Chapter-1

INTRODUCTION
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Learning is a cognitive-behaviour process. Individuals are endowed with this higher order cognitive-behaviour functioning to be a perfect learner. Children during their early development period learn to understand the spoken language first then learn to speak. During their school year they learn to read, write and solve arithmetic as per their age and cognitive ability. However, every child would not be able to learn as per their age and ability. The ability to read is one of the most important skills in contemporary society. Everything from choosing dishes on a restaurant menu to booking online air/rail tickets demands comprehension of written material. For some individuals, however, reading is complicated by a disorder commonly referred as dyslexia (Visser, Boden, & Giaschi, 2004).

According to the Census 2011, there are 26.81 million individuals with disabilities in India who constitute 2.21% of the total population (Census of India, 2013). A national survey has found that close to 25 percent students in class VIII cannot read class II textbooks. In 2014, about 25 percent of children enrolled in class V could read only simple sentences in English. As per the survey, 60.2 percent of children in class VIII could read simple sentences in English in 2009, but in 2014, the percentage came down to 46.8 (DH, 2015). Studies have shown that children with LDs do have deficits or difficulty in executive functioning. If the child cannot learn to read, write or do arithmetic, then it is time for professionals to think about a new technique/method to teach/train them as per their age, pace and ability. Individual training on EFs for children with LDs is important to accommodate them in academic and daily life.

1.1.1 Historical Perspectives

Individual with LDs have been known by different terminology. In the first half of twentieth century the largely used terms were ‘idiots’, ‘imbeciles’, ‘feebleminded’ and those in the second half used the term ‘severely and moderately subnormal’, ‘mentally handicapped’ or, in the case of the USA, ‘mentally retarded’. Definitions of
these terms are quoted by Tredgold in the 1908 (as cited in Porter & Lacey, 2005) edition of his textbook *Mental Deficiency* (pp75-76) in the following way:

a) **Feeblemindedness (high-grade amentia):** This is the mildest degree of mental defect and the feebleminded person is ‘one who has a mental defect exiting from birth or from an early age and is capable of earning a living under conducive environment, are incapable (a) of competing on equal terms with his normal fellows; (b) managing himself and his affaires with ordinary prudence’.

b) **Imbecility (medium-grade amentia):** Imbecile is defined as ‘one who has mental deficit exiting from birth or from an early age and is incapable of earning his own living but is capable of guarding himself against common physical dangers’.

c) **Idiocy (low-grade amentia):** The idiot is defined as ‘a person so deeply defective in mind from birth, or from an early age and is unable to guard himself against common physical dangers’.

It was not until the last few years of the century that people started to use the term ‘learning difficulties’ or ‘learning disabilities’. Across the centuries, people with LDs have been variously feared, hated, pitied, tolerated, respected or largely ignored.

The past centuries has observed huge changes from the workhouses and eugenics movement, institutionalization and de-institutionalization to community care and disability rights, to children with severe disabilities being viewed as ‘uneducable’ to being educable (but requiring segregated provision) and being eligible for education alongside their non-disabled peers in mainstream schools. People’s thinking has shifted considerably, but not evenly, across the last 100 years. The inter-war
years, for instance, did not produce substantial change in the lives of people with LDs, partly because of the depression and lack of funding for services but also because intelligence was thought to be fixed and any attempts to change it were futile (Porter & Lacey, 2005).

Stainton (2001; as cited in Porter & Lacey, 2005) reports that the history of LDs has been a marginal activity that has led to ‘errors and unsupported assumptions’. The increasing life history accounts provide important insight into the lives of people with learning difficulties.

The term “Learning disability” was coined by Samuel Kirk in 1962. Venkatesan (as cited in Basavaraj, 2007) has noted that LDs are known by many names such as specific learning disability, specific developmental disability, specific developmental disorder of scholastic skills, academic skill disorder and minimal brain dysfunction syndrome.

Despite an extensive literature, LDs in children remain to be a highly controversial issue among the academicians, clinicians and researchers. By and large, since the beginning, the definitions, assessments, and issues related to classification, causes, remediation or training and prognosis still remain unresolved. There is no single definition of LD throughout the American and/or European continents (Scruggs & Mastropieri, 2002). Therefore an attempt has been made below to give a comprehensive account of these issues.

1.1.2 Definitions of Learning Disabilities

There are many definitions of LDs, few have been given here:

Kirk (1962) defined LDs as follows: A learning disability refers to a retardation, or delayed development in one or more of the processes of speech, language, reading, writing, arithmetic, or other school subject resulting from a psychological handicap caused by a possible cerebral dysfunction and/or emotional or behavioural disturbances. It is not the result of mental retardation, sensory deprivation, or cultural and instructional factors.
Learning disabilities are neuropsychological disorders characterized by specific processing problems. For instance, dyslexia (reading disability) is particularly characterized by specific impairments in single word reading, reading fluency, and reading comprehension, usually resulting from deficient phonological processing (Pennington, Groisser, & Welsh, 1993).

Learning disabilities is a general term that refers to a “heterogeneous group of disorders manifested by significant difficulties in acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities. These disorders are intrinsic to the individual, and are presumed to be due to a central nervous system dysfunction and may occur across the life span. Problems in self-regulatory behaviours, social perception, and social interaction may exist with LDs but do not, by themselves, constitute a LD. