RAPID AUTOMATIZED NAMING AND READING IN 5-7 YEAR OLD MALAYALAM SPEAKING CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

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May, 2016

Certificate

This is to certify that this dissertation entitled **"Rapid automatized naming and reading in 5-7 year old Malayalam speaking children with Specific language impairment"** is a bonafide work in part fulfillment for the Degree of Master of Science (Speech-Language Pathology) of the student (Registration No.14SLP011). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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Declaration

This dissertation entitled **"Rapid automatized naming and reading in 5-7 year old Malayalam speaking children with Specific language impairment"** is the result of my own study under the guidance of Dr. Jayashree. C. Shanbal, Reader in Language Pathology, Department of Speech-Language Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in any other University for the award of any Diploma or Degree.

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CHAPTER 1: Introduction

Skills related to literacy emerge before formal training in a child's life. These emergent literacy skills have been differentiated into two by researchers: those that are basics for decoding (i.e., code related skill, decoding precursors, inside - out skills) and that are foundational for comprehension (i.e., meaning related skills, comprehension precursor, outside - in skill) (Scarborough, Hollis, Neuman & Dickinson, 2009).

Gough and Tunmer (1986) defined reading as the product of two interrelated but relatively independent skills: decoding and linguistic comprehension. Children are provided a distinguished platform for written language in support with neural connections that back the acquisition of oral language. Integration of a large amount of neural circuits in achieving accuracy and speed of reading are required to be a successful reader. Thus, reading is considered as a complex cognitive process that includes phonological awareness, phonological decoding, rapid automatized naming, spelling, orthographic knowledge and reading comprehension (Gayan & Olsen, 2003). The biggest challenge the children encounter is to match the speech phonemes with graphemes, thus reading development relies on definite awareness of the sounds of language (Liberman & Shankweiler, 1985).

A model for reading was designed which was one of the first attempt to emphasize on fluency (Samuel, 1979). It suggests that successful reading depends on not only accuracy but effort. Perfetti (1986) in his verbal efficiency theory of reading, indicated that reading comprehension was associated with accuracy as well as speed of single word identification. In terms of processing, speed of processing has gained attention to reading skill as an early predictor in children. In order to measure continuous serial naming speed, Denckla and Rudel (1974) introduced rapid automatized naming. Serial rapid naming is reported to simulate reading circuit that would be developed later. A study done by Ranjini and Rajasudhakar (2011) documented a developmental trend in RAN such that there was a significant difference in the mean time value taken across 6-8 years of typically developing Kannada speaking children. The participants in the younger age group took more time to complete the task as compared to older age groups whereas accuracy was stabilized in all the children.

Literature suggests that young child's later ability to connect and automatize whole sequences of letters and words with their linguistic information, regardless of writing system is predicted by a universal process known as RAN. Wagner et al., (1997) subsequently determined RAN as a significant predictor of growth in early (i.e., Kindergarten to Second Grade; First to Third Grade) as compared to later (i.e., Second to Fourth Grade) word reading skills. Children were found to be slower for an object RAN task who were identified as having dyslexia at the end of second year (at 3.5 years), reported in a longtitudinal study conducted at Finland (Torppa, Lyytinen, Erskine, Eklund & Lyytinen, 2010). In addition, RAN appears to differentiate between English children with and without a history of dyslexia (Raschle, Chang & Gaab, 2011).

As compared to typically developing, children with SLI acquire their first words later and slowly. There would be lexical deficits exhibited by these children for the words they acquired during developmental period. Naming picture task would be executed slowly and less accurately by children with SLI. Line drawings and familiar objects were named slowly by children with SLI as demonstrated in a study by Anderson (2001).

These naming deficits can be associated to a slower speed of processing. Also in a task like RAN, children with SLI find it difficult to disinhibit the preceding stimuli, perceive and get access to the lexicon for the following stimuli. Findings repeatedly indicate that the overall deficit in children with SLI are due to slow processing in linguistic as well as non linguistic aspects.

There have been supporting and opposing views regarding children with SLI who could show later reading problems. Study revealed that 50 % to 70% of young children with language impairment have concurrent reading disabilities (Aram, 1991). Research findings in yet another study on reading acquisition in Malayalam of 16 children with SLI suggest a significant lag in reading ability in the SLI population when compared to typically developing children (Swapna, 2003).

In children with dyslexia, it was often seen that the reading comprehension and accuracy which are two important aspects of reading skill were disassociated. Children with dyslexia were reported to have poor decoding or accuracy skills than comprehension skills (Bishop& Snowling, 2004). Poor reading comprehenders were reported to show average reading accuracy in the context of poor text comprehension (Cain, Oakhill & Bryant, 2004). These different reading outcomes may also show different rates of impairment in children with SLI. Thus, it was argued that different facets of reading are related with different predictive factors. Catts (1993) observed that phonological awareness and rapid naming predicted printed word recognition, whereas spoken language comprehension and production best predicted reading. Snowling (2000) found that 15–16 year old children whose language problems had resolved by 5.5 years did not differ from controls on tests of vocabulary and language comprehension but performed significantly less well on tests of phonological processing and literacy skill. It is likely that these children continue to have subtle language deficits and these become more apparent later in development in that they influence the ability of adolescents with a history of SLI to perform age appropriately in tasks involving reading (both decoding and comprehension).

Studies have indicated that phonological awareness (PA), letter name knowledge and RAN are considered as the best predictors of future reading difficulty. A study on normally developing children at four stages throughout kinder garden, followed till second grade on comprehension of untimed passage revealed that RAN was more highly correlated than PA to timed measures of single word and non word reading (Schatschneider, Fletcher, Francis, Carlson & Foorman, 2004). Timed reading measures are more influenced by RAN. It taps the sequential neural connections involved in naming and object identification. RAN task can be regarded as a part of processing speed. Children with slightly slow global processing are found to have slower RAN (Powell, Stainthorp, Stuart, Garwood & Quinlan, 2007). Alphanumeric RAN is strongly related to reading skill than non alpha numeric RAN. Study done by Georgia, Papadopoulos, Fella and Parilla (2012) indicated that even after the effects of orthographic processing speed and phonological awareness were controlled, RAN digits predicted the reading fluency. The interim pauses and the articulation time while naming the stimuli are speculated to mirror the inability of the subject to integrate the information presented visually with the stored representation and eventually slower to reach to the phonological codes from visual recognition unit. Word reading fluency is shown to be granted by RAN than text fluency. Studies revealed that there are several processes (e.g. semantic and syntactic) tied to text fleuncy reading when compared to word fluency which requires speeded word recognition.

Over the years, studies support that children with SLI, in later years of their life face learning difficulties or SLI seems to form a continuum to becoming learning disability (Snowling, Bishop & Stothard, 2000) once children enter into schooling. They are deviant in language skills as well as in their literacy skills. Large amount of research show that children with SLI have poor literacy skills. Fraser and Conti-Ramsden (2008) reported that speech and language skills are essential for acquiring reading and spelling abilities. They also stated that children with language impairment are more prone to have later literacy difficulties when compared to children having speech difficulty only. These children might have increased risk for having learning disability. A strong oral language is considered crucial for later development of language based literacy skills.

Need for the study

Rapid serial naming would reflect the ability of the child to integrate the lexical access of a stimuli and its verbal production simultaneously. This mirrors the similar process of reading which associates orthographic and phonological codes. So rapid naming is said to be one of the best predictor of reading failure in early childhood. Comparing the performance of RAN task and reading of words in early childhood might give an insight into the learning difficulties that a child with SLI is likely to encounter in school years.

Children with SLI are found to be slow in speed of processing at any task which requires lexical access. Thus RAN task, particularly the interim pause, articulation time and time taken to activate lexical access would reflect the processing time. A study done by Ranjini and Rajasudhakar (2011) documented a developmental trend such that there was a significant difference in the mean time value taken across 6-8 years of typically developing Kannada speaking children. The participants in the younger age group took more time to complete the task as compared to older age groups whereas accuracy was stabilized in all the children. Children at the beginning stage of reading connect the orthographic patterns to the phonological representation in their mental lexicon. Later these mappings are endowed by semantic attribute i.e., through word meanings. Thus regular words are read through grapheme-phoneme route and irregular word through semantic pathway. In children with SLI, the impaired phonological representation (Bishop & Snowling, 2004) and lexical semantic deficit (Lahey & Edwards, 1996) place them at risk for reading difficulties. The underlying cause for reading difficulties in these children could be the deficit in phonological awareness (PA), Rapid automatized naming (RAN) and combination of both the deficits, according to Double deficit hypothesis (Wolf & Bowers, 2000). Thus, reading difficulties arise in children with SLI as phonological awareness predicts and has a stronger relation with reading and spelling accuracy and RAN is a contributor of reading fluency and rate (Furnes & Samuelsson, 2011). Further, relation between RAN and reading could be drawn to suggest for any or some form of reading problems in children with SLI. If risk for reading difficulties can be determined very early, the chances to improve reading skills are greater. Studies done in various other languages on children with dyslexia suggest that relationship between RAN and reading is detrimental to the languages under study. For e.g., a study (Ibrahim, 2015) in Arabic, revealed a significant relation between RAN and reading in young children. Similarly a study done by Shanbal (2011) revealed a significant relation between RAN and reading in younger children. In yet other studies done in English revealed that RAN was an excellent tool for detecting risk for learning disabilities in general but was not especially effective in discriminating learning impaired children with and without reading difficulties from each other (Waber, Wolff, Forbes & Weiler, 2000).

When compared to English, Malayalam as a language is orthographically more regular and shallow. Studies have widely reported differences between languages with deep versus shallow orthographies to contribute to the phenotype of reading difficulties (De Jong & Van der Leij, 2003; Nopola-Hemmi, Myllyluoma, Voutilainen, Leinonen, Kere & Ahonen, 2002; Wimmer, 1993) and to the connection between RAN and reading disabilities (Korhonen, 1995; Van den Bos, 1998; Wimmer, 1993; Wimmer, Mayringer & Landerl, 1998; Wolf, Pfeil, Lotz & Biddle, 1994).

The sub-processes that are suggested to be common to both RAN and reading are visual pattern recognition and visual discrimination (Araújo, Inácio, Francisco, Faísca, Petersson & Reis, 2011), sound-symbol associations (Manis, Seidenberg & Doi, 1999), serial processing (Bowers, 1995), precise timing mechanisms (Bowers & Wolf, 1993) and oral output of the names (Georgiou, Parrila, Cui & Papadopoulos, 2013). These subprocesses which are observed to be impaired in children with SLI could have lead to stronger correlation between reading accuracy and RAN (Kail, 1994; Schul, Stiles, Wulfeck & Townsend, 2004; Hulme & Snowling, 2009). Considering the above notions on relationship between RAN and reading, the present study attempted to study the relation between rapid naming and its relation to reading in Malayalam speaking children with Specific Language Impairment (SLI).

Aim of the study

The aim of the present study is to investigate the relation between Rapid automatized naming (RAN) and reading in Malayalam speaking children with SLI.

Objectives of the study

The objectives of the study are

- To compare the performance of children with SLI and typically developing children on RAN.
- To compare the performance of children with SLI and typically developing children on reading.
- To study the relationship between RAN and reading in children with SLI.
- To observe the developmental trend in RAN across age group in children with SLI and typically developing children.

Hypotheses

- There is no significant difference in the performance of children with SLI and typically developing children on RAN.
- There is no significant difference in the performance of children with SLI and typically developing children on reading.
- There is no significant relationship between RAN and reading in children with SLI.

CHAPTER 2: Review of literature

Language is a unique feature in human beings. The human brains are wired in such a manner to acquire linguistic skills in a particular pattern which paved the way for other basic literacy related process in later life. Thus acquisition of language in early childhood is an important milestone. Children acquire the language effortlessly, paying less attention to the rules that govern structure and use. However for few children, the language is not acquired easily and those who has difficulty in learning language is referred to as having language delay, language disorder and language impairment. A deviant language can or cannot be associated with comorbid problems. When language impairment is not associated with any sensory, neural or motor development issues, then it is primarily termed as Specific language impairment (SLI). Leonard (1998) define SLI as a condition where a significant language learning difficulty is exhibited in the absence of cognitive, hearing, oral-motor, emotional or environmental deficits.

2.1 Diagnostic Criteria for SLI

The differential diagnosis of SLI from other language disorder is essential. Diagnosis becomes problematic due to coexistence with various other symptoms. Exclusionary criteria are considered rather than inclusionary criteria for diagnosis. Table 2.1 shows the criteria given by Leonard (1998) for the areas to be checked for children with SLI.

Table 2.1

Criteria for SLI

Factor	Criterion
Language ability	Language test scores of -1.25 standard deviations or lower at risk for social devalue
Nonverbal IQ	Performance of IQ of 85 or higher
Hearing	Pass screening at conventional levels
Otitis media with effusion	No recent episodes
Neurological dysfunction	No evidence of seizure disorders, cerebral palsy, brain lesions; not under medication for control of seizures
Oral structure	No structural anomalies
Oral motor function	Pass screening using developmentally appropriate items
Physical and social interactions	No symptoms of impaired reciprocal social interaction or restriction of activities

International Classification of Diseases-10 (ICD-10) defined SLI as when a child's language skills fall more than 2 SD below the mean and are at least 1 SD below non-verbal skills. The Diagnostic and Statistical Manual of Mental Disorders-IV-TR (DSM-IV-TR) considers the identical criteria and subgroups specific language impairment into expressive language disorder and expressive-receptive language disorder. The definition states that the language impairment is associated with functional impairment and there is a large difference or gap between language and nonverbal skills. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) omitted the term SLI following suggestions by the American Speech and Hearing Association (ASHA). ASHA proposed the term late language emergence (LLE). LLE is characterized by delay in language onset with no other associated disabilities or developmental delays in other domains such as cognitive and motor and diagnosed, when language development trajectories are below age expectations.

Bishop (1994) reported in a twin study that one of the identical twins diagnosed as SLI with large verbal- nonverbal discrepancy met the criteria whereas the other failed to meet even though both had similar and poor language abilities. He reported that some children don't meet the discrepancy between verbal and non verbal ability and still have linguistic characteristics of SLI. So discrepancy definition is indicated to be over-restrictive by Bishop (1997). Further, it was noticed by Rescorla (2002) that a child on clinical evaluation may reveal clear language impairment, but may perform adequate to the age level on tests. The relationship between language development, non verbal intellectual development is crucial in diagnosing SLI and has raised lot of confusions. However, the exclusionary criteria are being followed worldwide.

The prevalence rates of SLI are being estimated depending upon the criteria followed for diagnosing. Helminen and Vilkman (1989) estimated the prevalence rate of SLI within the range of 0.5% to 3% in Finnish children. McArthur, Hogben, Edwards, Heath and Mengler (2000) questioned the possibility of greater prevalence rate of SLI based on the undetermined relation between SLI and dyslexia. Prevalence estimation of 3% to 10% was reported by Hartley, Hill and Moore (2003).

Researchers suggested that heterogeneity in different children with SLI account for different patterns and it can be further divided into subtypes according to the language component that is impaired (Conti-Ramsden & Botting, 1999; Bishop, 2006).The most predominant subtypes of SLI existing is the one given by Rapin and Allen (1987). Linguistic analyses of phonological, lexical, morphosyntactic or pragmatic abilities gave three sub-types of developmental disorders and six profiles of language problems. They were mixed receptive-expressive disorders (involves 'verbal auditory agnosia' and 'phonologic-syntactic deficit disorder'), expressive disorders (involves 'verbal dyspraxia' and 'speech programming deficit disorder'), and higher-order processing disorders (involves 'lexical deficit disorder' and 'semantic-pragmatic disorder').

Comorbidity of other developmental areas in children with SLI has been reported (Cantwell & Baker, 1977; Stevenson & Richman, 1978; Clegg, Hollis, Mahwood & Rutter, 2005). Stevenson and Richman (1978) found significant behavioural problems in 59 % of children with expressive language delays. The prevalence of Attention deficit disorder (ADD) in children with SLI was reported to range from 20 % to 50 % (Riccio & Hynd, 1995).

2.2 Linguistic and non linguistic profiles in SLI

Primary indicator that differentiates children with SLI and typically developing children are delayed onset of first words (Bishop, 1997). Also they differ on the vocabulary size and the number of words spoken in spontaneous speech (Watkins, Kelly, Harbers & Hollis, 1995). They also exhibit limited depth of knowledge in terms of the amount of information that they give when defining words and by the number of semantically related answers in word association tasks. The reduced vocabulary size will result in less semantic and phonological representation which in turn leads to compromised lexical processing.

Continuing with impaired lexical processing, several authors support the fact that naming pictures are both slower and less accurate in children with SLI (Lahey & Edwards, 1996; Leonard, Nippold, Kail & Hale, 1983; Snowling, van Wagtendonk & Stafford, 1988; Wiig, Semel & Nystrom, 1982). The slower and inaccurate responses are presumed to be due to impairment in linguistic processing (Denckla & Rudel, 1976; Kail & Leonard, 1986) and non linguistic processing (Kail, 1994) deficits. Studies supporting this notion are as follows: Sheng and McGregor (2010) provided evidence in children with SLI for inefficient or impaired organization of the lexical-semantic system, which is especially noted in children who have a deficit in expressive vocabulary and a gap between receptive and expressive vocabulary. Frequent naming errors observed in a study of 16 children with SLI (mean age of 6.2 years), were attributed to the sparse semantic representations and limited semantic knowledge present in the mental lexicon of these children (McGregor, Newman, Reilly & Capone, 2002).

A study on children with SLI conducted by Lahey and Edwards (1999) observed more semantic related errors (e.g. “foot” for “shoe”) when compared to typical peers. It was observed that children with word-finding deficits exhibit more semantic errors.

These studies indicate a lexical semantic deficit and conclude that a missing or sparse lexical-semantic representation is present in children with SLI.

Poorer phonological representations are also noted in children with SLI aged 4 to 10 years due to poorer performance on non word repetition task. The reasons attributed to poorer performance are differences in auditory discrimination, forming and storing phonological representations in working memory or motor planning and execution (Edwards & Lahey, 1998). Evidence of poor phonological representations in children with SLI which increased their risk of literacy difficulties were reported in 63 children studied on measures of phonological representations - the Quality of Phonological Representations (QPR) and the Silent Deletion of Phonemes (SDOP) and a measure of phonological awareness - the Sutherland Phonological Awareness Test: Revised (Claessen & Leitao, 2012). Deficits which are prominent at syllable level than phoneme level was found in French speaking children with SLI as compared to their mean length of utterance matched typically developing children (Maillart & Parisse, 2006).

