DYSLEXIA ASSESSMENT PROFILE FOR IN INDIAN CHILDREN (DAPIC)

KUPPURAJ.S

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Dissertation submitted in part fulfillment

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CERTIFICATE

This is to certify that the dissertation entitled ***"Dyslexia assessment profile in Indian children (DAPIC)"*** is the bonafide work submitted in part fulfillment for the degree of Master of Science (Speech Language Pathology) of the student (Registration No.07SLP009). 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 ***"Dyslexia assessment profile in Indian children (DAPIC)"*** is the result of my own study under the guidance of Ms. Jayashree.C.Shanbal, Lecturer in Language Pathology, Department of Speech-Language Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any other University for the award of any Diploma or Degree.

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CHAPTER 1

Introduction

Reading is a complex cognitive process that involves multiple skills (Prema, 1997). Components of reading ability include phonological awareness, phonological decoding, reading comprehension, spelling, orthographic knowledge and rapid automatized naming (Gayan & Olsen, 2003). Before one becomes completely literate, he or she must develop early reading skills which comprised of steps like literacy *awareness, syntactic awareness, word recognition*, *phonological awareness*, *orthographic awareness* (Strommen & Mates, 1997).

Reading process is the conversion of print into auditory equivalents and the subsequent interpretation of those equivalents into meanings based on previously learned language. The reading process includes decoding of the print in to sound. Decoding begins with the process of converting individual letters into sounds and proceeds to the decoding of whole words and phrases. A person who cannot decode printed words cannot understand what those words mean. Comprehension is the next step which is the ability to interpret and understand the decoded words. Although adequate decoding is a prerequisite for reading it is not sufficient, comprehension is also required. The ability to comprehend what one reads is based on experience. Readers take what has been read and integrate it with previously learned language and experience.

The next component of literacy is writing. Written language is characterized by rules of phoneme grapheme correspondence (Nagy, Berninger, Abbott, Vaughan & Vermaulen, 2003), the rules of orthographic knowledge (processing written language letters and letter patterns), phonological knowledge (processing or manipulating oral language sounds), and morphological awareness in spelling performance have been well documented. As a result spelling is related to reading and written expression. Spelling is one of the most valued yet difficult skills in written communication. Spelling requires matching the sounds of language with the appropriate letters in order to accurately and reliably conveys messages. A child's ability to spell words correctly shows a sophisticated knowledge of letters, sounds and syllable patterns (Bear & Templeton, 1998). There are several stages through which a child travels before master spelling skill. Gentry (1982) proposes stages like precommunicative (where the child uses symbols from the alphabet but shows no knowledge of letter-sound correspondences), semi phonetic(sounds are assigned to letters), phonetic (The child uses a letter or group of letters to represent every speech sound that they hear in a word), transitional (the speller begins to assimilate the conventional alternative for representing sounds),and correct stage(the speller knows the English orthographic system and its basic rules). Frith (1985) also proposes parallel but different stages through which a child goes through before he acquires complete knowledge of spelling. These stages are logographic, alphabetic and orthographic stage of spelling development.

Fletcher. Lyon, Fuchs, & Barnes (2006) have quoted that reading is not natural and everyone is taught to read. Those children who lack the ability to learn literacy skills are considered 'dyslexic'. Despite years of research, mostly in the English language, there is still no consensus as to the definition of dyslexia, nor its underlying cause. The current dominant view (Masland, 1997) argues that the cause of the educational difficulties faced by dyslexics

centre around core difficulties in phonological awareness and word decoding skills. (Stanovich, 2000) admits that it may be related to deficits in processing novel letter string.

Smythe and Everatt (2000) proposed the following definition which incorporates many of the features identified by research as important in these diverse mono and multilingual environments.

> *"Dyslexia is a difficulty in the acquisition of literacy skills that may be caused by combination of phonological processing, visual and auditory system deficits. Lexical confusions and speed of processing difficulties may also be present. The manifestation of dyslexia in any individual will depend upon not only individual cognitive differences, but also the language used."*

There are several causes proposed in the literature for dyslexia. They are heredity (Pennington, 1989), brain differences (Galaburda, 1991), defects in rapid temporal information processing (Tallal, Miller & Fitch 1993), selective attention and attention deficit disorder (Zentall, 1993), middle ear problems (Roberts & Medley, 1995), Cognitive rigidity and learned helplessness (Clay, 1984). Akin causes of dyslexia, there are several types of learning difficulty (dyslexia) exist. Theoretically there are as many types of dyslexics as number of cases do, making the dyslexic group a heterogeneous one. Newcombe and Marshall (1984) proposed a reading model which explains normal visual word reading. This model composed of two routs namely lexical (direct route) through which words and irregular words are read. Another route of the model is the sublexical route (indirect route) through which non words are read. Castles and Coltheart (1993) broadly classifies dyslexia in

to two main types called phonological and surface dyslexics. He opined that with difficulties in sub lexical skills shall come under phonological dyslexics and if the children with dyslexia have difficulties in lexical skills, he/she may fall under surface dyslexia.

Edwards and Hogben (1999) included another type of dyslexia called mixed dyslexia, dyslexia of this subtype tend to find difficulties in both lexical and sublexical route of reading , along with already proposed two types. There are several other subtypes of dyslexia proposed by other investigators. Boder (1973) classifies dyslexics into dysphonetic (having difficulties especially with grapheme–phoneme conversion, i.e. with the indirect route for reading), dyseidetic (having difficulties with visual recognition of whole words, i.e. with the direct route for reading) and mixed (having both types of difficulties) subtypes. Bakker (1979, 1990) classifies dyslexia into P-types (relying on perceptual, analytical strategies for reading, which turns out to be slow, fragmented and hesitating), L-types (relying on linguistic, anticipatory strategies for reading, which allow for quicker reading but produce many, usually plausible and context-based errors) and M-types (mixed types, showing both slow, fragmented reading and many errors). Children with dyslexia and their subtypes need to be identified with appropriate assessment measures so that the intervention for the same can go according to the subtype of dyslexia that has been identified.

There are several western assessment tools available to assess dyslexia using standard scores. For e.g., Stanford diagnostic reading test-4(SDRT 4) by Karlsen and Gardner (1996), Test of Reading comprehension-3(TORC3) by Brown, Hammil and Weiderholt (1995), Woodcock Reading Mastery tests-Revised (WRMT-R) by Woodcock (1997), Oral and Written language scales (OWLS) by Carrow & Woolfolk (1995) , Test of Written expression (TOWE) by McGhee, Bryant, Larsen & Rivera (1995), Test of Written Language -3 (TOWL 3) by

Hammill and Larsen (1996),Test of Written Spelling-3 (TWS-3) by Larsen and Hammill (1994). However, existence of successful assessment tool in Indian multilingual context has been challenged. The purpose of an assessment should be to produce an appropriate individual education plan (IEP) that clearly identifies the individual's strengths and weaknesses, their specific needs, and the timescale and resources required to implement the IEP. It should attempt to match the teaching style to the preferred learning style of the individual in order to maximize the amount learnt in a given time. The term dyslexia may be used to refer to children presenting very different profiles of strengths and weaknesses, and therefore may be of limited use in determining the IEP. What is required is greater specificity, such as a child's ability in phonological and non phonological tasks, which will enable us to classify them under appropriate subtype, which will intern pave way for appropriate treatment plan. Thus need to understand the cognitive profile and attainment measures become even more important for planning intervention program for individual with dyslexia.

Moreover, the estimated prevalence rate of learning disability have been found to range from 3% to 10% (Snowling, 2000) that is approximately 1 in 59 or 1.69% or 4.6 million people in USA. Prevalence rate in India ranges from 3% to 10 %(Ramaa, 2000). The high prevalence rate of learning disability (3% to 10%, Ramaa, 1985) indicates the need for early identification and intervention based on individual performances. Reviewing the available literature, it has been found that dyslexic population in vastly heterogeneous and this heterogeneous nature in the dyslexic group poses the requirement to profile the learning disabilities on individual based performance. To avail the existing treatment program appropriately, it is important that the children with dyslexia are sub grouped under existing subtypes based on their individual performances after profiling.

Objectives of the study

I. To study the development of reading and writing skills in Indian children.

II. To identify subtypes of dyslexia based on the profiles established on children with dyslexia

CHAPTER 2

Review of literature

Literacy is defined as the minimal ability to read and write in a designated language, as well as a mindset or way of thinking about the use of reading and writing in everyday life. Literacy, requires an active, autonomous engagement with print and stresses the role of the individual in generating as well as receiving and assigning independent interpretations to messages (Harris & Hodges, 1995).The components of literacy includes reading, writing, and listening (Cunningham, 1995). Other components of literacy include phonological awareness, phonological decoding, reading comprehension, spelling, orthographic knowledge and rapid automatised naming (Gayan & Olsen, 2003).

2.1. Development of reading and writing skills.

Before one becomes completely literate, he or she must develop early reading skills which comprise of five steps (Strommen & Mates, 1997), in which each successive step is built up on the established previous stage.

First area to develop is *literacy awareness*, which is concerned with the young child's understanding and experience of print.

- The second area of reading development is *syntactic awareness* or knowledge of grammatical structure.

- The third area of reading development is *word recognition*. In this stage children are recognizing words as visual shapes rather than as combinations of letters.

- The fourth area is development in *phonological awareness*. Phonological skills develop across time and that various aspects of phonological sensitivity are differentially predictive of reading (Lonigan**,** Burgess, Anthony, & Barker, 1998).
- The final area of early reading is *orthographic awareness.* It is defined as knowledge about the writing system and how letters and letter strings are used to represent words. Evidences from literature reveals that has highly developed perceptions from the time of birth. With in a few days, a baby is able to distinguish the mothers voice from others voices and from less meaningful sounds. Thus the receptive faculty, the ability to distinguish and understand what is heard, develops from before oral language skill. *Reception and expression of oral language* are the child's first and for several years only means of communication; they are considered most critical in the development of reading skills.

Though there are several prerequisites for later reading development, not all the prereading skills are proven to be significantly influencing the later reading development. Phonological awareness has been shown to be a primary factor underlying early reading development (Ehri, Nunes, Willows, Schuster & Shanahan, 2001). Deficits in phonological awareness have been linked to reading disabilities (Lyon, Shaywitz & Shaywitz, 2003). Phonological awareness, when compared to many other predictors, was the most stable and robust indicator of later reading in the group of children who were followed from late preschool to kindergarten and first grade (Adams, 1990; Bryant, MacLean, Bradley & Crossland, 1990; Lundberg, Frost, Cunningham, 1991; Whitehurst & Lonigan, 2001; Lonigan, Burgess & Anthony, 2000). Manis, Seidenberg,Doi **,** McBride-Chang and Petersen (1996), Pennington, Cardoso-Martins, Green and Lefly (2001) and Torgesen, Wagner, Rashotte, Burgess and Hecht (1997) suggested after their longitudinal studies that phonological tasks like alliteration and rapid naming(RN) were differentially related to reading ability.

Specifically it has been suggested that although alliteration is the most important for the development of the ability to learn to read by phonological recoding, RN skills may be especially important for learning about the orthography of word. Naming objects rapidly has been considered as a skill necessary for fluent, skilled reading. Indeed, RN has been consistently found to be related to fluency of text reading even in the present study. The individual's writing ability can be a good predictor of reading thus spelling as a significant predictor of reading (Read, 1971; Clarke, 1988; Dyson 2001; Richgels, 2001; Whitehurst & Lonigan, 2001).

Once children begin reading however the best indicator of current and future reading may simply be reading itself (Bell, McCallum & Cox, 2003). Wagner et al., (1997) experimented the amount of information that a measure of phonological awareness could add to the prediction of reading once a measure of current word reading and vocabulary was considered .The results revealed that the phonological awareness is less efficient in prediction of reading as the child gets older. It is well accepted that reading consists of two components, decoding and comprehension (Aaron, Joshi & Williams, 1999). Decoding is the word recognition process that transforms print to words, whereas comprehension assigns meanings to words, sentences and texts. Catts and Kamhi (1999) reported that word recognition relies heavily on phonological and lexical knowledge where as comprehension of larger discourse units requires syntactic, morphologic, semantic and discourse knowledge. A logical consequence of the language basis of reading is that children who have deficiencies in one or more aspects of language will experience difficulty learning to read.

When the child enters school and turns to the task of reading, the visual discrimination task becomes of key importance. This skill must already be highly developed before letter recognition and the ability to identify the relatively small differences between one letter and another will be possible. In addition, the social and emotional development of

the child will prove vital to all school experiences. These prerequisite skills flow in to and influence the acquisition of the beginning reading skills. A child of average intelligence is expected to learn to read if he has only reasonably good teaching. Learning to read, for many children seems not to require much effort. They appear to attain this ability almost incidentally. They quickly make associations between the printed symbol, the auditory symbol and meaning which is referred to as *grapheme to phoneme correspondence*. Meanwhile for the development of reading patterns, ordering skills or the skills of directionality are required.

The acquisition of phonic skills or the acquisition of the relationship between specific sounds and specific symbols must be mastered in order for the children to succeed in their reading journey. However the relationship between the grapheme and the phoneme in all the language are not linear .The languages where there is only one sound for each letter, the assigning phoneme to a grapheme step is relatively easy. But in languages like English the association of various different letters sounds with a particular letter and various different letters with a particular sound makes mastery of the sound symbol relationship more difficult. Further to master in reading skill, the student must also be able to blend these sounds together into a recognizable word and to development the reading patterns, ordering skills or the skills of directionality are required. Additional abilities of word or the ability to divide words into syllables and use of structural word analysis to distinguish prefixes, suffixes and root meanings are also equally vital in reading process. Simultaneous with the acquisition of the phonic skills is the assignment of meaning to words encountered in print much of the initial meaning of these words is drawn from the children's background experiences in their environment. Comprehension skills develop and mature as the child encounters words in print that appear in a new context. The child learns that words have multiple meanings and that some words have implied or connotative meaning according to

the culture. As sentences combine into paragraphs and paragraphs into stories, the meanings of words and ideas become more complicated. Both literal and interpretive skills become increasingly important.

Further reading process can be explained through Dual Route Cascaded (DRC) model of reading. According to this model there are two routs in translating print in to sound. A lexical route, which utilize word-specific knowledge, and a non-lexical Grapheme-to-Phoneme Conversion (GPC) route, which utilize a sub-lexical spelling-sound correspondence rule system. The lexical route translates the pronunciation of a word based on word specific knowledge. The route consists of three components they are semantic system, the orthographic lexicon, and the phonological lexicon. The semantic system computes the meaning of a word, whereas the lexicons compute the words' orthographic and phonological form. The non-lexical route differs from the lexical route in both the knowledge base and the type of processing it employs. The non-lexical route generates the pronunciation of Letter string (be it a word or a non-word) via a set of sub-lexical spelling-sound Correspondence rules. The set of rules is encapsulated in the GPC module. Based on the two routes proposed, disruption in any of the pathway may result in reading difficulties of different varieties namely *phonological* and *surface dyslexia*. If the affected route is lexical route the patient is said to be having surface dyslexia. The characteristics of surface dyslexia are inability to read irregular words, while the patient has intact ability to read regular words and regular non words. If the non-lexical GPC route is affected, the patient may show difficulties in reading regular words and both regular and irregular non words.

In summary *reading process* is the conversion of print into auditory equivalents and the subsequent interpretation of those equivalents into meanings based on previously learned language. The reading process includes decoding of the print in to sound. Decoding begins with the process of converting individual letters into sounds and proceeds to the decoding of whole words and phrases. A person who cannot decode printed words cannot

understand what those words mean. Comprehension is the next step which is the ability to interpret and understand the decoded words. Although adequate decoding is a prerequisite for reading it is not sufficient, comprehension is also required. The ability to comprehend what one reads is based on experience. Readers take what has been read and integrate it with previously learned language and experience. The next component of literacy is writing. Written language is characterized by rules of phoneme grapheme correspondence the rules of orthographic knowledge (processing written language letters and letter patterns), phonological knowledge (processing or manipulating oral language sounds), and morphological awareness in spelling performance have been well documented (Nagy, Berninger, Abbott, Vaughan & Vermaulen, 2003). Spelling development in normal children can be derived from connectionist model (Seidenberg & McClelland, 1989) of alphabetic spelling development. Loosemore, Brown and Watson (1991) studied the development of alphabetical spelling system using the artificial connectionist model and concluded that during the early course of development, they observed regularization errors and these errors faded as the model was exposed to more alphabetical spelling system.

According to Gentry (1982), as the grade increases several stages in spelling development like precommunicative (where the child uses symbols from the alphabet but shows no knowledge of letter-sound correspondences), semi phonetic(sounds are assigned to letters), phonetic (The child uses a letter or group of letters to represent every speech sound that they hear in a word), transitional (the speller begins to assimilate the conventional alternative for representing sounds),and correct stage(the speller knows the English orthographic system and its basic rules).

According to Frith (1985) spelling and reading development interact leading to increased proficiency in each ability. He proposed of three stages through which a child goes through while acquiring spelling and reading like logographic, alphabetic, and orthographic.

Literacy development begins with logographic reading where child acquires a small sight vocabulary of written words and word recognition visually based but becomes increasing less efficient with development. E.G.' yellow' recognized by the "two sticks in the middle of the word" 'follow' read as "yellow" due to the double 'l' shared by both words. In the alphabetic stage of spelling development some phonological awareness is required. The child's wish to write brings about change from logographic stage to alphabetic stage. Here by practicing spelling child learns that spoken words can be broken down into speech sounds (phonemes) that map onto letters. Even though child applies letter-sound rules in spelling but rely on visual cues for reading. In the orthographic stage through considerable practice at reading using an alphabetic strategy child learns to recognize words as orthographic units. Further in this stage, word recognition occurs by accessing stored internal representations of abstract letter-by-letter strings. Orthographic representations used in this stage of reading are precise enough to be transferred to spelling. Thus, orthographic reading drives the development of orthographic spelling skills. To summarize Firth's stages, it can be correlated with Gentry's stages which says that spelling shifts from phonetic, to transitional, to correct spellings.

Writing is defined as a complex process linking language, thought and motor skills. Early writing is more closely linked to early spelling than to early reading. When children begin to spell, they use a simple decoding strategy based on sound-to-symbol correspondence, whereas early readers rely on a visual approach to word recognition (they tend to use contextual cues). Marsh, Friedman, Welch & Desberg (1980) investigated and reported that at a later stage, most children seem to learn to alternate between the two strategies. However this may not happen for children who have difficulty in learning to read.

