words and nonwords

MANOVA was used to examine whether any significant difference existed in the PVC in words and nonwords at different syllable lengths between the two age groups. The results revealed that the children in both the age groups differed significantly on the PVC in words only at 5syllable length at [F (1, 136) = 7.01, P<0.01], where the PVC was lower for 4-5year old children (mean = 99.33) than 5-6year old children (mean = 99.72). In PVC for nonwords, the two age groups differed only at 4syllable length at [F (1,136) = 4.59, P<0.05]

where the PVC was higher in 5-6year age group (mean = 99.34) compared to 4-5year age group children (mean = 98.71).

d. PVC within each age group:

i) PVC in the lower age group:

Repeated measure ANOVA was done to evaluate whether significant difference existed in the PVC in words and nonwords at different syllable lengths in the children of 4-5years age group. The results showed that the children in 4-5years of age performed significantly different on the PVC at different syllable lengths in both words [$F(3,195) = 8.71$, $P < 0.01$] and nonwords [$F(3,195) = 63.16$, $P<0.01$].

Further Bonefferoni's pairwise comparison test was used to find which syllable lengths differed significantly from each other on PVC in words and also in nonwords. The results indicated that the PVC at 2syllable length words was significantly different from that of PVC at 4- and 5-syllable length words. Also PVC at 3-syllable length was significantly different from PVC at 5-syllable length words and PVC at 4-syllable length was significantly different from PVC at 5-syllable length words. The children obtained similar scores on PVC at 2- and 3-syllable length words, and PVC at 3- and 4-syllable length words.

The PVC at 2-syllable length nonwords was similar to that of at 3-syllable length nonwords ($P>0.05$), whereas it differed significantly from that of 4-, and 5-syllable length nonwords ($P<0.01$). Furthermore the PVC at 5-syllable length nonwords was significantly different from that of 2-, 4- and 3-syllable length nonwords ($P<0.01$). Moreover PVC at 3-syllable length nonwords was different from that of PVC at 4-syllable length nonwords ($P<0.01$). The results of the Bonefferoni's pairwise comparison test for words and nonwords have been depicted in Table 20.

Table 20. *Results of the Bonefferoni's test for PVC in words & nonwords at different syllable lengths in the 4-5years age group.*

PVC in words & nonwords		Mean difference	p values
WPVC2sy	**WPVC3sy**	0.35	0.42
	WPVC4sy	0.34	0.01*
	WPVC5sy	1.67	0.01*
WPVC3sy	**WPVC4sy**	0.01	1.00
	WPVC5sy	1.31	0.04*
WPVC4sy	**WPVC5sy**	1.33	0.04*
NWPVC2sy	**NWPVC3sy**	0.30	0.08
	NWPVC4sy	1.29	0.00**
	NWPVC5sy	4.03	0.00**
NWPVC3sy	**NWPVC4sy**	0.99	0.01*
	NWPVC5sy	3.73	0.00**
NWPVC4sy	**NWPVC5sy**	2.74	0.00**

[W - words; NW - nonwords; PVC - percentage of vowels correct; TPVC - Total percentage of vowels correct; 2s - 2-syllable length, 3s - 3-syllable length; 4s - 4-syllable length; 5s - 5-syllable length; * $p<0.05$; ** $p<0.01$]

Paired-t test was used to compare the PVC between words and nonwords at each syllable length in the children of 4-5years age group. The results indicated that the PVC at 4-, 5-syllable length and also the overall PVC differed significantly for words from that of nonwords. However, the PVC at 2-and 3-syllable length was similar for both words and nonwords. The same is represented in Table 21.

Table 21. *Pairwise comparison of PVC between words and nonwords.*

Pairs	t values (65)	Sig. (2-tailed)
WPVC3sy - NWPVC3sy	0.22	0.83
WPVC4sy - NWPVC4sy	**3.46**	**0.001***
WPVC5sy - NWPVC5sy	**3.68**	**0.00***
WTPVC – NWTPVC	**5.70**	**0.00***

[W - words; NW - nonwords; PVC - percentage of vowels correct; TPVC - total percentage of vowels correct; 2s - 2-syllable length, 3s - 3-syllable length; 4s - 4-syllable length; 5s - 5-syllable length; *p <0.01]

ii) PVC in the older age group:

Repeated measure ANOVA was done to identify whether significant difference existed in PVC in words and nonwords at different syllable lengths in the children of 5-6years age group. The results revealed that there was no significant difference in the PVC at different syllable lengths in words at [F (3,213) =2.37, P>0.05]. However, a significant difference was present in the PVC at different syllable lengths in nonwords in children of 5-6years of age at [F (3,213) = 56.02, P<0.01]. The vowels in the words are present in the context of familiar phonological forms and hence there is no much error seen in the vowels in the words even in the longer syllable lengths.

Boneferroni's pairwise comparison test was not done to PVC in words at different syllable lengths as the mean values were similar for each of the syllable length and also no significant difference was done on repeated measure ANOVA for PVC across different syllable lengths. Furthermore, Boneferroni's pairwise comparison test was done to identify as to which pair of syllable lengths significantly differed in PVC in nonwords. The results showed a significant difference in the PVC at 5-syllable length nonwords compared to that of

2-, 3-, and 4-syllable length nonwords at P<0.01. There was no significant difference in the PVC at 2-, 3-, and 4-syllable length nonwords at P>0.05. The PVC in the 5-syllable lengths was slightly higher compared to other syllable lengths, because the error increased with the increase in the syllable length.

Table 22. *Results of the Bonefferoni's test for PVC in nonwords at different syllable lengths in the 5-6year age group.*

PVC in nonwords at different syllable length		Mean difference	p values
NWPVC2sy	**NWPVC3sy**	0.12	1.00
	NWPVC4sy	0.45	0.16
	NWPVC5sy	3.54	0.00*
NWPVC3sy	**NWPVC4sy**	0.34	0.59
	NWPVC5sy	3.43	0.00*
NWPVC4sy	**NWPVC5sy**	3.09	0.00*

[MD - mean difference; NW - nonwords; PVC - percentage of vowels correct; 2sy- 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; * p<0.01]

Paired-t test was done to compare the PVC between words and nonwords at each syllable length in the children of 5-6years of age. The results indicated that there was a significant difference in the PVC between words and nonwords only at 5-syllable length at [t (71) = 7.82, P<0.01] and also on the overall PVC between words and nonwords at [t (71) = 7.54, P<0.01]. The range of mean values for PVC was almost 96-100% in both words and nonwords at all of the syllable lengths. This shows that vowels were better repeated than consonants. This could be attributed to the fact that vowels are generally easy to articulate and mastered earlier in the children's phonetic inventory. Hence vowels are considered to be

better preserved in the repetition tasks. Similar results were obtained by Girbau and Schwartz (2008).

2. Percentage of Consonants Correct (PCC):

The mean and the standard deviation (SD) values for the Percentage of Consonants Correct (PCC) at each syllable length in both words and nonwords according to the chronological age and gender were computed and have been depicted in Table 23. The mean values indicate that the PCC was the highest for 2-syllable length words, followed by 3-syllable, 4-syllable and then 5-syllable words for both the age groups as shown in Figure 10. The same pattern was observed in the nonwords too and has been depicted in Figure 11, that is the errors increased with the increase in the syllable length. Further the PCC was higher for words compared to those of nonwords as can be observed from the Table 23.

Table 23. *Mean and standard deviation (SD) values for the PCC in both words and nonwords at different syllable lengths for both the age groups.*

W/NW at different syllable lengths	Chronological age	Females		Males		Total	
		Mean	SD	Mean	SD	Mean	SD
WPCC2sy	4-5yrs	100.00	0.00	100.00	0.00	100.00	0.00
	5-6yrs	100.00	0.00	99.83	0.91	99.93	0.59
	Total	100.00	0.00	99.92	0.64	99.96	0.43
WPCC3sy	4-5yrs	99.90	0.57	99.38	2.15	99.65	1.56
	5-6yrs	100.00	0.00	99.78	0.85	99.91	0.55
	Total	99.96	0.38	99.57	1.65	99.78	1.15
WPCC4sy	4-5yrs	99.71	0.82	99.61	0.92	99.66	0.87
	5-6yrs	99.58	1.65	99.92	0.46	99.72	1.30
	Total	99.64	1.34	99.76	0.75	99.69	1.12
WPCC5sy	4-5yrs	98.00	4.85	98.69	2.36	98.33	3.84
	5-6yrs	99.67	0.98	99.47	1.28	99.58	1.11
	Total	98.92	3.40	99.07	1.94	98.99	2.83
WTPCC	4-5yrs	99.37	0.976	99.29	1.32	99.33	1.15
	5-6yrs	99.76	0.58	99.67	0.72	99.72	0.64
	Total	99.59	0.80	99.47	1.08	99.53	0.94
NWPCC2sy	4-5yrs	100.00	0.00	100.00	0.00	100.00	0.00
	5-6yrs	99.88	0.77	99.67	1.27	99.79	1.01
	Total	99.93	0.574	99.84	0.89	99.89	0.73
NWPCC3sy	4-5yrs	99.71	0.96	99.69	0.99	99.70	0.97
	5-6yrs	99.68	0.99	99.67	1.017	99.68	0.99
	Total	99.69	0.97	99.68	0.99	99.69	0.98
NWPCC4sy	4-5yrs	98.82	2.24	98.60	1.79	98.71	2.02
	5-6yrs	99.23	1.61	99.50	1.02	99.34	1.39
	Total	99.05	1.91	99.03	1.53	99.04	1.74
NWPCC5sy	4-5yrs	95.94	3.67	96.00	3.09	95.97	3.37
	5-6yrs	96.57	2.77	95.80	4.28	96.25	3.47
	Total	96.29	3.20	95.90	3.68	96.12	3.41
NWTPCC	4-5yrs	98.13	1.72	97.81	1.80	97.98	1.75
	5-6yrs	98.54	1.23	98.24	1.70	98.41	1.44
	Total	98.36	1.48	98.02	1.75	98.20	1.61

[W - words; NW - nonwords; PCC - percentage of consonants correct; TPC - total percentage of consonants correct; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length]

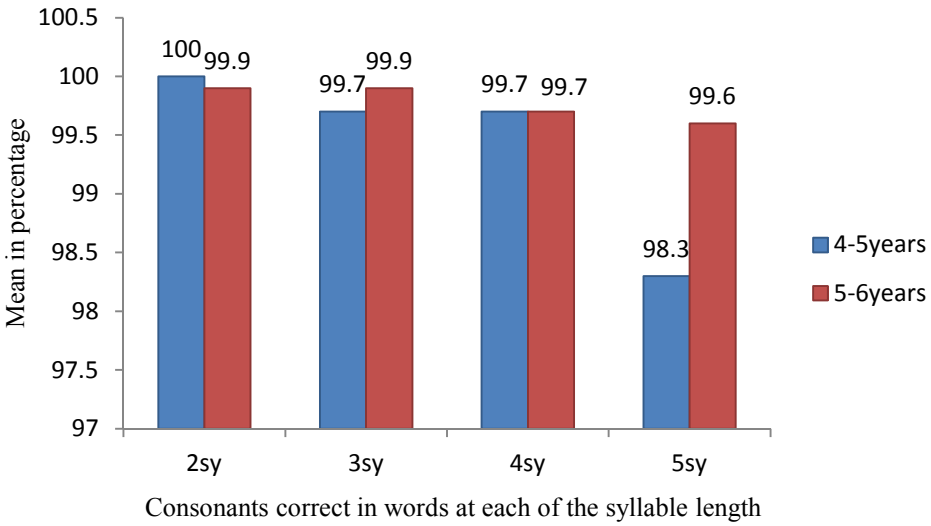

Figure 10. *PCC in word repetition across syllable length in both the age groups.*

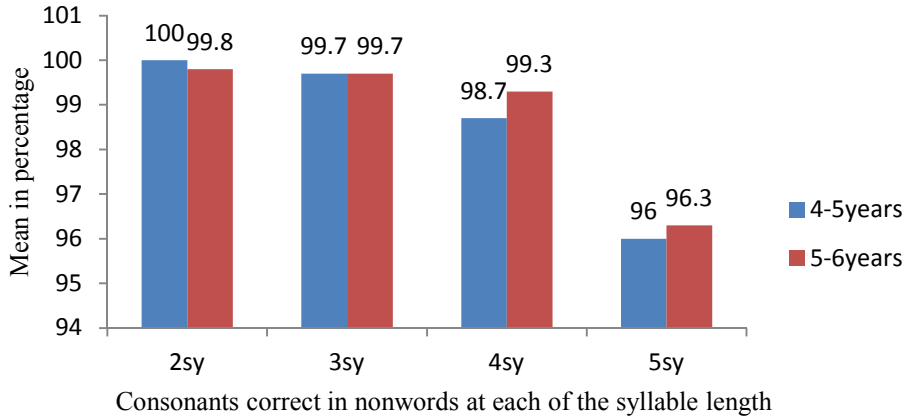

Figure 11. *PCC in nonword repetition across syllable length in both the age groups.*

Mixed ANOVA was used to examine the variation of PCC due to the effect of variables like words, nonwords, chronological age, and gender and syllable length. The results indicated a significant main effect of words and nonwords and in chronological age, whereas no significant main effect was found on gender. However significant interaction effect was found between words and nonwords with chronological age, syllable length, and words and nonwords with syllable length within groups or within subjects. There was no

significant interaction found between words and nonwords with gender, words and nonwords with chronological age and gender, syllables with chronological age, syllables with gender, syllables with chronological age and gender, words and nonwords with syllables and chronological age, words and nonwords with syllables and gender, between chronological age and gender, and words and nonwords with syllables, chronological age and gender. The same has been shown in Table 24.

Table 24. *Interaction among the different variables.*

Variables	df	F values	p values
WNW	1,134	79.86	0.00**
WNW * CA	1,134	5.75	0.02*
WNW * Gender	1,134	1.76	0.19
WNW * CA * Gender	1,134	0.09	0.77
Syllables	3,402	77.18	0.00**
syllables * CA	3,402	1.25	0.29
syllables * Gender	3,402	0.49	0.69
syllables * CA * Gender	3,402	0.44	0.73
WNW * syllables	3,402	30.21	0.00**
WNW * syllables * CA	3,402	0.56	0.64
WNW * syllables * Gender	3,402	0.64	0.59
WNW * syllables * CA * Gender	3,402	0.61	0.61
CA	1,134	13.62	0.00**
Gender	1,134	2.01	0.16
CA * Gender	1,134	0.49	0.49

[** $p<0.01$**; * $p<0.05$; WNW- words and nonwords; CA- chronological age]

The PCC was compared across the different syllable lengths using Boneferroni's pairwise comparison test. The results indicated that there was a significant difference in the PCC between different syllable lengths at P<0.05 as shown in Table 25.

Table 25. *Results of the Bonefferoni's test for PCC at different syllable lengths.*

Pairwise comparison of PCC at different syllable lengths		**Mean difference**	**p values**
PCC2sy	**PCC3sy**	0.67	0.03*
	PCC4sy	1.49	0.00**
	PCC5sy	4.42	0.00**
PCC3sy	**PCC4sy**	0.83	0.02*
	PCC5sy	3.76	0.00**
PCC4sy	**PCC5sy**	2.93	0.00**

[PCC - percentage of consonants correct; 2s - 2-syllable length, 3s - 3-syllable length; 4s - 4-syllable length; 5s - 5-syllable length; ** p<0.01; * p<0.05]

a. Comparison of total PCC in words and nonwords:

Mixed ANOVA was done to compare the total PCC in words and total PCC in nonwords between the two age groups and also between the genders. The results indicated that there was a significant main effect of the total PCC in words and nonwords at [F (1,134) = 89.06, p<0.01], and for the chronological age at [F (1,134) = 14.47, p<0.01] whereas no significant main effect was seen on gender alone (p>0.05). A significant interaction effect was found between the total PCC in words and nonwords with chronological age at [F (1,134) = 6.24, p<0.05]. Further no significant interaction was found between chronological age and gender, between total PCC for words, total PCC for nonwords and gender, and total PCC for words, total PCC for nonwords, chronological age and gender (p>0.05).

Table 26. *Interaction among the different variables.*

Variables	F values (1)	p values
WNW	89.060	0.00**
WNW * CA	6.237	0.01*
WNW	0.790	0.38
WNW * CA * Gender	0.359	0.55
CA	14.467	0.00**
Gender	1.448	0.23
CA * Gender	0.093	0.76

[** $p<0.01$; * $p<0.05$; WNW- words and nonwords; CA- chronological age]

b. Comparison of total PCC in words and nonwords between the age groups:

The mean values for the total PCC in words (4-5years, mean = 99.33; 5-6years, mean = 99.72) and for the total PCC in nonwords (4-5years, mean = 97.98; 5-6years, mean = 98.41) between the two age groups suggested higher scores by children in 5-6years age group. Furthermore, independent t-test was done to find the significant difference, if any, in the total PCC among words and total PCC among nonwords between the two age groups. The results revealed that both the groups obtained significantly different scores on the total PCC in words at [$t(136) = -2.80$, $p<0.01$] and also on the total PCC in nonwords at [$t(136) = -3.72$, $p<0.01$]. The mean values are also represented in the Figure 12.

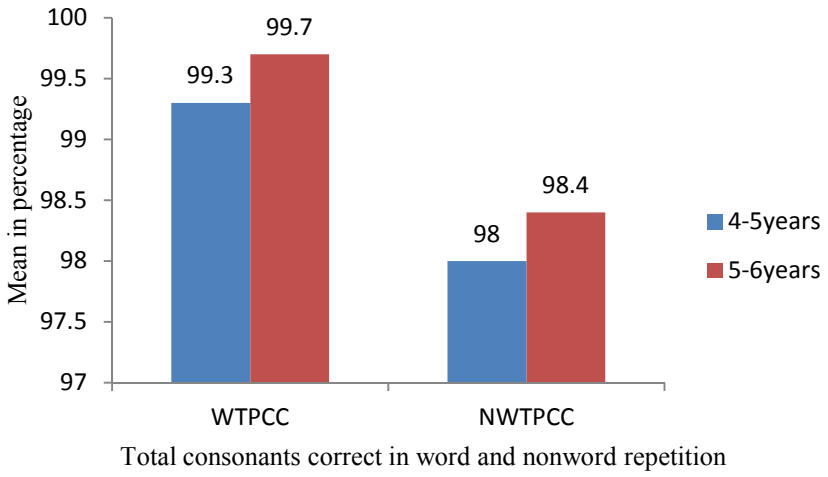

Figure 12. *Percentage of total PCC in word and nonword repetition across age groups.*

c. Effect of syllable length on the PCC in words and nonwords

MANOVA was used to examine whether any significant difference existed in the PCC in words at different syllable lengths between the two age groups. The results revealed that the children in both the age groups differed significantly (4-5years, mean =100; 5-6years, mean = 99.93) on the PCC in words only at 2syllable length at [F (1, 136) = 4.98, $p<0.05$], whereas the PCC were similar at 3, 4, and 5-syllable length words at $p>0.05$. The children in both the age groups made similar number of consonant errors on the 3-, 4-, and 5-syllable length words.

Furthermore MANOVA showed that there was a significant difference in the performance between the two age groups on the PCC in nonwords at different syllable lengths. Hence the PCC in nonwords at all the syllable lengths, that is at 2syllable length (4-5years, mean = 100; 5-6years, mean = 99.79) at [F (1, 136) = 6.94, $p<0.01$], 3syllable length (4-5years, mean = 99.70; 5-6years, mean = 99.68) at [F (1, 136) = 4.89, $p<0.05$], 4syllable length (4-5years, mean = 98.71; 5-6years, mean = 99.34) at [F (1, 136) = 11.60, $p<0.01$] and 5syllable length (4-5years, mean = 3.09; 5-6years, mean = 96.25) at [F (1, 136) = 5.56,

$p<0.05$] were significantly different between both the age groups. The consonant errors increased with the increase in the syllable length of the nonwords.

d. PCC within each age group:

i) PCC in the lower age group:

Repeated measure ANOVA was done to evaluate whether significant difference existed in the PCC in words and nonwords of different syllable lengths in the children of 4-5years age group. The results revealed that the children of 4-5years age obtained significantly different scores on the PCC at different syllable lengths in words at [$F(3,195) = 10.98$, $p<0.01$] and also in nonwords at [$F(3,195) = 36.41$, $p<0.01$].

Furthermore Bonefferoni's pairwise comparison test was used to find out which syllable lengths differed significantly from each other on PCC in words in 4-5years children. The results indicated that the PCC at 2syllable length words was significantly different from that of PCC at 3-, and 5-syllable length words. Furthermore PCC at 3-syllable length was significantly different from PCC at 5-syllable length words ($p<0.05$) and PCC at 4-syllable length was significantly different from PCC at 5-syllable length words ($p<0.05$). The results of the Bonefferoni's pairwise comparison test are shown in the Table 27.

Also Bonefferoni's pairwise comparison test was used to find out the significant difference, if any, in PCC in nonwords across different syllable lengths in 4-5years children. The children obtained significantly different scores on the PCC at 2-syllable length nonwords compared to that of PCC at 4-, and 5-syllable length nonwords; PCC at 3-syllable length nonwords compared to that of 4- and 5-syllable length nonwords, and PCC at 4-syllable length compared to PCC at 5-syllable length nonwords. The results of the Bonefferoni's pairwise comparison test are shown in the Table 27.

Table 27. *Results of the Bonefferoni's test for PCC in words & nonwords at different syllable lengths in the 4-5year age group.*

PCC in words & nonwords at different syllable length		Mean difference	p values
WPCC2sy	**WPCC3sy**	1.02	0.04*
	WPCC4sy	0.98	0.11
	WPCC5sy	2.66	0.00**
WPCC3sy	**WPCC4sy**	-0.04	1.00
	WPCC5sy	1.64	0.03*
WPCC4sy	**WPCC5sy**	1.68	0.01*
NWPCC2sy	**NWPCC3sy**	0.26	1.00
	NWPCC4sy	2.46	0.01*
	NWPCC5sy	7.18	0.00**
NWPCC3sy	**NWPCC4sy**	2.20	0.00**
	NWPCC5sy	6.92	0.00**
NWPCC4sy	**NWPCC5sy**	4.72	0.00**

[W - words; NW - nonwords; PCC - percentage of consonants correct; 2sy – 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; ** $p<0.01$; * $p<0.05$]

Paired-t test was used to compare the PCC between words and nonwords at each syllable length in the children of 4-5years age group. The results indicated that the PCC at 2-, 4-, and 5-syllable length differed significantly for words from that of nonwords. However, the PCC at 3-syllable length was similar for both words and nonwords. The same is represented in Table 28.

Table 28. *Pairwise comparison of PCC between words and nonwords at each syllable length in the 4-5years age group.*

PCC for words and nonwords at different syllable lengths	t values (65)	p values
WPCC2sy - NWPCC2sy	3.00	0.00*
WPCC3sy - NWPCC3sy	1.45	0.15
WPCC4sy - NWPCC4sy	4.93	0.00*
WPCC5sy - NWPCC5sy	6.21	0.00*

[W - words; NW - nonwords; PCC - percentage of consonants correct; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; df - degrees of freedom; * $p<0.01$]

ii) PCC in the older age group:

Repeated measure ANOVA was done to evaluate whether significant difference existed in the PCC in words and nonwords at different syllable lengths in the children of 5-6years age group. The results revealed that the children in this age group obtained significantly different scores on the PCC at different syllable lengths in words at [$F(3,213) = 6.12$, $p<0.01$] and nonwords at [$F(3,213) = 41.56$, $p<0.01$].

Furthermore Bonefferoni's pairwise comparison test was used to find which syllable lengths differed significantly from each other on PCC in words. The results indicated that the PCC at 2syllable length words was significantly different from that of PCC at 4-, and 5-syllable length words. Also PCC at 4-syllable length was significantly different from PCC at 5-syllable length words ($p<0.05$). There was no significant difference in the PCC at 2-syllable length compared to 3-syllable length words, PCC at 3-syllable length when compared to 4-, and 5-syllable length words. The results of the Bonefferoni's pairwise comparison test are shown in Table 29.

Bonefferoni's pairwise comparison test was also used to find out which syllable lengths differed significantly from each other on PCC in nonwords also. The results indicated that the PCC at 2syllable length nonwords was significantly different from that of PCC at 4-, and 5-syllable length nonwords. Also PCC at 3-syllable length and PCC at 4-syllable length was significantly different from PCC at 5-syllable length nonwords at ($p<0.01$). There was no significant difference in the PCC at 2-syllable length compared to 3-syllable length nonwords and PCC at 3-syllable length when compared to 4-syllable length nonwords. The results of the Bonefferoni's pairwise comparison test are shown in Table 29.

Table 29. *Results of the Bonnefferoni's test for PCC in words & nonwords at different syllable lengths in the 5-6year age group.*

PCC in words & nonwords at different syllable length		**Mean difference**	**p values**
WPCC2sy	**WPCC3sy**	0.86	0.47
	WPCC4sy	0.95	0.03*
	WPCC5sy	1.97	0.00**
WPCC3sy	**WPCC4sy**	0.09	1.00
	WPCC5sy	1.10	0.35
WPCC4sy	**WPCC5sy**	1.01	0.04*
NWPCC2sy	**NWPCC3sy**	0.58	0.79
	NWPCC4sy	1.51	0.01*
	NWPCC5sy	5.84	0.00**
NWPCC3sy	**NWPCC4sy**	0.93	0.31
	NWPCC5sy	5.26	0.00**
NWPCC4sy	**NWPCC5sy**	4.34	0.00**

[MD - mean difference; W - words; NW - nonwords; PCC - percentage of consonants correct; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; ** $p< 0.01$; * $p<0.05$]

Paired-t test was used to compare the PCC between words and nonwords at each syllable length in children of 5-6years age group. The results indicated that the PCC at 4- and 5-syllable length differed significantly for words from that of nonwords. However, the PCC at 2- and 3-syllable length was similar for both words and nonwords. The same is represented in Table 30.

Table 30. *Pairwise comparison on PCC between words and nonwords at each syllable length in the 5-6year age group.*

PCC between words and nonwords at each syllable length	**t values (71)**	**p values**
WPCC2sy - NWPCC2sy	1.92	0.06
WPCC3sy - NWPCC3sy	0.44	0.67
WPCC4sy - NWPCC4sy	2.63	0.01*
WPCC5sy - NWPCC5sy	6.92	0.00

[W - words; NW - nonwords; PCC - percentage of consonants correct; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; df - degrees of freedom; * $p<0.05$]

3. Percentage of errors:

The repetition responses were analyzed for errors like substitution, omission, and addition and the percentage of each of these were computed. The mean, median and standard deviation values were calculated using case summaries and has been represented in Table 31. The mean values indicated that the percentages of substitution (PSS) occurred to a greater extent in both words and nonwords which is also depicted in Figures 13 and 14.

Table 31. *Mean, median and standard deviation (SD) values for the errors at each syllable length in words and nonwords for both the age groups.*

	Chronological age								
	4-5years			5-6years			Total		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
WPSS2sy	0.83	0.00	1.88	0.21	0.00	1.01	0.51	0.00	1.52
WPSS3sy	2.02	0.00	3.35	1.02	0.00	2.14	1.50	0.00	2.82
WPSS4sy	1.90	0.00	3.22	1.15	0.00	2.52	1.50	0.00	2.89
WPSS5sy	3.06	2.00	3.37	2.28	2.00	3.43	2.65	2.00	3.41
WTPSS	2.08	1.43	2.07	1.36	0.71	1.84	1.70	1.07	1.98
NWPSS2sy	2.65	0.00	4.90	0.83	0.00	2.22	1.70	0.00	3.84
NWPSS3sy	2.93	0.00	4.28	1.53	0.00	2.68	2.20	0.00	3.59
NWPSS4sy	5.46	2.50	5.22	2.50	2.50	3.36	3.91	2.50	4.58
NWPSS5sy	11.55	10.00	8.38	8.97	8.00	6.94	10.21	8.00	7.75
NWTPSS	6.73	5.00	5.18	4.37	3.57	3.20	5.50	4.29	4.41
WPSO2sy	0.00	0.00	0.00	0.14	0.00	1.18	0.07	0.00	0.85
WPSO3sy	0.10	0.00	0.58	0.00	0.00	0.00	0.05	0.00	0.40
WPSO4sy	0.11	0.00	0.53	0.17	0.00	1.21	0.15	0.00	0.94
WPSO5sy	0.64	0.00	1.50	0.36	0.00	1.44	0.49	0.00	1.47
WTPSO	0.28	0.00	0.64	0.12	0.00	0.44	0.20	0.00	0.55
NWPSO2sy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWPSO3sy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWPSO4sy	0.19	0.00	1.01	0.04	0.00	0.30	0.11	0.00	0.73
NWPSO5sy	0.85	0.00	1.53	0.58	0.00	1.14	0.71	0.00	1.34
NWTPSO	0.35	0.00	0.64	0.22	0.00	0.41	0.28	0.00	0.54
WPSA2sy	0.08	0.00	0.62	0.07	0.00	0.59	0.07	0.00	0.60
WPSA3sy	0.05	0.00	0.41	0.00	0.00	0.00	0.02	0.00	0.28
WPSA4sy	0.04	0.00	0.31	0.04	0.00	0.30	0.04	0.00	0.30
WPSA5sy	0.15	0.00	0.53	0.06	0.00	0.33	0.10	0.00	0.44
WTPSA	0.09	0.00	0.27	0.04	0.00	0.16	0.06	0.00	0.22
NWPSA2sy	0.00	0.00	0.00	0.42	0.00	1.63	0.22	0.00	1.19
NWPSA3sy	0.15	0.00	0.70	0.09	0.00	0.55	0.12	0.00	0.63
NWPSA4sy	0.30	0.00	0.82	0.14	0.00	0.58	0.22	0.00	0.71
NWPSA5sy	0.80	0.00	1.65	0.28	0.00	0.79	0.53	0.00	1.30
NWTPSA	0.36	0.00	0.58	0.21	0.00	0.39	0.28	0.00	0.49