Perceptual deficits studies in children with SLI report poor performance on tasks that require discriminating consonant voicing, place of articulation and failure of categorical perception. Perceptual deficits involves impaired capacity to process rapid, sequential fast fading auditory signal such as spoken language and interfere in learning language. Extensive research on auditory processing deficits paved the way for the formulation of rapid temporal processing hypothesis given by Tallal and Piercy (1973). Studies also suggest that in spite of perceptual speech deficit, there are visual and tactile modalities that are affected, reported in 7-15 years old children with SLI aimed to investigate speed and efficiency of visuospatial attentional orienting, the speed of visual processing and motor response. The authors concluded saying that children with SLI exhibit slower visual processing, slower motor response and attentional orienting speed, compared to the control group (Schul, Stiles, Wulfeck & Townsend, 2004).

Kail (1994) gave Generalized Slowing Hypothesis which states that restricted and slower processing of linguistic and non-linguistic information is caused by limitations of processing capacity. This concurrent non-linguistic and linguistics deficit are reported to exhibit in children with SLI. This is being proved in several studies which require linguistic and non linguistic processing. One of them is slower reaction time measures. Miller, Kail, Leonard and Tomblin (2001) differentiate SLI from normal in terms of slower reaction times (RT) from those of TDC to the similar degree across tasks that demand the same number of processes.

Ullman and Pierpont (2005) proposed Procedural Deficit Hypothesis (PDH), explaining any abnormalities of brain structure will lead to underlying impaired procedural memory. Evidences indicate that poor word learning by children with SLI have a direct relation to impairment of phonological working memory (Oetting, Rice & Swank, 1995; Rice, Cleave & Oetting, 2000). Another underlying deficit is explained with inefficient inhibition hypothesis proposed by Bjorklund and Harnisfeger (1990); Wilson and Kipp (1998). This hypothesis lends evidence to the perseveratory errors noted in children with SLI in naming task. Inhibition of the previous response and accessing the succeeding competent target is speculated to cause perseveratory errors in children with SLI.

The difficulty in accessing, retrieving and combining varied types of information at the interfaces and to associate linguistic bases to other cognitive systems in children with SLI are described with Computational Complexity Hypothesis (CCH) developed by Jakubowicz (2003). Thus, all the underlying deficits in children with SLI are assumed to impose difficulty on linguistic and non linguistic processing.

The presence of language difficulties and problems in early literacy skills has been extensively researched and have been documented that children with language impairments are at risk to develop poor reading and writing ability (Wilson & Risucci, 1988). The problem often prevails from school years into adulthood (Stothard, Snowling, Bishop, Chipchase & Kaplan, 1998). These studies supports into one of the prevailing view that exists now, SLI is a continuum of specific reading disabilities. Recent findings report that there may be a stronger association between these developmental language disorders and dyslexia. Early deficits in semantics and syntax are reported in dyslexia (Scarborough, 1990; Snowling, Gallagher & Firth, 2003). Phonological processing deficits and word recognition problems are obvious in children with SLI (Catts, 1993). Several studies conclude that dyslexia and SLI resemble variants of the same developmental language disorder (Tallal, Allard, Millard & Curtiss, 1997). Few authors report to view SLI and dyslexia as two overlapping disorders (Bishop & Snowling, 2004) Tallal *et al.,* 1997 suggest that low achievement in word recognition at the age of 8 years was noted in 67% of children with SLI diagnosed at 4 years. Also, specific reading disability was exhibited by 50 % of school-age children with SLI (McArthur, Hogben, Edwards, Heath & Mengler, 2000).

The linguistic knowledge bases that emerge before early reading acquisition serve as developmental predictors to fluent and accurate reading. The basic foundation of reading, especially phonological processing abilities is built upon the existing language skills (Goswami & Bryant, 1990). Hence, oral language is found to be correlated with print concepts and phonological awareness in preschool years when reading accuracy and reading comprehension skills were monitored from first through fourth grades (Storch & Whitehurst, 2002). Studies have reported that reading acquisition period can be divided into 5 stages, wherein the stage 2 (5-7 years) deals with phoneme- grapheme correspondence rule and initial decoding of letters. It is also reported that at the end of the stage 2 i.e., at 7 years of age children relates letters and phonemes well which are the fundamental skills required in an early reader (Chall, 1983). In light of these relationships and the linguistic basis of many of these early developing literacy skills, the predictive factors of early literacy skills in typically developing children were investigated by several authors. Few predictors reported are phonological processing (Bradley & Bryant, 1985), print knowledge, letter recognition (Leppänen, Aunola, Niemi & Nurmi, 2008), phonological awareness (Boudreau & Hedberg, 1999), vocabulary (Nation & Snowling, 1998), syntactic knowledge (Guo, Roehrig & Williams, 2011) and verbal memory (Scarborough, 1991).

The predictors of early literacy are reported to vary across age. The study done by Ellis and Large (1988) found the best predictors to be phonological awareness and visual pattern recognition skills from 5-6 years and phonological awareness and auditory verbal tasks from 6-7 years of age. Also studies report that each early predictor accounted for different skills in the school years. One study explaining this view is done by Manis, Seidenberg and Doi (1999). They suggested phoneme awareness and rapid naming contributed separately in the second grade reading scores. But rapid naming correlated with orthographic skills and phoneme awareness to non word reading and reading comprehension.

Tiwari, Krishnan, Chengappa and Rajashekhar (2011) explored reading acquisition in Malayalam – English biliterates from 1st to 7th grade who were acquiring two different writing systems: alpha syllabic and alphabetic at a similar time. Two reading tasks, words and non word tasks were administered in both languages. Recognition and recall of letters were assessed in orthographic knowledge tasks whereas rhyme recognition, phoneme deletion, phoneme oddity and syllable deletion were assessed using phonological awareness tasks. Results indicated a progressive development of phonological knowledge in Malayalam when compared to English. Also the performance of phonological awareness tasks varied across language.

The close assosciation of RAN and reading draw attention to its ability to predict literacy skills and are supported by several studies that focus on the processes that are common to both.

2.3 Rapid Automatized Naming (RAN) and reading in children

Relation between RAN and reading is established through the evidence of RAN deficits in 7 to 10 year old children in the absence of phonological awareness deficits. (Powell, Stainthorp, Stuart, Garwood & Quinlan, 2007). Children with language impairment on measures of metalinguistic abilities such as letter-name knowledge, and rhyming tasks performed poorly than peers (Boudreau & Hedberg, 1999). Therefore it was hypothesized before that phonological awareness which is impaired in children with SLI develops dyslexia due to strong connection between phonological abilities, reading and spelling (Snowling, 2000). But in a longitudinal study by Vandewalle, Boets, Ghesquière and Zink (2012) reported poor phonological awareness till 8 years of age and when combined with poor rapid naming abilities, children with SLI were at risk for dyslexia. It was reported that phonological abilities does not predict early literacy skills across all types of orthography (Savage & Fredericks, 2005).

So the recent research as an alternative to phonological deficit alone focused on naming speed abilities as a predictor of reading. This view gained popularity after Double deficit hypothesis (DDH) was proposed by Wolf and Bowers (2000). It states that reading disability can be divided into three groups: deficit in phonological awareness (PA), Rapid automatized naming (RAN) and combination of both the deficits. Numerous studies have revealed that many individuals with RD typically demonstrate impaired RAN skills (Bowers, 1995) with the support of DDH. Later, an additional hypothesis was put forth stating that PA predicts and has a stronger relation with reading and spelling accuracy and RAN is a contributor of reading fluency and rate (Furnes & Samuelsson, 2011). Literature supports that RAN is a predictor in younger children's ability to automatize and connects symbols to letters (Tan, Spinks, Eden, Perfetti & Siok, 2005). Aarnoutse, van Leeuwe and Verhoeven (2005) suggested PA to be an early predictor of reading skill only in first school grades across transparent orthographies (Wimmer, Mayringer & Landerl, 2000) whereas RAN is an robust predictor for reading particularly rate and fluency, after early grades than PA (Norton & Wolf, 2012).

RAN was argued extensively to be included as under phonological awareness as it is dependent on the retrieval of phonological codes. Later studies which refuted the view of considering RAN as a part of PA came. The reasons given by the researchers are RAN and phonological processing are not strongly correlated (Swanson, Trainin, Necoechea & Hammill, 2003) because RAN and PA account for independent variance in reading ability (Cutting & Denckla, 2001). Also, genetic and neuro imaging studies found separate biological bases for RAN and PA abilities.

RAN is also known as rapid serial naming, serial visual naming, continuous rapid naming and rapid naming. It involves faster naming the series of stimulus presented randomly, but repeatedly in left to- right serial fashion. It includes tasks to name colours, digits, numbers and objects. An alternate and a complex form of RAN involve RAS (Rapid alternating stimuli) which usually involves naming of digits-letters and colours-digits-letters. Accuracy and speed are the measures assessed in RAN. Wolf and Bowers (1999) states that RAN is a highly speed sensitive tasks and includes cognitive and linguistic components such as recognizing the item to be named, finding the name in memory, planning its articulation. RAN assesses the extent to which a person can automatically link symbols to meaning.

Wolf, Bowers and Biddle (2000) adopted a Model of visual naming (Wolf & Bowers, 1999) to describe the multiple processes that are presumed to be involved in RAN. As depicted in Figure 2.1, a demanding series of attentional, perceptual, conceptual, memory, lexical and articulatory processes is involved in the process of visual naming. The first stage is paying attention which in turn activates the bi-hemispheric visual processing at multiple levels. Chase (1996) reports visual processing to occur within 60-80 milliseconds. It further leads to the identification or recognition processes, which occurred with the integration of known mental representation and the present stimulus. Faster the integration occurs, the speed of processing will be higher. Additional inputs influencing naming are affective factors and input from sensory modalities. Semantic processing, phonological access giving phonological representation and retrieval processes are integrated and motor commands to translate the phonological forms into articulated name. These processes occur in visual naming and it takes around 500 milliseconds to complete naming (Wingfield, 1968). In rapid naming an additional processing speed requirements (PSRs) accompany each of the components in naming. The extent of speed demands, complexity of the stimulus and rapid rate differentiates RAN from PA.

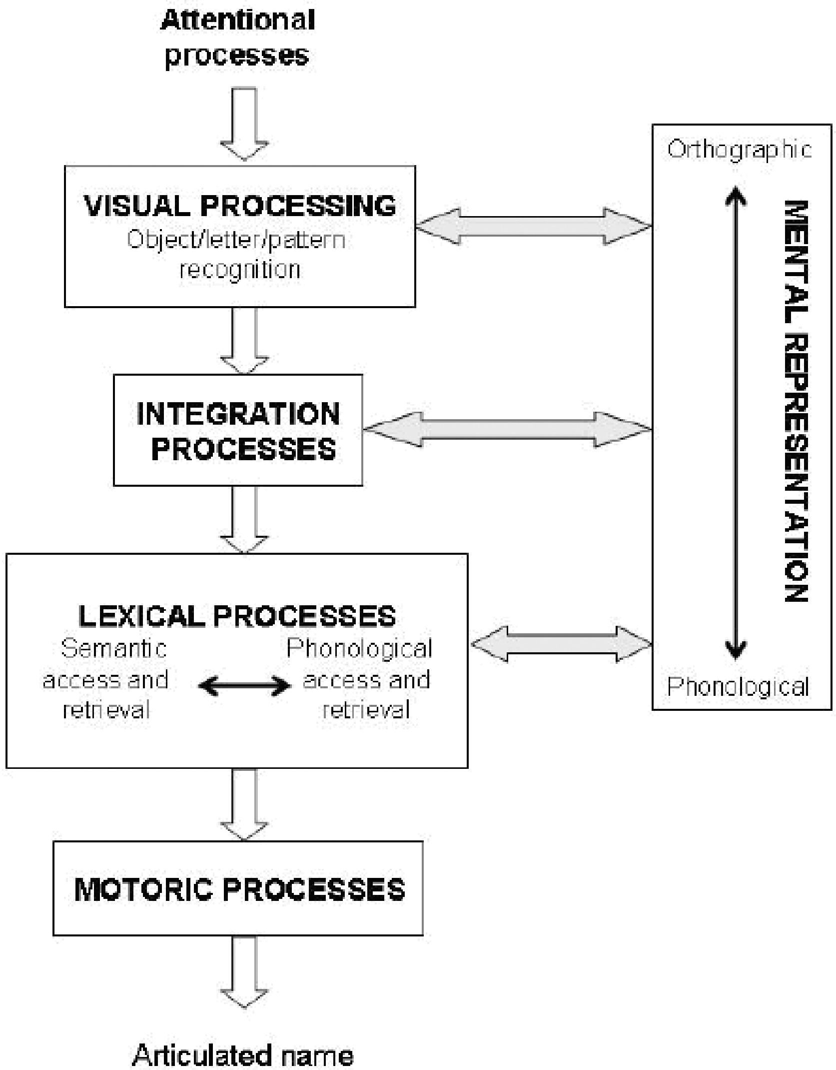

Figure 2.1: Model of visual naming

(*Source*: Adapted from "Naming-speed processes, timing, and reading: A conceptual review" Wolf, M., Bowers, P. G and Biddle, K. 2000, Journal of learning disabilities, *33*(4), 387-407)

Various researchers reported that the RAN performance improved as a function of age (Albuquerque & Simoes, 2010; Denckla & Rudel, 1974; Wolf & Denckla, 2005).

Albuquerque and Simoes (2010) reported a developmental trend on RAN digits and RAS colours-shapes in 7-15 years old typically developing Portugese children. The developmental trend across age was reported by Denckla and Rudel (1974) from 5 to 11 years of age on naming objects, colors, letters, and numbers. RAN is suggested to get faster as age increases due to the increase in global processing speed mechanism caused by age-related growth and development (Kail & Hall, 1994). Hence, evidence suggest that performance on RAN improves with age. Similar line of study was done in Indian context by Ranjini and Rajsudhakar (2011) on 6-8 years Kannada speaking typically developing children. Results revealed that older children named all the tasks with greater speed compared to younger children, but accuracy measures were found to be similar between age groups. Performance on RAN subtasks noted that participants took lesser time to read digits and alphabets (single category) and longer time to name colours-digits- letters (alternate category). Another study of RAN performance in children with dyslexia from Grade I to V observed a developmental trend (Kuppuraj, 2009). Studies have been conducted in Indian scenario to understand the development of RAN in simultaneous Kannada-English biliterate children from grade level to ten which indicates naming speed increased as a function of age and grade in both English and Kannada (Siddaiah, Saldanha, Venkatesh, Ramachandra & Padakannaya, 2013)

Different RAN tasks differ in their cognitive requirement and obtain different results. According to Cronin and Carver (1998) and Meyer, Wood, Hart and Felton (1998) alphanumeric stimuli are named rapidly than non alphanumeric stimuli. The reasons attributed are, due to semantic priming (Reynvoet, Brysbaert & Fias, 2002) and semantic uncertainty i.e., naming of colours and objects are not clear as in case of digits and letters (Johnson, Paivio & Clark, 1996) and increased practice and exposure (Klein, 2002). Studies indicated that naming becomes automatic as children rehearse more familiar letter names and digits (Bowers, 1995; Spring & Davis, 1988). Also it was reported that RAN colours and objects are semantic groups of stimulus with fuzzy semantic boundaries (Tannock, Martinussen & Frijters, 2000). A few studies have indicated that speeded naming of alphanumeric stimuli (digits and letters) are achieved by the age of 16 but the speed of naming non alphanumeric stimuli (colors and objects) continues to improve into mature adulthood (Van den Bos, Ziljlstra & Spelberg, 2002). Chakravarthi (2012) found that colour discrimination was difficult in Kannada speaking children with SLI from grade three to four compared to TDC. Several researchers reported that in school aged children, alphanumeric stimuli are strongly associated to decoding than non-alphanumeric stimuli (Georgiou & Parrila, 2013) and non-alphanumeric stimuli to general processing speed (Catts, Gillispie, Leonard, Kail & Miller, 2002), reading comprehension (Wolf, Bally & Morris, 1986) or attention and executive functions (Stringer, Toplak & Stanovich, 2004).

Rapid alternating stimuli (RAS) part of RAN is considered as multi componential in nature because alternating stimuli within a naming task requires more attention, executive functions, memory access, cognitive flexibility, and semantic processing (Albuquerque & Simoes, 2010). Wolf (1986) conducted 3 year longitudinal research using rapid alternating stimulus (RAS) letters-numbers and letters-numbers-colours differentiated poor and average readers. The integration of lower level skills as well as higher skills such as attending to the broader context and to the patterns in order to facilitate processing required in RAS made the task difficult in kindergarten. Hence, RAS are thought to be high predictors of later reading, particularly at the single-word reading level.

Few researchers studied the performance of RAN on language impaired (LI) individuals. RAN differentiated LI from controls and correlation between reading and language increases with age (Katz, Curtis & Tallal, 1992). Obregon (1994) reported that children with dyslexia performed poorer than typically developing children on RAN - letters, colours and objects. There are few studies of continuous, rapid-naming abilities in children and adolescents with primary language disorders. Wiig, Semel and Nystrom (1982) reported that children with primary language disorders were found to have rapid naming deficits on RAN- colours and shapes when compared with normal language development. Like typically developing children, a similar developmental trend was observed in children with language impairment across age on RAN tasks. Wiig, Zureich and Chan (2000) compared single dimension naming: colour and shape naming and two dimension naming: colour-shape naming in children with primary language impairment (LI) and typically developing age matched peers with ages 6, 7, 9, 11, 12, 15-16 years. Results revealed that accuracy measures did not differ across age in LI and controls as well as between the groups. Naming speed was found to differ between normative and children with LI for colour naming at age 12 and shape naming at ages 6, 9, and 12. Time taken to name colours decreased as age increases in normative and children with LI.

Coady (2013) compared children with SLI with age matched (AM) and vocabulary matched (VM) peers on picture naming (whose labels differed with word frequency and phonotactic patterns). Accuracy measures were reported to show no difference between children with SLI and AM, VM peers. But reaction time differed and was greater for children with SLI and robust for AM and VM children. Hence, Children with SLI are more susceptible to interference from words with frequent phonotactic pattern and from dense phonological neighbourhoods.

2.4 RAN and reading in children with SLI

The rapid serial naming task mirrors the process of reading. Due to the multi componential structure of RAN resembles reading circuitry which later contributes to overall reading fluency and comprehension of text. Both RAN and reading shares few sub components and they are as follows. First, RAN-reading relation emerge from visual processes like visual pattern recognition and visual discrimination (Araújo, Inácio, Francisco, Faísca, Petersson & Reis, 2011). Second, sound symbol association involved in both reading and RAN are similar (Manis, Doi & Bhadha, 2000). Third, both skills require serial processing (Bowers, 1995). Fourth, impairment in precise timing mechanisms is involved in naming deficits and reading disabilities (Bowers & Wolf, 1993). Finally, the relation between RAN and reading has been explained through oral output of the names of the stimuli (Georgiou, Parrila, Cui & Papadopoulos, 2013).