As a result spelling is related to reading and written expression. Spelling is one of the most valued yet difficult skills in written communication. Spelling requires matching the

sounds of language with the appropriate letters in order to accurately and reliably conveys messages. A child's ability to spell words correctly shows a sophisticated knowledge of letters, sounds and syllable patterns (Bear & Templeton, 1998). In children with dyslexia (CWD), damage to the orthographic input lexicon leading to inability to recognize words lexically, so they would not spell lexically and so will be regularizing the irregular words (Bub, Cancelliere & Kertesz, 1985; McCarthy & Warrington, 1986)

Literacy development is a multidimensional, complex process requiring adequate exposure to print and word knowledge which emerges with appropriate teaching. Fletcher et al (2003) has quoted that reading is not natural and everyone is taught to read. Those children who lack the ability to learn literacy skills are considered 'dyslexic'. Despite years of research, mostly in the English language, there is still no consensus as to the definition of dyslexia, nor its underlying cause. The current dominant view argues that the cause of the educational difficulties faced by dyslexics centre around core difficulties in phonological awareness and word decoding skills. Smythe and Everatt (2000) define that

> *"Dyslexia is a difficulty in the acquisition of literacy skills that may be caused by combination of phonological processing, visual and auditorysystem deficits. Lexical confusions and speed of processing difficulties may also be present. The manifestation of dyslexia in any individual will depend upon not only individual cognitive differences, but also the language used."*

Learning disabilities is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading and writing, reasoning a or mathematical abilities. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction even though a learning disability may occur concomitantly with other handicapping

conditions(i.e. sensory impairment and mental retardation), social and economic disturbances or environmental influences (i.e. cultural differences , insufficient /in appropriate instruction, psychogenic factors), it is not the direct result of those conditions or influence (Hammil, Leigh, McNutt & Larsen ,1987).

One of the evidences is provided by Scarborough (1990), who after examining the very early language deficits in 52 children with dyslexia, grouped 30 month old subjects into three sets. The first group had 20 children from families with an incidence of dyslexia who subsequently became disabled readers; the second group had 12 children from families with incidence of dyslexia became normal readers and the third group had 20 children who and no history of dyslexia (i.e. they were normally achieving). Scarborough (1990) found that children who demonstrated dyslexia usually experienced difficulty with three emergent literacy skills during the preschool period. The results showed that, at 2.5 years they produced shorter, syntactically simpler sentences with less accurate word pronunciations than other 2 year old while demonstrating normal lexical or speech discrimination skills. At three years of age, they began to demonstrate deficits in receptive vocabulary and object-naming abilities. At 5 years of age, they exhibited problems in object naming, poor rhyme recitation abilities, poor letter sound knowledge, and phonemic awareness deficits.

Difficulties of individuals with dyslexia extend beyond the domain of written language and can be found in performance on a range of tasks that require phonological processing (Gallagher, Frith, Snowling**,** 2000; Vellutino, Fletcher, Snowling, & Scanlon, 2004). Next to limitations of verbal short-term memory, deficient phonological awareness is the most consistently reported difficulty in dyslexics (Snowling, 2000). It involves reflecting on the sound structure of words separately from their meaning, grammar or spelling and is tested in tasks in which syllables or phonemes have to be identified, manipulated, added or deleted in spoken language Moreover, subtle impairments can be observed in speech

perception and production, including naming deficits, deficits in rapid automatized naming and verbal repetition deficits (Snowling, 2000).

There are several types of learning disabilities described in literature.

Factors that contribute to dyslexia include:

Heredity: Converging evidence indicates phonological awareness skills and subsequent deficient phonological coding of written language are genetically influenced**.** Pennington (1989) concluded that Dyslexia is familial, substantially heritable, and heterogeneous in its genetic mechanisms. At least some forms of familial dyslexia appear to be autosomal dominant, with linkage studies supporting both major locus on chromosome 15 and genetic heterogeneity. Lubs et al., (1991) recognized an interaction between a gene(s) for dyslexia, sex hormones, and possible even concomitantly caused immunologic responses in the development of brain in dyslexia. Findings from linkage studies suggest that there are genes that lead to dyslexia associated with chromosomes 15 and 6.

Brain differences: The overabundance of tree like connections produced during the development of the human brain is usually pruned-weeded out- by a natural process of selection resulting from chemical and experimental "environmental" influences. Galaburda (1991) found that the right hemisphere in brains of dyslexics have too many brain cells, suggesting that something has interfered with the normal pruning process". He reported that the left hemisphere planum temporale was larger in the brains of reading disabled persons, suggesting a generalized problem with necessary developmental pruning of some neuronal substrates. According to him an optimal match is needed between the number of neurons and their connections in a neural net so that a particular behavior can be achieved. Too many or too few neuron match ups can be deleterious for the developing skill. He also hypothesized that the neurons in questions ate not only misplaced, but the affected cortex is

different in terms of its cellular and connectional architecture, hence its functional architecture as well.

Defects in rapid temporal information processing in the nervous system (Tallal, Miller & Fitch, 1993) maintained that temporal mechanisms in the nervous system play a central role in aspects of information processing and production, and may be especially critical foe the normal production and maintenance of sensory motor integration systems as well as phonological systems. Findings from a series of studies beginning in the 1970s, led Tallal and colleagues to conclude that some students with developmental language and reading problems demonstrate a severe developmental deficit in processing brief components of information that enter the nervous system in rapid succession, and a concomitant motor deficit in organizing rapid sequential motor output (Tallal et al., 1993).They described this deficit as highly specific , impinging primarily on neural mechanisms underlying the organization of information with in the tens of millisecond range.

Selective attention and attention deficit disorder: The primary purpose of reading is to obtain the author's intended meaning. To do this one, must proceed through a series of reading skills. The most fundamental of these is the ability to attend selectively to relevant features while ignoring irrelevant stimuli. Selective attention develops with maturation and learning. A lag in its development can contribute to difficulties in reading, writing and spelling. When more then one learning disability co-exists with dyslexia, the co morbid condition is called dyslexia plus syndrome (California Department of Education, 1994).Attention deficit hyperactivity disorder has been implicated as a contributing factor to specific reading disability and in many cases, co-occurs with it. Zentall (1993) found that

students with ADHD are more likely to receive lower grades in academic subjects and on standardized reading and math tests that their normally achieving peers.

Middle ear problems: Roberts & Medley (1995) hypothesized that hearing loss associated with persistent and /or recurrent OME causes the child to receive a partial or inconsistent auditory signal. The child consequently encodes information incompletely and inaccurately into the database from which language develops. A child may then be at a disadvantage for learning speech and language. This, in turn may negatively influence later academic achievement, particularly in reading and other language based subjects. Additionally, a child who hears a decreased or inconsistent auditory signal may tune sound out and become inattentive.

Cognitive rigidity and learned helplessness: Possibly as a result of one or more of the above factors, many students with specific reading disabilities display cognitive rigidity that slows information retrieval. Clay (1984) suggested that students with reading disabilities have stopped making appropriate responses, and instead, rigidly specialize unparticular types of responses many of which are ineffective.

The causes of dyslexia can be comprehensively explained by the model given by Morton-Frith (1993). According to the model, four factors namely biological, cognitive, behavioral and environmental influences are essential for normal reading development. Genetic inheritance and bio-physico-chemico environment are assumed to be contributing to biological factors, which is internal and exhibited through reading problems. Cognitive processing in form of phonological processing, auditory processing, visual processing, speed of processing and lexical access too contribute to the successful reading .Other external environmental factors like language abilities of the child, teaching at school, socio economic status of the child and culture in which the child is being raised are assumed to be

influencing the reading development of the child. Because any of the causal and contributing factors previously presented may interfere with the normal, developmental progression of reading acquisition, a child may enter school unprepared for the materials and approaches used in the regular curriculum. Smythe (1999) reports, dyslexia may be caused by a combination of phonological, visual and auditory processing deficits. He adds that Word retrieval and speed of processing difficulties may also be present. A number of possible underlying biological causes of these cognitive deficits have been identified, and it is probable that in any one individual there may be several causes .In addition dyslexia may also be related to a number of problems which may include some or all of the following:

- Making errors with numbers (telephone numbers, reversing bus number etc.)
- Difficulty with organizational skills, including time management
- Misplacing personal items such as keys.
- Making mistakes copying things down (instructions, number etc.)
- Confusing dates, and missing appointments
- Difficulty with orientation, e.g. with maps or in strange towns
- Confusing left and right
- Problems with explaining ideas and concepts, particularly on paper.
- Word finding difficulties, and mispronunciation of long words.

While the dyslexics may experience difficulties in the acquisition of reading, writing and spelling, they can be taught to find strategies and alternative learning methods to overcome most of these and other difficulties. However some problems, such as poor spelling, may persist into adulthood. He also admits that every dyslexic is different, and should be treated as an individual. Werker & Tees (1987), revealed auditory processing deficit in dyslexics. Study by Tallal, Miller & Fitch (1993) from their study after extensive research about the processes those are affected in dyslexics concluded that temporal aspect

in auditory and visual processing are deficient in dyslexics. They explain that the acquisition of higher level speech processing of basic sensory information entering the nervous system in rapid succession, 'within milliseconds'. Thus there is a basic temporal impairment, a tenth of millisecond delay in the time information from peripheral sensory apparatus is relayed to the central nervous system .The delay in temporal integration causes a cascade effects, starting with the normal development of efficient phonological abilities, and in turn resulting in subsequent failure to learn to speak and read normally. Normal temporal sequencing is essential to develop neural representation of phonemes, which must be distinguished from the stream of speech and combined to form words (Tallal, Merzenich, Miller & Jenkns, 1998).

The deficit in temporal sequencing however is not limited to the auditory area. The magnocellular visual pathway that integrates rapid reception and rapid processing of visual information has been described as poorly functioning in dyslexia compared with the slower processing component of the visual system, the parvocellular system, the component important for analyzing a scene in greater and more leisurely detail.

2.2. Theories of Normal Reading

Cognitive neuropsychological dual route models (see Figure 1) propose that a skilled reader uses two main procedures for converting print into speech which are referred to as the lexical and sublexical processing routes. The lexical reading route relies on visual word recognition through access to an internal store of learned familiar words. This route allows successful and efficient processing of familiar words (both regular and irregular), but not novel words or pronounceable nonwords, thus the need for an alternative sublexical reading procedure. The sublexical reading procedure involves rule-based grapheme-to phoneme conversion and allows the skilled reader to "sound-out" unfamiliar words and nonwords.

The development of cognitive models of reading has largely been based on research investigating normal skilled reading and acquired reading disorders of adulthood. However, the suitability of applying such models to developmental disorders has been debated (Bishop, 1997; Frith, 1985; Seymour, 1987; Seymour & Bunce, 1994) due to their failure to specify explicitly the components and contents of partially formed systems and the principles by which an "illiterate" cognitive system changes or develops into a fully skilled adult system (Seymour, 1990). Developmental stage models have been proposed as an alternative theoretical framework (Frith, 1985; Seymour, 1987, 1990).

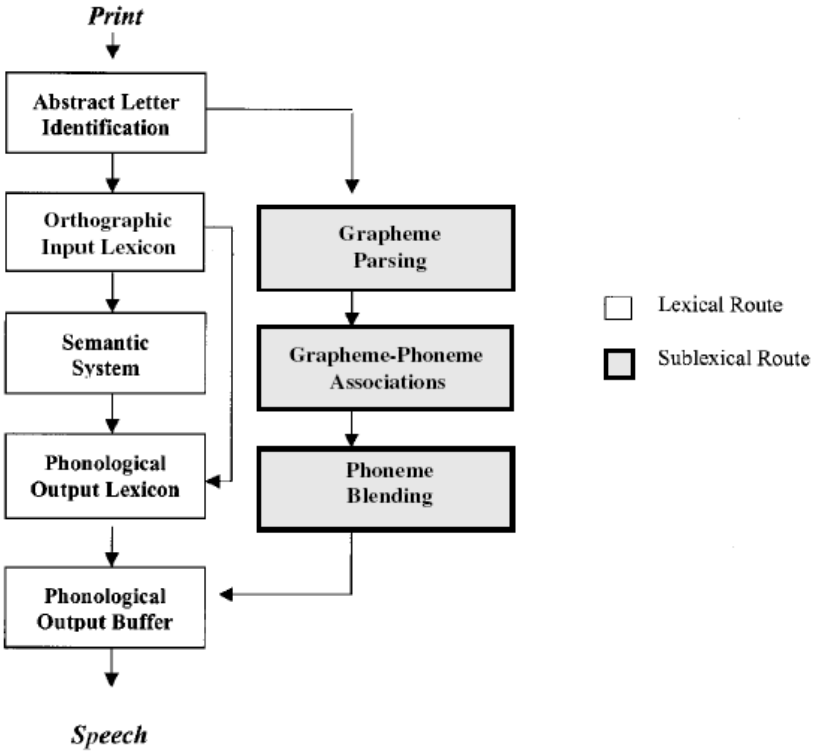


Figure. 1: Cognitive neuropsychological dual route model of reading (adopted from Newcombe & Marshall, 1984).

In brief, however, developmental models emphasize the importance of developmental aspects of learning to read and stress that different reading and spelling processes are favored at various stages of normal reading development. They stress the need for models of developmental dyslexia to incorporate an explanation of the *processes*

by which children achieve skilled reading. The challenge facing current theorists in this area lies in the formulation of a "static" model that can successfully represent a fluid (i.e., constantly changing) developing process. In addition, such a model would need to incorporate individual differences in innate preferences (or strengths and weaknesses) in early reading, as well as the possibility that the manner in which children acquire reading skills depends on teaching strategies employed in the classroom (Mann, 1986; Seymour, 1987; Seymour & Elder, 1986; Seymour & Evans, 1992; Stuart, 1995; Stuart, Masterson, & Dixon, 2000).

There is now growing evidence that current dual route models of adult skilled reading can be applied to developmental reading disorders (e.g., Castles & Coltheart, 1993; Coltheart, Bates & Castles, 1994). More specifically, one can propose that developmental dyslexia reflects a selective failure or delay in the acquisition of specific components of the model (Coltheart et al., 1994). A growing number of case studies of developmental dyslexia as well as studies of normal reading development are supporting this proposal (e.g., Castles & Coltheart, 1993; Coltheart et al., 1983; Edwards & Hogben, 1999; Hanley, Hastie & Kay, 1992; Temple & Marshall, 1983). It has been hypothesized that the representations of speech sounds (phonological representations) are coarsely coded and under-specified in phonological dyslexics (Elbro, 1996; Hulme & Snowling, 1992 and Snowling, 2000). In surface dyslexics the disconnection is in between the semantics and phonological functions leaving only the sub lexical route in operation (see Figure.1). So, the reading of non words is relatively intact in this population. Most studies in literature have found that surface dyslexics had weaker phonological deficits than phonological dyslexics (Manis, McBride-Chang, Seidenberg, Keating, Doi & Munson, 1997; Stanovich, Siegel & Gottardo, 1997).

Castles and Coltheart (1993) propose that children with developmental dyslexia can be broadly classified into two main subtypes, those with a relative delay in the development

of lexical or sublexical reading skills, commonly referred to as surface and phonological dyslexia, respectively. Current classification systems such as this readily highlight children with specific reading disorders (e.g., surface or phonological dyslexia). However, there is a significant proportion of children who present with a "mixed" picture of reading difficulties incorporating characteristics of both phonological and surface dyslexia subtypes (Edwards & Hogben, 1999), the mixed dyslexia subtype. Cognitive neuropsychologist s have paid little attention to this subgroup and it has been suggested that the cognitive neuropsychological approach "may not be very useful" for them in clinical settings (Coltheart et al., 1994).

Although a child with mixed dyslexia has deficits in both the lexical and sublexical processing routes, both have numerous sub-components, any one (or more) of which could be impaired. Without a theoretically driven framework and methodical assessment of both processing routes the nature of impairment and general treatment focus is difficult to determine.

2.3. Subtypes of Developmental dyslexia.

There are several subtypes of dyslexia reported in literature, in some cases, Dyslexia is characterized by distinct patterns of impairment on auditory, visual or cross-modal tasks. Among the well-known classification systems for subtypes of dyslexia is Boder's classification (Boder, 1973). It classifies dyslexics into dysphonetic (having difficulties especially with grapheme–phoneme conversion, i.e. with the indirect route for reading), dyseidetic (having difficulties with visual recognition of whole words, i.e. with the direct route for reading) and mixed (having both types of difficulties) subtypes. Another sub typing system is Bakker's classification (Bakker, 1979, 1990) into P-types (relying on perceptual, analytical strategies for reading, which turns out to be slow, fragmented and hesitating), L-types (relying on linguistic, anticipatory strategies for reading, which allow for quicker reading but produce

many, usually plausible and context-based errors) and M-types (mixed types, showing both slow, fragmented reading and many errors). In Bakker's model, the two subtypes are characterized by a different degree of involvement of the two cerebral hemispheres in the reading process, the right hemisphere being more activated in reading for P-types, the left one for L-types. Both classification systems, therefore, suggest that visual functions can be impaired or under activated in different dyslexia subtypes.

Ziegler, Castel, Pech-Georgel, George, Alario and Perry (2007) investigated developmental dyslexia within a well-understood and fully specified computational model of reading aloud: the dual route cascaded model (DRC) (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). The authors designed four tasks to assess each representational level of the DRC.i.e, letter level, orthographic lexicon, phonological lexicon, and phoneme system. The data showed no single cause of dyslexia, but rather a complex pattern of phonological, phonemic, and letter processing deficits. Importantly, most dyslexics had deficits in more than one domain. Sub typing analyses also suggested that both the phonological and surface dyslexics almost always had more than a single underlying deficit. Manis, Seidenberg, Doi, McBride-Chang and Petersen (1996) in their study reported of two subgroups that formed their data were phonological and surface dyslexia.

Stanovich, Siegel and Gottardo (1997) identified 17 phonological and 15 surface dyslexics from their sample of 68 reading disabled 3rd grade children by comparing them to chronological age controls on exception word and pseudo word reading. However, when the dyslexic subtypes were defined by referring to Reading level controls, 17 phonological and only one surface dyslexic were identified. When the chronological age defined subtypes were compared to reading level controls, the phonological dyslexics displayed superior exception word reading but displayed deficits in psuedoword naming, phonological

sensitivity, working memory, and syntactic processing. The surface dyslexics in contrast displayed a cognitive profile remarkably similar to that of the reading level controls.