[W-words; NW- nonwords; 2sy- 2-syllable length, 3sy- 3-syllable length; 4sy-4-syllable length; 5sy-5-syllable length; PSS - percentage of syllable substitutions; TPSS -Total percentage of syllable substitutions; PSO - percentage of syllable omissions; TPSO -Total percentage of syllable omissions; PSA - percentage of syllable additions; TPSA -Total percentage of syllable additions]

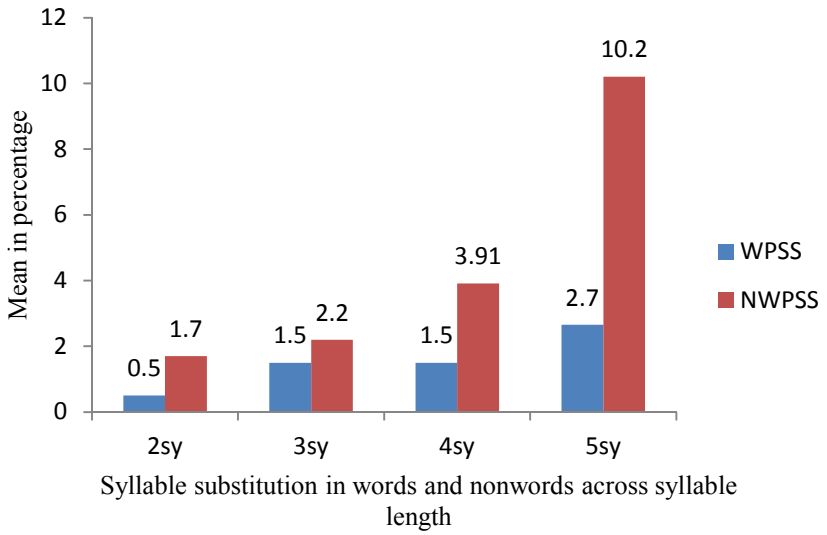

Figure 13. *Percentage of syllable substitutions in words and nonwords across syllable length.*

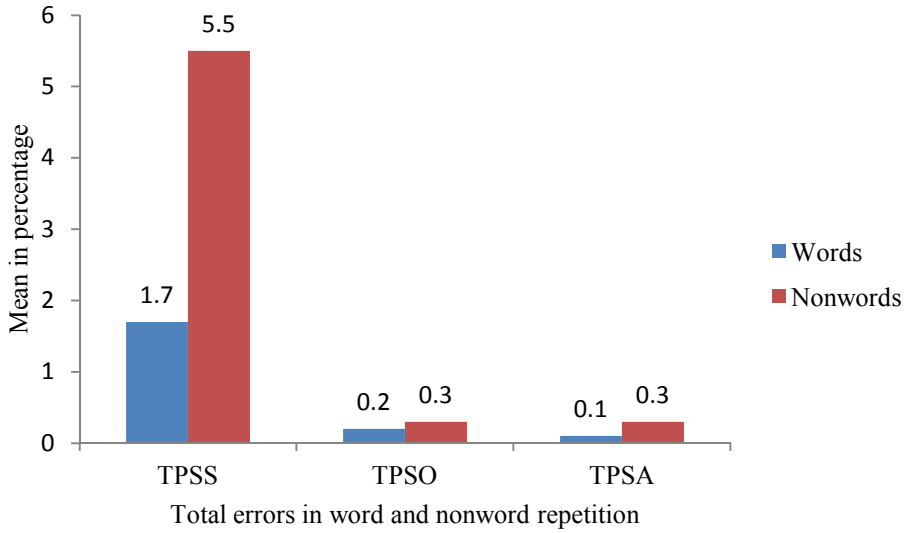

Figure 14. *Percentage of syllable substitutions (TPSS), omission (TPSO) and additions (TPSA) in words and nonwords.*

The PSS errors increased with the increase in the syllable length that is they were the least for the 2-syllable words compared to 3-syllable words, 3-syllable words compared to 4-syllable words and so on and the same has been depicted in Figure 15.

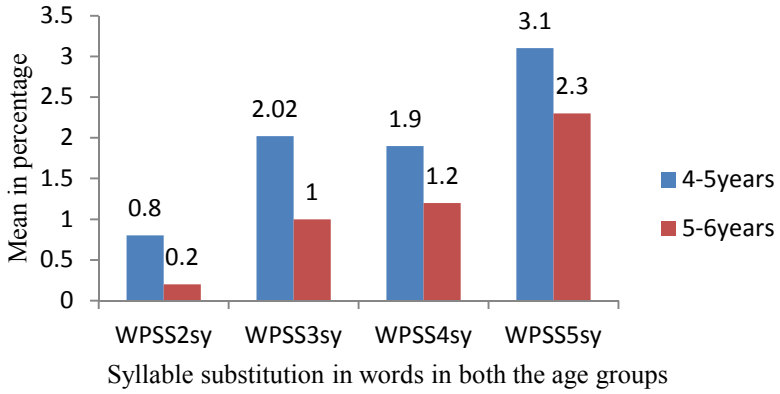

Figure 15. *Percentage of syllable substitution in words across syllable length in both the age groups.*

The percentage of omission (PSO) and percentage of addition (PSA) errors were very less compared to the PSS errors as can be observed from the means shown in the table above. Similar pattern was also found in the PSS errors in nonwords with the increase in the syllable length and the Figure 16 depicts the same. Similar results were obtained by Girbau and Schwartz (2008, 2007) and by Marton and Schwartz (2003), where they reported that the PSS were the most frequent type of errors seen in both typically developing and in children with SLI.

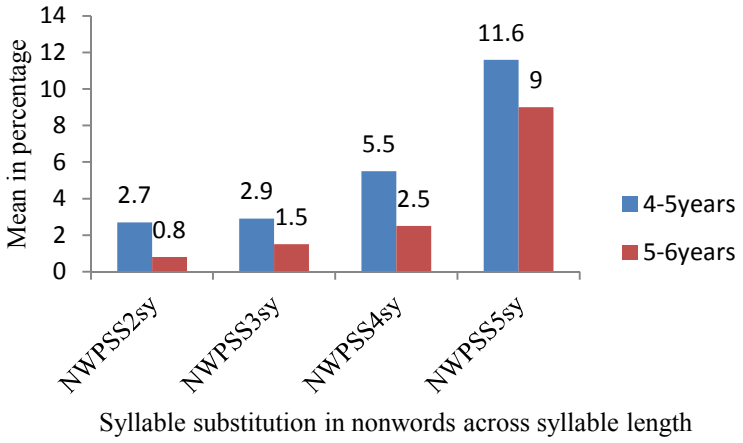

Figure 16. *Percentage of syllable substitution in nonwords across syllable length in both the age groups.*

Mann-Whitney U test was done to find out the significant difference, if any, in the PSS in words and nonwords between the two age groups at each syllable length. The results indicated (depicted in Table 32) that there was a significant difference between the two age groups in the PSS in words at 2-, 3-, 5-, and at overall words at $p<0.05$. Also there was a significant difference between the age groups in PSS in nonwords at 2-, 3-, 4-, and in overall nonwords.

The PSO and the PSA were not evaluated for the significant difference between the two age groups as the median was zero and the standard deviation values were very high.

Table 32. */z/ and p values for PSS for words and nonwords at each syllable length between the two age groups.*

PSS for words and nonwords	**/Z/**	**p values**
WPSS2sy	2.42	0.02*
WPSS3sy	2.05	0.04*
WPSS4sy	1.12	0.26
WPSS5sy	2.03	0.04*
WTPSS	2.48	0.01*
NWPSS2sy	2.48	0.01*
NWPSS3sy	2.04	0.04*
NWPSS4sy	3.73	0.00**
NWPSS5sy	1.75	0.08
NWTPSS	2.84	0.01*

[W-words; NW- nonwords; 2sy- 2-syllable length, 3sy- 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; PSS – percentage of syllable substitutions; TPSS-Total percentage of syllable substitutions]

4. Validation:

The test developed was validated by administering it on ten typically developing children in each of the two age groups (4-5years and 5-6years) who were not a part of the earlier subject sample selected. These twenty children were selected from new schools other than the schools from where the earlier 138 children were selected to participate in the study. They were administered with the complete test of 40 words and 40 nonwords along with the practice items auditorily through headphones using a laptop. They were given similar instruction as given to earlier set of children who participated in the study. The repeated responses of the children were transcribed verbatim using broad phonetic transcription online and were also recorded into the laptop. The responses were scored for both the accuracy of the responses and error analysis. The raw scores were calculated and the mean and standard deviation (SD) values were computed using descriptive statistics. The mean values of the validation samples were lying within the mean plus or minus SD values or closer to the mean values of the earlier 138 samples children who were tested, hence suggesting a good validity of the test.

Table 33. *Mean and standard deviation (SD) values for the validation samples of the twenty children and the 138 typically developing children considered previously.*

	Validation samples		**Mean of 138 children**	
	Mean	**SD**	**Lower bound**	**Upper bound**
WA2sy	9.60	0.68	9.63	10.21
WA3sy	9.45	0.69	8.89	10.29
WA4sy	9.45	0.69	8.5	10.4
WA5sy	8.95	1.36	7.28	11.56
WOA	37.45	2.50	34.91	40.55
NWA2sy	9.30	0.80	8.56	10.68
NWA3sy	8.55	1.23	8.39	10.34
NWA4sy	8.45	1.57	7.1	10.12
NWA5sy	6.10	1.25	4.01	8.40
NWOA	32.35	3.38	29.54	38.00

WNWA2sy	18.90	1.12	18.78	20.4
WNWA3sy	18.00	1.59	17.64	20.3
WNWA4sy	17.85	1.84	16.06	20.12
WNWA5sy	15.25	2.05	11.83	18.21
TWNWA	69.60	5.27	64.79	77.73
WPVC2sy	99.75	1.12	99.53	100.39
WPVC3sy	99.83	0.75	98.63	100.93
WPVC4sy	99.13	1.47	98.59	100.79
WPVC5sy	99.70	0.98	96.16	101.82
WTPVC	99.57	0.71	98.59	100.47
NWPVC2sy	98.25	2.94	99.16	100.62
NWPVC3sy	100.00	0.00	98.71	100.67
NWPVC4sy	98.88	1.72	97.3	99.21
NWPVC5sy	95.50	2.59	92.7	99.54
NWTPVC	97.75	1.40	96.59	99.81
WPCC2sy	97.62	3.62	98.15	100.95
WPCC3sy	98.38	2.02	95.1	102.14
WPCC4sy	98.66	3.11	95.88	101.3
WPCC5sy	98.17	3.39	93.57	100.93
WTPCC	98.31	2.15	96.39	100.27
NWPCC2sy	97.38	3.62	95.13	101.98
NWPCC3sy	95.59	3.88	94.93	101.33
NWPCC4sy	96.83	3.97	92.16	100.99
NWPCC5sy	92.89	4.80	84.88	99.26
NWTPCC	95.27	3.05	91.80	99.66

[W- words; NW- nonwords; WNW- words and nonwords combined; A2sy - accuracy at 2-syllable length nonwords; A3sy - accuracy at 3-syllable length nonwords; A4sy - accuracy at 4-syllable length nonwords; A5sy - accuracy at syllable length nonwords; WOA - overall accuracy for words; NWOA - overall accuracy for nonwords; TWNWA- accuracy for the entire words and nonwords combined; PVC - percentage of vowels correct; TPVC - total percentage of vowels correct; PCC - percentage of consonants correct; TPCC - total percentage of consonants correct].

5. Test-retest reliability

To examine the stability of the word and nonword repetition test performance across time, a subsample of 16 children (11%) of the total sample were retested by the same examiner within two weeks of the first test. Intraclass correlations were computed for total word + nonword score on the word and nonword repetition test. The test retest reliability was calculated using the Cronbach's coefficient alpha which was found to be 0.80. This suggested acceptable levels of test-retest reliability for the overall test.

6. Inter-rater reliability

Randomly selected subsamples of recordings were used to assess inter-rater reliability. A sample of 14 children (10%) of the total sample was independently blind-rated by the examiner and a trained SLP. Their scores for key measures were compared with online scoring by testers. Acceptable levels of reliability were achieved wherein the Cronbach's coefficient alpha was 0.71.

7. Clinical validity

Five children with language impairment were administered with the entire test developed i.e. the word and nonword repetition test to evaluate the clinical validity of the test. The children with the language delay were in the age range of 6.5-9years and all of them had a language age of 5-6yrs. The children with a language delay included two children with specific language impairment (SLI) and three children with Learning disability (LD) who were diagnosed by a qualified team of professionals including a speech-language pathologist and a clinical psychologist.

The repetition of words and nonwords by the children with language impairment were compared with the repetition scores of language age matched 5-6years old typically developing children. The two groups were compared on both the accuracy of the response, the percentage of vowels/consonants correct and also on the percentage of syllable substitution, omission or addition errors. The raw scores of repetition by both the groups were subjected to the descriptive statistics to obtain the mean and standard deviation values.

a. Accuracy of the responses:

The mean values indicated that the accuracy of repetition was higher in typically developing children compared to that of the children with language impairment at each syllable length and also on the overall scores in both words and nonwords which is depicted in Table 34 and Figures 17, 18, 19 and 20 respectively. Further the accuracy of scores decreased from 2 syllable to 5-syllable in both words and nonwords in both the groups. Also the accuracy scores were higher at each syllable length and also on the overall scores for words compared to that of nonwords in both the groups. The same is shown in Table 34.

Table 34. *Mean and standard deviation (SD) values for accuracy of words and nonwords at each syllable length for typically developing children and children with language impairment.*

Accuracy in words and nonwords	**Typically developing children (TD)**		**Children with language impairment (CLI)**	
	Mean	**SD**	**Mean**	**SD**
WA2sy	9.96	0.20	9.80	0.45
WA3sy	9.74	0.56	9.00	1.23
WA4sy	9.54	0.95	9.40	1.34
WA5sy	9.14	1.21	7.80	2.28
WOA	38.39	2.11	36.00	4.58
NWA2sy	9.67	1.23	8.40	0.89
NWA3sy	9.53	0.69	8.00	1.58
NWA4sy	9.04	1.13	4.60	1.34
NWA5sy	6.63	2.09	3.00	1.87
NWOA	34.99	3.11	24.00	3.74
WNWA2sy	19.75	0.47	18.20	1.10
WNWA3sy	19.26	0.95	17.00	2.55
WNWA4sy	18.60	1.73	14.00	1.23
WNWA5sy	15.64	3.13	10.80	3.42
WNWOA	72.68	6.22	60.20	6.72

[W- words; NW- nonwords; WNW- words and nonwords combined; A2sy - accuracy at 2-syllable length nonwords; A3sy - accuracy at 3-syllable length nonwords; A4sy - accuracy at 4-syllable length nonwords; A5sy - accuracy at syllable length nonwords; WOA - overall accuracy for words; NWOA - overall accuracy for nonwords; WNWOA- overall accuracy for words and nonwords combined].