Jones, Branigan and Kelly (2009) determined the components of RAN that differentiates children with dyslexia and without dyslexia and suggested that faster naming of sequential items in a matrix format, inhibition of preceding stimuli and faster processing of succeeding items simulate the process of reading. Another explanation of closer association between RAN and reading is due to the fact that RAN-reading association is mediated via orthographic processing (Bowers, Golden, Kennedy & Young, 1994). Hence, faster retrieval of the names of visual stimuli is examined in RAN which is an important aspect of the processes involved in later reading acquisition (Hulme & Snowling, 2009). An extensive research was done to approve RAN as one of the best predictor of reading fluency. RAN is thought of as a universal process and a predictor in later school years where the younger children with the help of linguistic information, relates the symbols to letters and automatize the whole sequences of letters and words, regardless of writing system. Wagner, Torgesen, Rashotte, Hecht, Barker, Burgess, Donahue and Garon (1997) subsequently determined that RAN was a significant predictor of growth in early (i.e., Kindergarten to Second Grade; First to Third Grade) as compared to later (i.e., Second to Fourth Grade) word reading skills. In a longitudinal study in Finland, it was noticed that slower naming of RAN objects in 3.5 years of age were identified as having dyslexia at second grade of their schooling (Torppa *et al*., 2010). Raschle, Chang and Gaab (2011) differentiated between English children with and without a history of dyslexia using RAN as tool. RAN differed between the groups, whereas other variables including expressive and receptive language and phonological variables did not vary. So, RAN which is a speed sensitive and an automatized task, automate linguistic and perceptual components and the connections involved in rapid serial naming is a well known predictor of reading ability.

Katz, Curtis and Tallal (1992) determined correlation between RAN scores and reading ability in both normals and children with language impairment at 4, 6 and 8 years of age. RAN scores correlated with reading abilities and the strength of this association increased with age. Therefore, RAN scores were highly correlated with reading abilities at 8 years of age. This is in contrast to the studies which describe RAN to be early predictor of reading in younger age groups.

Isoaho, Kauppila and Launonen (2015) studied 43 children with SLI on lexical naming, RAN and reading ability (technical reading and reading comprehension) at 1-3 years of age and at the end of each school year. Results indicated that at the age of 1 year, all RAN subtests correlated with technical reading. At the age of 2 years, only letter naming correlated with technical reading and with reading comprehension in year one. It was also found that no RAN subtest correlated with reading skills in year three. At the age of 9 years, reading abilities were better correlated with letter naming tasks. This result is in congruent with the study by Lervåg and Hulme (2009) that alphanumerical naming being the best predictor of reading development after the first school year. Hence, poor oral language accounts for poor decoding skills which later keep the child at risk of literacy skills.

Tiwari *et al*., 2011 examined the reading acquisition pattern in children learned to read and write two distinct writing systems. The results revealed a differential pattern of acquisition and noticed a gradual development of phonological awareness. However, there are also studies done in Indian scenario which suggests phonemic awareness as not to be a primary factor in reading (Patel & Soper, 1987; Prakash, 1987; Rekha, 1987). As indicated in literature, RAN is considered as one of the early predictors for identification of reading problems in language impaired children. A few studies also consider RAN as part of phonological processing affected in children with language impairment. Whether, RAN as a predictor is specific to few languages or applies to other languages is an interesting evidence to look out for. Hence, the present study attempted to investigate the relation between rapid automatized naming (RAN) and reading in Malayalam speaking children with SLI.

CHAPTER 3: Method

The present study will follow a case-control research design with two groups- clinical group (children with SLI) and typically developing children as comparative group.

The primary aim of the present study was to investigate the relation between RAN and reading in Malayalam speaking children with SLI.

The objectives of the study were,

- To compare the performance of children with SLI and typically developing children on RAN.
- To compare the performance of children with SLI and typically developing children on reading.
- To observe the developmental trend in RAN across age group in children with SLI and typically developing children.
- To study the relationship between RAN and reading in children with SLI.

3.1 Participants

The participants were divided into two groups: the clinical group and the typical group.

Clinical group: The clinical group consisted of 30 children with SLI of 5-7 years. The children were further subdivided into groups ($5.0 \leq A \leq 6.0$ years and $6.0 \leq A \leq 7.0$ years) with 15 children in each group.

Typical group: Typical group consisted of 60 typically developing children in the age range of 5-7 years of age. The children were further subdivided into groups ($5.0 \leq A \leq 6.0$ years and $6.0 \leq A \leq 7.0$ years) with 30 children in each group, age and gender matched.

Participant Selection Criteria

The participants in the two groups were selected on the basis of the following criteria:

- The diagnosis of the children with SLI was confirmed using the criteria given by Leonard, 1998). The objectives of Leonard's exclusionary criteria are psychological evaluation (IQ > 80), normal auditory threshold, absence of behavioral and/or emotional issues, absence of classical neurological symptoms such as cerebral palsy, intellectual deficiency. Participants were included into SLI group; if their grand language total was at least 1.25 SD lower than the standard language score for that chronological age on Malayalam Language Test (Rukmini, 1994).
- The language skills of the participants in normal group were screened on Malayalam language test (Rukmini, 1994).
- All the children were screened and ruled out for sensory-motor impairment using ICF CY checklist (WHO Work group version, 2004)
- All children were selected from mid/high socio economic status using Socio Economic Status Scale (Venkatesan, 2011).

- Screening Checklist for Auditory Processing (SCAP) (Yathiraj & Mascarenhas, 2003) checklist was used to rule out auditory processing deficits in the clinical group.

An informed consent was taken from all the participants and/ or caretakers before the actual testing. The children in the control group were matched for age, gender and socio-economic status of children in the clinical group in the ratio of 1:3 (with one child with SLI and three matched typically developing children).

Clinical group

The clinical group comprised of consisted of 30 children with SLI of 5-7 years who follows Leonard's exclusionary criteria. Table 3.1 shows the details of the children with SLI and language scores obtained on Malayalam Language Test (Rukmini, 1994).

Table 3.1

Language scores of children with SLI

Participants	**Age (in years)**	**Receptive language scores**	**Expressive language scores**	**Total language scores**
1	5.1	87.3	59.8	147.1
2	5.2	85.5	60.0	145.5
3	5.2	84.5	59.2	143.7
4	5.3	86.2	59.1	145.3
5	5.3	86.5	59.5	146
6	5.4	87.0	59.9	146.9
7	5.4	86.9	60.5	147.4
8	5.7	87.3	61.3	148.6

Table 3.1 *cont...*

Participants	Age (in years)	Receptive language scores	Expressive language scores	Total language scores
9	5.7	88.7	61.1	149.8
10	5.7	86.4	60.5	146.9
11	5.7	85.6	60.9	146.5
12	5.8	91.1	61.5	152.6
13	5.8	87.8	62.0	149.8
14	5.8	89.5	62.0	151.5
15	5.9	90.3	63.2	153.5
16	6.2	91.8	63.2	155
17	6.3	94.7	62.2	156.9
18	6.3	93.6	63.6	157.2
19	6.4	94.2	65.4	159.6
20	6.4	94.3	66.2	160.5
21	6.5	95.6	64.7	160.3
22	6.5	96.8	65.9	162.7
23	6.6	94.7	66.0	160.7
24	6.6	96.2	66.7	162.9
25	6.6	95.7	65.9	161.6
26	6.6	94.8	69.4	164.2
27	6.9	95.9	68.2	164.1
28	6.9	96.5	66.4	162.9
29	7.0	96.5	67.5	164
30	7.0	97.8	69.8	167.6

Control group

The controlled group comprised of 60 typically developing children in the age range of 5-7 years of age.

3.2 Stimulus material

Stimulus material included stimuli for RAN and oral reading task. RAN stimulus items such as colours, digits and objects were adapted from a study done by Ranjini (2011) on Rapid automatized naming - Kannada (RAN-K) in 6 -8 year old typically developing children. For the stimulus item letters, Malayalam alphabets which are acquired earlier and articulated earlier by the child were selected. RAN stimulus comprised of both single category tasks designed by Denckla and Rudel (1976) and relatively complex alternate category tasks given by Wolf (1986). Thus tasks selected for rapid naming include:

1. RAN single category :

   Non alphanumeric

- RAN Objects (RAN O)
- RAN colours (RAN C)

  Alphanumeric

- RAN numbers (RAN N)
- RAN letters (RAN L)

2. RAN Alternate category :

- RAN digit- letter (RAN DL)
- RAN colour-digit-letter (RAN CDL)

Stimulus for the oral reading task included subtest of reading from the Test of reading and metaphonological skills in Malayalm (Roopa, 2000).

3.3 Procedure

The stimulus for RAN was presented in power point presentation. The order of presentation was – letter, digits, colours, objects, digits – letters and colours – digits – letters. Each category was arranged in 5 rows and 10 classes randomly. The instruction given to the children were "Name the digits, letters, colours, objects, digit-letter and colour-digit- letter as fast as you can". The stimuli for oral reading were presented using DMDX software (Forster & Forster, 2003) (Version-DMDX 1.00 TIMEDX 1.00). Incorrect responses on RAN objects were asked to define and coded by type. Responses will be coded by asking questions for defining the stimuli such as 'What is it used for, who uses it' (functional), 'What is it like' (Physical), 'When or Where is it found' (Locative),'What kind of a thing is it' (Categorical)' (McGregor *et al*., 2002). The instruction for oral reading was "Read the words as soon as it appears on the screen".

3.4 Scoring and Analysis

The response of each child was recorded. The total time taken by the subject to complete each naming task (in seconds) and accuracy (number of correct response) was measured. Accurate self corrections by the child will be considered as correct response. Both single and alternating category in RAN were analysed separately. In oral reading, the words correctly read were given a score of 1. The obtained data was analyzed using the Statistical Package for the Social Sciences (SPSS) software package (Version 20.0)

CHAPTER 4: Results

The aim of the present study was to investigate the relation between rapid automatized naming (RAN) and reading in Malayalam speaking children with SLI in 5-7 years. The research also attempted to compare the performance of TDC and children with SLI, between age in both groups i.e., 5-6 years and 6-7 years and to find relation between rapid automatized naming (RAN) and reading in children. The data obtained from both the groups i.e., TDC and SLI group was analysed on measures of accuracy and total time taken on RAN task and measures of accuracy, reaction time and total time taken on reading task.

The data was subjected to statistical analysis for measures of accuracy and total time taken for six subtasks on RAN. The RAN subtasks included naming single category including Colours (C), Digits (D), Letters (L), Objects (O) and alternate category including Digits-Letters (D-L) and Colours-Digits-Letters (C-D-L). For reading task, accuracy, total time taken and reaction time were measured and analysed. As the data did not follow a normal distribution, Non-parametric tests were used for analysis. The data was analysed using the following statistical procedures:

- Descriptive statistics was carried out to find the mean, median and standard deviation (SD) for performance of TDC and children with SLI on RAN and reading.
- Non-parametric Mann-Whitney U test was used to compare the performance on RAN and reading between different age groups for TDC and children with SLI.

- Friedman test was done to determine for any statistical significant difference across RAN subtasks between both the groups i.e., TDC and SLI.
- Wilcoxon signed rank test was used to compare the measures of RAN in both the groups i.e., TDC and SLI.
- Spearman Correlation was done to determine any correlation between RAN and reading in TDC and children with SLI.

The results of the present study are explained under the following headings as follows,

4.1 Performance of typically developing children on RAN and reading.

4.2 Comparison of performance children with SLI and TDC on RAN and reading.

4.3 Relation between RAN and reading in children.

4.1 Performance of typically developing children on RAN and reading

The data was subjected to statistical analysis for measures of accuracy and total time taken on RAN task. For the reading tasks, the data was analysed for accuracy, total time taken and reaction time measures.

4.2 Accuracy measures on RAN tasks

The data obtained was analyzed for accuracy measures on RAN subtasks. The mean, median and standard deviation (SD) for accuracy measures were calculated for all RAN subtasks. Table 4.1 shows mean, median and SD values for accuracy measures on RAN subtasks in TDC

Table 4.1

Mean, median and SD values for accuracy measures on RAN subtasks in TDC

Age group (in years)	**RAN subtask**	**Mean**	**Median**	**S D**
5 – 6	**C**	49.56	50.00	0.67
	D	49.83	50.00	0.37
	L	49.73	50.00	0.44
	O	49.23	50.00	1.10
	DL	49.76	50.00	0.43
	CDL	49.30	50.00	0.87
	Total	297.43	298.00	1.75
6 – 7	**C**	49.83	50.00	0.37
	D	50.00	50.00	0.00
	L	49.96	50.00	0.18
	O	49.80	50.00	0.40
	DL	49.90	50.00	0.30
	CDL	49.60	50.00	0.67
	Total	299.10	299.00	0.99

Note: C=Colours, D=Digits, L=Letters, O=Objects, DL=Digit-Letters, CDL= Colours-Digits-Letters

Analysis of results as shown in table 4.1 showed that accuracy of naming for RAN subtasks was observed to be greater in 6-7 years (Mean= 299.10, SD=0.99) than in 5-6 years age group (Mean=297.43 , SD= 1.75). Mann-Whitney U test was used to compare accuracy between age group for overall accuracy measures on all 6 subtasks. The results revealed that there was a significant difference between age groups in TDC ($|Z|=3.99$, $p<0.05$) on RAN subtasks. Friedman test was done across RAN subtasks for TDC on accuracy measure and the results revealed that there was no significant difference within 5-6 years age group (χ^2 (5) = 9.815, $p>0.05$). A significant difference was observed within the age group 6-7 years (χ^2 (5) = 16.905, p< 0.05) across RAN accuracy measures. An improvement was observed for RAN accuracy scores from 5-6 years to 6-7 years age.

Further the data was analysed for different subtasks of RAN including naming single category including Colours (C), Digits (D), Letters (L), Objects (O) and alternate category including Digits-Letters (D-L) and Colours-Digits-Letters (C-D-L). Analysis of results for accuracy measure of naming on RAN C as shown in table 4.1 showed that accuracy of naming on RAN C was observed to be similar for 5-6 years (Mean= 49.56, SD=0.67) and 6-7 years (Mean=49.83, SD=0.37) age groups. Results on Mann-Whitney U test revealed that that there was no significant difference between the two age groups (|Z|=1.65, p>0.05) in TDC. An improvement in RAN C accuracy measures was observed between age groups (Figure 4.1).

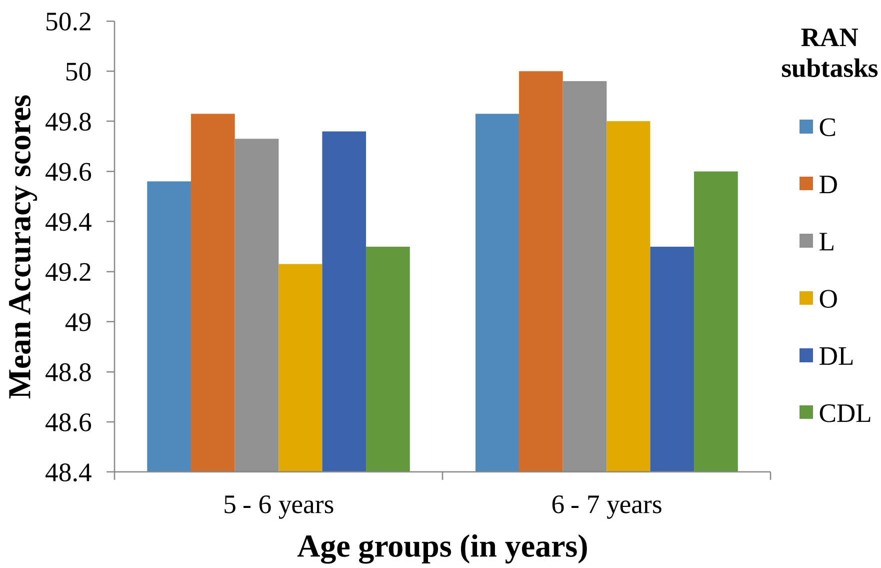

Figure 4.1: Comparison of performance for accuracy measure on RAN sub tasks in TDC

Note: C=Colours, D=Digits, L=Letters, O=Objects, DL=Digits- letters, CDL=Colour- Digits- Letter

Analysis of results of accuracy measure on naming RAN D as shown in table 4.1 showed that accuracy of naming of digits was observed to be greater in 6-7 years (Mean=50.00, SD=0.00) than 5-6 years age group (Mean=49.83, SD=0.37). Results on Mann-Whitney U test revealed that there was a significant difference between the two age groups ($|Z|= 2.31$, $p< 0.05$). An improvement in RAN D accuracy measures was observed between age groups (Figure 4.1).

Analysis of results for accuracy measure of naming RAN L as shown in table 4.1 showed that accuracy of naming on RAN L was observed to be greater in 6-7 years (Mean=49.96, SD=0.18) than 5-6 years age group (Mean=49.73, SD=0.44). Results on Mann-Whitney U test revealed that there was a significant difference between the age groups ($|Z|=2.51$, $p<0.05$). An improvement in RAN L accuracy measures was observed between age groups (Figure 4.1).

Analysis of results for accuracy measure of naming RAN O as shown in table 4.1 showed that accuracy of naming on RAN O was observed to be similar for 5-6 years and (Mean= 49.23, SD=1.10) 6-7 years age groups (Mean=49.80, SD=0.40). Results on Mann-Whitney U test revealed that there was no significant difference between the two age groups ($|Z|=1.90$, $p>0.05$). An improvement in RAN O accuracy measures was observed between age groups (Figure 4.1).

Analysis of results for accuracy measure of naming RAN DL as shown in table 4.1 showed that accuracy of naming on RAN DL was observed to be similar in 5-6 years (Mean=49.76, SD = 0.43) and 6-7 years (Mean=49.90, SD=0.30) age groups. Results on Mann-Whitney U test revealed that there was no significant difference between two age groups ($|Z|=1.37$, $p>0.05$). An improvement in RAN DL accuracy measures was observed between age groups (Figure 4.1).

Analysis of results for accuracy measure of naming RAN CDL as shown in table 4.1 showed that accuracy of naming on RAN CDL was observed to be similar in 5-6 years (Mean=49.30, SD= 0.87) and 6-7 years (Mean=49.60, SD=0.67) age groups. Results on Mann-Whitney U test revealed that there was no significant difference between two age groups ($|Z|=1.32$, $p> 0.05$). An improvement in RAN CDL accuracy measures was observed between age groups (Figure 4.1).