The cognitive mechanism underlying subtypes Dyslexia are still a matter of debate. Numerous theoretical approaches have identified different potential causes of dyslexia. The phonological theory (Snowling, 2000) which is the most influential account for reading problems relates dyslexia to a deficit in phonological awareness. Study by Moats and Foorman (1997) and Adams (1990) also suggests that children who learn to read alphabetical language system such as English proven to be having poor phonemic awareness tasks like rhyming and letter identification. In contrast, the auditory processing deficit theory (Tallal, 1980) assumes that dyslexics have deficit in (rapid) auditory processing .According to this theory; phonological problems are only secondary to the auditory deficits. Yet other researchers conceptualize dyslexia as a visual processing deficit arising from the impairment of the visual magnocellular system in the brain (Stein & Walsh, 1997).The role of attentional deficits for the development of dyslexia is also discussed (Hari & Renvall 2001).Attentional deficits are thought to interfere with the encoding of a sequence of letters, resulting in the confusion of letters and visual word forms. Interestingly, attentional deficits can be dissociated from phonological deficits, and both types of deficits are valid predictors for reading ability (Valdois, Bosse, & Tainturier, 2004).

Finally, the cerebellar theory (Nicolson, Fawcett, Berry, Jenkins, Deen & Brooks, 1999; Nicolson, Fawcett & Dean, 2001) argues that reading disabilities are a consequence of the impaired ability to automatize processes. It is assumed that the cerebellum supports the automatisation of basic articulatory and auditory abilities which are relevant for the grapheme-phoneme correspondence. All of these theories have seen supporting empirical evidence. Interestingly , however, not all dyslexics suffer from deficits in all cognitive domains or profit equally from all remediation techniques (Ramus,2 003).Thus, it is possible

that distinguishable phenotypes of dyslexia exist on the cognitive level (Ho, Chan, Lee, Tsang & Luan, 2000;& Ramus, 2004) for which universal or distinct genetic (Olson, 2002) and neurobiological (Ramus, 2004) causes are controversially discussed.Unrevelling different subtypes of dyslexia would be an essential prerequisite for developing or applying specifically targeted and thus more efficient remediation strategies .Likewise there can be a subtype of dyslexia named based on the homogeneity of performances of dyslexics among group. So the present study aims at sub grouping based on profile that will be obtained.

Several assessment tools are available for the assessment of dyslexia. Those can be broadly divided in to tests for reading and tests for writing. The assessment tools those are available for assessing dyslexics in English are as follows,

Cloze procedure (reading assessment):

In the cloze procedure, the student must read the passage and provide the missing words by analyzing the content and its structure. This procedure measures the reader's ability to interpret written passages, and it requires the student to use both comprehension skills and knowledge of linguistic structure. The percentage of correct responses can be determined and can serve as a rough indication of the reading level of the student. Usually every fifth or sixth word is deleted called fixed ratio approach, however Farhady and Keramati (1996) found that using this method versus other close methods resulted in different interpretations of student's reading abilities.

Maze procedure (reading assessment):

Another technique used to measure a student's reading comprehension and knowledge of linguistic structure in the maze procedure .This procedure is similar to the

cloze method, except that vertically presented choices are given instead of blanks. Parker, Asbrouck, and Tindal (1992) reviewed twenty years of research on the maze procedure and reported overall support of the technique of the maze procedure. Both the cloze and the maze procedures are examples of informal adaptations of curriculum materials in to assessment devices.

Diagnostic reading tests:

Diagnostic assessment tools helps screening the patient for the problem, identifying the problem and helps in informal determination of objectives and teaching strategies, and also in documentation of educational needs, and establishment of IEP goals. Gray oral reading test-Diagnostic (GORT-D) by Bryant and Wiederholt, (1991)is an individually administered set of reading tasks designed for children ages 51/2 through 12. It assesses the paragraph reading, decoding, word attack, word identification, morphemic analysis, contextual analysis, word ordering abilities. This test covers the main areas of oral reading and comprehension, although it contains a large number of structural analysis tasks as well.

Stanford diagnostic reading test-4(SDRT 4) by Karlsen and Gardner, (1996) is a group administered and individually administered instrument designed to measure a student's strengths and weaknesses in reading. It is used with students from the middle first grade through grade 12.The authors suggest that the results from the SDRT4 can be used to help in grouping students and in developing appropriate instructional strategies. The SDRT4 places special emphasis on the low achievement student, and it contains more easy items than many reading achievement test. This measures four major components of reading: Vocabulary, phonetic analysis, comprehension and scanning. It has got six levels each designed for different age ranges:

Red level-Used with students at the middle of grade 1 to middle of grade 2

Orange level-Used with students at the middle of grade 2 to middle of grade 3

Green level-Used with students at the middle of grade 3 to the middle of grade 4 and low achieving students in grade 5

Purple level-Used with students from grades 4.5 to 6.5

Brown level-Used with students from 6.5 to 8.9 and with low achieving high school students.

Blue level-Designed for use with students from grades 9 through 12.

For each level, several tests are given that measure performance in such areas as auditory vocabulary, auditory discrimination, comprehension, reading rate, and phonetic and structural analysis. There is one form for the first three levels and two forms for the last three. The SDRT4 is a well constructed diagnostic reading test. Its standardization sample was large and representative and the reliability and the validity good. It can therefore be used as a reasonable measure vocabulary, phonetic analysis, and comprehension and scanning, particularly for screening purposes. It gives more normative information but less informal information like error analysis than other diagnostic reading tests.

Test of Reading comprehension-3 (TORC3) by Brown, Hammil and Weiderholt (1995) is an individually administered instrument designed for students between the ages of 7 and 18.It can also be used with small groups of students. The test measures the comprehension of silent reading; therefore, individuals who have articulation or other oral reading problems are not penalized.8 subtests are included in the TORC-3.Subtests 1 to 4 are called the general reading comprehension core. Subtests 4 to 8 are called Diagnostic supplements which include General vocabulary, Syntactic similarities, Syntactic similarities, paragraph reading. The TORC3 is theoretically a measure of silent reading comprehension .Only a small part of the test actually focuses on traditional comprehension measures (that is, on reading a passage and answering questions about the content).

Woodcock Reading Mastery tests-Revised (WRMT-R) by Woodcock (1997a). This test includes six individually administered tests and a two-part supplementary checklist designed for individuals ages 5 to 75 and older. This test can be used for a variety of reasons including diagnosis of reading problems, program planning, and program evaluation. The subtests include, Visual –Auditory learning, letter identification, Word identification, Word attack, Word comprehension, Passage comprehension Supplementary letter checklist. The WRMT-R is probably the most popular norm- referenced diagnostic reading test used in special education. The tests are easy to administer and cover a number of abilities. It is however very tedious to score, so it is recommended the scores uses computer version of scoring. It appears that WRMT-R has improved many of the shortcomings of the original test. Although the norms are relatively new, the test itself, including the format and items are over 10 years old. Thus, there may be some questions about the items being consistent with today's curriculum.

Oral and Written language scales (OWLS) Carrow and Woolfolk (1995). It is a Written expression scale designed for individuals ages 5 through 21(the oral scales are for ages 3 through 21).It measures the individual's ability to communicate using written linguistic forms. The test measures written expression in three areas using two different methods. The three areas are conventions(e.g. spelling, punctuation, capitalization),Linguistics(e.g. using complex sentences, different verb forms)and content(e.g. appropriate word choice ,subject matter).These areas are measured through indirect writing tasks such as writing dictated sentences or combining sentences, and direct writing tasks. This test provides a potential valuable measure of both the mechanics and fluency of writing. A wide variety of derived scores are available for comparison purposes .One disadvantage is that the Written Expression Scale is packed and sold separately from the Oral Scales of the OWLS. It would

seem that the advantage of the OWLS is in giving an overall picture of language using the same comparison group. Having to use two separate tests tends to discourage that purpose.

Test of Written expression (TOWE) by McGhee, Bryant, Larsen and Rivera, (1995). It is an individually administered instrument that measures the six areas of ideation, semantics, syntax, spelling, capitalization, and punctuation. The TOWE is designed for use with students from ages 6 1/5 years through 14 years, 11 months. According to the TOWE authors, the test can be used to identify students who have writing problems and to discover the writing strength and weaknesses. It can also be used to help evaluate a student's progress and can be used by researchers who are interested in studying the area of written expression. The major sections of this test are *items* section and *essay* section. Item section consists of subsections like ideation, semantics, Syntax, Capitalizations, Punctuation, and Spelling. The essay component of TOWE requires the student to write an essay based on a story in which the beginning is provided.

Test of Written Language -3(TOWL 3) by Hammill and Larsen, (1996). It was developed to identify students who have problems with written expression, to indicate strengths and weaknesses in writing language skills, to document progress, and to aid in research studies related to the writing process. OWL 3 can be either individually or group administered and is designed to be used with students ages 7 through 17.The authors divide the area of written language into three components :conventional, linguistic and cognitive. They also refer to two formants or methods of eliciting writing samples: contrived and spontaneous. There are eight subtests on the TOWL-3.The first five are considered contrived, and the second three are considered spontaneous. The capacity to use written language is unfortunately; often overlooked in educational assessment .The TOWL-3 was developed to offer the special educator a measure in that area. The TOWL 3 measures

several components of written language and appears to be a considerable improvement over its processors.

Test of written Spelling-3(TWS-3) by Larsen and Hammill, (1994).Is an individually administered or group administered test designed to pinpoint a child's written spelling level and to specify the types of words with which a child is having problem. Its use as a group administered instrument is somewhat limited, however it is designed for use with children ages 6 to 18.the TWS 3 comprises one hundred spelling words divided in to two categories: Predictable and Unpredictable. The predictable subtest includes fifty words; these conform to usual spelling rules and generalizations .the unpredictable subtest also includes fifty words; these words do not follow the usual rules and therefore, primarily have to be memorized. Although the TWS-3 yields normative data, its real value lies in the informal use of the word lists. The idea of having predictable and unpredictable word lists is a good one. The reliability of the newest version has improved over the earlier version, however which makes the normative use more appropriate.

However well standardized the assessment tools are the heterogeneity in the dyslexic group poses the requirement to profile the learning disabilities on individual based performance. The purpose of an assessment should be to produce an appropriate individual education plan (IEP) that clearly identifies the individual's strengths and weaknesses, their specific needs, and the timescale and resources required to implement the IEP. It should attempt to match the teaching style to the preferred learning style of the individual in order to maximize the amount learnt in a given time. The term dyslexia may be used to refer to children presenting very different profiles of strengths and weaknesses, and therefore may be of limited use in determining the IEP. What is required is greater specificity, such as a child's ability in phonological discrimination and rhyming tasks, which may inform teaching

practice. This need to understand the cognitive profile and attainment measures becomes even more important with the assessment of the multilingual individual, since behavioral outcomes, such as literacy difficulties, can manifest in very different ways across different language contexts. Profiling means a lot especially in the Indian multilingual contexts as it is difficult to generalize about the assessment and remediation of the multilingual dyslexic individual since the context of language, culture and learning environment, can be very diverse.

Unraveling different subtypes of dyslexia would be an essential pre-requisite for developing or applying specifically targeted and thus more efficient remediation strategies . Hence, the skills based on which they can be profiled should be assessed and a standard scores should be developed based on which the dyslexic group can be compared. Meanwhile, the high prevalence rate of learning disability (3% to 10%, Ramaa, 2000) indicates the need for early identification and intervention based on individual performances. The lack of Indian tools for assessment of dyslexia and the heterogeneity of dyslexic group urges to develop a tool to profile dyslexics based on individual characteristics.

CHAPTER 3

Method

3.1. Participants

The participants of the present study included two groups. One group consisted of 60 school going normal children from grades I, II, III, IV and V. Each grade consisted of twelve children. The other group consisted of 16 children with dyslexia (CWD) who were identified as dyslexics at the institute using Test for Early Reading Skills (ERS) (Loomba, 1995) in the clinical set up. All the participants were native Kannada speakers with English as the medium of instruction.

A WHO Ten –Question Disability Screening Checklist (cited in Singhi, Kumar, Prabhjot and Kumar, 2007) and Developmental Screening Test (Bharathraj, 1972) was used to screen for normal children in terms of hearing, intelligence, motor and other factors like school performance, emotional or behavioral factors. The participants either had normal or corrected-to-normal vision. Written consent was obtained from all the participants prior to testing. This study was conducted with the understanding and consent of the participants and their parents. They were provided information in their language he/she was capable of understanding and were explained about the aims, method of the research and approximate duration of testing.

3.2. Procedure

The study was conducted in the following phases,

Phase I: Test Development

The test was adopted from International Dyslexia Test (IDT) developed by Ian Smythe (2000). IDT was earlier called as International cognitive profile test (ICPT), which included vast domains of cognitive skills for assessment of literacy skills. The International Dyslexia Test was born out of a research project to study the role of Orthography and phonology in dyslexia, and was first publicized at the International Dyslexia Conference in York in April 1997. To date (November 1999) the test has been "translated" into a number of languages including Russian, Hungarian and Chinese, with a number of others currently in progress. The authors of the test do not claim to answer the entire question, but the test can lead to a greater understanding of dyslexia, and lead towards improved diagnosis and remediation of the individual with dyslexia with Tasks that have been found to be crucial for reading and writing skill in children have been adapted for the present study and the rationale behind assessing them has been justified in the following sections. The final test

that was derived out of the IDT after revisions was called the Dyslexia assessment profile in Indian children (DAPIC).

The subtests adopted from the IDT (Smythe, 2000) included,

- Alphabet
- Shape copying
- Spelling
- Reading words and non words
- Phonological awareness skills
- Word non word repetition
- Rapid naming
- Sound discrimination

The alphabet subtest

The first stage of decoding stage is to learn that reading involves use of codes. Words are not written in arbitrary ways but according to an alphabetic principle by which letters have a regular and predictable relationship with sounds. Children come to understand that the alphabetic principle simplifies the reading process and that it is crucial that they attend to all of the letters to read accurately .The reader must also know the specific correspondence between letters and letter patterns and sounds. Acquiring this knowledge is primary task of decoding stage (Loomba, 1995). The alphabet subtest will help us know whether confirms that children have acquired this knowledge.

Shape copying

It is a test of visual perception and visual motor integration. This involves demonstrating children's competence by executing complicated motor operations such as drawing geometric forms from memory, tracing and copying (Crandall , Hammill, Witkowski & Barkovich (1968).Shape copying will help us further to know whether the child's fine motor skills are ready and are prepared to be used for writing skills.

Spelling

Normal spelling needs auditory and visual reception, auditory and visual memory, auditory and visual discrimination, association of auditory and visual stimuli, motor expression and vocal expression. Ability to spell enables the writer to concentrate on the ideas he wishes to convey rather than on the mechanics of writing. (Frostig and Maslow, 1967).

Reversals, Omissions and poor spacing are a characteristic of a young child's writing. It is the persistence of such errors over a long period of time that is indicative of writing difficulty. Johnson and Myklebust (1967), suggest that such difficulties are associated with

deficiencies in visual motor integration (dysgraphia), revisualization (memory), and formulation (syntax).

Reading word and Non word

The rationale for assessing person's reading rate lies in the centrality of automaticity. Extremely slow reading stimulates the decoding of a student with Learning disability. Decoding problems consume his/her cognitive resources, leaving little of them for comprehension, eventually reading comprehension becomes more difficult. An inability to decode non-words highlights the grapheme phoneme translation difficulties may lie at the heart of an individual's specific learning difficulties. It also establishes the subject's degree of familiarity with the possibilities of written English orthography (Ehri, 1992).

Phonological awareness skills

Children start to recognize similarities in sounds between words which have different meanings. It has been demonstrated that this prepares them well for learning about orthographic links between words once they begin the formal construction of linking phonemes to graphemes, (Maclean, Bryant & Bradley, 1987). The phonological awareness like rhyming and alliteration skills have been found to become predictors of reading skill in children learning to read English..

Word, Non word repetition

Word repetition in very young children have been found to be related to the vocabulary size of the child ,(Gathercole & Baddeley ,1989 ; Hoff, Cotre & Bridges 2008) .The evidence for deficits in a core phonological domain predicts that children with below average reading ability will experience particular problems in print related decoding tasks such as pseudo word reading .

Word and non word repetition may become measure of phonological working memory capacity in spite of the fact that researchers have consistently acknowledged that the task taps many language processes, including speech perception, phonological encoding, phonological memory, phonological assembly, and articulation. Poor performance on this task can be an indicator of phonological dyslexia. Because repetition accuracy depends on lexical and sub lexical properties. The Non word repetition can be used to examine the structural properties of the lexicon in both children with normal language and with specific language problems (Anderson, 1953).

Rapid naming

Naming speed task assess the rate at which a verbal label for high frequency visual stimuli is produced. If an individual takes much longer than average to name all the stimuli, that individual is said have a naming speed deficit. Bowers and Wolf (1993) stated that slow naming speed is implicated in failure to learn to recognize words quickly. Wolf, Bowers and

Biddle (2000) stated that naming speed (particularly serial naming speed) provides an early, simpler approximation of the reading process. They believed that naming speed is conceptualized as a complex ensemble of attentional, perceptual, conceptual, memory, phonological, semantic and motoric sub processes that place heavy emphasis on precise time requirements within each component and across all components.

Sound discrimination

Phoneme discrimination is the auditory processing skill, where a few Children with dyslexia have been reported to have difficulties in discriminating between two similar sounds auditory. (Morais ,Content , Cary, Mehler , & Segui 1989).

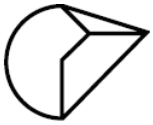
The tasks of the material have been divided under phonological and non phonological depending on the rationale those they assess phonological skills specifically and non-phonological skills in general. The tasks those are considered as phonological are Alphabet, SDis, NWreading, NWrep, alliteration and rhyming. And the tasks those are considered as non phonological are Wrep, Wreading, HQ, SC, RN and spelling. The following Table shows illustrations of tasks and scoring.

Phase II: Test administration

Testing environment

The test was administered in a quiet, noise free set up using a paper and pencil only. Table 1 below shows the subtests for the present study and the instructions that were given o the children prior to testing each of the tasks. The scoring was done as given in the Table 1.