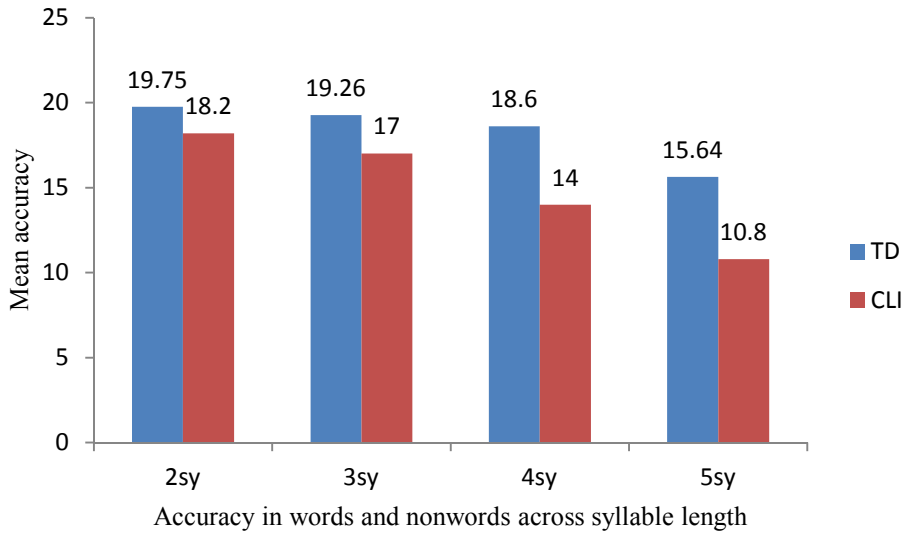

Figure 17. *Mean accuracy of word and nonword repetition across syllable length in both the groups.*

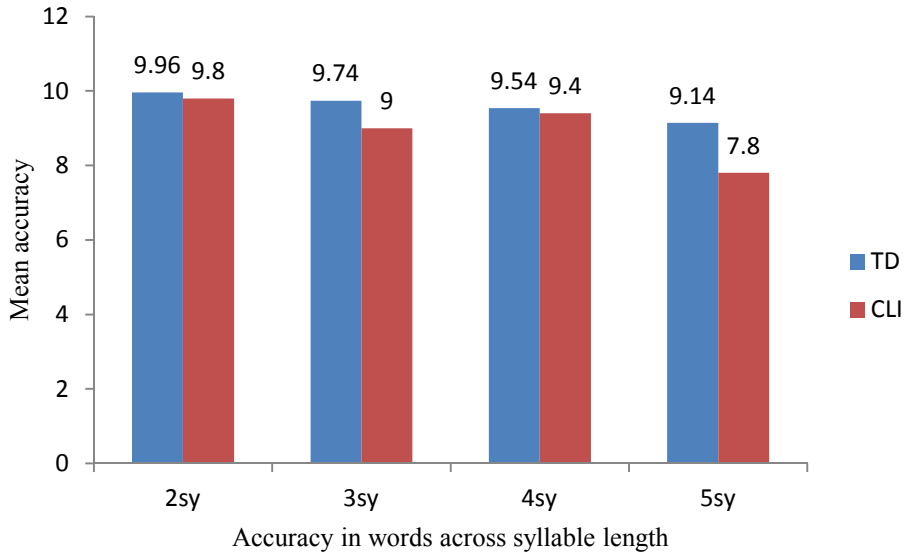

Figure 18. *Mean accuracy of word repetition across syllable length in both the groups.*

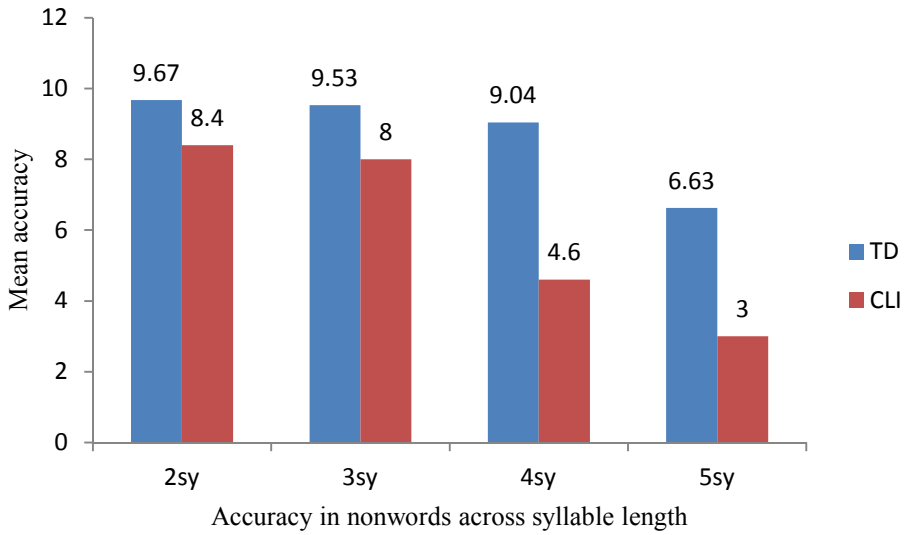

Figure 19. *Mean accuracy of nonword repetition across syllable length in both the groups.*

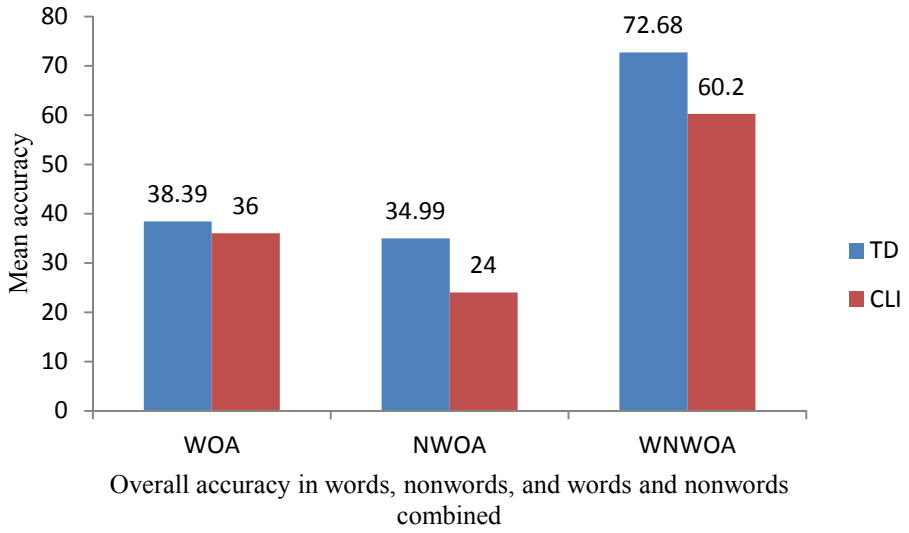

Figure 20. *Mean accuracy of words, nonwords and words and nonwords combined across syllable length in both the groups.*

Mann-Whitney U test was used to evaluate whether any significant difference existed between the performance of children with language impairment and typically developing children on the accuracy of the responses at each syllable length and also on the overall

accuracy scores in both words and nonwords. The results indicated a significant difference existed between both the groups in the accuracy of the responses in words only at 3syllable length, where the typically developing children obtained higher scores than that of children with language impairment at $p<0.05$. However, there was no significant difference in the accuracy of words at other syllable lengths and also on the overall scores.

Furthermore, there was a significant difference in the performance between the two groups on the accuracy of nonwords at all the syllable lengths viz. 2-, 3-, 4-, 5-syllable lengths and also at the overall accuracy scores on nonwords. The typically developing children performed significantly better compared to the children with language impairment in the nonwords. Also they obtained significantly higher scores on the total words and nonwords at each of the syllable lengths and also on the overall accuracy of repetition of total words and nonwords at $p<0.01$. The /z/-values and the level of significance values have been shown in Table 35.

Table 35. *Results of the Mann-Whitney U test for the accuracy of word and nonword repetition between typically developing and children with language impairment.*

Words and nonwords at different syllable lengths	**/z/ values**	**p values**
WA2sy	1.53	0.13
WA3sy	2.07	0.04*
WA4sy	0.17	0.86
WA5sy	1.85	0.06
WOA	1.82	0.07
NWA2sy	4.22	0.00**
NWA3sy	2.62	0.01*
NWA4sy	3.85	0.00**
NWA5sy	2.99	0.00**
NWOA	3.73	0.00**
WNW2sy	4.02	0.00**
WNW3sy	2.54	0.01*
WNW4sy	3.60	0.00**
WNW5sy	2.96	0.00**
WNWOA	3.38	0.00**

[W- words; NW- nonwords; WNW- words and nonwords combined; 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; WOA - overall accuracy for words; NWOA - overall accuracy for nonwords; WNWOA- overall accuracy for words and nonwords combined; ** $p<0.01$; * $p<0.05$].

The results indicated a poorer performance of children with language impairment especially on nonwords at all syllable lengths. This suggests that the entire nonword

repetition task viz. even the shorter syllable length nonwords were useful in differentiating children with language impairment from the language matched typically developing children.

The poorer performance of children with language impairment on the nonword repetition test in the present study is in consonance with the results of 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. Similar results were also obtained in earlier studies carried out in Kannada by Prema et al., (2010), and Shylaja and Swapna (2010).

The lower accuracy on the nonword repetition in children with LD obtained in the present study is in agreement with the results of earlier studies where it was reported that the deficit in nonword repetition is attested early in life and it was suggested to be underlying the deficits seen in both children with dyslexia and in children with SLI. They also suggested that the NWR performance is also a marker and precursor of literacy problems (de Bree, Rispens & Gerrits, 2007).

b. Percentage of phonemes correct:

The mean and the standard deviation values for the percentage of phonemes correct were computed using descriptive statistics. The percentage of vowels/consonants correct was compared between the two groups and is shown in Table 36. Both the groups obtained higher

percentage of vowels correct compared to that of consonants. This has been depicted in Figure 21.

The mean values of PVC (percentage of vowels correct) in words indicated that the children with language impairment obtained lower PVC at 5syllable length in words, whereas typically developing children obtained similar mean scores at all the syllable lengths in words. A similar pattern was observed in nonwords. Further the PVC in nonwords were higher for typically developing children compared to the children with language impairment as can be observed from the mean values. The typically developing children attained similar means of PVC on 2-, 3-, and 4-syllable lengths nonwords but achieved lower PVC mean scores on only 5-syllable length nonwords, while the children with language impairment obtained lower mean PVC scores on 2, 4, and also on 5-syllable length nonwords.

The mean values of the PCC indicated that the PCC was higher in words compared to that of nonwords in both typically developing children and children with language impairment. The mean PCC values in nonwords decreased from 2-syllable length nonwords to 5-syllable length nonwords. The children with language impairment obtained very less PCC scores at 5-syllable length nonwords compared to the typically developing children. The same is shown in Table 36.

Table 36. *Mean and standard Deviation (SD) for PVC and PCC in words and nonwords at each syllable length for typically developing children and children with language impairment.*

	Typically developing children (TD)		**Children with language impairment (CLI)**	
	Mean	**SD**	**Mean**	**SD**
WPVC2sy	99.93	0.59	100.00	0.00
WPVC3sy	99.91	0.55	99.33	1.49
WPVC4sy	99.72	1.30	100.00	0.00
WPVC5sy	99.58	1.11	97.60	2.61
WTPVC	99.72	0.64	99.00	1.08
NWPVC2sy	99.79	1.01	95.00	6.12
NWPVC3sy	99.68	0.99	98.67	1.83
NWPVC4sy	99.34	1.39	93.50	2.85
NWPVC5sy	96.25	3.47	93.20	5.93
NWTPVC	98.41	1.44	96.29	1.17
WPCC2sy	99.80	0.96	99.05	2.13
WPCC3sy	98.94	3.99	96.47	6.38
WPCC4sy	98.85	2.56	98.05	4.36
WPCC5sy	97.84	3.11	91.54	11.59
WTPC	98.76	1.67	95.54	6.61
NWPCC2sy	99.27	2.06	94.29	3.98
NWPCC3sy	98.69	2.41	93.53	4.83
NWPCC4sy	97.76	3.44	84.89	9.51
NWPCC5sy	93.43	5.96	77.69	8.88
NWTPCC	96.87	2.82	85.68	6.83

[W - words; NW - nonwords; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; PVC - percentage of vowels correct; TPVC - total percentage of vowels correct; PCC - percentage of consonants correct; TPCC - total percentage of consonants correct]

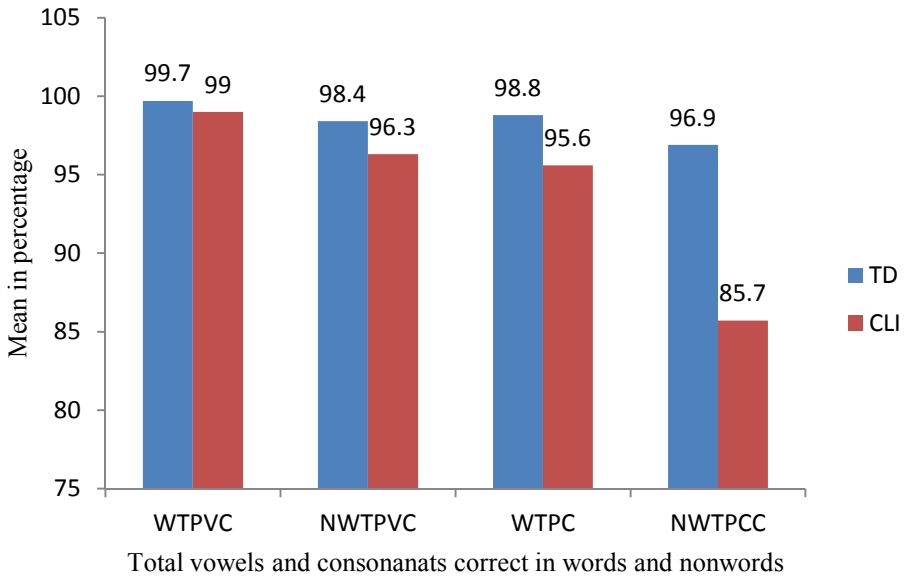

Figure 21. *Total percentage of vowels and consonants correct in words and nonwords in both the groups.*

Mann-Whitney U test was carried out to find out the significant difference, if any, in the PVC between the two groups in both words and nonwords. The results indicated that there was a significant difference in the PVC in words only at 5-syllable length and also at the total PVC in words between the two groups ($p<0.05$). The PVC in nonwords was significantly different between the children with language impairment and typically developing children at 2-, 3-, 4-, and total PVC in nonwords. That is the children with language impairment lower PVC scores than the typically developing children at 2-, 3-, 4-, and total PVC in nonwords. However there was no significant difference in the PVC between the two groups at 5-syllable length nonwords. The /z/ and p values have been depicted in Table 37. The lesser PVC in children with language impairment than the typically developing children suggests the relatively weaker phonological encoding in children with language impairment during the repetition tasks. Similar results were obtained in the study carried out by Girbau and Schwartz (2008), where they reported that the children with SLI did not

perform on par with the typically developing children and they obtained lesser PVC scores, whereas the typically developing children obtained almost ceiling level in the PVC scores.