Further, Wilcoxon signed rank test was done to observe significant difference between the measures: colour accuracy (CA), digit accuracy (DA), letter accuracy (LA), object accuracy (OA), digit-letter accuracy (DLA) and colour-digit-letter accuracy (CDLA) in 6-7 years. There was a significant difference between pairs: CA-DA ($|Z|=2.23$, $p<0.05$), LA-CA ($|Z|= 2.00$, $p<0.05$), OA-DA ($|Z|=2.44$, $p<0.05$), CDLA-DA ($|Z|=2.76$, $p<0.05$), CDLA-LA ($|Z|=2.49$, $p<0.05$), CDLA-DLA ($|Z|=2.31$, $p<0.05$).

To summarize the results for accuracy measures on RAN subtasks, it was noted that TDC performed better on naming RAN D (single category) in both age groups. In 5-6 year age group, order of accuracy obtained on RAN was D > D-L > L > C > CDL > O (Figure 4.1). In 6 -7 year age group, the order of accuracy obtained was D > L > D-L > C > O > CDL (Figure 4.1). Accuracy scores on RAN subtasks were similar for both age groups, i.e., 5-6 years and 6-7 years except for naming digits and letters.

5.2 Total time taken on RAN tasks

The data obtained was analyzed for total time taken on RAN subtasks. The mean, median and standard deviation (SD) for total time taken were calculated for all RAN subtasks. Table 4.2 shows mean, median for time taken on RAN subtasks in TDC.

Table 4.2

Mean, median and SD values for total time taken on RAN subtasks in TDC

Age group (in years)	RAN sub tasks	Mean	Median	S D
5 – 6 years	**C**	68.76	68.50	4.07
	D	61.60	62.00	2.52
	L	66.30	66.50	2.34
	O	80.10	80.50	3.35
	D L	59.96	60.50	3.07
	CDL	89.40	89.50	3.28
	Total	398.03	393.50	14.89
6 – 7 years	**C**	61.50	61.50	3.45
	D	55.90	56.00	0.99
	L	60.76	61.00	1.94
	O	69.56	71.50	3.45
	DL	49.23	49.50	3.02
	CDL	79.46	80.00	2.76
	Total	348.83	355.00	12.86

Note: C=Colours, D=Digits, L=Letters, O=Objects, DL=Digit-Letters, CDL=Colours-Digits-Letters
.

Analysis of results for total time taken on naming RAN subtasks as shown in table 4.2 showed that total time taken for RAN subtasks was observed to be greater in 5-6 years (Mean=398.03, SD=14.89) than in 6-7 years age groups (Mean=348.83, SD=12.86). Mann-Whitney U test was used to compare time taken between age group for all 6 subtasks. The results revealed that there was a significant difference between age groups in TDC (|Z|=6.65, $p<0.05$). Friedman test was done across RAN subtasks for TDC on total time taken results revealed that there was a significant difference for both 5-6 years (χ^2 (5)= 149.73, $p<0.05$) and 6-7years (χ^2 (5)= 148.42, $p<0.05$) age groups. A decrease in RAN time measures was observed from 5-6 years to 6-7 years.

Analysis of results for time taken to name RAN C as shown in table 4.2 showed that time taken to name RAN C was observed to be greater in 5-6 years (Mean=68.76, SD=4.07) than in 6-7 years age groups (Mean=61.50, SD=3.45). Results on Mann-Whitney U test revealed that there was a significant difference between two age groups (|Z|=6.27, $p<0.05$). A decrease in time on RAN C was observed from 5-6 years to 6-7 years. (Figure 4.2)

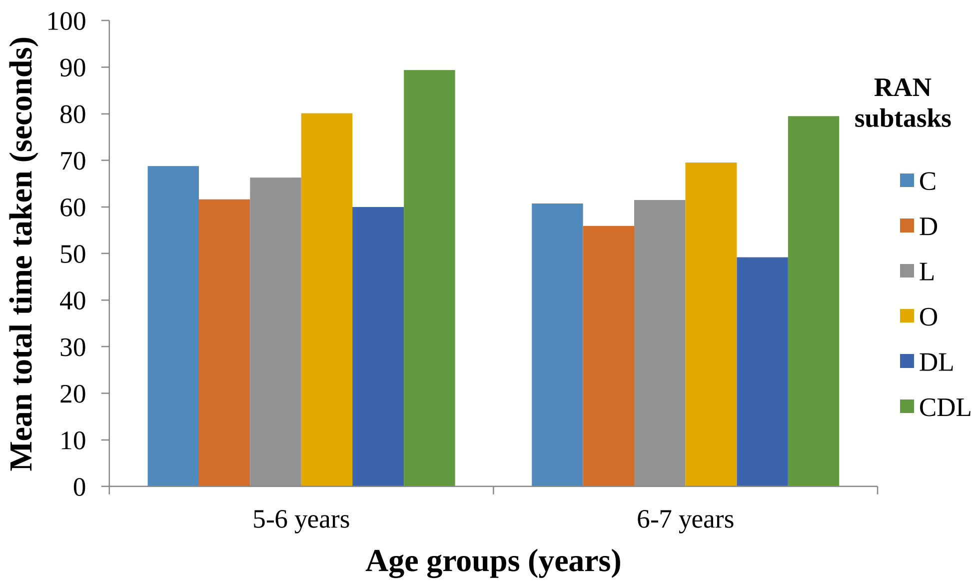

Figure 4.2: Comparison of performance for time taken on RAN sub tasks in TDC

Note: C=Colours, D=Digits, L=Letters, O=Objects, DL=Digits- letters, CDL=Colour- Digits- Letters.

Analysis of results for time taken to name RAN D as shown in table 4.2 showed that time taken to name RAN D was observed to be greater in 5-6 years (Mean=61.60 ,SD=2.52) than in 6-7 years age groups (Mean=55.90, SD =0.99). Results on Mann-Whitney U test revealed that there was a significant difference between two age groups ($|Z|=6.57$, $p<0.05$). A decrease in time on RAN D was observed from 5-6 years to 6-7 years (Figure 4.2).

Analysis of results for time taken to name RAN L as shown in table 4.2 showed that time taken to name RAN L was observed to be greater in 5-6 years (Mean=66.30, SD =2.34) than in 6-7 years age groups (Mean=60.76, SD =1.94). Results on Mann-Whitney U test revealed that there was a significant difference between two age groups ($|Z|=6.68$, $p<0.05$). A decrease in time on RAN L was observed from 5-6 years to 6-7 years (Figure 4.2).

Analysis of results for time taken to name RAN O as shown in table 4.2 showed that time taken to name RAN O was observed to be greater in 5-6 years (Mean=80.10 ,SD=3.35) than in 6-7 years age groups (Mean =69.56 ,SD=3.45). Results on Mann-Whitney U test revealed that there was a significant difference between two age groups ($|Z|=6.50$, $p<0.05$). A decrease in time on RAN O was observed from 5-6 years to 6-7 years (Figure 4.2).

Analysis of results for time taken to name RAN DL as shown in table 4.2 indicates that time taken to name RAN DL was observed to be greater in 5-6 years (Mean=59.96, SD=3.07) than in 6-7 years age groups (Mean = 49.23, SD=3.02). Results on Mann-Whitney U test revealed that there was a significant difference between two age groups ($|Z|=6.66$, $p<0.05$). A decrease in time on RAN DL was observed from 5-6 years to 6-7 years (Figure 4.2). Analysis of results for time taken to name RAN CDL as shown in table 4.2 showed that time taken to complete RAN CDL was observed to be greater in 5-6 years (Mean=89.40 ,SD=3.28) than in 6-7 years age groups (Mean=79.46, SD=2.76). Results on Mann-Whitney U test revealed that there was a significant difference between two age groups (|Z|=6.67, $p<0.05$). A decrease in time on RAN CDL was observed from 5-6 years to 6-7 years (Figure 4.2).

Further Wilcoxon signed rank test was done to observe the significance between measures: CTT (colour time taken) , DTT (digits time taken), LTT (letters time taken), OA (objects time taken), DLTT (digits-letters time taken) and CDLTT (colours digits letters time taken) in 5-6 years and 6-7 years age groups. There was a significant difference observed for between pairs: CTT-DTT (|Z|=4.79, $p<0.05$), LTT-CTT (|Z|=4.79, $p<0.05$), OTT-CTT (|Z|=4.79, $p<0.05$), DLTT-CTT=|Z|=4.64, $p<0.05$), CDLTT-DTT (|Z|=4.79, $p<0.5$), LTT-DTT (|Z|=4.84, $p<0.05$), OTT-DTT (|Z|=4.80, $p<0.05$), DLTT-DTT (|Z|=4.79, $p<0.05$), CDLTT-DTT(|Z|=4.80, $p<0.05$), OTT-LTT (|Z|=4.79, $p<0.05$), DLTT-LTT (|Z|=4.80, $p<0.05$),CDLTT-LTT (|Z|= 4.79, $p<0.05$), DLTT-OTT (|Z|=4.80, $p<0.05$), CDLTT-OTT (|Z|=4.79, $p<0.05$) and CDLTT-DLTT (|Z|=4.79, $p<0.05$) in 5-6 years. In 6-7 years, there was a significant difference between pairs: DTT-CTT (|Z|=4.84, $p<0.05$), LTT-CTT (|Z|=4.82, $p<0.05$), OTT-CTT (|Z|=4.79, $p<0.05$ DLTT-CTT (|Z|=4.80, $p<0.05$), CDLTT-CTT (|Z|=4.80, $p<0.05$), LTT-DTT (|Z|=4.83, $p<0.05$), OTT-DTT (|Z|=4.79, $p<0.05$), DLTT-DTT (|Z|=4.81, $p<0.05$), CDLTT-DTT (|Z|=4.80, $p<0.05$), OTT-LTT (|Z|=4.80, $p<0.05$), DLTT-LTT (|Z|=3.91, $p<0.05$), CDLTT-LTT (|Z|=4.81, $p<0.05$), DLTT-OTT (|Z|=4.80, $p<0.05$), CDLTT-OTT (|Z|=4.81, $p<0.05$) and CDLTT-DLTT (|Z|=4.79, $p<0.05$).

To summarize the results for time taken on RAN subtasks, TDC took longer time to name RAN CDL (alternate category). In 5- 6 year age group, order of time taken obtained on RAN was CDL > O > C > L > D > D-L (Figure 4.2). In 6 -7 year age group, the order of accuracy obtained was CDL > O > C > L > D > DL (Figure 4.2). Mean time taken on RAN subtasks was greater in 5-6 years age group than 6-7 years age group.

4.1.3 Performance of TDC on reading task

The data obtained from reading 30 single words were analyzed for measures of accuracy, total time taken to read and reaction time.. Table 4.3 shows mean, median and SD values of TDC on reading task between age groups

Table 4.3

Mean, median and SD values for reading accuracy, reaction time and total time taken on reading task in TDC

Age groups (in years)		**Reading Accuracy**	**Reaction time**	**Total time**
5 – 6	Mean	23.5	1705.31	83.83
	Median	23	1705.7	83.00
	SD	1.89	2.64	2.11
6 – 7	Mean	27.3	1696.06	76.13
	Median	23	1695.24	75.50
	SD	2.01	1.67	4.45
Total	Mean	25.40	1700.69	79.98
	Median	26.00	1700.22	82.00
	SD	2.72	5.15	5.19

Note: C = Colours, D = Digits, L = Letters, O= Objects, D-L = Digit-Letters, C-D-L= Colours-Digits-Letters

Analysis of results for reading accuracy, reaction time and total time taken on reading task as shown in table 4.3 showed that reading accuracy is greater in children in 6-7 years (Mean=27.3, SD=2.01) than 5-6 years age group (Mean=23.5, SD= 1.89). The reaction time measures were greater for 5-6 years (Mean=1705.31, SD=2.64) than 6-7 years age group (Mean=1696.06, SD=1.67). Total reading time was greater for 5-6 years (Mean=83.83, SD=2.11) than 5-6 years age group (Mean=76.13, SD=4.45). Results on Mann-Whitney U test revealed that there was a significant difference for reading accuracy (|Z|=5.443, p<0.05), reaction time (|Z|=6.655, p<0.05) and total time taken (|Z|=5.653, p<0.05) between age groups. Thus between age groups, there was improvement in reading accuracy scores, reduction in reaction time and total time taken (figure 4.3a, figure 4.3b and figure 4.3c).

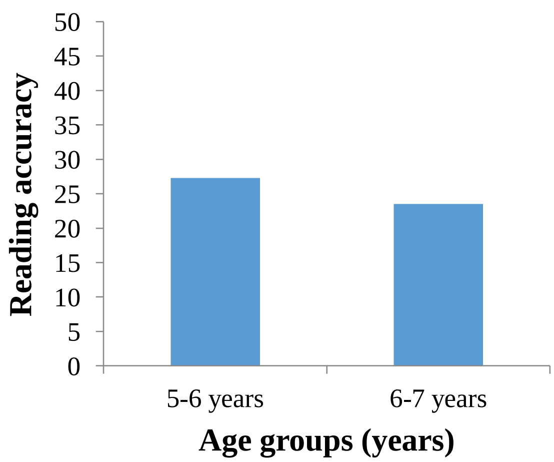

Figure 4.3a: Reading accuracy in TDC between ages

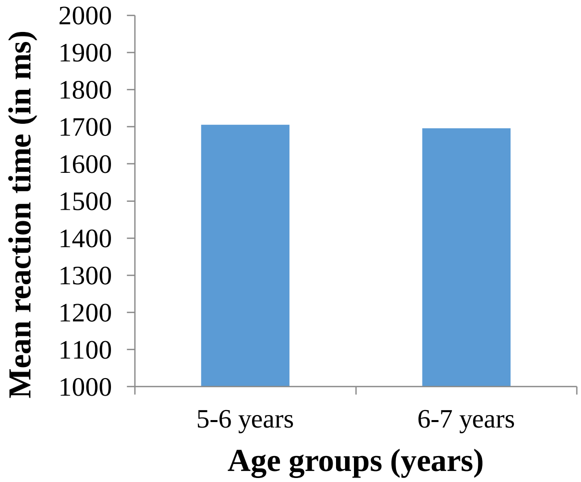

Figure 4.3b: Reaction time in TDC between ages.

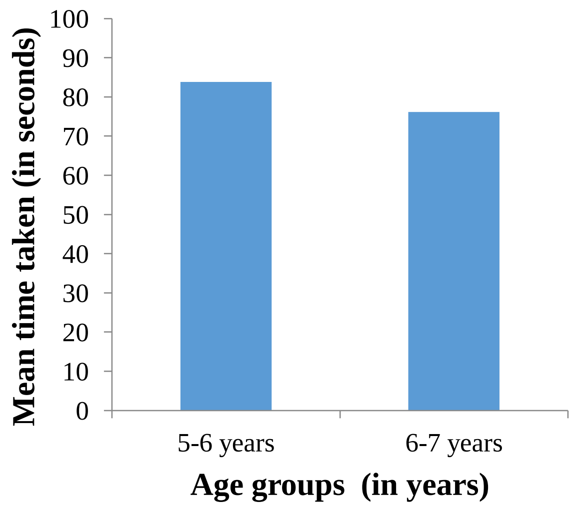

Figure 4.3b: Total time taken in TDC for reading between age groups

Children in the 6-7 years of age performed better on reading accuracy, showed reduced reaction time and lesser total time taken when compared to performance of children in the 5-6 years of age.

4.2 Comparison of performance of children with SLI and TDC on RAN and reading

The data was subjected to statistical analysis for measures of accuracy and total time taken on RAN subtasks. The mean, median and standard deviation (SD) of the accuracy measures were calculated for all subtasks.

4.2.1 Accuracy measures on RAN tasks between SLI and TDC

The data obtained was analyzed for accuracy measures of RAN subtasks. The mean, median and standard deviation (SD) of the accuracy measures were calculated for all subtasks. The incorrect responses of RAN objects were asked to define and coded on questions related to functional, physical, location and categorical attribute of the stimulus. Table 4.4 shows mean, median and SD values for accuracy measures on RAN sub tasks in TDC and children with SLI. Analysis of results as shown in table 4.4 showed that accuracy of naming on RAN subtasks in 5-6 years age group was observed to be greater in TDC (Mean=297.43, SD=1.75) than in children with SLI (Mean=190.05, SD=12.50). Similarly in 6-7 years age group, the accuracy of naming was greater in TDC (Mean =299.10, SD=0.99) than in SLI (Mean=199.66, SD=17.28).

Mann-Whitney U test was done to compare accuracy between age group on RAN subtasks in TDC and children with SLI. The results revealed that there was a significant difference between age groups in TDC ($|Z|=3.99$, $p<0.05$) and in children with SLI ($|Z|=4.40$, $p<0.05$).

Table 4.4

Mean, median and SD values for accuracy measures on RAN subtasks in TDC and children with SLI.

Age group (years)	RAN subtask	TDC			SLI		
5-6 years		**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
	C	49.56	50.00	0.67	32.60	32.50	2.39
	D	49.83	50.00	0.37	38.15	38.00	2.03
	L	49.73	50.00	0.44	33.10	33.00	2.22
	O	49.23	50.00	1.10	24.30	24.00	2.07
	DL	49.76	50.00	0.43	33.70	34.00	2.20
	CDL	49.30	50.00	0.87	28.20	28.00	2.23
	Total	297.43	298.00	1.75	190.50	191.00	12.50
6-7 years	C	49.83	50.00	0.37	37.50	38.00	0.70
	D	50.00	50.00	0.00	43.00	43	1.05
	L	49.96	50.00	0.18	38.10	38.0	0.87
	O	49.80	50.00	0.40	25.73	26.00	2.71
	DL	49.90	50.00	0.30	35.13	35.00	2.16
	CDL	49.60	50.00	0.67	33.70	34.00	0.94
	Total	299.10	299.00	0.99	199.66	200.00	17.28

Note: C= Colours, D= Digits, L= Letters, O= Objects, DL= Digit-Letter, CDL= Colours-Digits-Letters

Also, Mann-Whitney U test was done to compare the accuracy measure between TDC and children with SLI separately for each age group. Results revealed that accuracy of naming for subtasks in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=5.96$, $p<.0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=4.82$, $p<0.05$). Friedman test was done across RAN subtasks for accuracy measure and results revealed that there was no significant difference within 5-6 years age group ($\chi^2(5)=9.815$, $p>0.05$) and significant difference was observed within the age group 6-7 years ($\chi^2(5)=16.905$, $P<0.05$) in TDC. In children with SLI, there is a significant difference observed in 5-6 years ($\chi^2(5) = 92.76$, $p<0.05$) and 6-7 years age group ($\chi^2(5)=46.84$, $p<0.05$).Figure 4.4 shows greater accuracy scores on RAN tasks for TDC when compared to children with SLI in both age groups i.e., 5-6 years and 6-7 years.