Table 1. *The task and scoring for each of the subtests*

S.No.	**Subtest**	**Task**	**Scoring**
1.	Alphabet	To write the alphabet that is named. Alphabets those are visually similar are considered. Which includes b,d,n,u,m,w,p,9,q	1- Correct 0- Incorrect Total score: 9
2.	Shape copying(SC)	Copy the shapes that are given. There are totally four shapes (The shape that is displayed supposedly the most complicated) 	7- Most approximating shape 1- Least clear shape. Score:7 1 for correct and 0 for incorrect shapes for another three simple shapes. Score:3 Maximum score:10
3.	Written Language *a)Spelling*	Has to write down the spelling for words and non words that are dictated. There are 30 words, 10 non words. However, the non words are also following the phonotactics of English	1- Correct 0- Incorrect Total score:40
	b*)Handwriting quality(HQ)*	Scored from Spelling performances	5- Very good handwriting 1- Bad handwriting. Total score: 5

4.	Reading word(Wreading)	Has to read the words that are given(list consists of few irregular words)	1- Correct 0- Incorrect Total score: 70
5.	Reading non word(NWreading)	Has to read the non words that are given	1- Correct 0- Incorrect Total score: 10
6.	Repetition of word(Wrep)	Has to repeat the word after examiner.	1- Correct 0- Incorrect Total score: 7
7.	Repetition of non word(NWrep)	Has to repeat the nonword after examiner	1- Correct 0- Incorrect Total score: 8
8.	Rhyming and Alliteration	Has to find out the word which are in *rhyme* E.g. Bat, Mat, Wall- Here "Bat" and "Mat" are in rhyme with each other where as the 'Wall" is not He has to find out the words which are in *alliteration* with other words. E.g. Shine, Shoe, Shop, Monsoon. Here all the words but Monsoon begin with different letter, or not in alliteration with other words.	1- Correct 0- Incorrect Total score: 30 Rhyming:20 Alliteration:10
9.	Rapid naming(RN)	Has to name the pictures those are given.	Time taken to completely name all the pictures.
10.	Sound discrimination	Has to say whether presented two words are same or different. E.g. Cat, Rat- Different Pin, Pin- Same	1- Correct 0- Incorrect Total score: 20

The scoring was done as given in the Table 1.Among all the subtests RN was the only timed test. On the other tasks the performance was scored for correct and incorrect responses. The responses were coded .The data was subjected to quantitative (details of statistical procedure are mentioned in the results section) analysis and further a qualitative analysis was also done. The results of this study have been discussed in the following sections.

CHAPTER 4

Results

The aims of the study were

I. To study the development of reading and writing skills in Indian children.

II. To identify subtypes of dyslexia based on the profiles established on children with dyslexia

The following statistical techniques were used to analyze the data obtained from the study:

a) *Multivariate Analysis of Variance* (MANOVA) was used to compare the means across grades.

b) A *post-hoc Duncan* analysis was done to explore which grades are significantly different from each other.

c) *Kruskal-Wallis*, test was used to check for performance of children with Dyslexia on various tasks

d) *Bonferroni test* was carried out to explore the performance of children across tasks and if they were different across grades in Children with dyslexia (CWD) group.

~~d)~~e) A *multiple hierarchical regression analysis* was carried out on normal group to find out the best predictors of reading skill among all the tasks

e)f) *Cluster analysis* was done to derive the different clusters /subtypes among children with dyslexia (CWD).

The results of the study are described under the following sections,

4.1 .Performance of normal children and CWD across various tasks.

4.2 .Comparison of performance of normal children and children with dyslexia (CWD).

4.3. Sub typing of dyslexia based on profiling and cluster analysis.

4.1. Performance of normal children and CWD across various tasks

Participants for the normal group consisted of 60 children from grades I to V. Each grade consisted of 12 children. All the 12 tasks were administered on all the subjects and results are discussed in the following sections.

Multivariate Analysis Of Variance (MANOVA) was done with grades as independent variable and task as dependent variable. Table 2 shows mean and standard deviation (SD) for normal children of grades I to V on all the tasks.

The Table 2 shows that the performance of normal children improved from lower grades to higher grades on tasks like HQ, SC, spelling and Wreading. Thus, showing a developmental trend on these tasks. It is evident from the Table, on the alphabet subset, all children in the grade I itself were able to score the maximum .This indicates that the development of alphabet writing have already taken place by grade I itself.

Table 2: *Mean and Standard Deviation (SD) of scores of Grades I to V.*

Tasks	Grades									
	I		II		III		IV		V	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Alphabet	9	0	9	0	9	0	9	0	9	0
HQ	3.83	0.94	4.00	0.74	4.17	0.72	4.67	0.89	4.83	0.39
RN	37.67	4.12	40.92	7.66	39.50	5.27	31.50	4.96	25.75	4.00
SC	8.08	2.07	8.75	1.22	8.92	1.24	9.42	.90	9.92	0.29
NW reading	5.17	1.75	5.08	2.78	7.00	2.26	7.33	1.83	7.58	1.97
Alliteration	2.92	2.27	3.50	2.71	6.42	2.15	6.17	2.40	9.08	1.24
Rhyming	3.92	3.39	0.42	0.99	7.33	2.35	10.33	4.70	14.50	3.00
Wrep	4.17	1.11	3.75	1.06	4.92	0.90	5.58	0.99	5.25	0.96
NWrep	4.33	0.89	4.17	1.53	5.17	1.11	6.17	0.72	6.50	0.67
SDis	17.42	1.88	17.08	1.56	18.67	1.15	19.58	1.44	20.00	0
Spelling	8.67	3.85	8.75	2.14	16.00	3.36	18.42	7.09	29.25	3.16
Wreading	15.58	7.23	20.08	4.17	26.67	4.03	31.25	10.97	54.67	6.36

[Handwriting Quality(HQ), Rapid Naming(RN), Shape Copying(SC), Non Word Reading (NWreading), Word Repetition(Wrep), Non Word repetition (NWrep), Sound Discrimination(SDis),Word Reading(W reading)]

On the *handwriting quality (HQ)* task, results showed that children in the higher grades showed better performance than the lower grades (see Table 2) and significant difference was noticed at $F(4, 55) = 3.88$, $p < 0.01$. Post –Hoc Duncan results showed no significant difference among grades I through III, however children in grade V performed significantly better than Grade IV. On the *shape copying (SC)* task, results revealed that children in the higher grades showed better performance than the lower grades (see Table 2) and significant difference was noticed at $F(4, 55) = 3.53$, $p<0.05$. Post –Hoc Duncan results showed no significant difference among grades I through III, however grade V participants performed significantly better than grade IV. On both *spelling and reading* tasks, results revealed that children in the higher grades showed better performance than the lower grades (see table 2). For the *spelling* task, significant difference was found at $F(4, 55) = 47.44$, $p<0.001$. For the *reading* task, significant difference was found at $F(4, 55) = 56.35$, $p<0.001$. The Post-hoc Duncan analysis revealed that grades I and II were not significantly different from each other, while grade III performed significantly better than grade II. The results also showed that grade III and IV were not significantly different from each other; however children in grade V performed significantly better than grade IV participants. Overall, there was a developmental pattern observed on tasks like *handwriting quality (HQ), shape copying (SC), spelling and reading words (Wreading)*.

Results in Table 2 further revealed that performance of children on tasks like NWreading, rhyming, Wrep, NWrep and SDis, showed that children in grade I performed

better than grade II, this was not found to be statistically significant. However, the performances of children improved from grade III to grade V on these tasks significantly. On *word repetition (Wrep)* task, results showed that the performance of children improved from grade III to grade V and this was found to be significant at $F(4, 55) = 6.81$, $p<0.001$. On the *non word repetition (NWrep)* task , results showed that the performance of children improved from grade III to grade V and this was found to be significant at $F(4, 55) = 12.44$, $p<0.001$ level of significance. On *the sound discrimination (SDis)* task results revealed that the performance of children improved from grade III to grade V and this was found to be significant at $F(4, 55) = 10.56$, $p<0.001$. For all of these three tasks, Post-hoc Duncan analysis revealed no significant difference between grade I and II, while it showed that grade III was significantly different than grade I and II . There was no significant difference between grade IV and V on this task. Performance of children in grade IV and V was found to be better than grade III.

On the *non word reading (NWreading)* task results, showed that grade I performed better than grade II, and the performance of children improved from grade III to grade V(see Table 2) and this was found to be significant at $F(4, 55) = 3.82$, $p < 0.01$ level of significance. Post-hoc Duncan analysis revealed that there was no significant difference across grade I and grade II. There was no significant difference across grades III, IV and V. On r*hyming* task, significant at $F(4, 55) = 36.62$, $p<0.001$ level of significance. Surprisingly, grade II children performed significantly poorer than grade I children; however from grade III through V the performance improved. Post-hoc Duncan analysis revealed that all the grades performed significantly different from each other on this task and an increasing trend was observed for d V were in increasing order (see Figure 2). Also to note, a high standard deviation score revealed a high variability of performance amongst children on rhyming task.

On the *alliteration* task the performance of normal improved as the grade increased, the pattern was observed only till grade III, while the children in grade IV students performed better than grade V (see Table 2). For the *alliteration* task significant difference was noticed at F (4, 55) =15.15, p< 0.001 level of significance. Post-hoc Duncan analysis did not show any significant difference between grades I and II, and between grade IV and grade III, grade V performed significantly better than grade III and IV. On the *rapid naming (RN)* task, grade I took more time compared to grade III. Grade V took lesser time compared to grade IV .Grade II took more time than grade I (see Table 2). For the RN task significant difference was noticed at F (4, 55) =16.69, p< 0.01 level of significance. Post –Hoc Duncan results showed no significant difference among grades I through III, however grade V participants performed significantly better than grade IV.

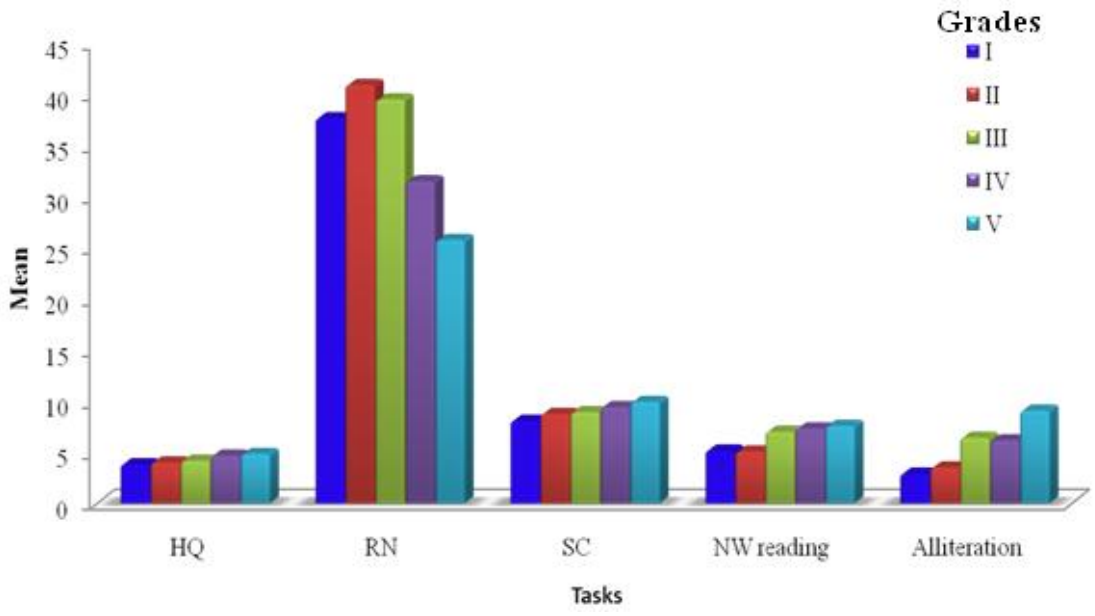


Figure: 2. Performance of normal on tasks (HQ, RN, SC, NWreading and alliteration) across grades.

As shown in Figure 2 and 3 describes, the performances on tasks has been found to be increasing grades, on rhyming task where the grade II have performed worse than grade I. The trend is not exactly in increasing pattern on tasks of Wrep and SDis as well.

To summarize, performance of normal children across all the tasks HQ,SC,alphabet,spelling,Wreading,NWreading,alliteration,rhyming,Wrep,NWrep, RN,SDis.The Figures shows that there is a developmental trend across all the tasks however, only a few tasks have been found to be significant across grades

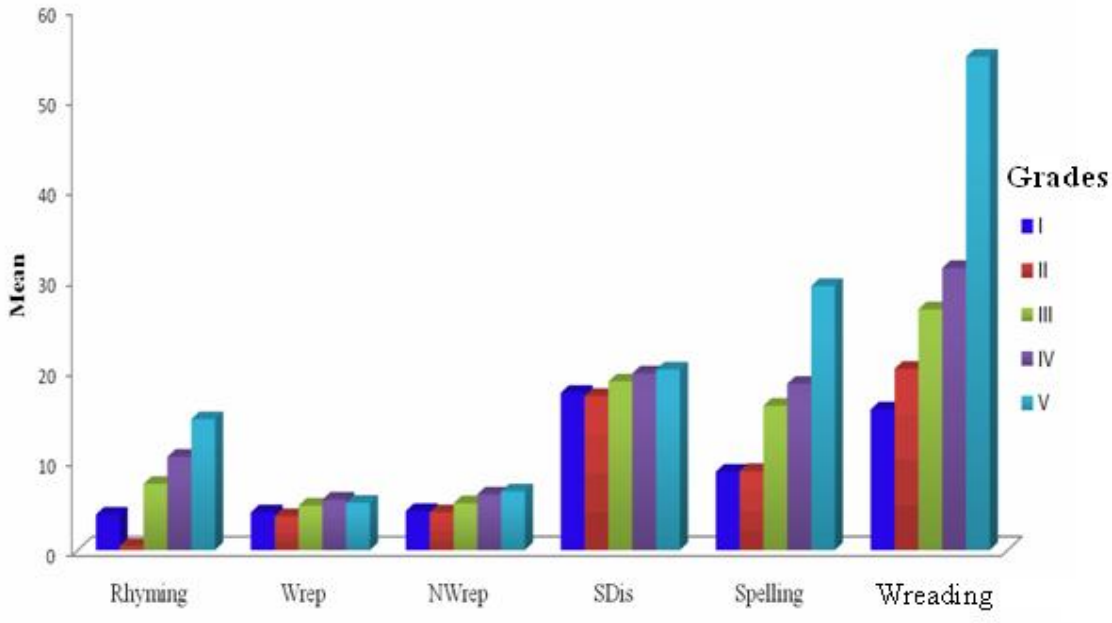


Figure: 3.Performence of normal on tasks (rhyming, Wrep, NWrep, SDis, spelling and Wreading) across grades**.**

A multiple regression analysis for the entire sample was done to arrive at the regression equation which was significant at F (9, 50) =44.73, p< 0.01.Combined reading task which included word reading (Wreading) and nonword reading (NWreading) was considered to arrive at the regression equation. The multiple regression for the entire sample revealed that rapid naming, alliteration, sound discrimination and spelling were the four significant predictors for the reading score (r^2=0.89; Rapid Naming β =-.469; p<0.05; Alliteration β =1.016; p<0.05; Sound Discrimination β =-1.54; p<0.05; Spelling: β=1.3 03; p<0.001.

4.2. Comparison of performance of normal children and children with dyslexia

The CWD group consisted of sixteen children with dyslexia (CWD) who participated in the study. There were three CWD in each group of grade I, grade II, grade III and grade V. Only grade IV consisted of four CWD. An individual profile of each child with dyslexia was derived after a detailed qualitative analysis of all the samples.

The data was further analyzed using Kruskal-Wallis non parametric test to check for performance of children with dyslexia on various tasks. Results showed that the

performance of children with dyslexia on tasks of alphabet, SC, NWreading, and Wrep were not significantly different.

Independent sample–t test was administered to arrive at mean and standard deviation (SD) to compare normal children and CWD, since they are two different groups, following Table 3 displays the mean and SD for overall performance of normal children and CWD.

Table 3 displays the mean and standard deviation of two groups of the study.In order to explore the tasks those are significantly different among normal and CWD groups, Mann-Whitney U test was administered, and results revealed that they are significant at $p< 0.05$. Results showed that normal group were significantly better than CWD group on most of the tasks but CWD performed as good as normal children on phonological awareness tasks like alliteration, rhyming and on SDis. Figure 4 shows compare the performances of normal and CWD groups across all the tasks across grades I to V.

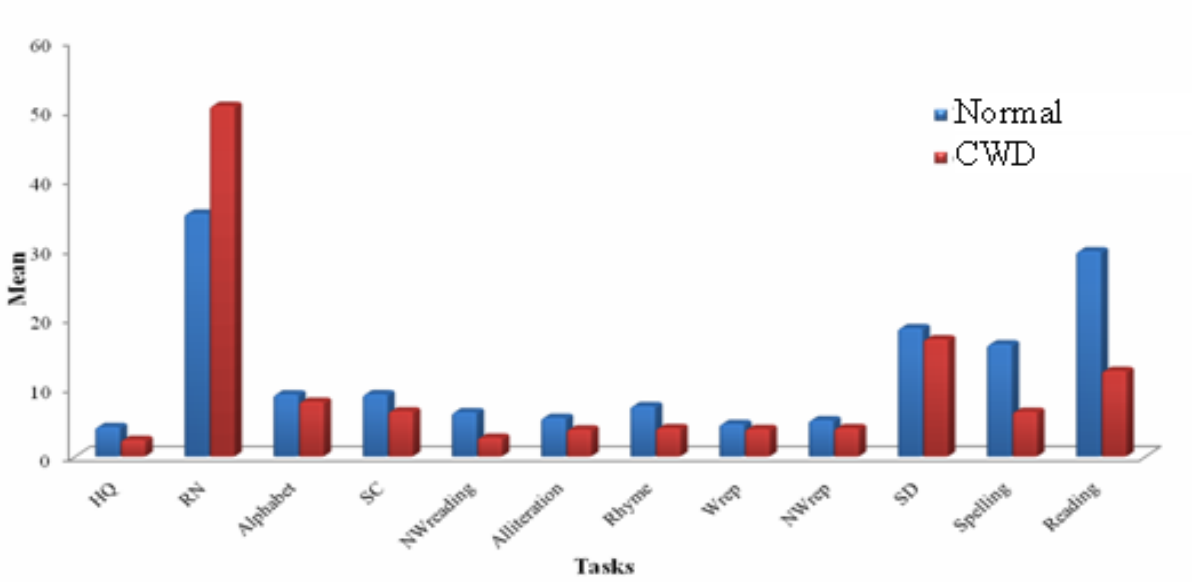
Table 3: *Mean and SD for overall performance of normal children and CWD*

Subtests	Groups					
	Normal			CWD		
	N	Mean	SD	N	Mean	SD
HQ	60	4.30	.83	16	2.44	1.26
RN	60	35.07	7.71	16	50.63	20.30

Alphabet	60	9.00	.00	16	7.94	1.91
SC	60	9.017	1.38	16	6.56	2.37
NWreading	60	6.43	2.35	16	2.75	1.39
Alliteration	60	5.62	3.10	16	3.94	3.13
Rhyme	60	7.30	5.79	16	4.12	4.21
Wrep	60	4.73	1.19	16	4.00	1.09
NWrep	60	5.267	1.38	16	4.12	1.26
SD	60	18.55	1.76	16	16.94	5.94
Spelling	60	16.22	8.68	16	6.50	5.39
WReading	60	29.65	15.31	16	12.38	8.71

[Handwriting Quality(HQ), Rapid Naming(RN), Shape Copying(SC), Non Word Reading (NWreading), Word Repetition(Wrep), Non Word repetition (NWrep), Sound Discrimination(SDis),Word Reading(W reading)]

As it can be evidently observed from the Figure, CWD were found to perform poorly than the normal children on all tasks. Mann-Whitney U test was used to compare between grades of normal and CWD group as well. The results are described below,



[HQ-Handwriting Quality, RN-Rapid Naming, SC-Shape Copying, NW reading-Non Word reading, Wrep-Word repetition, NWrep-Non Word repetition, SDis -Sound Discrimination, WReading-Word reading]

Figure: 4. Mean scores for normal children and children with dyslexia across tasks.