The PCC in words between the groups compared using Mann-Whitney U test indicated that there was no significant difference in the PCC between the two groups at any of the syllable lengths. However the PCC in nonwords were significantly different between the two groups at all the syllable lengths, and also on the overall PCC in nonwords. The /z/ and p values have been depicted in Table 37. 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.

The children in both the groups obtained higher PVC than the PCC. 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.

Table 37. *Results of Mann-Whitney U test for the PVC and PCC between typically developing and children with language impairment.*

PVC and PCC for words and nonwords	/z/ values	p values
WPVC2sy	0.26	0.79
WPVC3sy	1.91	0.06
WPVC4sy	0.61	0.55
WPVC5sy	2.79	0.01*
WTPVC	2.21	0.03*
NWPVC2sy	4.54	0.00**
NWPVC3sy	2.06	0.04*
NWPVC4sy	4.53	0.00**
NWPVC5sy	1.31	0.19
NWTPVC	2.90	0.00**
WPCC2sy	1.53	0.13
WPCC3sy	1.21	0.23
WPCC4sy	0.06	0.96
WPCC5sy	1.93	0.05
WTPC	1.90	0.06
NWPCC2sy	4.02	0.00**
NWPCC3sy	2.88	0.00**
NWPCC4sy	3.62	0.00**
NWPCC5sy	3.39	0.00**
NWTPCC	3.60	0.00**

[W - words; NW - nonwords; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; PVC - percentage of vowels correct; TPVC - total percentage of vowels correct; PCC - percentage of consonants correct; TPCC - total percentage of consonants correct; ** $p<0.01$; * $p<0.05$]

c. Percentage of errors:

The errors such as syllable substitutions, omissions and additions were noted and converted into percentage values. The mean and standard deviation (SD) values were computed using the descriptive statistics for all the errors in both the groups. These values have been depicted in Table 38. The mean and SD values suggested that the syllable substitutions were the most frequent type of errors seen in the repetition of words and nonwords in both the groups compared to the syllable omissions and additions. The percentage of syllable substitutions (PSS) was more in nonwords than words in both the groups. Also the PSS errors increased with the increase in the syllable length in both the groups. Furthermore the mean values of PSS indicated a higher percentage of errors in the children with language impairment compared to the typically developing children. This has been depicted in Figure 22.

Table 38. *Mean and standard deviation (SD) values for percentage of different errors in words and nonwords at each syllable length for typically developing and children with language impairment.*

Errors	Typically developing children (TD)		Children with language impairment (CLI)	
	Mean	**SD**	**Mean**	**SD**
WPSS2sy	0.2	1.01	1.00	2.24
WPSS3sy	1.0	2.14	4.00	5.48
WPSS4sy	1.15	2.52	2.00	4.47
WPSS5sy	2.28	3.43	6.80	10.83
WTPSS	1.36	1.84	4.00	6.17
NWPSS2sy	0.83	2.22	8.00	6.71
NWPSS3sy	1.53	2.68	8.00	7.67
NWPSS4sy	2.50	3.36	18.50	7.42
NWPSS5sy	8.97	6.94	24.40	5.90
NWTPSS	4.37	3.20	16.88	5.52
WPSO2sy	0.14	1.19	0.00	0.00
WPSO3sy	0.00	0.00	0.00	0.00
WPSO4sy	0.17	1.21	0.00	0.00
WPSO5sy	0.36	1.44	1.20	1.79
WTPSO	0.12	0.44	0.43	0.64
NWPSO2sy	0.00	0.00	0.00	0.00
NWPSO3sy	0.00	0.00	0.67	1.49
NWPSO4sy	0.03	0.30	0.00	0.00
NWPSO5sy	0.58	1.14	2.00	3.46
NWTPSO	0.22	0.41	0.00	0.00
WPSA2sy	0.07	0.59	0.00	0.00
WPSA3sy	0.00	0.00	0.00	0.00
WPSA4sy	0.03	0.29	0.00	0.00
WPSA5sy	0.06	0.33	0.40	0.89
WTPSA	0.04	0.16	0.14	0.32
NWPSA2sy	0.42	1.63	1.00	2.24
NWPSA3sy	0.09	0.55	0.00	0.00
NWPSA4sy	0.14	0.58	0.50	1.12
NWPSA5sy	0.28	0.79	0.80	1.10
NWTPSA	0.21	0.39	0.57	0.60

[W-words; NW- nonwords; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; PSS - percentage of syllable substitutions; TPSS -Total percentage of syllable substitutions; PSO - percentage of syllable omissions; TPSO -Total percentage of syllable omissions; PSA - percentage of syllable additions; TPSA -Total percentage of syllable additions]

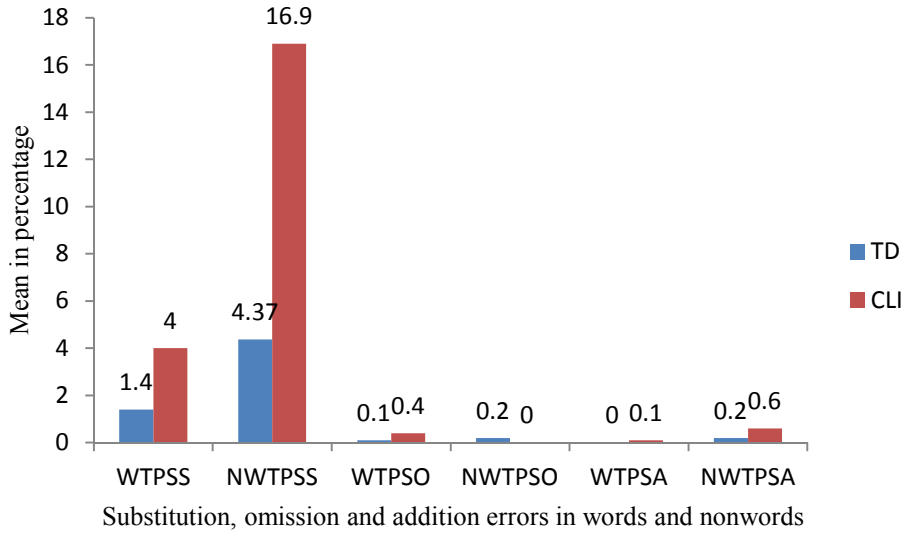

Figure 22. *Total percentage of errors (PSS, PSO & PSA) in both the groups of children for words and nonwords.*

The Mann-Whitney U test suggested a significant difference in the PSS errors in nonwords at each of the syllable length between the children with language impairment and typically developing children ($p<0.05$). However, the results showed no significant difference in the PSS in words at different syllable lengths. The /z/ and the /p/ values have been depicted in Table 39. The results of the present study are in consonance with the earlier studies where it was found that the substitutions are the most commonly identified error pattern in nonword repetition studies with young English-speaking children with typical and atypical language development (e.g., Dollaghan et al., 1998; Edwards & Lahey, 1998; Edwards et al., 2004) and phonological disorders (Munson, Edwards, & Beckman, 2005). Similarly, in Girbau and Schwartz's (1997, 1998) studies, phoneme substitutions were the most prevalent error patterns in the repetitions of Spanish-speaking children with typical language development and children with language impairment. According to Edwards and Lahey (1998), phoneme substitutions suggested that there is a slot for every phonetic segment to be produced in the phonetic representation of working memory, but that errors can occur in the association links

between these slots and the segmental information that is to be produced. That is, substitution errors also suggest that the target articulatory pattern is not yet robustly encoded.

The PSO was significantly different between the two groups at only 5-syllable length words and also at only 3-syllable length nonwords. The /z/ and the /p/ values have been depicted in Table 39. The PSO were observed less frequently than the PSS in repetition tasks. Similar results were observed by Edwards and Lahey (1998) where they reported that the omissions or deletions appeared to become more prevalent as length in syllables increased. It could be that, as the length of the nonword increased, the participants experienced difficulty with forming or holding detailed phonological representations in working memory. Nevertheless no significant difference was found in PSA between the two groups at different syllable lengths in both words and nonwords as the PSA were very less frequently seen during the repetition tasks.

Table 39. *Results of the Mann-Whitney U test for the percentage of errors between typically developing and children with language impairment.*

Percentage of errors in words & nonwords	/z/ values	p values
WPSS2sy	1.53	0.13
WPSS3sy	1.95	0.05
WPSS4sy	0.16	0.87
WPSS5sy	1.31	0.19
WTPSS	1.47	0.14
NWPSS2sy	4.68	0.00**
NWPSS3sy	2.75	0.01*
NWPSS4sy	3.85	0.00**
NWPSS5sy	3.35	0.00**
NWTPSS	3.72	0.00**
WPSO2sy	0.26	0.79
WPSO3sy	0.00	1.00
WPSO4sy	0.38	0.71
WPSO5sy	2.19	0.03*
WTPSO	2.00	0.05
NWPSO2sy	0.00	1.00
NWPSO3sy	3.80	0.00**
NWPSO4sy	0.26	0.79
NWPSO5sy	0.99	0.32
NWTPSO	1.26	0.21
WPSA2sy	0.26	0.79
WPSA3sy	0.00	1.00
WPSA4sy	0.26	0.79
WPSA5sy	1.91	0.06
WTPSA	1.26	0.21
NWPSA2sy	1.02	0.31
NWPSA3sy	0.38	0.71
NWPSA4sy	1.26	0.21
NWPSA5sy	1.56	0.11
NWTPSA	1.80	0.07

[W-words; NW- nonwords; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; PSS - percentage of syllable substitutions; TPSS -Total percentage of syllable substitutions; PSO - percentage of syllable omissions; TPSO -Total percentage of syllable omissions; PSA - percentage of syllable additions; TPSA -Total percentage of syllable additions; ** $p<0.01$; * $p<0.05$]

In summary the results of the present study revealed that children of 4-6years performed better on the repetition of words than that of the nonwords. The children of 5-6years performed better than 4-5years on word and nonword repetition tasks, had higher percentage of vowels and consonants correct, lower percentage of syllable substitution, omission and addition errors indicating a developmental progression in the repetition and phonological working memory skills. Further the children with language impairment performed poorer than the typically developing children wherein they obtained poorer scores on 3syllable length words and on the nonword repetition task at all the syllable lengths and also on the overall nonword repetition task indicating a deficit in their phonological working memory capacity. The word and the nonword repetition test was also subjected to validity and reliability procedures and the results revealed acceptable levels of validity and reliability.

CHAPTER V

SUMMARY AND CONCLUSIONS

Cognition and language are closely related, and there are connections between cognitive development and language development. Memory is an important component of cognition which refers to the mental ability of an organism to acquire, store, retain and retrieve any information. Working memory (Baddeley & Hitch, 1974; Baddeley, 2003a, 2003b) has been proposed as a subcomponent of memory process that is reported to be involved in storage and processing of verbal information. The processes within the working memory which is considered as highly specialized for language learning and which retains verbal information is called phonological working memory loop. Any problem in the phonological working memory is considered to seriously hamper the child's acquisition of basic language and literacy skills during the early years of school which form the basic building for later scholastic achievements.

For many years, researchers have tried to assess the capacity of the phonological working memory and the most widely used technique has been the nonword repetition task. The nonword repetition task is thought to reflect some of the underlying cognitive difficulties, perhaps those concerned with working memory, phonological memory or long-term word knowledge (Gathercole, 1995). 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 deficits in phonological working memory. Nonword repetition abilities have been shown to be reduced in children with different communication disorders. Further, the repetition of nonwords has been shown to be highly correlated with a variety of language measures such as receptive vocabulary and indices of speech output,

including repertoire of vocabulary, utterance length and grammatical complexity, in typically and atypically developing children.

Several nonword repetition tests have been published. Two widely used published nonword repetition tests in the West are the Children's Test of Nonword Repetition (CNRep; Gathercole & Baddeley, 1996) and the Nonword Repetition Test (NRT; Dollaghan & Campbell, 1998). Archibald and Gathercole (2006) stated that the CNRep and the NRT may measure different abilities and that the NRT, particularly focused on measuring phonological working memory.

The focus of research in the recent past has been primarily on the repetition of nonwords. However, a recent study (Casalini, Brizzolara, Chilosi, Cipriani, Marcolini, Pecini, Ronoli, & Burani, 2007) investigated repetition of real words as well as nonwords, and found that children with SLI had significantly lower scores on both real words and nonwords compared with age-matched controls. Consequently Seeff-Gabriel, Chiat & Roy (2008) constructed a test named the Early repetition Battery (ERB) which consisted of two subtests viz. The preschool Repetition test (PS Rep) and The sentence Imitation Test (SIT). The PSRep presents children with a set of real words and a set of nonwords which was designed to assess the phonological processing abilities of preschool children. Since the tests especially the NRT and PSRep have been found to be effective in identifying the phonological working memory and phonological processing deficits in children with various communication disorders, are quick and easy to administer and have several other advantages, it is essential to construct these tests in other languages. Such tests in the Indian context are limited. Hence this project was planned with the aim of developing a word and a nonword repetition test in Kannada language (along the lines of NRT and PSRep) for children in the age group of 4-6 years.

A total of one hundred and thirty eight typically developing Kannada speaking children with chronological age ranging between 4 to 6 years served as participants for the study. They were divided into two groups which included sixty six children (thirty four females and thirty two males) in 4-5years and seventy two children (forty two females and thirty males) in 5-6years age range. The children in both the groups were selected from around ten different schools in Mysore district of Karnataka and were learning English as their second language in school. They were divided into lower, mid, and higher socioeconomic status categories using Socio Economic Scale by Venkatesan (2009). In addition the WHO Ten-question disability screening checklist (Singhi, Kumar, Malhi, & Kumar, 2007) was administered to rule out any disability. The children in both the age groups had normal hearing, and had normal receptive and expressive language skills as determined by using Kannada Language Test. It was ensured that none of the children had inappropriate phonological process and articulatory errors with respect to their age as screened with Kannada articulation test for any age.