It was observed that TDC performed better than children with SLI in age groups, i.e., 5-6 years and 6-7 years on RAN accuracy measures. Also improvement in accuracy scores was observed between age groups i.e., 5-6 years and 6-7 years.

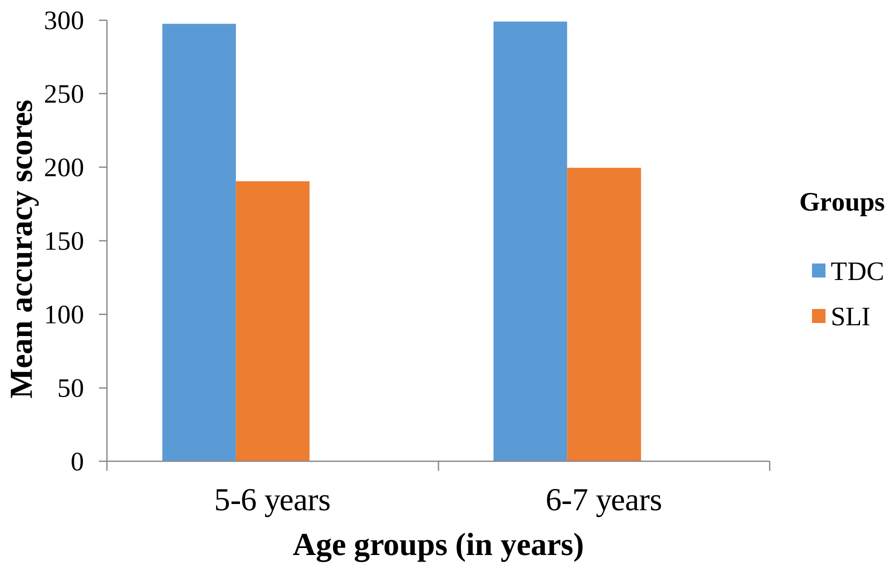

Figure 4.4: Comparison of performance for accuracy measures on RAN subtasks in TDC and children with SLI

Note: C = Colours, D = Digits, O = Objects, DL = Digits- letters, CDL = Colour- Digits- Letters.

Analysis of results for accuracy measures of naming RAN C as shown in table 4.4 showed that accuracy of RAN C in 5-6 years age group was observed to be greater in TDC (Mean=49.56, SD=0.67) than in children with SLI (Mean=32.60, SD=2.39). Similarly in 6-7years age group, the accuracy of RAN C was greater in TDC (Mean= 49.83, SD=0.37) than in SLI (Mean=37.50, SD=0.70). Mann-Whitney U test was done to compare the performance of RAN C in TDC and children with SLI between age groups. The results revealed that there is no significant difference between age groups in TDC (|Z|=5.44, p>0.05) and a significant difference observed in children with SLI (|Z|=4.29, p<0.05). Mann-Whitney U test was done to compare the accuracy of RAN C measure between TDC and children with SLI separately for each age group. Analysis of results revealed that accuracy of RAN C in 5-6 years age group obtained a significant difference between TDC and children with SLI (|Z|=6.15, p<0.05). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI (|Z|=5.40, p<0.05). It was observed that TDC performed better than children with SLI on RAN C accuracy measure. Also, improvement in RAN C accuracy scores was observed between age groups i.e., 5-6 years and 6-7 years in both groups.

Analysis of results of accuracy measure of naming of RAN D as shown in table 4.4 showed that accuracy of RAN D in 5-6 years age group was observed to be greater in TDC (Mean=49.83, SD=0.37) than in children with SLI (Mean=38.15, SD=2.03). Similarly in 6-7 years age group, the accuracy of RAN D was greater in TDC (Mean=50.00, SD=0.00) than in SLI (Mean = 43.00 ,SD=1.05). Mann Whitney U test was done to compare the performance of RAN D in TDC and children with SLI between age groups. The results revealed that there is no significant difference between age groups in TDC (|Z|=2.31, $p>0.05$) and a significant difference in children with SLI (|Z|=4.33, $p<0.05$). Mann-Whitney U test was done to compare the accuracy of RAN D between TDC and children with SLI separately for each age group. Analysis of results revealed that accuracy of RAN D in 5-6 years age group obtained a significant difference between TDC and children with SLI (|Z|= 6.35, $p<0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI (|Z| =6.16, $p<0.05$). It was observed that TDC performed better than children with SLI on RAN D in both age groups. Also, improvement in RAN D accuracy scores was observed between age groups i.e., 5-6 years and 6-7 years in both groups.

Analysis of results for accuracy measure on naming RAN L as shown in table 4.4 indicates that accuracy of RAN L in 5-6 years age group was observed to be greater in TDC (Mean=49.73, SD=0.44) than in children with SLI (Mean=33.10, SD=2.22). Similarly in 6-7 years age group, the accuracy of RAN L was greater in TDC (Mean=49.96, SD=0.18) than in SLI (Mean=38.10, SD=0.87). Mann-Whitney U test was done to compare the performance of RAN L in TDC and children with SLI between age groups. The results revealed that there is no significant difference between age groups in TDC (|Z|=2.31, $p>0.05$) and a significant difference observed in children with SLI (|Z|=4.22, $p<0.05$). Mann-Whitney U test was done to compare the accuracy of RAN L measure between TDC and children with SLI separately for each age group. Analysis of results revealed that accuracy of RAN L in 5-6 years age group obtained a significant difference between TDC and children with SLI (|Z|=6.22, $p<.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI (|Z|=5.96, $p<0.05$. It was observed that TDC performed better than children with SLI on RAN L in both age groups. Also, improvement in RAN L accuracy scores was observed between age groups i.e., 5-6 years and 6-7 years.

Analysis of results of accuracy measure of naming RAN O as shown in table 4.4 indicates that accuracy of RAN O in 5 -6 years age group was observed to be greater in TDC (Mean=49.23, SD=1.10) than in children with SLI (Mean=24.30 , SD=2.07). Similarly in 6-7 years age group, the accuracy of RAN O was greater in TDC (Mean=49.80, SD=0.40) than in SLI (Mean=25.73, SD=2.71). Mann-Whitney U test was done to compare the performance of RAN O in TDC and children with SLI between age groups. The results revealed that there is no significant difference between age groups in TDC ($|Z|=1.90$, $p>0.05$) and a significant difference observed in children with SLI ($|Z|=4.22$, $p<0.05$). Mann-Whitney U test was done to compare the accuracy of RAN O measure between TDC and children with SLI separately for each age group. Analysis of results revealed that accuracy of RAN O in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=6.12$, $p<.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=5.30$, $p<0.05$). Coding and defining the naming error on RAN O did not give appropriate answers from children with SLI. Hence coding of the incorrect responses was not carried out. It was observed that TDC performed better than children with SLI on RAN O in both age groups. Also, improvement in RAN O accuracy scores was observed between age groups i.e., 5-6 years and 6-7 years.

Analysis of results for accuracy measure of naming RAN DL as shown in table 4.2 showed that accuracy of RAN DL in 5-6 years age group was observed to be greater in TDC(Mean= 49.76, SD=0.43) than in children with SLI (Mean=33.70, SD=2.20). Similarly in 6-7 years age group, the accuracy of RAN DL was greater in TDC (Mean=49.90, SD=0.30) than in SLI (Mean=35.13, SD=2.16). Mann-Whitney U test was done to compare the performance of RAN DL in TDC and children with SLI between age groups. The results revealed that there is no significant difference between age groups in TDC ($|Z|=1.3$, $p>0.05$) and a significant difference observed in children with SLI ($|Z|=4.14$, $p<0.05$). Mann-Whitney U test was done to compare the accuracy of RAN DL measure between TDC and children with SLI separately for each age group. Analysis of results revealed that accuracy of RAN DL in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=6.26$, $p<0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=5.63$, $p<0.05$). It was observed that TDC performed better than children with SLI on RAN DL in both age groups. Also, improvement in RAN DL accuracy scores was observed between age groups i.e., 5-6 years and 6-7 years.

Analysis of results for accuracy measure of naming RAN CDL as shown in table 4.4 showed that accuracy of RAN CDL in 5-6 years age group was observed to be greater in TDC (Mean=49.30, SD=0.87) than in children with SLI (Mean=28.20, SD=2.23). Similarly in 6-7 years age group, the accuracy of RAN CDL was greater in TDC (Mean=49.60, SD=0.67) than in SLI (Mean =33.70, SD=0.94). Mann-Whitney U test was done to compare the performance of RAN CDL in TDC and children with SLI between age groups. The results revealed that there is no significant difference between age groups in TDC ($|Z|=1.32$, $p>0.05$) and a significant difference observed in children with SLI ($|Z|=4.37$, $p<0.05$). Mann-Whitney U test was done to compare the accuracy of

RAN CDL measure between TDC and children with SLI separately for each age group. Analysis of results revealed that accuracy of RAN CDL in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z| = 6.08$, $p<0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z| = 5.08$, $p<0.05$) It was observed that TDC performed better than children with SLI on RAN CDL in both age groups. Also, improvement in RAN CDL accuracy scores was observed between age groups i.e., 5-6 years and 6-7 years.

Further, Wilcoxon signed rank test was done to observe significant difference between the measures: colour accuracy (CA), digit accuracy (DA), letter accuracy (LA), object accuracy (OA), digit-letter accuracy (DLA) and colour-digit-letter accuracy (CDLA) in 5-6 and 6-7 years. There was a significant difference between pairs: CA-DA ($|Z|=3.94$, $p<0.05$), OA-CA ($|Z|=3.94$, $p<0.05$), DLA-CA ($|Z|=3.08$, $p<0.05$), CDLA-CA ($|Z|=3.94$, $p<0.05$), LA-DA ($|Z|=4.05$, $p<0.05$), OA-DA($|Z|=3.95$, $p<0.05$), DLA-DA ($|Z|=3.94$, $p<0.05$),CDLA-DA($|Z|=4.00$, $p<0.05$), OA-LA=3.95, $p<0.05$), DLA-LA=2.24, $p<0.05$), CDLA-LA ($|Z|=3.96$, DLA-OA ($|Z|=3.96$, $p<0.05$), CDLA-OA ($|Z|=3.95$, $p<0.05$), CDLA-DLA ($|Z|=3.98$, $p<0.05$) in 5-6 year age group. In 6-7 year age group, there was a significant difference between pairs: DA-CA($|Z|=2.84$, $p<0.05$), LA-CA($|Z|=2.44$, $p<0.05$), OA-CA($|Z|=2.84$, $p<0.05$), CDLA-CA ($|Z|=2.85$, $p<0.05$), LA-DA ($|Z|=2.91$, $p<0.05$), OA-DA($|Z|=2.84$, $P<0.05$), DLA-DA ($|Z|=2.82$, $p<0.05$), CDLA-DA($|Z|=2.85$, $p<0.05$), OA-LA ($|Z|=2.84$, $p<0.05$), CDLA-LA ($|Z|=2.85$, $p<0.05$), DLA-OA ($|Z|=2.83$, $p<0.05$), CDLA-OA ($|Z|=2.83$, $p<0.05$), CDLA-DLA ($|Z|=2.83$, $p<0.05$).

To summarize the results for accuracy measures on RAN subtasks, TDC performed better than children with SLI (Figure 4.4). Mean accuracy scores were greater in 6-7 years than 5-6 years age group in children with SLI. Similar to the findings in TDC, children with SLI had greater accuracy scores on naming RAN D (single category) in both age groups. In 5- 6 year age group, order of accuracy obtained on RAN was D > DL > L > C > CDL > O (Figure 4.4). In 6 -7 year age group, the order of accuracy obtained was D > L > C > DL> CDL > O (Figure 4.4).

4.2.2 Total Time for RAN tasks between SLI and TDC

The data obtained was analyzed for total time taken on RAN subtasks. The mean, median and standard deviation (SD) for total time taken were calculated for all RAN subtasks. Table 4.5 shows mean, median and SD values of TDC and children with SLI for total time taken on RAN tasks between age groups.

Table 4.5

Mean, median and SD values for total time on RAN subtasks in TDC and children with SLI

Age group (in years)	**RAN subtask**	**TDC**			**SLI**		
		Mean	Median	SD	Mean	Median	SD
5-6	C	68.76	68.50	4.07	94.50	94.00	38.25
	D	47.40	48.00	1.54	61.60	62.00	0.99
	L	52.40	52.40	1.67	66.30	66.50	2.34
	O	80.10	80.50	3.35	115.30	111.50	0.21
	DL	59.96	60.50	3.07	72.00	72.50	2.15
	CDL	89.40	89.50	3.28	140.85	132.00	4.22
	Total	398.03	393.50	14.89	300.01	313.30	35.45

Table 4.5 *cont..*

Age group (in years)	**RAN subtasks**		**TDC**			**SLI**	
6-7	C	60.76	61.00	1.94	91.70	92.00	0.67
	D	42.50	43.00	1.57	55.90	56.00	0.67
	L	47.30	48.00	1.44	61.50	61.50	1.44
	O	69.56	71.50	3.45	111.40	111.50	0.09
	DL	49.23	49.50	3.02	66.40	66.50	1.17
	CDL	79.46	80.00	2.76	126.00	126.00	0.08
	Total	348.83	355.00	12.86	299.24	299.25	2.49

Note: C = Colours, D = Digits, L = Letters, O= Objects, D-L = Digit-Letters, C-D-L= Colours-Digits-Letters

Analysis of results as shown in table 4.5 showed that total time taken on RAN subtasks in 5-6 years age group was observed to be greater in TDC (Mean=398.03, SD=14.89) than in children with SLI (Mean=300.01, SD=35.45). Similarly in 6-7 years age group, total time taken was greater in TDC (Mean =348.83, SD=12.86) than in SLI (Mean=299.24, SD=2.49). Mann-Whitney U test was done to compare total time taken between age group on RAN subtasks in TDC and children with SLI. The results revealed that there was a significant difference between age groups in TDC (|Z|=6.65, p<.0.05) and in children with SLI (|Z|=2.20, p<0.05). Also, Mann-Whitney U test was done to compare the accuracy measure between TDC and children with SLI separately for each age group. Analysis of results revealed that total time taken for subtasks in 5-6 years age group obtained a significant difference between TDC and children with SLI (|Z|=5.94, p<.0.05). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI (|Z|=4.68, p<0.05). Friedman test was done across RAN subtasks for accuracy measure and results revealed that there was no significant difference within 5-6 years age group ($\chi^2(5)=9.815$, $p>0.05$) and significant difference was observed within the age group 6-7 years ($\chi^2(5)=16.905$, $P<0.05$) in TDC. In children with SLI, there is a significant difference observed in 5-6 years ($\chi^2(5)= 92.76$, $p<0.05$) and 6-7 years age group (χ^2 (5) =46.84, $p<0.05$). It was observed that children with SLI took more time than TDC on RAN subtasks for both age groups. A decrease in RAN time measures was observed from 5-6 years to 6-7 years (Figure 4.5).

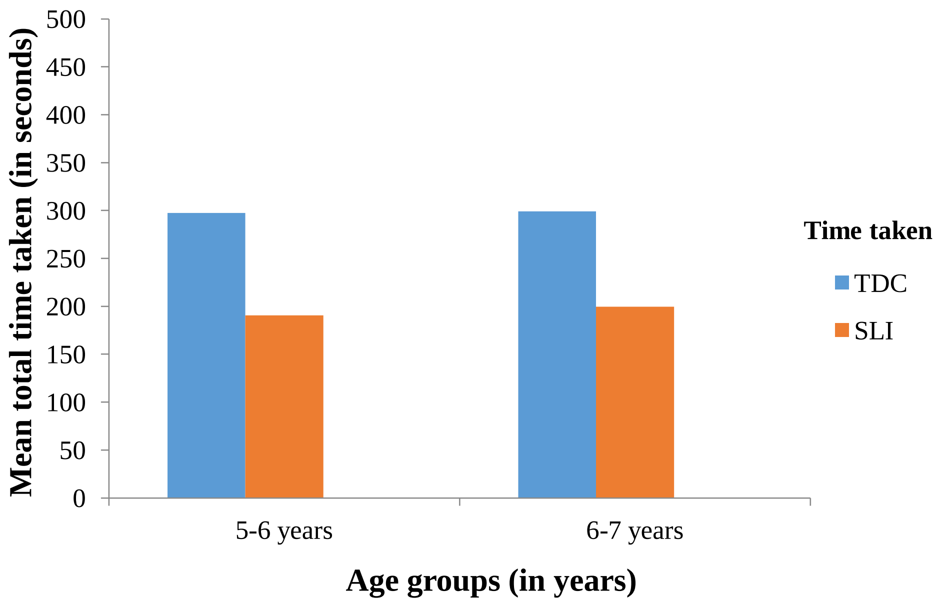

Figure 4.5: Comparison of performance for time taken to name RAN subtasks in TDC and children with SLI

Note: C = Colours, D = Digits, O = Objects, DL = Digits- letters, CDL = Colour- Digits- Letters.

Analysis of results of total time taken to name RAN C as shown in table 4.5 showed that time taken to name RAN C in 5-6 years age group was observed to be greater in children with SLI (Mean=94.50, SD=38.25) than in TDC (Mean=68.76 , SD=4.07). Similarly in 6-7 years age group, the time taken to name RAN C was greater in children with SLI (Mean=91.70, SD=0.67) than in TDC (Mean=60.76, SD=1.94). Mann-Whitney U test was done to compare the performance of time taken to name RAN C in TDC and children with SLI between age groups. The results revealed that there is a significant difference between age groups in TDC ($|Z|=6.27$, $p< 0.05$) and no significant difference in children with SLI ($|z|=2.15$, $p>0.05$). Mann-Whitney U test was done to compare the RAN C time measure between TDC and children with SLI separately for each age group. Analysis of results revealed that time taken to name RAN C in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z| = 2.97$, $p<0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=4.27$, $p<0.05$). It was observed that children with SLI took more time than TDC on RAN D for both age groups. A decrease in RAN C time measures was observed from 5-6 years to 6-7 years

Analysis of results for time taken to name RAN D as shown in table 4.5 shows that time taken to name RAN D in 5-6 years age group was observed to be greater in children with SLI (Mean=61.60, SD=0.99) than in TDC (Mean=47.40, SD=1.54). Similarly in 6-7 years age group, the time taken to name RAN D was greater in children with SLI (Mean=55.90, SD=0.67) than in TDC (Mean=42.50, SD=1.50). Mann-Whitney U test was done to compare the performance of time taken to name RAN D in TDC and children with SLI between age groups. The results showed that there is a significant difference between age groups in TDC ($|Z|=6.57$, $p<0.05$) and in children with SLI ($|Z|= 4.26$, $p<.0.05$). Mann-Whitney U test was done to compare the RAN D time measure between TDC and children with SLI separately for each age group. Analysis of results revealed that time taken to name RAN D in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=5.96$, $p<.0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=4.72$, $p<.0.05$). It was observed that children with SLI took more time than TDC on RAN D for both age groups. A decrease in RAN D time measures was observed from 5-6 years to 6-7 years.