On the alphabet task CWD in lower grades performed poorer than normal, but it was not statistically significant. In the *grade I* the tasks on those where CWD performed similar to normal are alliteration, rhyming and Wrep. In the *grade II*, like grade I CWD performed similar to normal, in tasks like alliteration, rhyming and Wrep. But unlike grade I participants, grade II participants of CWD performed similar to normal on NWrep as well.

In the *grade III,* normal children performed better than CWD on tasks like HQ, alphabet, SC, NWreading, alliteration, rhyming, spelling and on Wreading. Where as CWD could match the performance of normal children on tasks of RN, Wrep, NWrep, and SDis.

Grade IV CWD performed significantly poorer only on tasks of HQ, RN, NWreading, Wrep, and NWrep. On all the other tasks they were able to match the normal children performance in this grade. Normal children in grade V and CWD was compared, the results show that normal children of grade V performed better than CWD on most of the tasks, but performed similar to CWDs on tasks of RN, alliteration, Wrep, NWrep and SDis.

The performance of CWD was compared with normal children qualitatively,

- On qualitative analysis it was found that, on *spelling* and *handwriting quality* tasks regularization error, inappropriate spacing between letters, unfinished or omitted words were seen in CWD compared to normal children. When the CWD were asked to write the alphabets, they seemed to produce the mirror images of the alphabet they were attempting to write (e.g. writing 9 for p), though these errors were seldom seen in young normal children.
- The scores of Shape Copying task was reflected in Handwriting Quality in both Normal and CWD group. In other words children who performed better in Shape Copying were found to have better handwriting quality and vice versa.

- On the task of alliteration and rhyming, the CWD were not able to keep the presented three words of one stimulus in their working memory in order to identify

the words those have the same first letter or words those are in rhyme with each other. They also showed difficulty in understanding the instruction for these tasks, and most of the times tried to identify the first two of three presented stimuli as the appropriate response, which might have been due to their working memory deficit rather than a deficit in alliteration and rhyming task itself. Though these similar errors were seen in normal children as well, however, the errors found were lesser and more errors were found in the earlier grades in normal children.

- On the Wreading task, it was evident that CWD performed much poorer than the normal children in reading words as well as non-words. A few CWD were able to read non words with difficulty, however most of them (CWD) performed poorly on this task. CWD failed to use the strategy of reading the word as whole there by implementing lesser lexical cue compared to normal. When it came to reading non words the CWD group exhibited difficulty in implementing grapheme phoneme rules, there by exhibiting slower decoding skills.

- On the repetition (words and nonwords), compared to normal children, the CWD showed difficulty in repetition when the length of the stimuli increased from monosyllabic to disyllabic words .Showing that the errors made are predominantly due to deficit in inappropriate phonological working memory.

- On rapid naming task, one salient feature observed among the subjects was that they tend to skip a whole series while naming given series of items. Otherwise there were no qualitatively different responses observed in CWD compared to normal children. CWD children took relatively more time in comparison to normal children.

- On sound discrimination task, the quality of error observed in CWD was similar to normal.

4.3. Sub typing of dyslexia based on profiling and cluster analysis

Cluster analysis was carried out as part of quantitative analysis for the CWD group in order to classify them in to different clusters based on homogeneity among subjects on various tasks. The tasks those were considered to arrive at overall Dendrogram were SDis, Wrep, NWrep, Wreading, NWreading, alliteration, rhyming, RN and spelling. The results are described in terms of overall clusters, phonological and non phonological clusters.

4.3.1. Overall clusters.

Following Figure 5 shows the Dendrogram obtained using phonological and non phonological tasks.

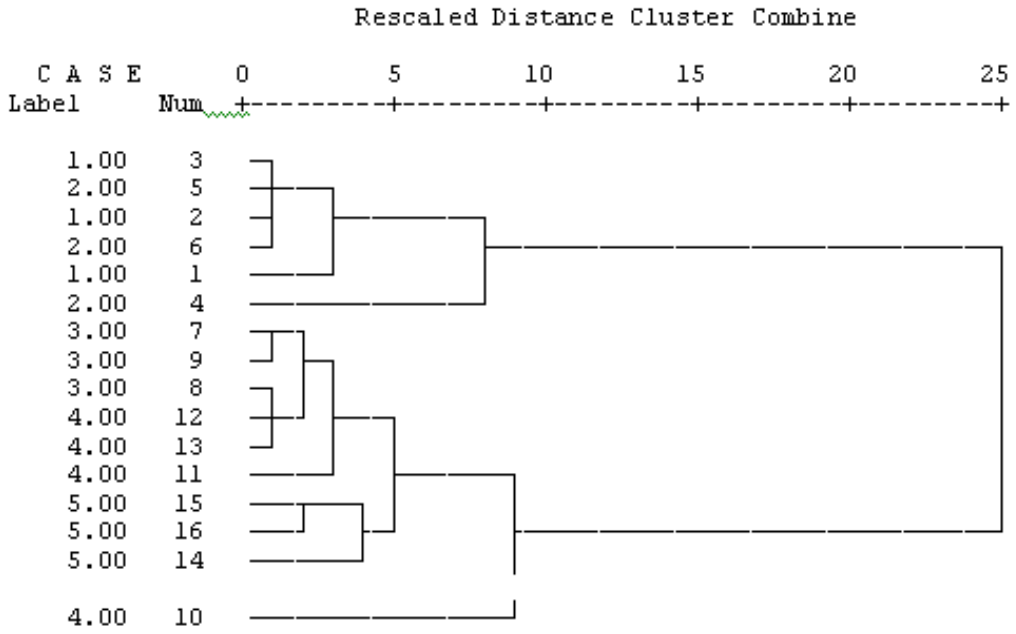


Figure: 5 Dendrogram depicting all the clusters in the CWD group

Analysis revealed that Subjects 3, 2, 5, 6 performed similarly thereby forming a cluster (Cluster I) themselves(see Appendix B). The typical characteristics of these clusters were,

- Errors exhibited on a*lphabet task* itself
- Very poor performance in *spelling task*
- Poor performance in *alliteration* and *rhyming tasks*.

Subject 1 (Ia) also performed similar to this cluster but it fell slightly apart, since this subject couldn't manage any score on Spelling task (see Appendix B).

Subject 4(Ib) Having taken maximum time for performing the *Rapid Naming* task falls slightly apart from Cluster the cluster I and Ia (see Appendix B).

Subjects 7 and 9 formed the cluster II. The typical features of this cluster were,

- In the *Wrep* task subjects could repeat only up to stimulus series which had four words in it
- In the *NWrep* task subjects could repeat only up to stimulus series which had three non words in it
- Subjects scored just over ten in W*reading task*, and most of the stimulus words read correctly was with in first ten.
- Both the subjects performed poorly on *rhyming task*
- In the *NWreading* task only single syllable words were read correctly by subjects in this cluster(see Appendix B)

Cluster III was formed by the subjects 8, 12 &13.The common features of this cluster were,

- Subjects performed similarly on W*reading task* (i.e. number of correct responses were 10and 13 respectively)
- The time taken for *RN* was almost same duration (38 and 37 seconds respectively)
- Performed poorly on *spelling task.* (see Appendix B)

Subject 11 (IIIa) was slightly different from the cluster III, since its performance on spelling was better compared to subjects in cluster III.

Subjects 14, 15 and 16 fall in a same region of the Dendrogram forming its own cluster (Cluster IV), the characteristic features they shared are,

- Fair performance on *spelling*
- On the *Wrep* task subjects could repeat only up to stimulus series which had four words in it
- On the *NWrep* task subjects could repeat only up to stimulus series which had three non words in it

- In the *NWreading* task only single syllable words were read correctly by subjects in this cluster

Ultimately, lonely subject that didn't seem to fall near any of the cluster was the 10th (X) subject (see Appendix B). The reason for being solace in the Dendrogram was that this was the only subject who read even one of the bisyllabic words in *NWreading*

This was the only subject who read half of the words correctly in *reading task* (i.e.35 words), and scored maximum in this task compared to all the other tasks.

Overall Clusters classification:

Cluster I-3, 2, 5, and 6

Ia-1

Ib-4

Cluster II-7&9

Cluster III-8, 12 &13

IIIa-11

Cluster IV-14, 15, 16

In order to classify the CWD into phonological and non phonological group the data was further analyzed considering phonological and non phonological tasks separately. The phonological tasks considered were SDis, NWrep, NWreading, alliteration and rhyming (see Figure 6). The nonphonological tasks considered were Wreading, NWreading, RN and spelling (see Figure.7).

4.3.2. Phonological clusters

The following Figure 6 shows the Dendrogram acquired for clusters among phonological tasks.

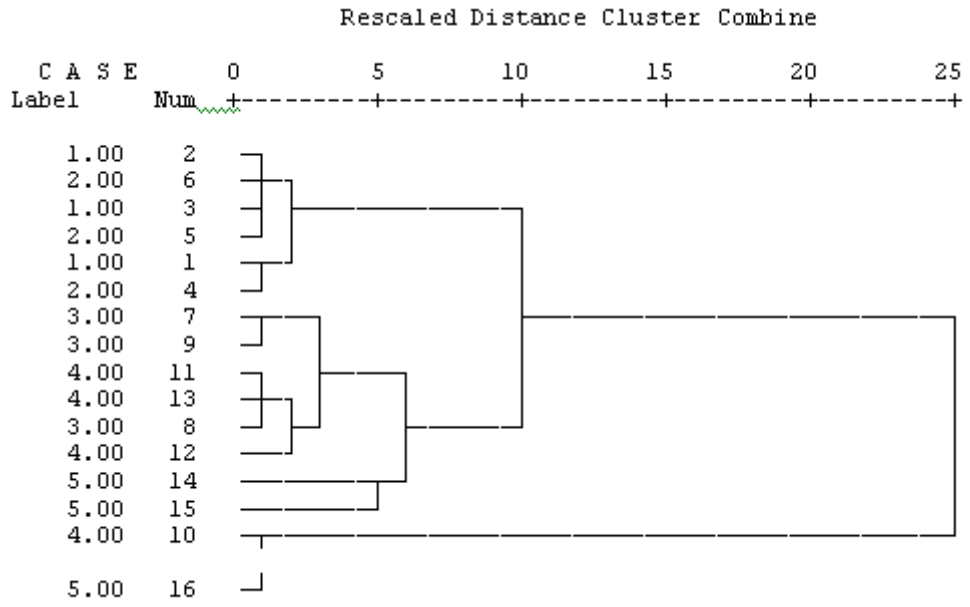


Figure: 6 .Clusters for phonological tasks

Subjects 2, 3, 5 and 6 formed *cluster a,* the common phonological features they shared in this cluster were,

- Performed good on *alliteration* task
- Performed good on *rhyming* task
- In the *NWrep* task the performance was poor ,managed to repeat stimulus series which had two nonwords in it (see Appendix B).

Subjects 1 and 4 formed the *cluster b*, the common phonological features they shared in this cluster were,

- In the *NWrep* task subjects could repeat only up to stimulus series which had one and two non words in it respectively(poor performance)
- Poor performance in *NWreading*, alliteration and rhyming tasks. (see Appendix B)

Cluster c was formed by subjects 7 and 9. The common phonological features of this group were,

- In the *NWrep* task subjects could repeat only up to stimulus series which had three non words in it (poor to fair performance)
- Both the subjects performed poorly on *rhyming task*
- In the *NWreading* task only single syllable words were read correctly by subjects in this cluster (see Appendix B).

Cluster d was formed by the subjects 8, 11 &13. The common phonological features of this cluster were,

- ✓ Read only the monosyllable words in *NWreading*

- ✓ Good performance in *NWrep*
- ✓ Performed relatively better than other clusters on *alliteration* task.
- ✓ Poor performance in *rhyming* task(see Appendix B)

Subject 12 formed the *Cluster d1*, since this subject performed fair in rhyming task.

Cluster e was formed by the subject 14 since this subject had salient feature of very poor performance on rhyming and good performance on alliteration task.

Cluster f was formed by the subject 15, the salient phonological feature it had from other clusters was that it had very good performance on alliteration and fair performance on rhyming task.

Cluster g is formed by subjects 10 and 16 and the common features these subjects shared were that all the phonological tasks were performed fair to good. Even very good performance noticed in alliteration tasks of subject 10(see Appendix B).

Cluster classification for phonological tasks.

Cluster a – 2, 3, 5 and 6

Cluster b- 1 and 4

Cluster c- 7 and 9

Cluster d- 8, 11 and 13

Cluster d1- 12

Cluster e- 14

Cluster f-15

Cluster g-10 and 16

4.3.3. Non-phonological clusters.

The following Figure 7 shows the Dendrogram acquired for clusters among non phonological tasks.

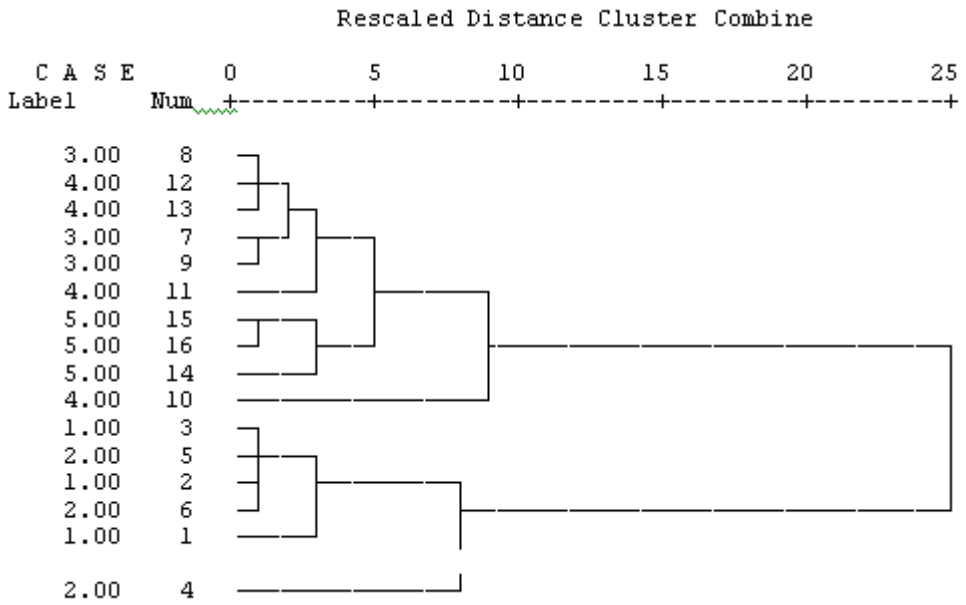


Figure: 7. Clusters for non phonological tasks

Subjects 8, 12 and 13 forms the *cluster (a),* the common non phonological features of this group were, that all the subjects performed poorly on *Spelling, WReading and Wrep* (see Appendix B).

Subject 7 and 9 forms the *cluster (b),* the common non phonological features they shared were that they had good performance on *Wrep* and the correct responses in Wreading task was over ten in both the subjects (poor).

Subjects 11 formed *cluster (b1)* performed fairly on spelling, fairly on *Wreading* ad very poor on *Wrep* thus forming a different cluster (see Appendix B).

Cluster (c) formed by 15 and 16, the features of this cluster were their fair performance on Wrep and Spelling tasks and Very poor to poor performance in *Wreading* task (see appendix II).

Subject 10 formed the *cluster (d)* performed good on *Wreading* and *spelling* and poor on *Wrep.*

Subject 14 formed the *cluster (d1),* since they had very poor performance in *Wreading* and *spelling.* These clusters also had fair performance in *RN* and *Wrep*.

Subjects 2, 3, 5 and 6 forms the *Cluster (e)* the common non phonological features were, They performed poorly on *spelling* and *Wreading* but fair performance on *Wrep* task.

Subject 1*(e1)* Spelled none of the words and read none of the words. The subject repeated repeat only the first series of stimulus which had only two words in it.

Subject 4 formed the *cluster (f)* since they showed Very poor performance on *spelling* and *Wreading* and fair performance on *Wrep* task (see Appendix B).

Cluster Classification for Non phonological tasks.

Cluster a- 8, 12 and 13

Cluster b-7 and 9

Cluster c- 15 and 16

Cluster d-10

Cluster d1-14

Cluster e- 2, 3, 5, and 6

Cluster e1-1

Cluster f-4

Following Table 4 displays the classification of subgroups of dyslexics based on phonological and non phonological tasks.

Table 4. *Sub grouping of CWD under phonological, non phonological and mixed type.*

Phonological	Surface	Mixed
Subjects 1,4,16,14 & 10	Subject 15	Subjects 2,3,5,6,7,8,9,11, 12 and 13

Subjects were classified as phonological dyslexics {1, 4, 16, 14, 10} if they showed difficulties on tasks of *NWreading, NWrep, alliteration and rhyming.* Subjects were classified as surface dyslexics {15} if they find difficulties in tasks of *Wreading, Wrep, RN and Spelling.* Subjects were classified as Mixed {2, 3, 5, 6, 8, 9, 11, 12, 13} if they show difficulty in both phonological and non phonological tasks.

To summarize, the quantitative clusters and the qualitative analysis reveal that the group of CWD children which seem to have been a part of the study are of mostly the phonological(7)and the mixed dyslexia subtypes(9), however one of the surface dyslexics(1) also identified. More number of mixed groups was found in the study compared to the phonological types. The data again shows the existence heterogeneity in children with dyslexia.