The present study was carried out in three phases, which included construction of the word and the nonword repetition test in Kannada, standardization of the word and nonword repetition test, and establishment of the validity of the test. The real words of varying syllable lengths (2syllable, 3syllable, 4syllable and 5syllable length) were selected from Computerized Linguistic Protocol (in Kannada) for Screening Children (CLIPS) (Anitha & Prema, 2008), 'With a little bit of help-Early Language Training Manual' (Karanth, Manjula, Prema, & Geetha, 1999) and also from the Kannada text books of school children of 4-6years. A total of 80 meaningful words were selected and different rules were applied to create 'nonwords'. The final list consisted of 40 words, 40 nonwords (test items) and 5 words & 5 nonwords as practice items were then audio-recorded by a female native speaker of

Kannada using the "PRAAT" software (downloadable software for speech recording and analysis) using a Compaq Presario C 700 laptop system.

Following this, the list of recorded words and nonwords along with 10 practice items were presented to the subjects selected for the study. The words and nonwords were randomized and presented and their responses were audio recorded. The total time taken to complete the repetition test was 10 minutes. They were given a tangible reinforcement as a token of appreciation for their efforts. The test-retest and inter-rater reliability was established as a part of standardization. The validity of the test was established by administering the test to 10 other typically developing children and children with SLI and LD in each age group who did not belong to the group selected for the study. The test administration was carried out in a similar manner as mentioned above.

The participants' responses which were audio recorded 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 obtained data were appropriately tabulated and subjected to statistical measures. SPSS software (version 16.0) package was used for statistical analysis.

The results revealed that the accuracy of the repetition scores was better for words on the whole and at all syllable lengths compared to nonwords for both age groups and gender which can be attributed to the effect of lexical status. Further the children in the higher age group performed better on the repetition of words and nonwords than the children in the lower age group. This shows that as children grow their phonological working memory also matures. Their better performance could be attributed to the more proficient articulatory abilities and better subvocal rehearsal mechanism of the phonological loop which helps to

actively maintain the to-be-repeated 'skeleton' of sub-lexical components (e.g., syllables, onsets-rimes).

In general, the children in both the age groups performed better on the 2- and 3-syllable length nonwords than on 4- and 5-syllable length nonwords. This might be attributed to the lesser frequency of exposure of the children at this age to longer syllable length words. The longer length stimuli would tax the storage and rehearsal functions of the loop very much, which would lead to less complete and precise short-term representations and further less accurate repetitions of novel phonological forms.

Further the results indicated a significant difference between the performance of children of 4-5 and 5-6years age group on 2 and 3-syllable length words where in the performance of children in 5-6years was significantly better than that of the children in the 4-5years age group. However, with respect to the repetition of nonwords, there was a significant difference between the children of the two age groups, on 3-, 4- and 5-syllable length nonwords. The results indicate that there is a greater development between age groups at 2 and 3 syllable length word level compared to the 4 and 5 syllable length word level. This indicates that the refining of the phonological working memory progresses in a step by step fashion from 2 and 3 syllable to 4 and 5 syllable level. Furthermore, the results of the study revealed that there was no significant difference in the performance of 4-5year and 5-6year old children belonging to different SES on both words and nonwords at any of the syllable lengths.

The responses of the children were also analyzed in terms of percentage of phonemes correct with respect to vowels (PVC) and consonants (PCC) and also the type of errors exhibited (syllable substitutions, additions, omissions) by the children during the repetition task.

The PVC and PCC were highest for words compared to nonwords for both the age groups and gender. Further it was seen that the PVC and PCC decreased with the increase in the syllable length i.e. decreased from 2-syllable length words to 5-syllable length words. Similar results were found on the nonwords too. The results also suggested that both the age groups obtained significantly different scores on the total PVC in words, but not on nonwords. The PCC in words differed significantly only at 2syllable length whereas the PCC in nonwords differed significantly at all the syllable lengths. The range of mean values for PVC was almost 96-100% and PCC was 93-99% in both words and nonwords at all of the syllable lengths. This shows that vowels were better repeated than consonants. This could be attributed to the fact that vowels are generally easy to articulate and mastered earlier in the children's phonetic inventory. Hence vowels are considered to be better preserved in the repetition tasks.

The percentage of syllable substitution (PSS) was the most frequently occurring error in both words and nonwords. The PSS errors increased with the increase in the syllable length in words as well as in nonwords. The percentage of omission (PSO) and percentage of addition (PSA) errors were very less compared to the PSS errors.

With respect to the validity check, the mean values of the samples (10 other typically developing children) were lying within the mean plus or minus SD values or closer to the mean values of the earlier 138 samples children who were tested hence suggesting a good validity of the test. The test retest reliability was calculated using the Cronbach's coefficient alpha which was found to be 0.80. This suggested acceptable levels of test-retest reliability for the overall test. Acceptable levels of interrater reliability were also achieved with the Cronbach's coefficient alpha being 0.71.

To assess the clinical validity of the task, the repetition of words and nonwords by the children with language impairment were compared with the repetition scores of language age matched 5-6years old typically developing children. The mean values indicated that the accuracy of the repetition were higher in typically developing children compared to that of the children with language impairment at each of the syllable length and also on the overall scores in both words and nonwords. Further the accuracy of scores decreased from 2 syllable to 5-syllable in both words and nonwords in both the groups. Also the accuracy scores for words overall and at each syllable length were higher compared to that of nonwords in both the groups. The results indicated a poorer performance of children with language impairment especially on nonwords at each of the syllable length, indicating a deficit in phonological working memory capacity. This suggests that the entire word and the nonword repetition task was useful in differentiating children with language impairment from the language matched typically developing children.

The mean values of PVC in words indicates that the children with language impairment obtained lower PVC at 5syllable length in words, whereas typically developing children obtained similar mean scores at all the syllable lengths in words. Further the PVC in nonwords were higher for typically developing children compared to the children with language impairment. The typically developing children attained similar means of PVC on 2-, 3-, and 4-syllable lengths nonwords but achieved lower PVC mean scores on only 5-syllable length nonwords while the children with language impairment obtained lower mean PVC scores on 2, 4, and also on 5-syllable length nonwords. The lesser PVC in children with language impairment than the typically developing children suggests the relatively weaker phonological encoding in children with language impairment during the repetition tasks.

The PCC was higher in words compared to that of nonwords in both typically developing children and children with language impairment. The mean PCC values in

nonwords decreased from 2-syllable length nonwords to 5-syllable length nonwords. The children with language impairment obtained very less PCC scores at 5-syllable length nonwords compared to the typically developing children. On the whole, the children in both the groups obtained higher PVC than the PCC.

The PSS was the most frequent type of errors seen in the repetition of words and nonwords in both the groups compared to the PSO and PSA. The PSS errors were more in nonwords than words in both the groups. Also the PSS errors increased with the increase in the syllable length in both the groups. Furthermore PSS indicated a higher percentage of errors in the children with language impairment compared to the typically developing children. The PSO was significantly different between the two groups at only 5-syllable length words and also at only 3-syllable length nonwords. No significant difference was found in PSA between the two groups at different syllable lengths in both words and nonwords as the PSA were very less frequently seen during the repetition tasks

To conclude the children of 4-6years performed better on the repetition of words than that of the nonwords. The children of 5-6years performed better than 4-5years on word and nonword repetition tasks, had higher percentage of vowels and consonants correct, lower percentage of syllable substitution, omission and addition errors indicating a developmental progression in the repetition and phonological working memory skills. Further the children with language impairment performed poorer than the typically developing children wherein they obtained poorer scores on 3syllable length words and on the nonword repetition task at all the syllable lengths and also on the overall nonword repetition task indicating a deficit in their phonological working memory capacity.

Implications of the study

This study provides an insight into the phonological working memory skills in typically developing children in the age group of 4-6 years and in children with language impairment. The present study provides a test material (a word and a nonword repetition task) and norms for assessing the phonological working memory in children. The present study has important implications for early childhood assessment and intervention. 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

There is a need for further research focusing on the evaluation of phonological working memory in children with language impairment across different age groups, assessing 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., comparing the nonword repetition task with the other

processing related measures like sentence recall, digit recall etc. Research can be also undertaken to evaluate the clinical utility of the nonword repetition task in comparison to the standardized language measures.

REFERENCES

Adams, A. M., & Gathercole, S.E. (1995). Phonological working memory and speech production in preschool children. *Journal of Speech and Hearing Research,* 38, 403-414.

Adams, A. M., & Gathercole, S. E. (2000). Limitations in working memory: Implications for language development. *International Journal of Language and Communication Disorders, 35* (1), 95-116.

Alloway, T. P., Gathercole, S. E., Willis, C., & Adams, A. M. (2004). A structural analysis of working memory and related cognitive skills in young children. *Journal of Experimental Child Psychology,* 87 (2), 85-106.

Archibald, L. M. D., & Gathercole, S. E. (2006). Visuospatial immediate memory in specific language impairment. *Journal of Speech, Language, and Hearing Research*, 49 (2), 265 - 277.

Archibald, L. M. D., & Gathercole, S. E. (2006b). Nonword repetition: A comparison of tests. *Journal of Speech, Language, and Hearing Research*, 49, 970-983.

Baddeley, A. (1986). *Working Memory*. New York: Clarendon/Oxford University press.

Baddeley, A. D. (1996). *Your Memory: A User's Guide, 3rd Edition*. Prion Books, London.

Baddeley, A. D. (1996a). Exploring the central executive. *Quarterly Journal of Experimental Psychology,* 49A, 5–28.

Baddeley, A. D. (1996b). The fractionation of working memory. *Proceedings of the National Academy of Sciences USA,* 93, 13468–13472.

Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Science,* 4, 417-423.

Baddeley, A. D. (2002). Is working memory still working? *European Psychologist,* 7 (2), 85-97. Reprinted from American Psychologist, 56 (11), 851-64.

Baddeley, A. D. (2003a). Working memory and language: an overview. *Journal of Communication Disorders,* 36, 189-208.

Baddeley, A. D. (2003b). Working memory: looking back and looking forward. *Nature Reviews: Neuroscience*, 4, 829-839.

Baddeley, A. D. (2007). *Working memory, thought, and action*. Oxford, United Kingdom: Oxford University Press.

Baddeley, A. D., Gathercole, S. E., & Papagno, C. (1998). The phonological loop as a language learning device. *Psychological Review*, 105, 158–173.

Baddeley, A. D., & Hitch, G. (1974). Working memory. In G.H. Bower (Eds.), *The psychology of learning and motivation: Advances in research and theory*, 8, 47–89, New York: Academic Press.

Bakhtiar, M., Abad Ali, D. A., & Sadegh, S. P. M. (2007). Nonword repetition ability of children who do and do not stutter and covert repair hypothesis. *Indian Journal of Medical Sciences, 61(8),462-470.*

Beckman, M. E., & Edwards, J. (2000). Lexical frequency effects on young children's imitative productions. In M. Broe and J. Pierrehumbert (Eds.), Papers in Laboratory Phonology (pp.208–218). Cambridge: Cambridge University Press. .

Best, J. B. (1999). Cognitive Psychology. USA: Wadsworth Publishing Co.

Bishop, D. V. M., Carlyon, R. P., & Deeks, J. M. (1999). Auditory temporal processing impairment: Neither necessary nor sufficient for causing language impairment in children. *Journal of Speech, Language, and Hearing Research*, 42, 1295-1310.

Bishop, D., & Edmundson, A. (1986). Is otitis media a major cause of specific developmental language disorders? *British Journal of Disorders of Communication*, 21, 321- 338.

Bishop, D. V. M., North, T., & Donlan, C. (1996). Nonword repetition as a behavioural marker for inherited language impairment: Evidence from a twin study. *Journal of Child Psychology and Psychiatry,* 37, 391- 403.

Bowey, J. A. (1996). On the association between phonological memory and receptive vocabulary in five-year-olds. *Journal of Experimental Child Psychology*, 63, 44–78.

Bowey, J. A. (2001). Nonword repetition and young children's receptive vocabulary: A longitudinal study. *Applied Psycholinguistics,* 22, 441-470.

Brady, S. A. (1997). Ability to encode phonological representations: An underlying difficulty of poor readers. In B. Blackman (Eds.), *Foundations of reading acquisition and dyslexia: Implications for early intervention* (pp. 2–28). Lawrence Erlbaum Associates, Hillsdale, NJ.

Briscoe, J., Bishop, D. V. M., & Norbury, C.F. (2001). Phonological processing, language, and literacy: A comparison of children with mild-to-moderate sensorineural hearing loss and those with specific language impairment. *Journal of Child Psychology and Psychiatry,* 42, 329- 340.

Burt, L., Holm, A., & Dodd, B. (1999). Phonological awareness skills of 4-year-old British children: An assessment and developmental data. *International Journal of Language and Communication Disorders,* 34, 311-35.

Calderon, J., & Gutierrez-Clellen, V. F. (2003). Spanish nonword repetition in emerging bilingual children. *Paper presented at the 4th International Symposium on Bilingualism.*

Campbell, T., Dollaghan, C., Needleman, H., & Janosky, J. (1997). Reducing bias in language assessment: processing-dependent measures. *Journal of Speech and Hearing Research*, 40 (3), 519-525.

Campbell, T. F., Needleman, H. L., Riess, J. A. & Tobin, M. J. (2001). Bone lead levels and language processing performance. *Developmental Neuropsychology*, 18, 171–186.

Carter, A. K., Dillon, C. M., & Pisoni, D. B. (2002). Imitation of nonwords by hearing impaired children with cochlear implants: Suprasegmental analyses. *Clinical Linguistics and Phonetics,* 16, 619–638.

Casalini, C., Brizzolara, D., Chilosi, A., Cipriani, P., Marcolini, S., Pecini, C., Ronoli, S., & Burani, C. (2007). Non-word repetition in children with specific language impairment: a deficit in phonological working memory or in long-term verbal knowledge? *Cortex,* 43 (6), 769-776.

Chiat, S., & Roy, P. (2007). The Preschool Repetition Test: an evaluation of performance in typically developing and clinically referred children. *Journal of Speech, Language, and Hearing Research*, 50, 429-443.

Coady, J. A., & Aslin, R. N. (2004). Young children's sensitivity to probabilistic phonotactics in the developing lexicon. *Journal of Experimental Child Psychology, 89,* 183-213.

Comblain, A. (1999). The relevance of a nonword repetition task to assess the phonological short term memory of individuals with Down syndrome. *Down Syndrome Research and Practice*, 6(2), 76-84.

Conti-Ramsden, G., Botting, N., & Farragher, B. (2001). Psycholinguistic markers for specific language impairment (SLI). *Journal of Child Psychology and Psychiatry*, 42, 741–748.

Conti-Ramsden, G. M., & Durkin, K. (2007). Phonological short-term memory, language and literacy: developmental relationships in early adolescence in young people with SLI. *Journal of Child Psychology and Psychiatry*, 48 (2), 147-156.

de Bree, E., Rispens, J., & Gerrits, E. (2007). Non-word repetition in Dutch children with (a risk of) dyslexia and SLI. *Clinical Linguistics and Phonetics,* 21(11-12), 935-44.