Analysis of results for total time taken to name RAN L as shown in table 4.5 showed that time taken to name RAN L for all the tasks in 5-6 years age group was observed to be greater in children with SLI (Mean=66.30, SD=2.34) than in TDC (Mean=52.40, SD=1.67). Similarly in 6-7 years age group, the time taken to name RAN L was greater in children with SLI (Mean=61.50, SD=1.44) than in TDC (Mean=47.30, SD=1.44). Mann-Whitney U test was done to compare the performance of time taken to name RAN L in TDC and children with SLI between age groups. The results revealed that there is a significant difference between age groups in TDC ($|Z|=6.68$, $p<0.05$) and in children with SLI ($|Z|=4.17$, $p<0.05$). Mann-Whitney U test was done to compare the RAN L time measure between TDC and children with SLI separately for each age group. Analysis of results showed that time taken to name RAN L in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=5.96$, $p<0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=4.74$, $p<.05$). It was observed that children with SLI took more time than TDC on RAN L for both age groups. A decrease in RAN L time measures was observed from 5-6 years to 6-7 years.

Analysis of results for total time taken to name RAN O as shown in table 4.5 showed that time taken to name RAN O in 5-6 years age group was observed to be greater in children with SLI (Mean=115.30, SD=0.21 than in TDC (Mean=80.10, SD=3.35). Similarly in 6-7 years age group, the time taken to name RAN L was greater in children with SLI (Mean=111.40, SD=0.09) than in TDC (Mean=69.56, SD=3.45). Mann-Whitney U test was done to compare the performance of time taken to name RAN O in TDC and children with SLI between age groups. The results revealed that there is a significant difference between age groups in TDC ($|Z|=6.50$, $p<0.05$) and in children with SLI ($|Z|=4.14$, $p<0.05$). Mann-Whitney U test was done to compare the RAN O time measure between TDC and children with SLI separately for each age group. Analysis of results revealed that time taken to name RAN O in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=5.95$, $p<0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=4.71$, $p<0.05$). It was observed that children with SLI took more time than TDC on RAN O for both age groups. A decrease in RAN time measures was observed from 5-6 years to 6-7 years.

Analysis of results for total time taken to name RAN DL as shown in table 4.5 showed that time taken to name RAN DL in 5 -6 years age group was observed to be greater in children with SLI (Mean=72.00, SD=2.15 than in TDC (Mean=59.96 SD=3.07). Similarly in 6-7 years age group, the time taken to name RAN DL was greater in children with SLI (Mean=66.40, SD=1.17) than in TDC (Mean=49.23 ,SD=3.02). Mann-Whitney U test was done to compare the performance of time taken to name RAN DL in TDC and children with SLI between age groups. The results revealed that there is a significant difference between age groups in TDC ($|Z|=6.66$, $p<0.05$) and in children with SLI ($|Z|= 4.37$, $p<0.05$). Mann-Whitney U test was done to compare the RAN DL time measure between TDC and children with SLI separately for each age group. Analysis of results revealed that time taken to name RAN DL in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=5.95$, $p<.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z| = 4.70$, $p<.05$). It was observed that children with SLI took more time than TDC on RAN DL for both age groups. A decrease in RAN DL time measures was observed from 5-6 years to 6-7 years.

Analysis of results for total time taken to name RAN CDL as shown in table 4.5 showed that time taken to name RAN CDL in 5-6 years age group was observed to be greater in children with SLI (Mean=140.85, SD=4.22 than in TDC (Mean=89.40, SD=3.28). Similarly in 6-7 years age group, the time taken to name RAN DL was greater in children with SLI (Mean=126.00, SD=0.08) than in TDC (Mean=79.46 ,SD=2.76). Mann-Whitney U test was done to compare the performance of time taken to name RAN CDL in TDC and children with SLI between age groups. The results showed that there is a significant difference between age groups in TDC ($|Z|=6.67$, $p<0.05$) and in children with SLI ($|Z|=4.35$, $p<0.05$). Mann-Whitney U test was done to compare the RAN CDL time measure between TDC and children with SLI separately for each age group. Analysis of results revealed that time taken to name RAN CDL in 5-6 years age group obtained a significant difference between TDC and children with SLI ($|Z|=5.95$, $p<0.05$). Similarly in 6-7 years age group, there is a significant difference between TDC and children with SLI ($|Z|=4.71$, $p<0.05$). It was observed that children with SLI took more time than TDC on RAN CDL for both age groups. A decrease in RAN time measures was observed from 5-6 years to 6-7 years.

Further Wilcoxon signed rank test was done to observe the significance between measures: CTT (colour time taken) , DTT (digits time taken), LTT (letters time taken), OA (objects time taken), DLTT (digits-letters time taken) and CDLTT (colours digits letters time taken) in 5-6 years and 6-7 years age groups. There was a significant difference observed for between pairs: OTT-CTT ($|Z|=3.36$, $p<0.05$), CDLTT-CTT ($|Z|=3.36$, $p<0.05$), OTT-DTT ($|Z|=3.92$, $p<0.05$), DLTT-DTT ($|Z|=3.98$, p<).05), CDLTT-DTT ($|Z|=3.92$, $p<0.05$), OTT-LTT ($|Z|=3.92$, $p<0.05$), DLTT-LTT ($|Z|=3.97$, $p<0.05$), CDLTT-LTT ($|Z|=3.92$, $p<0.05$), DLTT-OTT ($|Z|=3.92$, $p<0.05$), CDLTT-OTT ($|Z|= 3.93$, $p<0.05$) and CDLTT-DLTT ($|Z|=3.92$, $p<0.05$). In 6-7 years, there was significant difference observed between pairs: DTT-CTT ($|Z|= 2.82$, $p<0.05$), LTT-CTT ($|Z|= 2.81$, $p<0.05$), OTT-CTT ($|Z|=2.80$, $p<0.05$), DLTT-CTT ($|Z|=2.81$, $p<0.05$), CDLTT-CTT ($|Z|=2.80$, $p<0.05$), LTT-DTT ($|Z|=2.82$, $p<0.05$), OTT-DTT ($|Z|= 2.81$, $p<0.05$), DLTT-DTT ($|Z|=2.82$, $p<0.05$), CDLTT-DTT ($|Z|=2.80$, $p<0.05$), OTT-LTT ($|Z|= 2.80$, $p<0.05$), DLTT-LTT ($|Z|=2.91$, $p<0.05$), CDLTT-LTT ($|Z|=2.81$, $p<0.05$), DLTT-OTT ($|Z|=2.81$, $p<0.05$), CDLTT-OTT ($|Z|=2.91$, $p<0.05$) and CDLTT-DLTT ($|Z|=2.80$, $p<0.05$)

To summarize the results for time taken on RAN subtasks, children with SLI took longer time than TDC for both age groups. Mean total time taken was greater in 5-6 years than in 6-7 years age for both the groups i.e., TDC and SLI. Similar to the findings in TDC, children with SLI took longer time to name RAN O (single category) in both the age groups. In 5- 6 year age group, order of time taken obtained on RAN was CDL > O >

C > L > D > D-L (Figure 4.5). In 6 -7 year age group, the order of accuracy obtained was CDL > O > L > C > D > DL (Figure 4.5).

4.2.3 Comparison of performance of children with SLI and TDC on Reading

The data obtained from reading 30 single words were analyzed for measures of accuracy, total time taken to read and reaction time in children with SLI and TDC and children with specific language impairment. Descriptive statistics showed mean, median and SD for all the measures on reading in TDC and children with SLI. Table 4.6 shows mean, median and SD values of TDC and children with SLI on reading between age groups.

Table 4.6

Mean, median and SD values of reading accuracy, reaction time and total time taken on reading task in children with SLI and TDC

	TDC		**SLI**	
Age group (in years)	**5-6**	**6-7**	**5-6**	**6-7**
Reading accuracy				
Mean	27.3	23.5	14.95	12.7
Median	27.00	23.00	15.00	12.00
SD	1.89	2.01	1.90	1.33
Reaction time (in ms)				
Mean	1696.06	1705.31	2099.74	2107.63
Median	1695.24	1705.72	2098.16	2107.65
SD	1.67	2.64	3.60	1.77
Total time taken (in seconds)				
Mean	76.13	83.83	115.31	121.12
Median	75.5	83.00	115.00	32.10
SD	4.45	2.11	60.97	32.10

Analysis of results of reading accuracy, reaction time and total time taken on reading task in TDC and children with SLI as shown in table 4.6 showed that in 5-6 years of age, reading accuracy is greater in TDC (Mean=27.30, SD=1.89) than in children with SLI (Mean=14.95, SD=1.90). In 6-7 years age group, reading accuracy is greater in TDC (Mean=23.5, SD=2.01) than in children with SLI (Mean=12.7, SD=1.33). The reaction time measures were greater in children with SLI (Mean=2099.74, SD=3.60) than in TDC (Mean=1696.06, SD =1.67) in 5-6 years age group. In 6-7 years age group, reaction time measures are greater in children with SLI than in TDC (Mean=2107.63, SD=1.77) than in TDC (Mean=1705.31, SD=2.64). Total reading time was greater in children with SLI (Mean=115.31, SD=60.97) than in TDC (Mean=76.13, SD=4.45) in 5-6 year age group. In 6-7 year age group, total reading time is greater in children with SLI (Mean=121.12, SD=32.10) than in TDC (Mean =83.83, SD=2.11). Mann-Whitney U test was used to compare accuracy between age groups. The results showed that there is a significant difference between age groups in TDC for reading accuracy ($|Z|=5.443$, $p<0.05$), reaction time ($|Z|=6.655$, $p<0.05$) and total time taken ($|Z|= |5.653|$), $p<0.05$). Also there is a significant difference between age groups in children with SLI for reading accuracy ($|Z|=2.93$, $p<0.05$), reaction time ($|Z|=4.26$, $p<0.05$) and total time taken ($|Z|=4.146$. $p<0.05$). Further comparison of reading measures between TDC and children with SLI was done separately for each age group. Results revealed that there is a significant difference between TDC and children with SLI for reading accuracy ($|Z|=5.97$, $p<0.05$), reaction time ($|Z|= 5.94$, $p<0.05$) and total time taken ($|Z|=4.75$, $p<0.05$) in 5-6 years age group. Also in 6-7 years age group, there is a significant difference between TDC and children with SLI for reading accuracy ($|Z|=4.71$, $p<0.05$), reaction time

(|Z|=4.68. p<0.05) and total time taken (|Z|= 4.71), p<0.05). Thus, children with SLI had less accuracy scores, greater reaction time and total time taken as compared to TDC. (figure 4.6a, figure 4.6b and figure 4.6c)

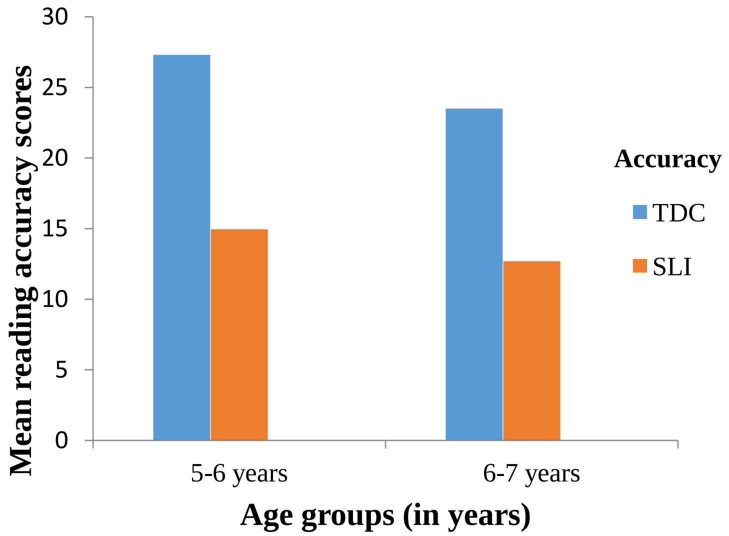

Figure 4.6a: Comparison of reading accuracy in children with SLI and TDC.

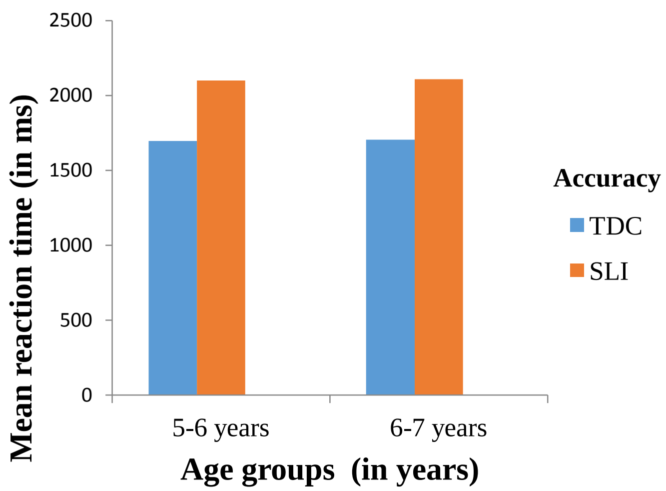

Figure 4.6b: Comparison of reaction time in children with SLI and TDC.

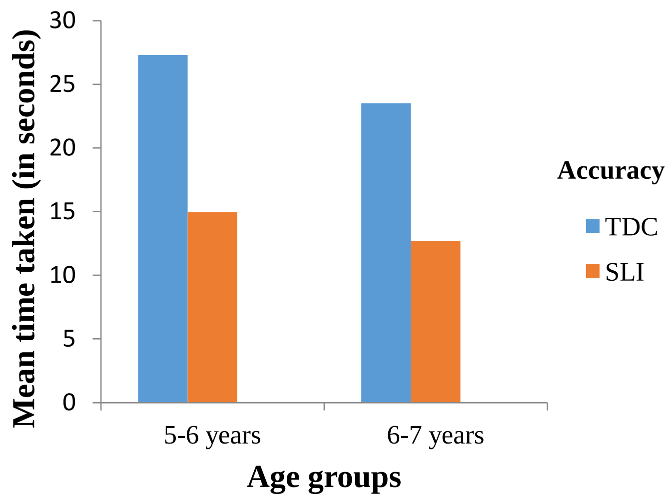

Figure 4.6c: Comparison of total time taken in children with SLI and TDC for reading.

In summary, the results indicated that children with SLI performed poor on reading with less reading accuracy, reduced reaction time and total time taken when compared to TDC in both the age groups .i.e., 5-6 years and 6-7 years.

4.3. Relation between RAN and reading in children with SLI

The study also aimed to explore the relation between RAN and reading in children with SLI. Data obtained for accuracy measure of RAN and reading accuracy were considered for determining the relation between them. The spearmen correlation coefficient (ρ) was calculated for the variables. The data was interpreted for the strength of correlation, where a Spearmen ρ value of $0 < \rho < 0.3$ low correlation, $0.3 < \rho < 0.7$ moderate correlation, $\rho > 0.7$ high correlation.

Correlation between RAN measures and reading accuracy was determined. Table 4.7 shows correlation coefficient for overall RAN accuracy measures and reading accuracy in children with SLI and TDC between age groups.

Table 4.7

Correlation coefficient for RAN accuracy measures and Reading accuracy children with SLI and TDC

Age groups (in years)	SLI	TDC
5-6	0.68*	0.17
6-7	0.80	-0.37
Total	0.84	0.25

$*p < 0.05$

There was no significant correlation observed between overall RAN accuracy and reading accuracy for both groups i.e., TDC and SLI. In children with SLI, there is a significant correlation observed for accuracy measures with reading accuracy in 5-6 years age group. A significant positive moderate correlation, $\rho = 0.68$ was observed for overall RAN accuracy and reading measure in children with SLI at 5-6 years of age.

Correlation was also determined for accuracy measure of each subtasks and reading accuracy. Table 4.8 shows correlation coefficient for accuracy measures of RAN subtasks and reading accuracy in children with SLI and TDC between age groups.

Table 4.8

Correlation coefficient for RAN subtasks accuracy measures and Reading accuracy children with SLI and TDC

Age groups (in years)	RAN task	TDC	SLI
5-6	**C**	0.23	0.62*
	D	0.09	0.70*
	L	-0.29	0.70*
	O	-0.04	0.59*
	DL	-0.24	0.64*
	CDL	0.18	0.69*
	Total	-0.17	0.68 *
6-7	**C**	0.17	0.03
	D	0.05	0.27
	L	0.04	0.20
	O	-0.24	0.16
	DL	-0.00	0.65
	CDL	-0.16	-0.07
	Total	-0.37	0.80

**p <0.05*

There was no significant correlation observed between accuracy measures of RAN subtasks and reading accuracy in children with SLI at 6-7 years of age. There was a significant correlation observed between accuracy measures of RAN subtasks and reading accuracy in children with SLI at 5-6 years of age. However, there was no significant correlation observed between accuracy measures of RAN and reading accuracy in TDC for both age groups.

A significant positive moderate correlation $\rho= 0.70$, $\rho= 0.70$, $\rho = 0 .69$, $\rho = 0.68$, $\rho= 0.64$ and $\rho= 0.59$ ($p < 0.05$) was observed for time taken for RAN L, RAN D, RAN CDL, RAN DL and RAN C respectively for 5-6 years age group in SLI. There is no significant correlation observed for RAN accuracy measures with reading accuracy in children with SLI for 6-7 years age group.

In summary, accuracy scores on RAN subtasks were similar in TDC for both age groups, i.e, 5-6 years and 6-7 years except for naming digits and letters. Also, mean time taken on RAN subtasks was greater in 5-6 years age group than 6-7 years age group in TDC. TDC performed better than children with SLI in both age groups, i.e, 5-6 years and 6-7 years on RAN accuracy and time measures. Also improvement in accuracy scores was observed between age groups i.e, 5-6 years and 6-7 years. On both time and accuracy measures, letters and digits were found to have better performance than other RAN subtasks in TDC and children with SLI for both age groups. Children with SLI performed poorer on reading with less accuracy scores, greater reaction time and total time taken as compared to TDC. There was a significant correlation was observed between RAN accuracy measures and reading accuracy in children with SLI, only in 5-6 years age group

CHAPTER 5: Discussion

The aim of the present study was to investigate the relation between rapid automatized naming (RAN) and reading in Malayalam speaking children with SLI in 5-7 years. Performance of children with SLI was compared with TDC on measures of accuracy and total time taken on RAN task and measures of accuracy, reaction time and total time taken on reading task. The objectives of the study were:

- To compare the performance of children with SLI and typically developing children on rapid automatized naming (RAN).
- To compare the performance of children with SLI and typically developing children on reading.
- To observe the developmental trend in RAN across age group in children with SLI and typically developing children.
- To study the relationship between RAN and reading in children with SLI.