CHAPTER 5

Discussion

The results of the study will be discussed in terms of,

- Development of reading and writing skills based on the adopted IDT (Smythe, 2000) in normal children from grade I through grade V. This section will also include discussion over the performance of children with dyslexia in comparison to the normal grade level children.

- Subtypes of dyslexia based on the profile

5.3 Development of reading and writing skills in normal children and performance of CWD

Discussion for normal development and comparison of CWD with normal will be discussed for tasks of alphabet, HQ, SC, spelling, Wreading and NWreading, Wrep and NWrep, RN, alliteration and rhyming, SDis.

5.1.1. Alphabet task.

On the *alphabet task* all the normal children performed excellently. A few children with dyslexia in lower grades (I and II) showed errors in alphabet writing which resembled mirror images of target letter (9 for p). The mirror writing feature observed in the lower grades (I, II and III) of dyslexics could be due to directional confusion nature for forms of CWD Directional confusion is the reason for reversing of letters, Directional confusion also tend to occur in handedness (right or left) Hornsby (1999). However this mirror writing features in this population disappeared as grades improved it was appeared in lower grades. Visual errors have also been reported by Terepocki, Kruk, and Willows (2002) who compared 10-year-old average readers and children with reading disability. The children with reading disability made more orientation errors than average readers on computer-based reversal detection tasks (numbers, letters, letter strings, words), and more reversal errors on controlled writing tasks. The authors suggest that the difficulties of reading disabled group in discriminating similar looking items could be due to poorly specified representations of letters. They concluded that although reversal errors are likely to disappear in children with reading disability as their reading and writing skills improve.

5.1.2. Handwriting quality (HQ) and Shape copying (SC)

It is evident from the results of the present study performance of normal children improved from grade I to grade V on both the visuo-motor tasks such *as handwriting quality and shape copying.* This may be attributed to better fine motor control over this skill with development. It was found that performance on both the motor tasks (handwriting quality and shape copying) have increased parallelly from lower grades to higher grades suggesting the interdependence of these two skills for writing skill. Qualitative analysis of their handwriting revealed that children in the lower grade wrote large letters, poorly spaced and

offline writing. Whereas, those children in the higher grades like grade IV and grade V had improved writing in terms of better spacing, smaller and more uniformity compared to the lower grades. Gessel and Amatruda (1947) reported that around 5-6 years the child improves in his/her grasping and co ordination and at about 6 years copies capital letters. The authors also reported that they can write, but the writing is large, awkward, uneven, and irregular in size and position at around 7 years. They added that penmanship becomes smaller and more uniform at around 9 years. These findings of the present study evidenced that these skills are acquired much earlier that they were ought to be as mentioned in the Gessel and Amatruda (1947) study.

With respect to children with dyslexia, the results of the present study showed that CWD children were found to have poorer hand writing quality and shape copying in comparison to normal children. Literature suggests that children with developmental dyslexia have been found to have poor fine motor abilities and often poor writing skills (Denckla, 1985). Motor problems are frequently observed in dyslexic children (Snowling, 2000, 2005). It is estimated that about 60% of children with reading disability have a developmental coordination disorder or some other problems with motor skills (Viholainen et al., 2002). A developmental coordination disorder, also referred to as dyspraxia, is characterized by difficulties with gross and fine motor movements (Snowling, 2000) in children with dyslexia, thus reflecting on their poor writing skills.

5.1.3. Spelling

Results of the present study also showed that the performance on *spelling task* increased from lower to higher grades. It was found that children in the earlier grades used

symbols from the alphabet but showed no knowledge of letter-sound correspondences (indicating the precommunicative stage of spelling development according to Gentry (1982). In the later grades children were found to make better letter-sound correspondences and further higher grades (grade IV and grade V), children were able to understand the basic spelling rules of English and use them appropriately for reading purpose. The results also support Frith's developmental model for reading (Frith, 1985) in which she proposed three stages which a child goes through while acquiring spelling and reading like logographic, alphabetic and orthographic stages. Logographic stage is a more primitive stage of learning to read whereas orthographic stage is a much developed stage of reading and the alphabetic stage is a transition from logographic to orthographic stage. From the present study, it is evident that the errors made by normal children (e.g., writing '*bot'* for *'boat'*) in the lower grades (grade I and II) could be due to the transition period from alphabetic to orthographic stage. Empirical support for the present findings has been drawn from other studies in literature which uses connectionist model (Seidenberg & McClelland, 1989) of alphabetic spelling development. Loosemore, Brown and Watson (1991), studied the development of alphabetical spelling system using the artificial connectionist model and concluded that during the early course of development, they observed regularization errors and this errors faded as the model was exposed to more alphabetical spelling system. The findings of present study are tallying with the findings of Richard et al., (1991), since normal children of lower grades performed poorly on irregular words from the stimuli. They used regular spellings for irregular words. (e.g. '*hart'* for '*heart'*). As the grades increased, the normal children of the present study performed better on irregular words suggesting the construction of orthographic lexicon in them. This was evident when the data was qualitatively analyzed. Thus, the present study supports various other studies suggesting different stages of spelling development in children.

Further, a regression analysis in the present study revealed that spelling is a significant predictor of reading skill with the significant value of β=1.3 03; p<0.001.The findings of the present study is in consonance with Read (1971), Clarke (1988), Dyson (2001), Richgels (2001), Whitehurst and Lonigan, (2001) who also found spelling as a significant predictor of reading in their study. This was evident when the data was qualitatively analyzed. Thus, the present study supports various other studies suggesting different stages of spelling development in children.

On spelling tasks, CWD were found to perform poorer than the normal children in the present study. Qualitative analysis revealed that CWD even in the higher grades showed more errors in comparison to young normal children. The errors revealed that CWD in higher grades who were supposed to have reached the orthographic stage of spelling (Frith, 1985) are still in logographic or alphabetic or in a transition from logographic stage to alphabetic stage. For e.g., some CWD wrote '*butter'* as *'better'*, which means that these children are still using the logographic strategy as the two words are visually similar. Other errors like regularization errors were again found to be more in CWD compared to normal children. Regularization errors in CWD may be due to their poor representation of words in orthographic lexicon. A study by Bub, Cancelliere and Kertesz, 1985, McCarthy and Warrington, 1986 who discussed this as damage to the orthographic input lexicon because of which CWD would not recognize words lexically, so they would not spell lexically and so will be regularizing the irregular words. We can also hypothesize from Bub et al., 1985, and McCarthy and Warrington, 1986) that CWD of higher grades have not completely acquired the orthographic lexicon thus committing regularization errors (e.g. '*cattel'* for '*cattle'*).

5.1.4. Word reading (Wreading) and Non word reading (NWreading)

The present study showed improved performance on *word reading and non word reading* tasks from lower to higher grades in normal children. However, the performance of word reading was comparatively better than the non word reading task in all the grades. The beginners (grade I & II) seemed to read both the word and non word not analytically, but as a whole (e.g. reading '*yoll'* as '*doll'*). These findings are in consonance with Frith (1985) whose model can be used to explain word reading. This could be attributed to lack of decoding or absence of alphabetical knowledge in their repertoire in younger children. In other words, children in their lower grades treat a visual word as a visual object. It can be hypothesize that these lower grades normal children are still in logographic to alphabetic stage of Frith's model. Typically, according to Frith this alphabetical stage is followed by orthographic stage. This refers to the mastery of the alphabetic principle of phonography according to which written words may be segregated into left to right series of letters, each of which can be decoded as standing for as segment of speech. These segments correspond to the linguistic abstractions, the phonemes, by which the set of vowels and consonants composing the syllables of the spoken language are identified.

The features observed in the present study can be contradicted with Beers (2007) where he suggests that the first two stages of reading development (discusses only word reading where as this stages does not explain non word reading). Stage I in her study

included decoding Stage (grades 1-2; Ages 6-7) where the student's central task is learning arbitrary letters and associating them with corresponding parts of spoken words. The children in grades I and II of the present study didn't seem to use decoding strategy (letter by letter reading) to read the given word (where they seemed to use logographic skills). The next stage according to her is confirmation, fluency, ungluing from print, and automaticity stage (grades 2-3; Ages 7-8) where readers do experiments with their phonic skill. This stage is also a consolidation of what was learned in Stage 1. The children in present study of these grades (grade III) tried experimenting with their phonic skills; this was evident from their inquisitiveness to read the new words with their phonic skills, which enabled them to improve in their reading scores (as you can see the increase in reading scores gradually). It was also evident that children in these stage of the present study read words correctly even tough they had not encountered those words in past (lack of prior word knowledge). She calls the third stage as Reading for Learning the New Stage (Grades 4-8; ages 9-13) where the readers need to bring prior knowledge to their readings which enable them to acquire facts. Grade IV and V of our present study performed better compared to lower grades since they might have used their previous knowledge of word meaning.

Poor performance of normal children lower grades on non word reading task can be explained using the developmental stage models of reading like the dual route models suggested in literature (Newcombe & Marshall, 1984; Castles & Coltheart, 1993). The performance of normal children in present study improved from lower grade through higher grades. To read a non word, it is the sub lexical processing which is important. It involves rule-based grapheme-to phoneme conversion and allows the skilled reader to "sound-out" unfamiliar words and nonwords. Results of the present study are indicative that probably in the lower grades, children have still not developed the component process (GPC buffer in case reading a non word) that requires sub lexical processing to read a non word correctly.

The present study supports various other studies who discuss about development of reading using various models (Castles & Coltheart, 1993).

The performance of CWD was significantly poorer than normal in both word reading and non word reading tasks. Snowling (2000) reported that CWD have problems at the phonological level, which leads to the expectation that they should be at least slow, and at worst fail, to develop alphabetical decoding skills .The poor performance of CWD on Wreading can be explained through Frith's model (1985) of reading development. According to this model, in order to read a word, it is significant to have an orthographic stage of reading development. Having acquired this transition from alphabetical to orthographic stage it is possible to assign the appropriate phoneme to graphemes. In the present study we can hypothesize that, this stage of development is deficient in CWD, thus this population find difficulties reading word. Poor performance of non word reading in CWD can again be explained based on dual route models (Newcombe & Marshall, 1984) like for normal children. In literature, developmental dyslexia is considered to be a disorder which reflects a selective failure or delay in the acquisition of specific components of the model (Coltheart et al., 1994). CWD even in the higher grades were found to perform poorly in the present study. It could be that CWD have still not developed the component process (GPC buffer in case reading a non word) that requires sub lexical processing to read a non word correctly. The present study supports various other studies who discuss about reading in developmental dyslexia using various models (e.g., Castles & Coltheart, 1993; Coltheart et al., 1983; Edwards & Hogben, 1999; Hanley, Hastie, & Kay, 1992; Temple, 1984; Temple & Marshall, 1983). Thus, an inadequate development of GPC buffer might be the reason for poor performance in CWD on non word reading task.

5.1.5. Word repetition (Wrep) and Non word repetition (NWrep)

On the *word repetition* task, normal children in the present study, showed no significant improvement in the lower grades (grade I and II), whereas showed significant improvement in the higher grades (grades III, IV and V) only. Gathercole & Baddeley (1989); Hoff, Cotre and Bridges (2008) have reported that word repetition in very young children is related to their vocabulary size of the child. This means that children in the higher grades have better and greater vocabulary size than the lower grades and hence the former perform better than the latter on word repetition task indicative of an obvious developmental trend. Findings of the present study in CWD showed that these children performed significantly poorer than normal children on Wrep task. The difference was found to be lesser in the lower grades and found to be more in higher grades. Studies done by Scarborough (1990); Lyytinen, Poikkeus, Laakso, Eklund, and Lyytinen (2001), Gallagher, Frith and Snowling (2000), Snowling, Gallagher, Frith (2003), Carroll and Snowling (2004) found that children at risk for dyslexia show delays in lexical development, both in expressive and receptive vocabulary. This vocabulary delays might have caused poor vocabulary repertoire available for the CWD. According to these studies, the difference in performance between CWD and normal children seem to increase with grade, as found in the present study, where the CWD performed more poorly than normal children on higher grades compared to lower grades.

Similar to word repetition task, on *non word repetition* task, the performance found to have improved significantly in the higher grades (III, IV and V) only. Literature strongly suggests that those children developing language normally who score higher on receptive vocabulary measures repeat nonwords more accurately than do children with lower

receptive vocabulary scores (Gathercole & Baddeley 1989,Metsala 1999). It has been found to be indicative of phonological working memory capacity (Coady & Evans, 2008) which means developmentally older children have a better capacity of phonological working memory which in turn help them repeat or read non words appropriately compared to younger children who are still building up their phonological repertoire and/or knowledge. In turn, older children can figure out reading even new and unfamiliar words using their phonological working memory capacity. Coady & Evans (2008) results on children ability to repeat non words (which will indicate vocabulary strength) revealed that children scored significantly better in NWrep tasks only in lower grades suggesting the strong vocabulary construction only during early grades .The findings of the present study are in contradiction with Coady & Evans (2008) , since the children of present study showed significant improvement in scores of NWrep only in higher grades(grade IV and V).It can be concluded from the present study that children continue to construct their vocabulary even in higher grades. The CWD of the present study performed poorly compared to normal children on NWrep task suggesting poor phonological working memory capacity, lexical (the degree of accuracy correspondence to lexical intactness)and phonological knowledge. Snowling and colleagues found that children with dyslexia experienced a greater degree of difficulty with non-words repetition, especially at longer lengths. They concluded that children with dyslexia have difficulty with phonological analysis and articulatory assembly processes. (Snowling 1981, Snowling et al., 1986) then used NWrep task to examine lexical and phonological processing in a group of CWD. They hypothesized that speech-motor programs would be used for familiar words, while such programs would be unavailable for non-words. Successful repetition of non-words would require 'subjects to process the auditory stimulus, to decode the sound segments, and to recode these as instructions in the form of a speech-motor program (Snowling 1981). This decoding and recoding deficits reported by Snowling could be given as a reason for poor performance of CWD on NWrep task.

5.1.6. Rapid naming

On *rapid naming* task, children in the present study showed increasing performance from lower to higher grades suggesting a developmental pattern. The increasing performance was not significant in lower grades (grade I, II and III) and found to be significantly increasing in higher grades (grade IV and V). This could be because the time taken to access a lexicon from their repertoire is faster with the development of children. Study by Wagner, Torgesen, Roshotte, Hecht, Baker and Burgess (1997) investigated the relative contribution of RN to later reading ability in three developmental periods from kindergarten to grade II, from grade I to grade III and from grade II to grade IV. They concluded that RN was a significant variation for word reading till kindergarten to grade III only. Findings of present study contradict Wagner et al., (1997) study as in the present study RN was found to be improving significantly in higher grades (grade IV and V) only. In other words RN was also found to be influencing reading in children of higher grades.

The results of the present study also revealed that RN is a significant predictor of reading skill with the significance value $\beta = -.469$; $p<0.05$. Manis, Seidenberg and Doi (1999). Murphy and Pollatsek, (1994) Pennington, Cardoso-Martins, Green and Lefly (2001) and Torgesen, Wagner, Rashotte, Burgess and Hecht (1997) suggested after their longitudinal studies that alliteration and RN are differentially related to reading ability. Specifically it has been suggested that although alliteration is the most Important for the development of the ability to learn to read by phonological recoding, rapid naming skills may be especially important for learning about the orthography of word- a skill necessary for fluent, skilled

reading. Indeed, RN has been consistently found to be related to fluency of text reading even in the present study.

On RN task, the performance of CWD was significantly poorer than normal children suggesting poor phonological accessing speed in CWD. The CWD in present study performed with same accuracy as normal children do, however they had consumed longer duration to name all the items in the stimulus. Our findings are in consonance with study by study by Bowers and Wolf (1993) which admitted that deficit in rapid naming are most strongly associated with deficits in the development of orthographic representations for words. It can be hypothesized that children with slow naming speed activate the visual and phonological codes for printed letters too slowly to allow efficient encoding of the specific letter combinations in words. The study also supports Snyder and Downey (1995) who compared the performance of children with dyslexia and normal reading achievement on tasks of serial rapid naming. Their results revealed that the CWD had significantly longer reaction times and production durations than their normal peers despite similar levels of accuracy.

5.1.7. Alliteration and rhyming

The tasks of alliteration and rhyming are discussed simultaneously since these skills constitute evidence for children's awareness of the sound system (phonological awareness skills) that is manifested in their spontaneous play with language. On rhyming task, the results revealed that the performance improved significantly from grade III till V. However, in the lower grades, grade I performed better than grade II, which could be attributed to existence of variability in data as suggested by large standard deviation (see Table 2). On the

alliteration task the significant improvement in performance was noticed only for higher grades (grade III, IV and V). Van Kleeck and Bryant (1984) found that some children began indicating conscious awareness of the rhyming process as young as 2 yrs 8 months. MacLean, Bryant and Bradley (1987) in an experimental task asked children to identify the non rhyming word in a set of three words. They found that three year old subjects could detect rhyming and alliteration at a conscious level. They also found a high correlation between knowledge of nursery rhymes and success on phonological awareness tasks and that both these abilities were related to early reading skills at the age of 4 years 6 months. Wagner et al., (1997) concludes after his study that phoneme awareness tasks are significant contributors to reading in higher grades only(grade III and IV).The present study also showed that rhyming and alliteration tasks improved significantly only in higher grades (grade III, IV and V), thus in consonance with Wagner et al (1997). The results of the present study also found alliteration as a significant predictor of reading with significance value of $\beta = 1.016$; $p<0.05$. Findings of the present study is in consonance with the results of investigators like Adams (1990); Bryant, MacLean, Bradley & Crossland (1990), Lundberg, Frost , Petersen & Yopp (1992), Cunningham (1991); Whitehurst & Lonigan (2001), Lonigan, Burgess & Anthony (2000). Wagner et al., (1997) experimented the amount of information that a measure of phonological awareness could add to the prediction of reading once a measure of current word reading and vocabulary was considered. The results revealed that the phonological awareness is less efficient in prediction of reading as the child gets older.