Dollaghan**, C.,** Biber, & Campbell, T. (1993). Constituent syllable effects in a nonsense-word repetition task. *Journal of Speech and Hearing Research*, 36, 1051-1054.

Dollaghan, C., & Campbell, T. (1998). Nonword repetition and child language impairment. *Journal of Speech, Language, and Hearing Research, 41,* 1136-1146.

Edwards, J., & Lahey, M. (1998). Nonword repetition of children with specific language impairment: exploration of some explanations for their inaccuracies. *Applied Psycholinguistics,* 19, 279–309.

Edwards, J., Beckman, M. E., & Munson, B. (2004). The interaction between vocabulary size and phonotactic probability effects on children's production accuracy and fluency in nonword repetition. *Journal of Speech, Language, and Hearing Research, 47*, 421-436.

Ellis Weismer, S., Tomblin, J. B., Zhang, X., Buckwalter, P., Chynoweth, J. G., & Jones, M., (2000). Nonword repetition performance in school-age children with and without language impairment. *Journal of Speech, Language, and Hearing Research,* 43, 865–878.

Gathercole, S. E. (1995). The assessment of phonological memory skills in preschool children. *British Journal of Educational Psychology*, 65, 155–164.

Gathercole, S. E. (1999). Cognitive approaches to the development of short-term memory. *Trends in Cognitive Sciences*, 3, 410–419.

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics*, 27(4), 530- 540.

Gathercole, S. E. & Adams, A. M. (1993). Phonological working memory in very young children. *Developmental Psychology, 29*, 770-778.

Gathercole, S. E., & Adams, A. M. (1994). Children's phonological working memory: Contributions of long-term knowledge and rehearsal. *Journal of Memory and Language, 33*, 672-688.

Gathercole, S. E., & Baddeley, A. (1989). Evaluation of the role of phonological STM in the development of vocabulary in children: A longitudinal study. *Journal of Memory and Language,* 28, 200- 213.

Gathercole, S, E., & Baddeley, A. (1990a). Phonological memory deficits in language impaired children: Is there a causal connection? *Journal of Memory and Language*, 29, 336- 360.

Gathercole, S, E., & Baddeley, A. (1990b). The role of phonological memory in vocabulary acquisition: A study of young children learning new words. *British Journal of Psychology*, 81, 439–454.

Gathercole, S. E., & Baddeley, A. (1993). *Working memory and language*. East Sussex, United Kingdom: Lawrence Erlbaum Associates.

Gathercole, S. E., & Baddeley, A. D. (1996). *The Children's Test of Nonword Repetition.* London: Psychological Corporation.

Gathercole, S. E. (1999). Cognitive approaches to the development of short-term memory. *Trends in Cognitive Sciences*, 3, 410–419.

Gathercole, S. E., Frankish, C. R., Pickering, S. J., & Peaker, S. (1999). Phonotactic influences on short-term memory. *Journal of Experimental Psychology, Learning, Memory and Cognition,* 25(1), 84- 95.

Gathercole, S. E., Willis, C., & Baddeley, A. D. (1991b). Nonword repetition, phonological memory and vocabulary development: A reply to Snowling, Chiat and Hulme. *Applied Psycholinguistics, 12*, 375-379.

Gathercole, S. E., Willis, C., Emslie, H., & Baddeley, A. D. (1991). The influences of number of syllables and wordlikeness on children's repetition of nonwords. *Applied Psycholinguistics*, 12, 349–367.

Gathercole, S. E., Willis, C., Emslie, H., & Baddeley, A. D. (1992). Phonological memory and vocabulary development during the early school years: A longitudinal study. *Developmental Psychology*, 28, 887 - 898.

Girbau, D. (2009). Psycholinguistic abilities and phonological working memory in bilingual children with specific language impairment: A cross-cultural study. In E. F. Caldwell (Eds.), *Bilinguals: Cognition, Education and Language Processing* (pp. 65-80). New York: Nova Science Publishers, Inc. ISBN: 978-1-60741-710-1.

Girbau, D., & Schwartz, G. R. (2007). Non-word repetition in Spanish-speaking children with specific language impairment (SLI). *International Journal of Language and Communication Disorders*, 42, 59– 75.

Girbau, D., & Schwartz, G. R. (2008). Phonological working memory in Spanish-English bilingual children with and without specific language impairment. *Journal of Communication Disorders,* 41, 124-145.

Grant, J., Karmiloff-Smith, A., Berthoud, I., & Christophe, A. (1996). Is the language of people with Williams syndrome mere mimicry? Phonological short-term memory in a foreign language. *Cognitive Neuropsychiatry*, 15, 615–628.

Grant, J., Karmiloff-Smith, A., Gathercole, S. A., Paterson, S., Howlin, P., Davies, M., & Udwin, O. (1997). Phonological short-term memory and its relationship to language in Williams syndrome. *Cognitive Neuropsychiatry*, 2, 81–99.

Gray, S. (2003). Diagnostic accuracy and test–retest reliability of nonword repetition and digit span tasks administered to preschool children with specific language impairment. *Journal of Communication Disorders,* 36, 129–151.

Gupta, P. (2005). Primacy and recency in nonword repetition. *Memory,* 13, 318-324.

Hakim, H. B., & Ratner, N. B. (2004). Nonword repetition abilities of children who stutter: An exploratory study. *Journal of Fluency Disorders,* 29, 179-99.

Hoffman, L. M., & Gillam, R. B. (2004). Verbal and spatial information processing constraints in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 47 (1), 114- 125.

Jarrold, C., & Baddeley, A. D. (2001). Short-term memory in Down syndrome: Applying the working memory model. *Down Syndrome Research and Practice*, 7(1), 17-23.

Jarrold, C., Baddeley, A. D., & Hewes, A. K. (2000). Verbal short-term memory deficits in Down syndrome: A consequence of problems in rehearsal? *Journal of Child Psychology and Psychiatry,* 41, 233-244.

Kamhi, A. G., & Catts, H. W. (1986). Toward an understanding of developmental language and reading disorders. *Journal of Speech and Hearing Disorders*, 51, 337–347.

Kamhi, A. G., Catts, H. W., Mauer, D., Apel, K., & Gentry, B. F. (1988). Phonological and spatial processing abilities in language- and reading-impaired children. *Journal of Speech and Hearing Disorders,* 53, 316–327.

Kjelgaard, M. M., & Tager-Flusberg, H. (2001). An investigation of language impairment in autism: Implications for genetic subgroups. *Language and Cognitive Processes,* 16, 287-308.

Kolk, H., & Postma, A. (1997). Stuttering as a covert repair phenomena. In Curlee, R. F., & Siegel, G. M., (Eds.), *Nature and treatment of stuttering (new directions).* Needham Height, MA: Allyu & Bacon, 182-203.

Laws, G. (1998). The use of nonword repetition as a test of phonological memory in children with Down syndrome. *Journal of Child Psychology and Psychiatry*, 39, 1119-1130.

Leonard, L. (1998). *Children with specific language impairment*. Cambridge, MA: MIT Press.

Leonard, L., Miller, C., & Finneran, D. (2009). Grammatical morpheme effects on sentence processing by school-aged adolescents with specific language impairment. *Language and Cognitive Processes,* 24, 450- 478.

Marton, K., & Schwartz, G. R. (2003). Working memory capacity and language processes in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 46, 1138-1153.

McCarthy, R. A., & Warrington, E. K. (1984). A two-route model of speech production: Evidence from aphasia. *Brain,* 107, 463-85.

Metsala, J. L. (1999). Young children's phonological awareness and nonword repetition as a function of vocabulary development. *Journal of Experimental Child Psychology,* 91 (1), 3-19.

Michas, I., & Henry, L.A. (1994). The link between phonological memory and vocabulary acquisition. *British Journal of Developmental Psychology,* 12, 147-163.

Miller, C. A., Kail, R., Leonard, L., & Tomblin, J. B. (2001). Speed of processing in children with specific language impairment. *Journal of Speech and Hearing Research*, 44 (2), 416-433.

Montgomery, J. W. (1995a). Sentence comprehension in children with specific language impairment: The role of phonological working memory. *Journal of Speech, Language, and Hearing Research,* 38 (1), 187- 199.

Montgomery, J. W. (1995b). Examination of phonological working memory in specifically language impaired children. *Applied Psycholinguistics*, 16, 355– 378.

Montgomery, J. (2000). Verbal working memory and sentence comprehension in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, *43*, 293–308.

Montgomery, J. (2002). Understanding the language difficulties of children with specific language impairments: Does working memory matter? *American Journal of Speech-Language Pathology*, 11, 77– 91.

Montgomery, J. W. (2003). Working memory and comprehension in children with specific language impairment: What we know so far. *Journal of Communication Disorders*, 36, 221-231.

Montgomery, J. W. (2004). Sentence comprehension in children with specific language impairment: effects of input rate and phonological working memory. *International Journal of Language and Communication Disorders,* 39, 115–133.

Munson, B. (2001). Phonological pattern frequency and speech production in children and adults. *Journal of Speech, Language, and Hearing Research, 44*, 778-792.

Munson, B., Edwards, J., & Beckman, M. E. (2005). Phonological knowledge in typical and atypical speech sound development. *Topics in Language Disorders*, 25, 190-206.

Nelson, K. (1987). Some observations from the perspective of the rare event cognitive comparison theory of language acquisition. In K. E. Nelson and A. van Kleeck (Eds.), *Children's language* (pp. 22-331). Hillsdale, NJ: Erlbaum.

Plunkett, K., & Marchman, V. (1993). From rote learning to system-building—acquiring verbal morphology in children and connectionist models. *Cognition*, 48, 21–69.

Prema K.S. Rao., Prasitha, P., Savitha, S., Purushotham, P., Chitra, R., & Balaji, R. (2010). Clinical markers for identification of children with Specific Language Impairment (SLI). In D. Vasanta (Eds*.). Indian Journal of Applied Linguistics*, 36, 1-2, (pp.181-198), Bahri Publications.

Rispens, J., & Parigger, E. (2010). Non-word repetition in Dutch-speaking children with specific language impairment with and without reading problems. *British Journal of Developmental Psychology,* 28(1), 177-188.

Roy, P., & Chiat, S. (2004). A prosodically controlled word and nonword repetition task for 2-to 4-year-olds: evidence from typically developing children. *Journal of Speech, Language, and Hearing Research*, 47, 223-234.

Sahlen, B., Wagner C. R., Nettelbladt, U., & Radeborg, K. (1999). Language comprehension and non-word repetition in children with language impairment, *Clinical Linguistics & Phonetics*, 13 (5), 369 – 380.

Seeff-Gabriel, B., Chiat, S., & Roy, P. (2008). *The Early Repetition Battery*. London: Pearson Assessment.

Service, E. (1992). Phonology, working memory, and foreign language learning. *The Quarterly Journal of Experimental Psychology*, 45A (1), 21–50.

Service, E., & Kohonen, V. (1995). Is the relation between phonological memory and foreign- language learning accounted for by vocabulary acquisition? *Applied Psycholinguistics,* 16,155-172.

Shylaja, K., & Swapna, N. (2010). Nonword repetition in children with language impairment: An exploratory study. Student research at AIISH (articles based on dissertation done at AIISH), Volume VIII: 2009-10, Part-B, 263-272.

Somy, E. S., & Geetha Y.V. (2008). Nonword repetition skills in 5-6year old Kannada speaking children with and without stuttering. Student research at AIISH (articles based on dissertation done at AIISH), Volume VI: 2009-10, Part-B, 291-310.

Stokes, S. F., Wong, A. M-Y., Fletcher, P., & Leonard, L. B. (2006). Nonword repetition and sentence repetition as clinical markers of specific language impairment: the case of cantonese. *Journal of Speech and Hearing Research*, 49 (2), 219 - 236.

Windsor, J., & Hwang, M. (1999). Testing the generalized slowing hypothesis in specific language impairment. *Journal of Speech, Language, and Hearing Research*, 42, 1205–1218.

Yoss, K. A., & Darley, F. L. (1974). Developmental apraxia of speech in children with defective articulation. *Journal of Speech and Hearing Research,* 17, 386-398.

Zamuner, T., Gerken, L. A., & Hammond, M. (2004). Phonotactic probabilities in young children's speech productions. *Journal of Child Language,* 31, 515-536.

Appendix I

Practice Items

Syllable length(sy)	Words	Nonwords
2sy	ṯaṯṯe	ṯeṯṯa
3sy	n̪aviḷu	n̪aḷuvi
4sy	bha:n̪uva:ra	va:bha:n̪ura
5sy	meṯṯiḷugaḷu	ḷuṯṯiḷugame
5sy	baṭa:ɳigaḷu	ṭa:baḷuɳiga

Test Items

Stimulus No.	Syllable length(sy)	Words	Nonwords
1.	2sy	maɳe	meɳa
2.	3sy	tʃappaḷi	ḷippatʃa
3.	4sy	ṭaraka:ri	raka:ṭari
4.	5sy	tʃamatʃagaḷu	tʃagaḷumatʃa
5.	2sy	tʃa:pe	tʃe:pa
6.	3sy	kaṭṭaḷe	ḷeṭṭaka
7.	4sy	garagasa	garasaga
8.	5sy	vima:ɳagaḷu	ma:ḷuvigaɳa
9.	2sy	ɳi:ḷi	ɳo:ḷi
10.	3sy	ṭabaḷa	ḷabaṭa
11.	4sy	maɳejaḷḷi	jaḷḷiɳema
12.	5sy	tʃiraṭegaḷu	tʃiḷuṭeraga
13.	2sy	ḍa:ra	ḍe:ra
14.	3sy	kaḍime	ḍikame
15.	4sy	ḍi:pagaḷu	paḍi:gaḷu
16.	5sy	ɳo:ḍuṭiḍḍa:ne	ɳo:ṭiɳeḍḍaḍu
17.	2sy	beɳɳu	buɳɳe
18.	3sy	ṭakkaḍi	ḍikkaṭa
19.	4sy	maḷagiḍe	giḷaḍema
20.	5sy	baḷapagaḷu	pabaḷugaḷa
21.	2sy	mi:ɳu	mu:ɳi
22.	3sy	tʃapa:ṭi	ṭipa:tʃa
23.	4sy	ʃaɳiva:ra	ɳiva:ʃara
24.	5sy	ma:viɳamara	ma:raviɳama
25.	2sy	waḍe	weḍa
26.	3sy	tʃakkuḷi	ḷikkutʃa
27.	4sy	maɳegaḷu	maḷuɳega
28.	5sy	kuḍuregaḷu	gareḷukuḍu
29.	2sy	ḍi:pa	ḍa:pi
30.	3sy	basava	sabava
31.	4sy	bi:gagaḷu	gabi:ḷuga
32.	5sy	ṭagijuvuḍu	ḍugijuṭavu
33.	2sy	ka:ge	ke:ga
34.	3sy	gaɳe:ʃa	ʃaɳe:ga
35.	4sy	baḷegaḷu	gaḷebaḷu
36.	5sy	kaɳɳaḍigaḷu	ḍiɳɳagakaḷu
37.	2sy	ba:ji	bi:ja
38.	3sy	beraḷu	beḷura
39.	4sy	maragaḷu	maḷugara
40.	5sy	baḍaɳeka:ji	ḍabaka:ɳeji

Appendix II

WORD SCORE SHEET

Practice Items	Number of presentations	Discontinue Rule	Accuracy & Error analysis
1. t̪aṭṭe 2. n̪avil̪u 3. bha:n̪uva:ra 4. meṭṭil̪ugaḷu 5. baṭa:ṇigaḷu Correct responses are not required to proceed to the test items.	If the child does not respond to a practice item allow up to 2 further presentations.	None: attempt to administer all items.	Calculate a) Accuracy- i) total number of words correct and also number of words correct at each syllable length; ii) total number and percentage of vowels and consonants correct; b) Error analysis- total number and percentage of syllable substitutions, omissions and additions. All the measures should be calculated at each of the syllable length and on overall word test items.