Findings of the present study are discussed under the following sections:

5.1 Performance of typically developing children on RAN and reading.

5.2 Comparison of performance of children with SLI and TDC on RAN and reading.

5.3 Relationship between RAN and reading in children with SLI.

5.1 Performance of typically developing children on RAN and reading

The findings of the current study revealed that children in the age range of 6-7 years of age showed better performance with greater accuracy scores on overall RAN tasks when compared to 5-6 years of age. The improvement in accuracy measure between age groups indicated a developmental trend on RAN tasks. One of the reasons attributed to the reduced accuracy scores in 5-6 years age group is that RAN involves an integrated process of attentional, perceptual, conceptual, memory, lexical (semantic, phonologic access and retrieval) and motoric-sub-processes as explained using Model of visual naming (Wolf, Bowers & Biddle, 2000). The younger children may experience difficulty in the continuous activation and inhibition of the lexical access during rapid serial naming. The failure in naming an item could be due to break down at any level of visual naming i.e., attentional processes, visual processing, lexical process or in the integration of the multiple components. Also better accuracy scores in 6-7 years of age might be that they are more exposed to letters, digits, colours and objects. Children tend to rehearse and automatize naming as age increases which results in faster retrieval. This is in support of the previous studies which report that faster naming occurs once the process of naming becomes automatic after children becomes more familiar or rehearsed with letter names (Bowers, 1995; Spring & Davis, 1988). RAN performance increase as a function of age and supported by various authors like Albuquerque and Simoes (2010), Denckla and Rudel (1974), and Wolf and Denkla (2005). Accuracy scores on RAN subtasks were similar for both age groups, i.e., 5-6 years and 6-7 years except for naming digits and letters.

Findings of the present study unveiled that TDC performed better on naming RAN D (single category) in both age groups. It was observed that digits and letters were named better than colors and objects. The better performance of TDC on digits and letters (alphanumeric stimuli) conforms with the studies on development of RAN which have suggested that letter naming and digit naming (alphanumeric) develop faster when compared to colour naming or object naming (non alphanumeric) (Meyer *et al*., 1998). This could be due to the practice, exposure and emphasis on alphabets and digits given by the adults and care givers at home or in school set ups. Adults or caregivers engage in activities which focus more on letter and digit knowledge by as they foresee the children's need on building literacy skills. Hence, naming of alphanumeric stimuli (digits and letters) is faster and gets automatized earlier than non-alphanumeric stimuli (colours and objects). This automatization of digits and letters are reported to be transferred to acquire reading skills and consistently predict the variation in later reading skill (Cronin & Carver, 1998).

Findings of the present study revealed that children performed poorer on RAN-objects and colours than digits and letters. Unlike alphanumeric stimuli which taps the orthographic pattern recognition, non alphanumeric stimuli has been reported to follow a different cognitive process for naming (Tannock *et al*., 2000; Van den Bos *et al*., 2002). Difficulty in the serial naming of colours and objects can be attributed to developmental immaturity. A few studies have indicated that fastest speeds of naming alphanumeric stimuli are reached by the age of 16, the speed of naming colors and objects continues to improve (i.e., become faster) into mature adulthood (Van den Bos *et al*., 2002). Also, selection between competing response alternatives and inhibition of inappropriate response activation is necessary in rapid serial naming. Thus, inhibition and activation is easier for digits and letters as they have a clear clarity of phonological and orthographic category which are well over learned unless colours and objects. Earlier studies reported that colours and objects are categories of stimuli with fuzzy semantic boundaries (Tannock *et al.*, 2000). In contrast, letter and number terms have well-defined, non overlapping boundaries and belong to categories with a limited set of stimuli. Also, naming of colours and objects requires good visual processing and recognition as they have less distinct features when compared to digits and letters. Hence, naming colours and objects is not an automatized process and requires working memory to semantically process, for lexical access and for phonological retrieval.

The findings of the present study revealed that the performance of children on RAN CDL (colours-digits-letters) was found to be poorer than all other RAN subtasks in both age groups (i.e., 5-6 years and 6-7 years). The lower accuracy scores for RAN CDL can be attributed to the following reason that naming of CDL taxes the working memory as the demands on it are more when compared to naming other single categories (colours, digits, letters and objects). According to the model of visual naming, the processes involved in naming alternate category is multi componential in nature i.e., it requires integration of attention, visual processing, lexical processing and motoric processing (Wolf *et al*., 2000). Alternating stimuli within a naming task is thought to be more demanding on the attention and executive functions, cognitive flexibility, memory access, and semantic processing than RAN single category (Albuquerque & Simoes, 2010). However DL (digits-lettters), an alternate category was named better than colours, objects and CDL. This could be attributed to factors such as greater exposure, practise which could later alter it to becoming an automatized process.

Findings of the present study also revealed that mean time taken on RAN subtasks was greater in 5-6 years age group than 6-7 years age group. The findings indicate a faster and better performance by the 6-7 years children than the 5-6 year old children indicating a developmental trend on RAN tasks. One justification that can be attributed to the above finding is that the participants in the 5-6 years age group were observed to make greater word switches to Malayalam and English while naming colours, objects and digits (e.g., Naming the colour 'red' in English and /ʃtuvappɚ/). Thus, the shift from one language to another and retrieve the semantic and phonologic representation of the item for that particular language could have been difficult in younger children. It can also be attributed that the phonologic representation for an item may not be well developed in 5-6 years when compared to 6-7 years of age. Studies have been conducted in Indian scenario to understand the development of RAN in simultaneous Kannada-English biliterate children from grade level to ten which indicates naming speed increased as a function of age and grade in both English and Kannada (Siddaiah *et al*., 2013). Another reason for children getting faster at the rapid naming task as age increases is due to the increase in global processing speed mechanism caused by age-related growth and development (Kail & Hall, 1994).

Greater time taken to name CDL, which require rapid alternate serial processing, can be attributed to the need to shift to three semantic fields and to integrate the processes such as visual recognition, lexical access and articulation. The pause time between naming each item can be considered as the time taken to reach the succeeding competent target stimuli and inhibition of the preceding response. As reported by Wolf (1986), rapid serial naming of alternate category tasks in comparison to single category require the integration of those lower level skills as well as higher skills such as attending to the broader context and to the patterns in order to facilitate processing. Gradual automatization of digit and letter naming is reflected as reduced time taken to name them (Cronin & Carver, 1998). Hence time taken to name alphanumeric stimuli was lesser when compared to non alphanumeric stimuli.

The findings of the current study revealed that children in the age range of 6-7 years of age showed better performance on reading task with greater accuracy scores, shorter reaction time and lesser total time taken when compared to 5-6 years of age. Similar observation were reported by Tiwari *et al*., (2011) of a developmental trend in reading acquisition across age in Malayalam speaking children from Grades I to VII. Studies have reported that reading acquisition period are divided into 5 stages, wherein the stage 2 (5-7 years) deals with phoneme- grapheme correspondence rule and initial decoding of letters. It is also reported that at the end of the stage 2 i.e., at 7 years of age children relates letters and phonemes well which are the fundamental skills required in a early reader (Chall, 1983). Thus, it can be inferred that TDC in 6-7 years acquire better understanding of the decoding syllables to letters and shows better performance than 5-6 years age group. In summary, it was observed that older age group children (6-7 years) had achieved greater accuracy scores than younger age group (5-6 years) across RAN tasks and reading tasks. For RAN accuracy and time measures, naming of letters and digits were observed to be better than naming of colours, objects and alternate category in both age groups of TDC.

5.2 Comparison of performance of children with SLI and TDC on RAN and reading

Performance of RAN and reading was analyzed for children with SLI and TDC between two age groups, i.e., 5-6 years and 6-7 years. The findings of the present study revealed that children with SLI performed poorer than children with SLI on RAN accuracy measures. Poorer performance of children with SLI compared to TDC could be attributed to the deficit or break down at any level of visual naming as explained in Model of visual naming (Wolf *et al*., 2000). Children with SLI might have difficulty in shifting the attention, from one stimuli to another, recognizing the stimuli visually, retrieving the lexical from the mental lexicon and access the phonological representation. It was observed that the participants with SLI had omitted few items during serial naming and identified RAN objects differently. For e.g., ‘bangle’ was named as ‘circle’. Regarding the levels of break down, initially the deficit lies at paying attention to the stimuli, visually recognizing and processing it. This finding is in congruence with the study reported that children with SLI when compared to typically developing children showed longer response times on visual processing (Schul *et al.*, 2004). Also, in the present study semantic and phonologic errors were observed during rapid naming in children with SLI possibly due to lexical semantic deficit (Lahey & Edwards, 1996; Leonard, Nippold, Kail & Hale, 1983) and impaired phonological representation often reported in children with SLI (Bishop & Snowling, 2004; Conti-Ramsden, Botting & Faragher, 2001). Another reason that could be attributed to poorer performance on RAN could be reduced vocabulary size secondary to delayed language development leading to weaker semantic representations and smaller lexicon. Thus, impoverished and sparse semantic representations make the lexical retrieval difficult in children with SLI (McGregor & Apel, 2002; McGregor *et al*., 2002). Another possible view is generalised slowing hypothesis in children with SLI proposed by Kail (1994). Children with SLI in the current study took longer time than TDC and showed slower processing of linguistic and non linguistic information which could be due to limited processing capacity). Perseveratory errors were also observed in children with SLI in the current study of possibly due to failure of inhibition of the previous response and accessing the succeeding competent target as suggested in the Inefficient inhibition hypothesis (Bjorklund & Harnisfeger, 1990; Wilson & Kipp, 1998).

Finally, it could not be a single deficit, but integration of the processes needed for visual naming that is impaired, which could have resulted into inaccurate responses. This is affirmed by Computational Complexity Hypothesis (CCH) given by Jakubowicz, 2003. According to this hypothesis, children with SLI have difficulty in accessing and integrating different processes, thus relating cognitive system to language. To conclude, lesser accuracy in the performance of children with SLI can be accounted for visual processing deficit, lexical semantic deficit, weaker semantic representation, phonological impairment, inefficient inhibition and impaired integration of processes.

Findings of the RAN accuracy measures were similar as in TDC, with greater scores for digits and letters. Better performance on digits and letters (alphanumeric stimuli) confirms the studies on development of RAN skills which suggest that letter naming and digit naming (alphanumeric) develop faster as compared to colour naming or object naming (non alphanumeric) (Meyer *et al*, 1998). The poorer accuracy scores on RAN in both age groups were observed for object naming. The errors made by the SLI participants in the current study for naming RAN O were semantic errors (‘iron’ for knife, ‘leg’ for ‘chappal’), visual perceptual errors (‘circle’ for bangle) and phonologic errors (‘/kaṭṭil/’ for ‘/kat̺t̺i/’). It can be inferred that reduced accuracy for objects can be accounted for weaker semantic representation and visual processing deficit. The phonological errors made can be confirmed through the evidence that children with SLI make phonological errors during naming tasks at higher rates than their peers (Lahey & Edward, 1999).

The better performance of RAN DL over RAN L in the younger age group children with SLI is due to the poor phonological awareness of letters and letter recognition whereas digits were named with greater accuracy. So serial naming of DL was favoured with accurate responses of digits compared to letters. Even though digits were named accurately, few visual errors were exhibited: confusion of ‘9’ to ‘6’, phonological error or a perseveratory error such as naming /ranḍɚ/ as /red/ etc. As indicated by Chakravarthi (2012), colour discrimination was difficult in children with SLI as compared to TDC. Children with SLI also exhibited colour naming errors: semantic errors (‘red’ as ‘pink’ and’ rose’) and phonologic error (/blu/ as /blak/). One possible reason that can be accounted for the errors would be inefficient inhibition of the colours resulting into interference and other, would be due to visual processing deficits. In semantic errors, adjacent colour naming errors was noted (‘pink’ and ‘rose’ for ‘red’) than distant colour naming. To conclude, impaired processing of each component, w.r.t the visual, semantic and phonologic errors reflects the poorer accuracy scores in children with SLI.

Findings of the current study revealed that children with SLI took longer time than TDC for both age groups. In general, the longer time taken by children with SLI can be attributed to the deficit in global processing speed and slowing hypothesis (Kail, 1994) which explains information processing in children with SLI to be relatively slower on any linguistic and non linguistic tasks. The phonological and semantic errors, pause time between each RAN item which reflects the increased time taken for semantic processing and phonological retrieval could have resulted in the increased time in children with SLI. This could be justified by the presence of different type of phonological impairment in children with SLI, namely difficulty processing and storing novel phonological information in phonological working memory (Edwards & Lahey, 1998). Also, as indicated by inefficient inhibition hypothesis children with SLI fail to inhibit the previous response and access the next target response. The failure in inhibition could have also lead to longer time to name. Mean total time taken was found to be greater in 5-6 years than in 6-7 years age for both TDC and SLI. Similar to the findings in TDC, children with SLI took longer time to name RAN O (single category) and RAN CDL (alternate category) in both age groups. The longer time taken for CDL, an alternate RAN category can be attributed to difficulty perceiving and producing rapid, sequential information due to a developmental language disorder.

The findings of the current study revealed that children with SLI performed poorer on reading tasks compared to TDC in both groups i.e., 5-6 years and 6-7 years. The poor reading accuracy scores can be accounted to the poor decoding of letters and awareness of phonemes that has to be followed during the period of reading acquisition as suggested by Chall (1983). Also the delay in language development could contribute to poor decoding abilities. The basic foundation of reading, especially phonological processing abilities is built upon the existing language skills (Goswami & Bryant, 1990). As reported in a longitudinal study half of the children became dyslexic and most explicit routes impaired were either phonological awareness, naming speed, or letter knowledge problems that increase in severity with age. Studies indicate that SLI is a continuum of dyslexia reported by Tallal *et al*., 1988 that low achievement in word recognition at age 8 was noted in 67% of children with SLI diagnosed at 4 years of age. The linguistic and nonlinguistic characteristics typical to children with SLI such as visual processing deficits, lexical semantic deficits, poor inhibition and activation of phonemes and impaired phonological representation add to the underlying language impairment.

5.3 Relationship between RAN and reading in children with SLI

Findings of the study revealed that there was no significant correlation between RAN accuracy measures and reading accuracy in TDC for both age groups. Also, findings of the current study revealed a significant correlation between RAN accuracy measures and reading accuracy in children with SLI, only in the 5-6 years age group. Literature supports that RAN is a predictor in younger children's ability to automatize and connects symbols to letters (Tan *et al*., 2005). Likewise, correlation between reading ability and RAN was found only in the younger age groups and this correlation was not significant in the older age group (Isoaho *et al*., 2015). Similar study reported in literature by Katz *et al*., (1992) comparing RAN scores and tests of reading performance, assessed at ages 6 and 8 years old, revealed significant correlations between RAN verbal and reading scores at both ages in children with language impairment. The relation between RAN and reading is that both requires speeded naming of multiple items in a matrix format and inhibition of previous (already named) stimuli and efficient processing of upcoming items (Jones *et al*., 2009).

As indicated by Bowers (1995), the serial format of RAN mirrors the sequence of letters in a word and demands quick lexical retrieval and coordination of the process required extracting accurate information from serial arrays. Hence, the sub-processes that are suggested to be common to both RAN and reading are visual pattern recognition and visual discrimination (Araújo *et al.*, 2011), sound-symbol associations (Manis *et al.*, 1999), serial processing (Bowers, 1995), precise timing mechanisms (Bowers & Wolf, 1993) and oral output of the names (Georgiou *et al*.,2013). These subprocesses which are observed to be impaired in children with SLI could have lead to stronger correlation between reading accuracy and RAN (Schul *et al.*, 2004 ; Hulme & Snowling, 2009 ; Kail, 1994). Another explanation of closer association between RAN and reading could be due to the fact that reading and RAN-reading association is mediated via orthographic processing (e.g., Bowers, Golden, Kennedy & Young, 1994). It could be that the processes underlying slow naming speed contributing to reading failure through preventing the decoding of connections between phonemes and orthographic patterns at subword and word levels of representation, limiting the quality of orthographic representations in long-term memory. Poor orthographic representation increases the amount of repeated practice needed before an orthographic code to be learned as a lexical or sublexical unit (Bowers & Wolf, 1993). Hence, better performance of alphanumeric stimulus in children with SLI could have resulted in a good correlation of RAN and reading accuracy. However, when compared to TDC, children with SLI especially the younger aged children who are beginners in reading would be slow to activate the letters in the lexicon and identify them in a printed word form. Hence, these children would not gain knowledge of orthographic patterns or form orthographic representations of words as quickly or easily as children with faster letter identification as seen in typically developing children.

Another explanation accounted is the poor oral language of younger aged children with SLI which may result into poor decoding skills (Naucler, 2004). The older age group children in the 6-7 years are assumed to have better decoding skills than younger age group of SLI in the present study. The previous finding of better performance of 6-7 years than 5-6 years on RAN tasks can be considered to understand it better. As noted by Meyer *et al*., 1998, alphanumeric stimulus such as letters and digit tend to automatized with increase in age. Similarly word recognition and production are assumed to automatize in older children. The support for this assumption is lent through the reported study by Reitsma (1983); Ziegler and Goswami (2005). They report that the decoding skills children are acquired by children over time once they apply naming abilities with greater accuracy and speed. Subsequently, word recognition becomes automatized in the older age group.This holds good for a transparent orthography like Malayalam studies as well who report that RAN remains as a predictor of reading in transparent orthographies across grades. Similar findings were observed in Dutch, Greek, or German (Georgiou *et al.*, 2008; Landerl & Wimmer, 2008; Mann & Wimmer, 2002). Despite the nature of the language, RAN seems to be a predictor at an early period of reading acquisition identified in children with SLI.

Summary and Conclusions

Reading is a complex cognitive process, where language forms the basis for understanding and making interpretations out of what is being heard. Factors which influence the acquisition of reading are phoneme awareness, letter knowledge, vocabulary and serial naming. Among these, phonological awareness possessed at younger age was proved to be the best predictor of future reading abilities in earlier literature. Later, it was known that the predictors of reading at school years can vary across orthographies. Phonological awareness was indicated to be predictor of reading fluency in opaque orthography. RAN is considered to be yet another correlate of reading ability in transparent than in opaque languages (Georgiou, Parrila & Liao, 2008). RAN mirrors the process of reading and taps a cognitive mechanism more than retrieving phonolological codes. Children with SLI, who are at risk for dyslexia requires focus on examining the factors which influence their reading abilities later. Hence, RAN an early predictor of reading is assumed to be impaired in Children with SLI.