Further, results of the present study showed that on rhyming and alliteration task, CWD performed poorly than the normal children and performance are varying across grades. This poor performance (slow development of phonemic awareness) can also be correlated with their poor development in word reading skills. The present findings on CWD are in consonance with study by Scarborough (1990) who concluded that at 5-year-olds who

exhibited weaknesses in object-naming, phonemic awareness, and letter-sound knowledge turned poor readers in their early reading days suggesting poor phonemic awareness in CWD. Studies by Moats and Foorman (1997) and Adams (1990) also suggests that children who learn to read alphabetical language system such as English proven to be having poor phonemic awareness tasks like rhyming and letter identification. The deficits noticed in phonological awareness has been explained using the phonological theory (Snowling, 2000) which is the most influential account for reading problems relates dyslexia to a deficit in phonological awareness. Lyon, Shaywitz and Shaywitz, (2003) provided evidence for linkage between lack of phonological awareness and reading disabilities.

5.1.8. Sound discrimination (SDis)

On the task of *SDis* the performance on normal children were improving from lower through higher grades. It was not found to be significant in lower and higher ends whereas only grade III found to be significantly better than grade II. In other words there was no improvement in sound discrimination skill as the child grows older. The insignificant improvement in scores of auditory discrimination findings are in consonance with study by Neff (2006) who concluded that both spectral and temporal cues attain adult like by the age of six. It was evident from the present study that SDis was a significant predictor of reading skill with the significance value of. $\beta = -1.54$; $p<0.05$.It is in consonance with the study done by Talcott et al., (2000) who concluded that auditory sensitivity as a predictor of later reading skill.

In the present study the CWD showed poor performance compared to normal children, though it was not statistically significant. Tallal (1980) proposed that children with specific reading difficulties are deficient in processing brief and rapidly changing acoustic information like brief acoustic events in stop consonants. (Werker & Tees, 1987) have

contributed to the evidence that dyslexia is associated with auditory perceptual problems. Smythe (1999) Perceptual difficulties, as described above, could adversely interfere with building up and stabilizing phonological representations as the boundaries of two consonants (as these seem particularly affected) may become blurred or distorted in some children with dyslexia. Such noisy phonological representations may well explain the delay that dyslexic individuals have with learning new words, as they may need more tokens of the same word to establish a phonological representation of a word. Furthermore, 'fuzzy' phonological representations may also lead to in accurate segmentation and manipulation of sounds within a syllable, which, in turn, is a very important factor when learning to relate graphemes to phonemes. The insignificant poor performance of CWD compared to normal is supported by Ramus (2001) who concluded that subconscious processing is intact in dyslexics and it is only the higher (lexical) process that is affected. Tallal, Merzenich, Miller and Jenkins (1998) reported that normal temporal sequencing is essential to develop neural representation of phonemes, which must be distinguished from the stream of speech and combined to form words .We can hypothesize from Tallal et al., (1998), the delay in temporal integration caused a cascade effects, starting with the normal development of efficient phonological abilities, and in turn resulting in subsequent failure to learn to speak and read normally in CWD.

To summarize, a developmental trend has been observed in normal children on all the tasks from grade I through grade V, except on the tasks of SDis and alphabet writing. Normal children in the lower grades were found to perform better than the children in the higher grades which can be been explained using the developmental stage models of reading. Children in the lower grades perform poorly on tasks of reading as they may not have developed all the component processes that are essential for reading familiar as well as unfamiliar words. Further, children with dyslexia (CWD) even in the higher grades have performed significantly

poorer than younger normal children on various tasks indicating that there could be a delay or deficit in the acquisition of component processes for reading in these children.

5.4 Subtypes of dyslexia based on the profile

The major aim of the present study was to subtype children with dyslexia based on the individual profiles obtained after administering the IDT (Smythe, 2000) and cluster analysis done on the data obtained. It was evident from cluster analysis in the present study that dyslexia is not a homogenous group but a heterogeneous group with existence of three major subtypes of dyslexia including phonological, surface and mixed types. Children with dyslexia (CWD) who fell under the *phonological subtype* in the study included {1, 4, 14, 16, 10}.The cluster that fell under the *surface subtype* of dyslexia included {13}. The cluster under the *mixed subtype* included CWD {2, 3, 5, 6, 7, 8, 9, 11, 12, 15} (See Table 5). The present thus, supports the existence of heterogeneity in developmental dyslexia as suggested by various investigators earlier and recently by Zeigler et al., (2007). They opined that there exists no homogenous group of developmental dyslexia. They also derived and sub grouped their children with dyslexia under 3 broad classes, namely phonological, surface and mixed types of dyslexia. Present study also supports Castles and Coltheart (1993) who tested a sample of 53 poor readers on their ability to read aloud sets of irregular words and nonwords. Eight subjects were identified as pure developmental phonological dyslexics whose nonword reading was poor, compared with chronological age- matched controls, but their exception word reading was within normal range. Another 10 subjects were classified as pure developmental surface dyslexics whose exception word reading was poor but their nonword reading fell within normal range. Further they found that 27 subjects performed poorly on both tasks and were therefore not classified as “pure” cases and were considered

as “mixed” cases. These children showed a significant discrepancy between their scores on the exception word and nonword tasks. This 2 way classification has been documentad by several other authors in their study. Manis et al., (1996) in their study reported of two subgroups that were acknowledged to be forming their data, they were phonological and surface dyslexia. Stanovich, Siegel & Gottardo (1997) identified 17 phonological and 15 surface dyslexics from their sample of 68 reading disabled 3rd grade children by comparing them to chronological age controls on exception word and pseudo word reading. However, when the dyslexic subtypes were defined by referring to Reading level controls, 17 phonological and only one surface dyslexic were identified. When the chronological age defined subtypes were compared to reading level controls, the phonological dyslexics displayed superior exception word reading but displayed deficits in pseudo word naming, phonological sensitivity, working memory, and syntactic processing. The surface dyslexics in contrast displayed a cognitive profile remarkably similar to that of the reading level controls.

The present study is in consonance with Ziegler et al., (2007) and Castles et al., (1993) who identified three broad subtypes of dyslexia.ie phonological, surface and mixed varieties. The current classification has also been supported by Bakker (1979, 1990) who classified dyslexics into P-types (relying on perceptual, analytical strategies for reading, which turns out to be slow, fragmented and hesitating), L-types (relying on linguistic, anticipatory strategies for reading, which allow for quicker reading but produce many, usually plausible and context-based errors) and M-types (mixed types, showing both slow, fragmented reading and many errors).In the present study, the CWD who had difficulties on NWrep, NWreading, alliteration and rhyming were classified as phonological subtype and CWD who performed well on phonological tasks but had difficulties on task of word reading were classified as surface subtype. The CWD who had difficulty in both phonological

(NWreading, NWrep, alliteration, rhyming) and non phonological (Wreading, Wrep, RN and spelling) tasks were classified under mixed dyslexics.

5.2.1. The phonological subgroup

CWD of phonological subtype could have performed poorly on phonological related tasks in comparison to the others due to deficit in the sub lexical processing of phonemes (Castles & Coltheart, 1993). In this group it was found that CWD performed poor mostly on nonword reading tasks. By theory, to read a non word, it is crucial to have phoneme grapheme conversion system intact. However, children with phonological dyslexia are unable to read non words as it is hypothesized that the sub lexical route which is composed of grapheme to phoneme conversion system is grossly affected (see Figure 1). Elbro (1996), Hulme and Snowling (1992) and Snowling (2000) propose a hypothesis which says that the representations of speech sounds (phonological representations) are coarsely coded and under-specified in phonological dyslexics. A more basic auditory processing deficit has also been considered as a possible underlying cause in phonological dyslexics (Farmer & Klein, 1995; Tallal, 1980). Yet this theory does not seem to be able to account for most dyslexics' phonological deficit (Ramus, 2003).

Apart from poor performance on non-word reading tasks, children with phonological dyslexia have been found to perform poorly on tasks of manipulating phonemes in order to facilitate learning to spell and further facilitate better reading Bradley, & Bryant, 1978; Griffiths, & Snowling, 2002; Morris , Stuebing, Fletcher, Shaywitz, Lyon, Shankweiler, et al. (1998)). The main features of phonological deficit can be highlighted by three main types of tasks (Snowling, 2000). Firstly, dyslexics perform poorly on tasks which require phonological

awareness, for instance paying attention to and manipulating individual speech sounds. CWD with phonological deficit in the present study also showed poor performances on rhyming and alliteration tasks which are considered tasks of phonological awareness (Smythe, 2000). Secondly, they have difficulty when required to name series of objects (rapid automatized naming) rapidly as seen in the present study. Thirdly, their verbal short-term memory is reported to be deficient compared to controls which is manifested by a lower memory span and poor nonword repetition, and impacts negatively on list learning, story recall, paired-associate learning, and the more complex phonological awareness tasks such as spoonerisms (Blomert & Mitterer, 2004; Tijms, 2004; Vellutino, Harding, Phillips, & Steger, 1975).

5.2.2. The surface subgroup

The reason for the performance of the surface dyslexic profile could be due to a nonphonological deficit in the lexical route as suggested also by Castles and Coltheart, (1993). In surface dyslexics the disconnection is in between the semantics and phonological functions leaving only the sub lexical route in operation (see fig.1). So, the reading of non words is relatively intact in this population. Most studies in literature have found that surface dyslexics had weaker phonological deficits than phonological dyslexics (Manis, McBride-Chang, Seidenberg, Keating, Doi & Munson, 1997); Stanovich, Siegel, & Gottardo, 1997).The present study demonstrates similar results, whereas Zeigler et al., (2007) suggested that phonological deficits were as strong in surface dyslexics as in phonological dyslexics. In the present study, apart from good performance of surface dyslexics on phonological related tasks, it was noteworthy that these children also performed better on rapid naming tasks. A contradicting study to our findings was that of study by Zeigler et al (2007) who indicated clearly a different picture of surface dyslexia than the one commonly

suggested in the literature. Although their surface dyslexics showed small impairments in orthographic access (letter search deficit in words, which resulted in reduced word superiority effects compared to phonological dyslexics), the main deficits were phonological in nature (picture naming and phoneme matching).

5.2.3. The mixed subgroup

The performance of mixed group in the present study could be due to the deficits in both the routes of reading. i.e., sublexical and lexical route as suggested by Edwards & Hogben, 1999) It can be hypothesized that the combined deficits in orthographic lexicon and in Grapheme Phoneme (GPC) rules could have resulted in mixed dyslexia (see Figure.1). In other words they have difficulty in reading stimuli that requires both lexical and sub lexical processing (Edwards & Hogben, 1999). Various hypothetical reasons have been purported for the occurrence of mixed dyslexia in CWD. Castles and Coltheart (1993) reported of three reasons for occurrence of mixed dyslexia in CWD population. The first reason relates to the structure of the model itself- the computational Dual Route Cascaded (DRC) model of Coltheart and colleagues (Coltheart, Curtis, Atkins, & Haller, 1993; Coltheart, Rastle, Perry,

Langdon, & Ziegler, 2001). The lexical and nonlexical routes of the DRC are not completely independent, but have three components in common: *visual feature detectors, abstract letter units, and the phoneme output system* (see Figure-1) Therefore, a deficit in any one of these components can lead to impairments in both lexical (surface) and sub lexical (phonological) pathways. The second reason why deficits in lexical and sub lexical system might co-occur relates not to the structure of the dual-route model itself but to the other distal factors that may have influenced the development of the components of the model in the first place. Even though the processes themselves may be distinct, there are numerous factors—personality, cognitive, social, and educational—that are likely to influence the speed and efficiency of children's acquisition of both the lexical and the nonlexical routes, and to an approximately equal degree. The third reason why deficits in lexical and sub lexical system might co-occur is that, although the orthographic lexicon and the GPC procedure in the DRC model operate independently, this does not mean that they are learned independently.

To summarize, heterogeneity in the dyslexia data was confirmed in the present study. Three major subtypes were identified based on cluster analysis and profiling and this could be explained using dual route model. The phonological subtype has been hypothesized to be occurring due to poor sublexical processing; the surface subtype has been hypothesized to be occurring due to poor lexical processing. The most prevalent mixed type has been hypothesized to be occurring due to deficit in both lexical and sublexical route of the dual route processing for reading.

Summary and Conclusion

Literacy is defined as the minimal ability to read and write in a designated language. The components of literacy include reading, writing, listening, phonological awareness, phonological decoding, reading comprehension, spelling, orthographic knowledge and rapid automatized naming. Phonological awareness among others has been shown to be a primary factor underlying early reading development. Learning to read, for many children seems not to require much effort. They appear to attain this ability almost incidentally. However, it seems to be correct in the languages where there is only one sound for each letter, where the assigning phoneme to a grapheme step is relatively easy. But in languages like English the association of various different letters sounds with a particular letter and various different letters with a particular sound makes mastery of the sound symbol relationship more difficult. This irregularity in the language itself makes it even more difficult in those children who are poor in reading and writing skills.

Dyslexia can be described as the person who has difficulty in reading even though sufficient teaching has been offered. As there are number of causes of dyslexia, there are number different types of dyslexia making dyslexia a heterogeneous group .Though there are several different types of dyslexia practically can exist for the convenience of classification different subtypes have been proposed in the literature. One of the major classifications is proposed by Castles and Colthart (1993) based on dual route model. The subtype classification proposed by these authors includes phonological (CWD finding difficulty in phonological tasks), surface (CWD finding difficulty in word reading) and mixed (CWD finding difficulties both in phonological and non phonological tasks) type. Sixty normal children, 12 in each grade from grade I to V was taken to form a normal group. The children

with dyslexia (CWD) consisted of 16 children, with 3 children from each grade except grade IV which had 4 children in it.

Descriptive statistical procedures were used in order to compare the performance of normal children for all the grades across different grades. The mean and standard deviation table showed that tasks like SC, HQ, Spelling and Wreading showed clear developmental trend from lower to higher grade. On tasks like NWreading, Rhyming, Wrep, NWrep , alliteration, RN and SDis lower grades didn't reveal any increasing trend where as higher grades revealed developmental trend. Normal children in the lower grades were found to perform better than the children in the higher grades which can be been explained using the developmental stage models of reading. Children in the lower grades perform poorly on tasks of reading as they may not have developed all the component processes that are essential for reading familiar as well as unfamiliar words. Further, children with dyslexia (CWD) even in the higher grades have performed significantly poorer than younger normal children on various tasks indicating that there could be a delay or deficit in the acquisition of component processes for reading in these children.

Results are also discussed for the comparison of normal group against CWD group which showed that CWD performed poorer than normal children on all the tasks. A regression analysis was carried out to obtain the predictors for reading. Results indicated that that tasks like rapid naming (RN), alliteration, sound discrimination (SDis) and spelling were found to be the predictors for reading. Further the data was analyzed qualitatively, and the major findings were explained. This included mirror images in alphabet task, difficulty in understanding the instruction on tasks of alliteration and rhyming, poor performance on alliteration and rhyming, GPC usage in reading words and non words, inappropriate working

memory leading to poor performance in repetition (word and non word) task and the tendency to skip a whole series while naming given series of items on RN task. The results of the sub grouping revealed that 7 were phonological dyslexics, 1 was surface dyslexics and 9 were mixed group. Thus, heterogeneity in developmental dyslexia was confirmed in the present study. The phonological subtype has been hypothesized to be occurring due to poor sublexical processing; the surface subtype has been hypothesized to be occurring due to poor lexical processing. The most prevalent mixed type has been hypothesized to be occurring due to deficit in both lexical and sublexical route of the dual route processing for reading (Newcombe & Marshall, 1984; Castles & Coltheart, (1993).

Implications of the study

- The result of the present study reveal that DAPIC can be used as a tool to profile those children who show difficulties in phonological and non phonological tasks of literacy. The tool needs to be further administered on a larger sample to generalize the findings and use regularly for the assessment of children with reading problems.

- The results of the present study reveal that differentiating among dyslexia subtypes with specific impairments allows a more fine grained understanding of disorder than simply comparing dyslexics with normal. The profiling and sub typing of the present study also lead us to understand and plan for individualized education program (IEP) for children with developmental dyslexia. Various treatment programs has been suggested in the literature namely relay strategy by Hatfield (1983) and decompositional (sublexical) strategy by

Tuchman (2000) for treating phonological dyslexia. To be effective, the review sited , showed that programs must focus on phonics , early diagnosis with remedial intervention and followed by teaching programs tailored for individual needs(MOE literature review,2007).Such treatment program for other type of dyslexia can be developed and they are identified.

- The present study also highlights on predictors of reading ability, which will foster the versatility of the present profiling tool to be used as a screening tool. Which supposedly include that are significant predictors of the reading skill like RN, SDis, alliteration and spelling

Limitations of the study

- This study included a small sample of children for each grade. Administering it on larger sample would help in standardization of the tool for assessing children with dyslexia.

- An additional, large scale study might also look at the prevalence of domain general and domain-specific impairments in dyslexia. In the current study, we were concerned with overall group differences, but given a larger sample, it would be interesting to classify the dyslexic group further.

- Other domain specific tasks of phoneme awareness skills like phoneme stripping, word attack tasks could have been included in the test to give a complete profile of individual's phonemic awareness skills.

- Other factors like socio- economic status, educational background of parents were not explored in the study.