Item Score
Circle 1 if the child repeats the item correctly, with all phonemes of the target present in the correct order (allowing for only systematic/consistent substations due to phonological processes and dialectal influences). Circle 0 if the response is not a correct repetition. Circle NR if the child refuses to attempt a repetition. If the child scores 0, transcribe response in the space provided. If the child self-corrects, score the self-corrected response. For vowels and consonants correct and types of errors, calculate the number and then convert it into percentage.

No.	Target	Score			Transcription
1	man̪e	1	0	NR	
2	tʃappal̪i	1	0	NR	
3	t̪araka:ri	1	0	NR	
4	tʃamatʃagaḷu	1	0	NR	
5	tʃa:pe	1	0	NR	
6	kat̪t̪al̪e	1	0	NR	
7	garagasa	1	0	NR	
8	vima:n̪agaḷu	1	0	NR	
9	n̪i:l̪i	1	0	NR	
10	t̪abal̪a	1	0	NR	
11	man̪ejal̪l̪i	1	0	NR	
12	tʃirat̪egaḷu	1	0	NR	
13	d̪a:ra	1	0	NR	
14	kaḍime	1	0	NR	
15	d̪i:pagaḷu	1	0	NR	
16	n̪o:ḍut̪id̪d̪a:n̪e	1	0	NR	
17	ben̪n̪u	1	0	NR	
18	t̪akkaḍi	1	0	NR	
19	mal̪agid̪e	1	0	NR	
20	baḷapagaḷu	1	0	NR	
21	mi:n̪u	1	0	NR	
22	tʃapa:t̪i	1	0	NR	
23	ʃan̪iva:ra	1	0	NR	
24	ma:vin̪amara	1	0	NR	
25	waḍe	1	0	NR	
26	tʃakkul̪i	1	0	NR	
27	man̪egaḷu	1	0	NR	
28	kud̪uregaḷu	1	0	NR	
29	d̪i:pa	1	0	NR	
30	basava	1	0	NR	
31	bi:gagaḷu	1	0	NR	
32	t̪agijuvud̪u	1	0	NR	
33	ka:ge	1	0	NR	
34	gaṇe:ʃa	1	0	NR	
35	baḷegaḷu	1	0	NR	
36	kan̪n̪aḍigaḷu	1	0	NR	
37	ba:ji	1	0	NR	
38	beraḷu	1	0	NR	
39	maragaḷu	1	0	NR	
40	bad̪an̪eka:ji	1	0	NR	
Word total		**40**			

Score by item length				No. vowels correct				No. consonants correct			
2sy	3sy	4sy	5sy	2sy	3sy	4sy	5sy	2sy	3sy	4sy	5sy
/10	**/10**	**/10**	**/10**	**/20**	**/30**	**/40**	**/50**	**/21**	**/34**	**/41**	**/52**
%	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
			/40				**/140**				**/148**
			%				**%**				**%**

Appendix II

NONWORD SCORE SHEET

Practice Items	Number of presentations	Discontinue Rule	Accuracy & Error analysis
1. t̪eṭṭa 2. n̪al̪uvi 3. va:bha:n̪ura 4. l̪uṭṭiḷugame 5. ṭa:baḷuṇiga Correct responses are not required to proceed to the test items.	If the child does not respond to a practice item allow up to 2 further presentations.	None: attempt to administer all items.	Calculate a) Accuracy- i) total number of nonwords correct and also number of nonwords correct at each syllable length; ii) total number and percentage of vowels and consonants correct; b) Error analysis- total number and percentage of syllable substitutions, omissions and additions. All the measures should be calculated at each of the syllable length and on overall nonword test items.

Item Score

Circle 1 if the child repeats the item correctly, with all phonemes of the target present in the correct order (allowing for only systematic/consistent substations due to phonological processes and dialectal influences). Circle 0 if the response is not a correct repetition. Circle NR if the child refuses to attempt a repetition. If the child scores 0, transcribe response in the space provided. If the child self-corrects, score the self-corrected response. For vowels and consonants correct and types of errors, calculate the number and then convert it into percentage.

No.	Target	Score			Transcription
1	men̪a	1	0	NR	
2	l̪ippatʃa	1	0	NR	
3	raka:t̪ari	1	0	NR	
4	tʃagaḷumatʃa	1	0	NR	
5	tʃe:pa	1	0	NR	
6	l̪et̪t̪aka	1	0	NR	
7	garasaga	1	0	NR	
8	ma:ḷuvigan̪a	1	0	NR	
9	n̪o:l̪i	1	0	NR	
10	l̪abat̪a	1	0	NR	
11	jal̪l̪in̪ema	1	0	NR	
12	tʃiḷut̪eraga	1	0	NR	
13	d̪e:ra	1	0	NR	
14	ḍikame	1	0	NR	
15	pad̪i:gaḷu	1	0	NR	
16	n̪o:t̪in̪ed̪d̪aḍu	1	0	NR	
17	bun̪n̪e	1	0	NR	
18	ḍikkat̪a	1	0	NR	
19	gil̪ad̪ema	1	0	NR	
20	pabaḷugaḷa	1	0	NR	
21	mu:n̪i	1	0	NR	
22	t̪ipa:tʃa	1	0	NR	
23	n̪iva:ʃara	1	0	NR	
24	ma:ravin̪ama	1	0	NR	
25	weḍa	1	0	NR	
26	l̪ikkutʃa	1	0	NR	
27	maḷun̪ega	1	0	NR	
28	gareḷukud̪u	1	0	NR	
29	d̪a:pi	1	0	NR	
30	sabava	1	0	NR	
31	gabi:ḷuga	1	0	NR	
32	d̪ugijut̪avu	1	0	NR	
33	ke:ga	1	0	NR	
34	ʃaṇe:ga	1	0	NR	
35	gaḷebaḷu	1	0	NR	
36	ḍin̪n̪agakaḷu	1	0	NR	
37	bi:ja	1	0	NR	
38	beḷura	1	0	NR	
39	maḷugara	1	0	NR	
40	d̪abaka:n̪eji	1	0	NR	
Nonword total		**40**			
Word total		**40**			
Word + Nonword Score		**80**			

Score by item length				No. vowels correct				No. consonants correct			
2sy	3sy	4sy	5sy	2sy	3sy	4sy	5sy	2sy	3sy	4sy	5sy
/10	/10	/10	/10	/20	/30	/40	/50	/21	/34	/41	/52
%	%	%	%	%	%	%	%	%	%	%	%
			/40				/140				/148
			%				%				%

Appendix III

Percentile for the Word and Nonword Repetition Test

Percentile	Overall word accuracy scores	
	4-5years	5-6years
5	30.70	33.00
10	33.00	35.30
25	36.00	38.00
50	38.00	39.00
75	39.00	40.00
90	40.00	40.00
95	40.00	40.00
100	40.00	40.00

Note: Percentile '5' indicates that only 5% of the children are scoring less than 30.70 in 4-5years age group and less than 33.00 in 5-6years age group in the repetition of words.

Percentile	Overall nonword accuracy scores	
	4-5years	5-6years
5	21.05	29.00
10	24.70	30.00
25	30.00	33.00
50	34.00	35.00
75	36.00	37.75
90	37.30	39.00
95	38.00	39.00
100	40.00	40.00

Note: Percentile '5' indicates that only 5% of the children are scoring less than 21.05 in 4-5years age group and less than 29.00 in 5-6years age group in the repetition of nonwords.

Percentile	Overall word and nonword accuracy scores	
	4-5years	5-6years
5	56.70	61.95
10	59.70	67.00
25	65.75	71.00
50	71.50	74.00
75	75.00	76.75
90	76.30	78.00
95	77.00	79.00
100	80.00	80.00

Note: 5 Percentile indicates that only 5% of the children are scoring less than 56.70 in 4-5years and in 5-6years only 5% of the children are scoring less than 61.95 in the overall task of word and nonword repetition.

Interpretation of the Percentile Ranks

Percentile	Classification
90-100	Above average performance
50- 89	Average performance
5-49	Poor performance

Mean and standard deviation (SD) values for percentage of vowels correct and percentage of consonants correct in both words and nonwords at different syllable lengths for both the age groups

W/NW different syllable lengths	CA	Total	
		Mean	SD
WPVC2sy	4-5yrs	100.00	0.00
	5-6yrs	99.93	0.59
WPVC3sy	4-5yrs	99.65	1.56
	5-6yrs	99.91	0.55
WPVC4sy	4-5yrs	99.66	0.87
	5-6yrs	99.72	1.30
WPVC5sy	4-5yrs	98.33	3.84
	5-6yrs	99.58	1.11
WTPVC	4-5yrs	99.33	1.15
	5-6yrs	99.72	0.64
NWPVC2sy	4-5yrs	100.00	0.00
	5-6yrs	99.79	1.01
NWPVC3sy	4-5yrs	99.70	0.97
	5-6yrs	99.68	0.99
NWPVC4sy	4-5yrs	98.71	2.02
	5-6yrs	99.34	1.39
NWPVC5sy	4-5yrs	95.97	3.37
	5-6yrs	96.25	3.47
NWTPVC	4-5yrs	97.98	1.75
	5-6yrs	98.41	1.44
WPCC2sy	4-5yrs	100.00	0.00
	5-6yrs	99.93	0.59
WPCC3sy	4-5yrs	99.65	1.56
	5-6yrs	99.91	0.55
WPCC4sy	4-5yrs	99.66	0.87
	5-6yrs	99.72	1.30
WPCC5sy	4-5yrs	98.33	3.84
	5-6yrs	99.58	1.11
WTPCC	4-5yrs	99.33	1.15
	5-6yrs	99.72	0.64
NWPCC2sy	4-5yrs	100.00	0.00
	5-6yrs	99.79	1.01
NWPCC3sy	4-5yrs	99.70	0.97
	5-6yrs	99.68	0.99
NWPCC4sy	4-5yrs	98.71	2.02
	5-6yrs	99.34	1.39
NWPCC5sy	4-5yrs	95.97	3.37
	5-6yrs	96.25	3.47
NWTPCC	4-5yrs	97.98	1.75
	5-6yrs	98.41	1.44

[W - words; NW - nonwords; CA- Chronological age, PVC - percentage of vowels correct; TPVC - total percentage of vowels correct; PCC - percentage of consonants correct; TPC - total percentage of consonants correct; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length]

Mean median and standard deviation (SD) values for the errors at each syllable length in words and nonwords for both the age groups

W/NW different syllable lengths	Chronological age								
	4-5years			5-6years			Total		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
WPSS2sy	0.83	0.00	1.88	0.21	0.00	1.01	0.51	0.00	1.52
WPSS3sy	2.02	0.00	3.35	1.02	0.00	2.14	1.50	0.00	2.82
WPSS4sy	1.90	0.00	3.22	1.15	0.00	2.52	1.50	0.00	2.89
WPSS5sy	3.06	2.00	3.37	2.28	2.00	3.43	2.65	2.00	3.41
WTPSS	2.08	1.43	2.07	1.36	0.71	1.84	1.70	1.07	1.98
NWPSS2sy	2.65	0.00	4.90	0.83	0.00	2.22	1.70	0.00	3.84
NWPSS3sy	2.93	0.00	4.28	1.53	0.00	2.68	2.20	0.00	3.59
NWPSS4sy	5.46	2.50	5.22	2.50	2.50	3.36	3.91	2.50	4.58
NWPSS5sy	11.55	10.00	8.38	8.97	8.00	6.94	10.21	8.00	7.75
NWTPSS	6.73	5.00	5.18	4.37	3.57	3.20	5.50	4.29	4.41
WPSO2sy	0.00	0.00	0.00	0.14	0.00	1.18	0.07	0.00	0.85
WPSO3sy	0.10	0.00	0.58	0.00	0.00	0.00	0.05	0.00	0.40
WPSO4sy	0.11	0.00	0.53	0.17	0.00	1.21	0.15	0.00	0.94
WPSO5sy	0.64	0.00	1.50	0.36	0.00	1.44	0.49	0.00	1.47
WTPSO	0.28	0.00	0.64	0.12	0.00	0.44	0.20	0.00	0.55
NWPSO2sy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWPSO3sy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWPSO4sy	0.19	0.00	1.01	0.04	0.00	0.30	0.11	0.00	0.73
NWPSO5sy	0.85	0.00	1.53	0.58	0.00	1.14	0.71	0.00	1.34
NWTPSO	0.35	0.00	0.64	0.22	0.00	0.41	0.28	0.00	0.54
WPSA2sy	0.08	0.00	0.62	0.07	0.00	0.59	0.07	0.00	0.60
WPSA3sy	0.05	0.00	0.41	0.00	0.00	0.00	0.02	0.00	0.28
WPSA4sy	0.04	0.00	0.31	0.04	0.00	0.30	0.04	0.00	0.30
WPSA5sy	0.15	0.00	0.53	0.06	0.00	0.33	0.10	0.00	0.44
WTPSA	0.09	0.00	0.27	0.04	0.00	0.16	0.06	0.00	0.22
NWPSA2sy	0.00	0.00	0.00	0.42	0.00	1.63	0.22	0.00	1.19
NWPSA3sy	0.15	0.00	0.70	0.09	0.00	0.55	0.12	0.00	0.63
NWPSA4sy	0.30	0.00	0.82	0.14	0.00	0.58	0.22	0.00	0.71
NWPSA5sy	0.80	0.00	1.65	0.28	0.00	0.79	0.53	0.00	1.30
NWTPSA	0.36	0.00	0.58	0.21	0.00	0.39	0.28	0.00	0.49

[W-words; NW- nonwords; 2sy - 2-syllable length, 3sy - 3-syllable length; 4sy - 4-syllable length; 5sy - 5-syllable length; PSS - percentage of syllable substitutions; TPSS -Total percentage of syllable substitutions; PSO - percentage of syllable omissions; TPSO -Total percentage of syllable omissions; PSA - percentage of syllable additions; TPSA -Total percentage of syllable additions]