The present study thus aimed to investigate the relation between rapid automatized naming (RAN) and reading in Malayalam speaking children with SLI. The present study considered two groups: clinical group (children with SLI) and age, gender matched control group (typically developing children) in the age range of 5-7 years. The clinical group was selected using Leonard's (1998) criteria for diagnosing SLI. Rapid automatized naming (RAN) of colours, digits, letters (single category) and digits-letters, colours-digits-letters and reading tasks were assessed in TDC and children with SLI.

Measures of accuracy and time were analysed in RAN tasks. For reading task, accuracy, total time taken and reaction time were measured and analysed.

The objectives of the study are

- To compare the performance of children with SLI and typically developing children on RAN.
- To compare the performance of children with SLI and typically developing children on reading.
- To study the relationship between RAN and reading in children with SLI.
- To observe the developmental trend in RAN across age group in children with SLI and typically developing children.

It was inferred from the current study that performance of RAN was better in older age group i.e., 6-7 years than younger age group i.e., 5-6 years in TDC for both measures of accuracy and time. The reasons accounted for this discrepancy in performance are failure to integrate the processes such as attention, visual, lexical semantic and phonological in younger children which would result in break down at any one of these level. Also the rehearsal and automatization increased the performance of 6-7 years TDC. Also, findings of the present study showed performance of TDC was better on naming RAN- digits for measures of accuracy. In 5- 6 year age group, order of accuracy obtained on RAN was D > DL > L > C > CDL > O. In 6 -7 year age group, the order of accuracy obtained was D > L > DL > C > O > CDL. The higher accuracy scores of letters and digits could be attributed to fact that letter naming and digit naming (alphanumeric) develop faster as compared to colour naming or object naming (non alphanumeric) (Meyer *et al.,* 1998). Lower accuracy scores for colours-digits- letters, an alternate category would be due to the difficulty to access three semantic fields in series.

Findings of the present study showed TDC took longer time to name RAN colours-digits-letters (CDL, alternate category). In 5- 6 year age group, order of time taken obtained on RAN was CDL > O > C > L > D > DL. In 6 -7 year age group, the order of accuracy obtained was CDL > O > C > L > D > DL. The longer time consumed for RAN CDL could be the need to shift to three semantic fields and integration of the process required for naming increased the time taken to name CDL. Greater automatization achieved for digits and letters is reflected as reduced time taken to name them. The findings of the current study revealed that children in the age range of 6-7 years of age showed better performance on reading task with greater accuracy scores, short reaction time and lesser total time taken when compared to 5-6 years of age. It could be due to the faster decoding of letters and syllables in 6-7 years of age than 5-6 years (Chall, 1983). Thus, it can be concluded that the hypothesis formulated is rejected as there is a significant difference found between 5-6 years and 6-7 years of age in TDC on RAN and reading. It was found that older children performed better than the younger children.

Performance of RAN and reading was analyzed for and children with SLI and TDC between two age groups, i.e., 5-6 years and 6-7 years. The findings of the present study revealed that children with SLI performed poorer than children with SLI on RAN accuracy measures on both age groups. Poorer performance of children with SLI can be accounted for visual processing deficit, lexical semantic deficit, weaker semantic representation, phonological impairment, inefficient inhibition, reduced global processing speed and impaired integration of processes. Similar to the findings in TDC, children with SLI had greater accuracy scores on naming RAN D (single category) in both age groups. In 5- 6 year age group, order of accuracy obtained on RAN was D > DL > L > C > CDL > O. In 6 -7 year age group, the order of accuracy obtained was D > L > C > DL> CDL > O. The visual, perseveratory, semantic and phonologic errors which reflect the impaired processing of each component of visual naming resulted in lower accuracy scores in children with SLI. The greater scores on digits and letters are assumed to be due to faster development of alphanumeric stimuli than non-alphanumeric stimuli (Meyer *et al.,* 1998).

Findings of the current study revealed that similar to the findings in TDC, children with SLI took longer time to name RAN CDL (alternate category) in both age groups. In 5- 6 year age group, order of time taken obtained on RAN was CDL > O > C > L > D > D-L (Figure 4.2). In 6 -7 year age group, the order of accuracy obtained was CDL > O > L > C > D > DL (Figure 4.2). This could be due to naming of CDL taxes the working memory as well all the processes involved in visual naming requiring shift to three semantic fields are required. The reason attributed to the better performance of DL could be more exposure, practice which later altered it to an automatized process. The findings of the current study revealed that children with SLI performed poorer on reading tasks compared to TDC in both groups .i.e, 5-6 years and 6-7 years. The poor reading accuracy scores can be accounted to the poor decoding of letters and awareness of phonemes that has to be followed during the period of reading acquisition as suggested by Chall (1983).Thus, it can be concluded that the hypothesis formulated is rejected as there is a significant difference found between performance of TDC and children with

SLI for both age groups on RAN and reading. There was a significant difference found between 5-6 years and 6-7 years in children with SLI on RAN and reading. It was found that older children performed better than the younger children

Findings of the current study revealed a significant correlation between RAN accuracy measures and reading accuracy in children with SLI, only in the 5-6 years age group. These sub processes common to both RAN and reading such as visual pattern recognition and visual discrimination, sound-symbol associations, serial processing , precise timing mechanism and oral output of the names which are observed to be impaired in children with SLI could have lead to stronger correlation between reading accuracy and RAN (Schul *et al.*, 2004). Younger children who are beginners to read cannot activate the letters in a word in sequence (similar to the process of RAN) and later result into reading difficulties. Thus, it can be concluded that the hypothesis formulated is accepted as there was no a significant correlation found between RAN and reading in TDC for both age group. There was no significant correlation between RAN and reading in SLI. The younger age group i.e., 5-6 years revealed a significant correlation between RAN and reading.

Reading acquisition is viewed as highly coordinated process between phonological and semantic sources. Children at the beginning stage of reading connect the orthographic patterns to the phonological representation in their mental lexicon. Later these mappings are endowed by semantic attribute i.e., through word meanings. Thus regular words are read through grapheme phoneme route and irregular word through semantic pathway. In children with SLI, the impaired phonological representation

(Bishop & Snowling, 2004) and lexical semantic deficit (Lahey & Edwards, 1996) place them at risk for reading difficulties. The underlying cause for reading difficulties in these children could be the deficit in phonological awareness (PA), Rapid automatized naming (RAN) and combination of both the deficits, according to Double deficit hypothesis (Wolf & Bowers, 2000). Thus, reading difficulties arise in children with SLI as phonological awareness predicts and has a stronger relation with reading and spelling accuracy and RAN is as a contributor of reading fluency and rate (Furnes & Samuelsson, 2011). Thus present study confirms role of RAN as an indicator to predict the linguistic and cognitive processes required for reading skills in children with SLI at younger age.

Implications of the Study

The current study in children with SLI and typically developing Malayalam speaking children indicated a developmental trend on RAN and reading tasks. The speed of processing was not found to have relation between RAN and reading in Malayalam speaking younger aged children with SLI. This strengthens the view that language difficulties at younger age may contribute to reading difficulties later. Also, the results provide theoretical implications in terms of the naming processes and impairment in children with SLI. It gives a direction that RAN could be assumed as one of the early predictor of literacy skills in younger aged children with SLI. Hence it is suggested to include RAN tasks along with phonological awareness to tap the literacy difficulties in children and as a measure of the efficiency of processes related to word retrieval and reading fluency (Wolf & Denckla, 2005).

The study also gives provides opportunity for further researchers to conduct similar studies in different languages. The present study which, explores the relation between RAN and could be done in much younger age group considered for this study.

Limitations of the study

The samples of SLI are collected from a particular district and hence cannot be generalized to all Malayalam speaking children with SLI in 5-7 years of age

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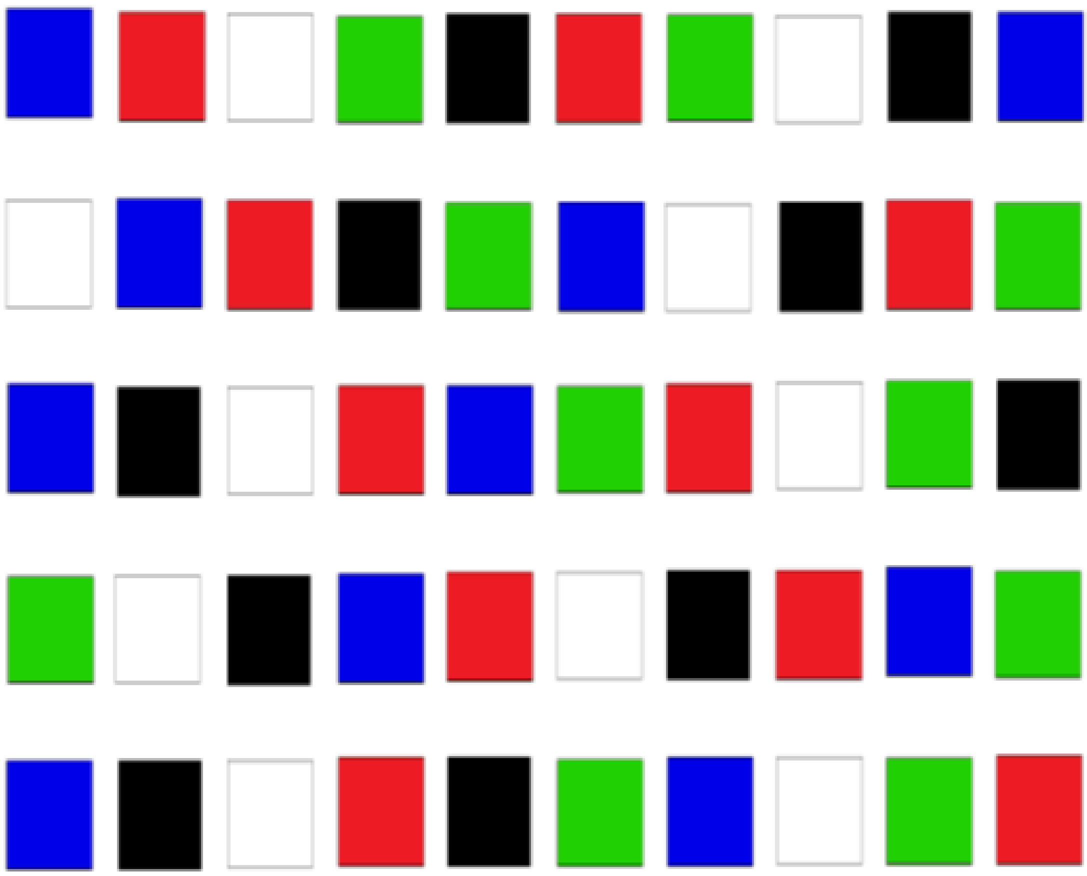
APPENDIX 1

RAN COLOURS



RAN DIGITS

4	7	2	6	9	7	6	2	9	4
2	4	7	9	6	4	2	9	7	6
4	9	2	7	4	6	7	2	6	9
6	2	9	4	7	2	9	7	4	6
4	9	2	7	9	6	4	2	6	7

RAN LETTERS

ത മ ക പ വ മ പ ക വ ത

ക ത മ വ പ ത ക വ മ പ

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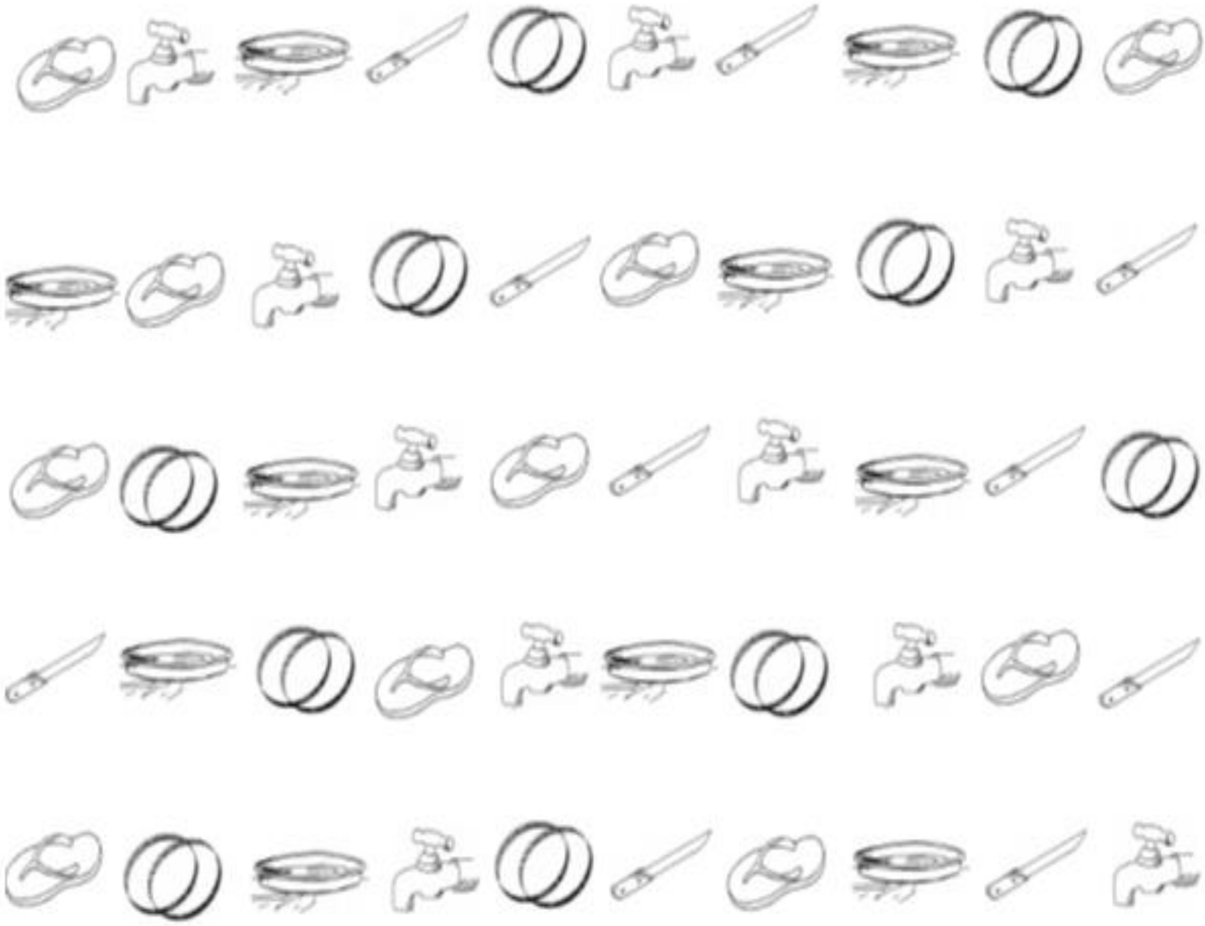
RAN OBJECTS



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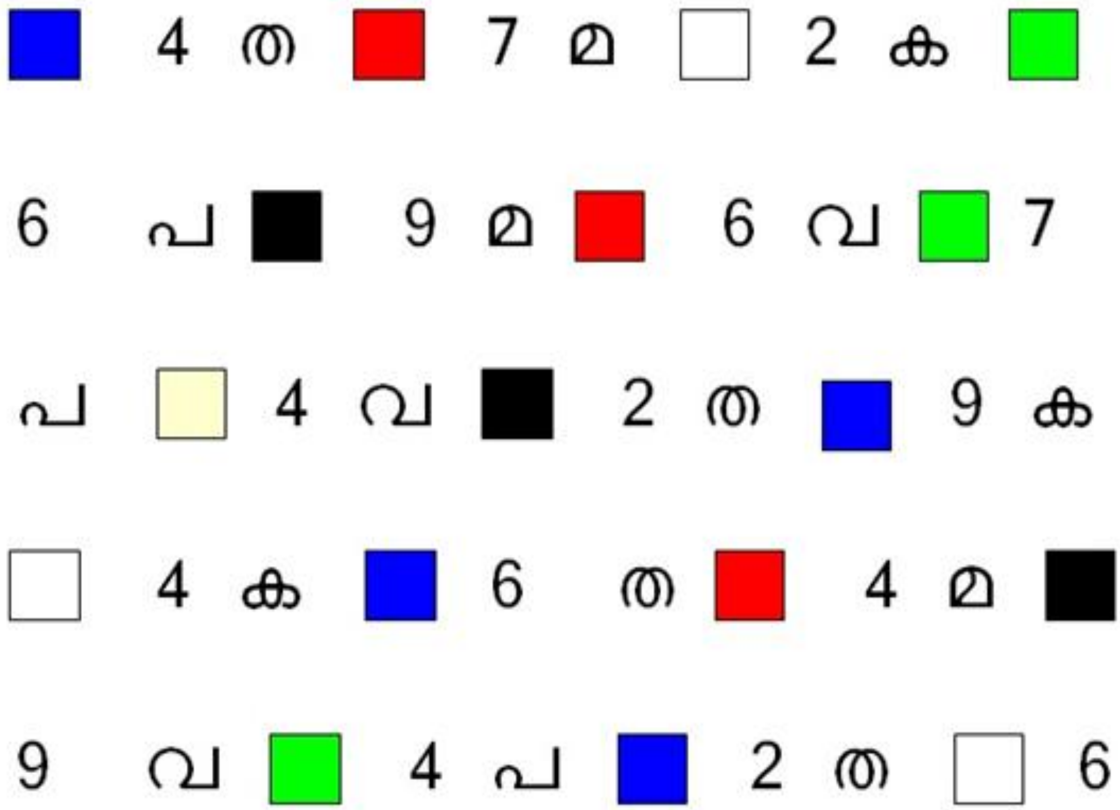
RAN DIGITS –LETTERS

4	ത	7	മ	2	ക	6	പ	9	വ
6	മ	4	പ	7	വ	9	ക	2	ത
7	ക	6	ത	9	മ	2	പ	4	വ
2	ത	9	ക	4	പ	7	വ	6	മ
4	പ	2	വ	9	ത	6	മ	7	ത

RAN COLOUR-DIGIT-LETTER



APPENDIX 2

WORDS FOR READING TASK IN MALAYALAM

ആന	ഇല
അല	ഇര
അമ്മ	കട
അപ്പം	കുട
അറ	മാനം
അവൻ	മനം
ബലം	മരം
ഏണി	ഒന്ന്
എലി	ഓല
താലം	തല

പാവ	തലം
പച്ച	തന്നു
പണി	ഉരി
പറവ	വല
പിട	ഈര