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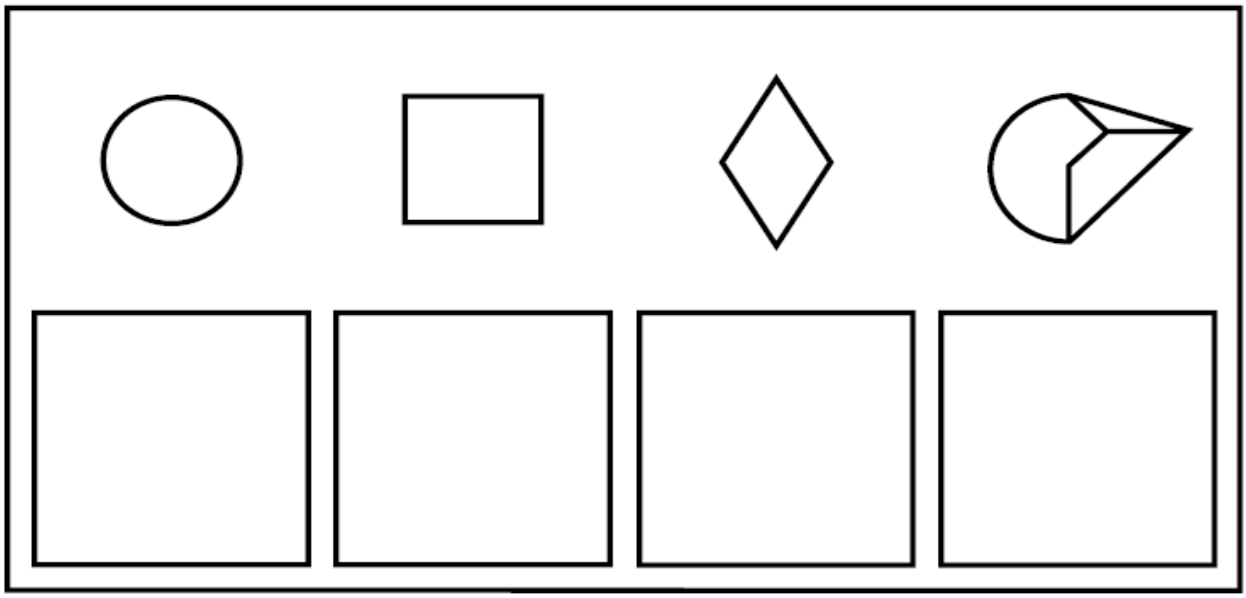
Appendix A

Test Material

1. Alphabet test

1)b, 2)d, 3)p, 4)9, 5)q, 6)m, 7)w, 8)u, 9)n

2. Shape copying



3. Writing

A) Spelling (Linguistic component)

1) Lot — A lot of people watch television. Write **lot**
2) Pig — The farmer had a pig to sell. Write **pig**
3) Cug — They couldn't fine the cug anywhere. Write **cug(bug)**
4) This — This cake is better than that cake. Write **this**
5) Be — Be careful crossing the road. Write **be**
6) Fish — Haddock is one kind of fish. Write **fish**

7) Tent Campers use a tent. Write **tent**
8) Yoll He did not want to yoll the boat. Write **yoll.(doll)**
9) Step In the dark, you must mind your step. Write **step**
10) Much She did not like chocolate very much. Write **much**
11) Boat The man wanted the boat to go fishing. Write **boat**
12) Crisp Biscuits should be chrisp. Write **crisp**
13) Brin There was a fine brin that morning. Write **brin(pin)**
14) Garden She grows flowers in her garden. Write **garden**
15) Butter Butter is made from milk. Write **butter**
16) Nothing A man who has lost everything has notyhing.Write **nothing**
17) Wooden A cook sometimes uses a wooden spoon. write **wooden**
18) Moid She put the paper on the moid.Write **moid(void)**
19) Swan A swan has a long neck. Write **swan**
20) Another After trying one, he asked another. Write **another**
21) Angry Angry people sometimes shout .Write angry
22) Cattle Cattle graze in the field .Write **cattle**
23) Rilt He could see the rilt clearly. Write **rilt(hilt)**
24) Promise A promise should be kept. Write **promise**
25) Country France is the country across the channel. Write **country**
26) Hospital A nurse works in a hospital. Write **hospital**
27) Driggle The draggle was covered in the green paint. Write **draggle(wriggle)**
28) Trousers In hot climates, men wear short trousers. Write **trousers**
29) Thread To make a necklace , you thread beads on a string. Write **thread**
30) Sword He soldier carried a sword. Write **sword**
31) Passage He walked down a long passage. Write **passage**
32) Plicant The boy was very plicant. Write **plicant(ant)**
33) Stronk He could not stronk easily. Write **stronk(honk)**
34) Quarter A fourth is quarter. Write **quarter**
35) Heart The heart pumps blood through our body. Write **heart**
36) Cladition There was not much cladition that day.Write cladition(tradition)
37) Biscuit She had a biscuit with her tea.Write **biscuit**
38) Parcel Parcel for the post should be wel wrapped.Write **parcel.**
39) Trabnag The trabnag did not move. Write **trabnag**
40) Adventure Most boys and girls like adventure stories. Write **adventure.**

B) Handwriting quality(Non linguistic component)

4. Reading test

1. tree
2. little
3. milk
4. egg
5. book.
6. school

7. sit
8. frog
9. playing
10. bun
11. flower
12. road
13. clock
14. train
15. light
16. picture
17. think
18. summer
19. people
20. something
21. dream
22. downstairs
23. biscuit
24. shepherd
25. thirsty
26. crowd
27. sandwich
28. beginning
29. postage
30. island
31. Saucer
32. angel
33. ceiling
34. appeared
35. knife
36. canary
37. attractive
38. imagine
39. nephew
40. gradually
41. smoulder
42. applaud
43. disposal
44. nourished
45. diseased
46. university
47. orchestra
48. knowledge
49. audience
50. situated
51. physics
52. campaign
53. choir
54. intercede
55. fascinate
56. Forfeit
57. siege

58. recent
59. plausible
60. prophecy
61. colonel
62. soloist
63. systematic
64. slovenly
65. classification
66. genuine
67. institution
68. pivot
69. conscience
70. heroic

5. Non word reading test

Practice items:

hab: lib: feg:

Test items:

One syllable	***Two syllable***
1. Gat	6.higure
2. Rop	7.kibnick
3. Shug	8.Pachine
4. Hild	9.clabnag
5.Narge	10.tringdom

6. Alliteration test

Practice item 1.

Sell big bang

Fat **hot** felt

Practice item 2.

block bright **plate**

stair **trick** swop

Test items 1 .

1.Gap got **nod**

2.Net **dig** nip

3.**Rope** take time

4.Big **pit** ball

5.Form fat **van**

Test items 2.

6. **train** plane prone

7. spade start **break**

8. crumb **twist** climb

9 . pram **trap** plan

10. great glue **crane**

7. Rhyming test

Practice items:

Tack **need** hack

Rap lap **nag**

Fit till bill

Test items1.

1. Main **line** pain muddle
2. Fog log **bag**
3. **Fuss** tilt wilt
4. Neck peck **beg**
5. Nap **hip** sap
6. Pen hen **pet**
7. **Red** big dig
8. **Pip** top hop

Test items 2 .

11. **buckle** puddle
12. tight light **ride**
13. **niece** cheese please
14. nip **fib** tip
15. tone **home** phone
16. cattle battle handle
17. should wood **food**
18. **neat** weed seed

9. Hid did **dub**
10. Pack **buck** rack
19. ship rip **stop**
20 .tree **need** free

8. Word repetition

1. Pin cat
2. Cap sky tin
3. Mat crow pick
4. Rain pen chair men
5. Pit day log shirt
6. Cow wool snake hut grape
7. Plank lion heel plot den

9. Non word repetition

1. Ket
2. Lum
3. Mup hin
4. Ret spige
5. Trum frut nabe
6. Ronch tarp keld
7. Horp brid nate proog
8. Fode wike drup cren

10. Rapid naming

11. Sound discrimination

Prctice item:

Pig Dig-different

Bat Bat-Same

Lake Date-different

Test items:

1. Rip tip
2. Sick sack
3. Side side
4. Pet bet
5. Big bog
6. Sit sit
7. Bed bad
8. Dam mad
9. Slow snow
10. End and
11. Fish fish
12. Shelled shield
13. Halt hall
14. Try tie
15. Tilt tilt
16. Ship sheep
17. Raw war
18. Throw throw
19. Rip reap
20. Nib nip

Score Sheet

Name :

School:

Grade:

Age on test time and Gender:

Tested by:

Scores for screening tests

Screening Test	Maximum score	Individual's score
A Ten-question disability screening test	10	
DST		

Total screening score:

Individual's score:

Test domain	Maximum score	Individual's score
1.Alphabet	9	
2.Shape copying	10	
3.writing a) spelling b)handwriting quality	 40 5	
4.Reading test	70	
5.Non word reading test	10	
6.Alliteration	10	
7.Rhyme	20	

8.Word repetition	7	
9.Non word repetition	8	
10.Rapid naming	Time taken	
11.Sound discrimination	20	

Total score:209 (excluding the duration taken in rapid naming section)

Individual's total score:

1.Alphabets: (mention the letters that are written incorrectly)

2. Shape copying: (0= not attempting,7= most appropriate shape)

1.

2.

3.

4.

3.Writing

a)spelling: (1 for each correctly spelled word)

1.	11.	21.	31.
2.	12.	22.	32.
3.	13.	23.	33.
4.	14.	24.	34.

5.	15.	25.	35.
6.	16.	26.	36.
7.	17.	27.	37.
8.	18.	28.	38.
9.	19.	29.	39.
10.	20.	30.	40.

b)Handwriting quality:(1=bad,5=very good)

4.Reading test: (one score for correctly read word)

1) a. b. c. d. e.

2) a. b. c. d. e.

3) a. b. c. d. e.

4) a. b. c. d. e.

5)a. b. c. d. e.

6)a. b. c. d. e.

7)a. b. c. d. e.

8)a. b. c. d. e.

9)a. b. c. d. e.

10)a. b. c. d. e.

11)a. b. c. d. e.

12)a. b. c. d. e.

13)a. b. c. d. e.

14)a. b. c. d. e.

5.Non word reading test: (score one for each correctly read non word)

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

6.Alliteration: (one score for each correct responses)

1. 6.
2. 7.
3. 8.
4. 9.
5. 10.

7.Rhyming test: (one score for each correct responses)

1. 11.
2. 12.
3. 13.
4. 14.
5. 15.
6. 16.
7. 17.

8.

9.

10.

18.

19.

20.

8.Word repetition: (one score for each correct responses)

1.

2.

3.

4.

5.

6.

7.

9.Non word repetition:(score one for each correct responses)

1.

5.

2. 6.

3. 7.

4. 8.

10.Rapid naming: (note the number of items named at the end of one minute)

11.Sound discrimination:

1. 11.

2. 12.

3. 13.

4. 14.

5. 15.

6. 16.

7.	17.
8.	18.
9.	19.
10.	20.

Appendix B

Profile on Qualitative analysis of individual data

Subject 1. (Grade I)

Alphabet: Correctly wrote the alphabets *b* and *m* only

SC: Performed very poorly

Spelling: Unable to spell any of the words

*HQ***:** Very poor, managed no score

*Reading***:** Unable to read any of the word

NWreading: unable to read any of the non word

*Alliteration***:** Managed no score

*Rhyming***:** Managed no score

*Wrep***:** Managed to repeat only the first series of stimulus which had only two words *(e.g. pin, cat)*

NWrep: Managed to repeat the first two non word series only, they were made of one nonword consisted of single syllable. The subject couldn't repeat the third nonword since it had two words.

*RN***:** Took 78 seconds to name all the 35 items in correct order

*SDis***:** Correctly discriminated only three stimuli.

Subject 2 (Grade 1)

Alphabet: Wrote all of the alphabets without error

SC: Copies the first three simple shapes exactly, but only fairly well the complex one.

Spelling: lot, be, fish and *tent* were spelled correctly out of all forty words.

HQ: Quality was bad.

Reading: Managed to correctly read only the first eight items

NWreading: Could read only two of the single syllable nonword.

Alliteration: Correctly identified only the alliterated words in second stimuli

Rhyming: Didn't manage any correct responses

Wrep: Could repeat stimulus series which had up to four words in it.

NWrep: Could manage to repeat stimulus series which had up to two non words only.

RN: Took 62 seconds to correctly name all of the items.

SDis: side, reap, nip were the ones which were incorrect**.**

Subject 3(Grade 1)

Alphabet: unable to write *d, p,* and *m*

SC: Completed the simple ones with ease, but managed to copy the final shape only lesser than fair.

Spelling: *lot, be* and *much* were written correctly

HQ: Performed fairly

Reading: First three items (*tree, little and milk*) then 6th *(school*) and eleven (*flower*) were correctly read.

NWreading: Managed to read three of the one syllable nonword only.

Alliteration: Poor performance (only 1 and 8 were correct)

Rhyming: Very poor performance

Wrep: Could repeat stimulus series which had up to four words. (Fair performance)

NWrep: Managed only the first two series, which had only one word each (poor performance)

RN: took 71 seconds to correctly name all the items.

SDis: performed relatively well.

Subject 4 (Grade II)

Alphabet: Excellent performance

SC: simple shapes are drawn correctly, poor copying of complex shape

Spelling: Very poor performance

HQ: Bad performance

Reading: Managed only 3(very poor performances)

NWreading: Managed to read only three of the monosyllabic words

Alliteration: Poor performance

Rhyming: Poor performance

Wrep: Could repeat stimulus series which had up to four words in it.

NWrep: Could repeat stimulus series which had up to two non words in it

RN: Took 92 seconds to name all the items

SDis: Performed poorly

Subject 5 (Grade I1)

Alphabet: *m* was written incorrectly

SC: Correctly written simple shapes, complex shape was better approximating towards stimulus shape

Spelling: Very poor performance

HQ: Performed fairly

Reading: Seven of the words were read correctly (poor performance)

NWreading: No correct responses

Alliteration: Poor performance

Rhyming: Poor performance

Wrep: Could repeat stimulus series which had up to four words.

NWrep. Could repeat stimulus series which had up to two non words in it

RN: Took 73 seconds to name all the items

SDis: Performed fairly well

Subject 6 (Grade 1I)

Alphabet: Had confusion between *9, q* and couldn't write *u.*

SC: Correctly written simple shapes, complex shape was fairly drawn.

Spelling: Very poor performance

HQ: Performed fairly

Reading: Six of the words were read correctly, still a poor performance

NWreading: Managed to read only three of the monosyllabic words

Alliteration: Poor performance

Rhyming: Poor performance

Wrep: Could repeat stimulus series which had up to four words.

NWrep: Could repeat stimulus series which had up to two non words in it

RN: Took 66 seconds to repeat all the items.

SDis: Performed fairly well

Subject 7 (Grade II1)

Alphabet: Performed excellently

SC: All the simple shapes were copied correctly, good performance in copying complex shape

Spelling: Performed poorly

HQ: Bad performance

Reading: Number of correct responses is over ten, and most of the correct responses were correct for the first ten stimulus.

NWreading: Managed only the single syllable words.

Alliteration: Fair performance

Rhyming: Poor performance

Wrep: Good, managed up to stimulus series which had four words in it

NWrep: Good, managed to repeat stimulus series which had three nonwords in it

RN: Took 48 seconds to name all the items

SDis: Excellent performance

Subject 8 (Grade II1)

Alphabet: Performed excellently

SC: All the simple shapes were copied correctly, fair performance in copying complex shape

Spelling: Performed poorly

HQ: Good performance

Reading: Number of correct responses was ten, and most of the correct responses were correct for the first ten stimulus

NWreading: Managed to read only the single syllable words.

Alliteration: Fair performance

Rhyming: Poor performance

Wrep: Good, managed up to stimulus series which had four words in it

NWrep: Good, managed to repeat stimulus series which had three nonwords in it

RN: Took 38 seconds to name all the items

SDis: Good performance

Subject 9 (Grade III)

Alphabet: Confusion exhibited between 9 and q

SC: All the simple shapes were copied correctly, fair performance in copying complex shape

Spelling: Performed poorly

HQ: Good performance

Reading: Number of correct responses was over ten, and most of the correct responses were correct for the first ten stimulus.

NWreading: Managed only the single syllable words.

Alliteration: Poor performance

Rhyming: Poor performance

Wrep: Fair, managed up to stimulus series this had four words in it

NWrep: Good, managed to repeat stimulus series which had three nonwords in it

RN: Took 44 seconds to name all the given items

SDis: Good performance

Subject 10 (Grade IV)

Alphabet: Excellent performance

SC: Excellent performance

Spelling: Good performance

HQ: Very good, closely approximating excellence

Reading: Half of the words were read correctly (i.e. 35, however 90 percent of the correctly read words were in first half of the stimulus)

NWreading: Could even read one bisyllabic nonword

Alliteration: Very good performance

Rhyming: Good performence

Wrep: Could repeat only up to three word stimulus series (very poor performance)

NWrep: Good, managed to repeat stimulus series which had three nonwords in it

RN: Took 32 seconds to name all the items

SDis: Excellent performence

Subject 11(Grade 1V)

Alphabet: Excellent performance

SC: Performed very good in complex shape

Spelling: Fair performance

HQ: Good performance

Reading: Fair performance

NWreading: Read only monosyllabic words

Alliteration: Poor performance

Rhyming: Poor performance

Wrep: Could repeat only up to three word stimulus series (very poor performance)

NWrep: Good, managed to repeat stimulus series which had two nonwords in it

RN: Took 45 seconds to name all the items

SDis: All are correct except 19th item, i.e *rip* and *reap* (Very good performance)

Subject 12(Grade 1V)

Alphabet: Excellent performance

SC: Good Performance in complex shape

Spelling: Poor performance

HQ: Very good performance

Reading: Poor performance

NWreading: Read only the monosyllabic words

Alliteration: Poor performance

Rhyming: Fair performance

Wrep: Could repeat only up to three word stimulus series (very poor performance

NWrep: Good, managed to repeat stimulus series which had two nonwords in it

RN: Took 37 seconds to name all the items

SDis: Excellent performance

Subject 13(Grade 1V)

Alphabet: Excellent performance

SC: Good Performance in complex shape

Spelling: Poor performance

HQ: Very good performance

Reading: Poor performance

NWreading: Read only the monosyllabic words

Alliteration: Good performance

Rhyming: Poor performance

Wrep: Fair, managed up to stimulus series this had four words in it

NWrep: Good, managed to repeat stimulus series which had two nonwords in it

RN: Took 40 seconds to name all the items

SDis: Excellent performance

Subject 14 (Grade V)

Alphabet: *u* was written incorrectly

SC: Could not copy two of the simple shapes and poor copying of complex shape

Spelling: Very poor performance

HQ: Poor performance

Reading: Very poor performance

NWreading: Only monosyllable words

Alliteration: Good performance

Rhyming: Very poor performance

Wrep: Fair, managed up to stimulus series this had four words in it

NWrep: Good, managed to repeat stimulus series which had three nonwords in it

RN: Took 27 seconds to name all the items

SDis: Excellent performence

Subject 15(Grade V)

Alphabet: Excellent performance

SC: Good copying of complex shape

Spelling: Fair performance

HQ: Good performance

Reading: Less than half is read correctly (poor performance)

NWreading: Only monosyllable words were read correctly

Alliteration: Very good performance

Rhyming: Fair performance

Wrep: Fair, managed up to stimulus series this had four words in it

NWrep: Good, managed to repeat stimulus series which had three nonwords in it

RN: Took 26 seconds to name all the items

SDis: Excellent performance

Subject 16(Grade V)

Alphabet: Excellent performance

SC: Good copying of complex shape

Spelling: Fair performance

HQ: Very good performance

Reading: Very poor performance

NWreading: Only the monosyllable words were read correctly

Alliteration: Good performance

Rhyming: Good performance

Wrep: Fair, managed up to stimulus series this had four words in it

NWrep: Good, managed to repeat stimulus series which had three nonwords in it

RN: Took 31seconds to name all the items

SDis: Excellent performance

*Performance rating-very bad <bad < very poor <poor < fair <good < very good <excellent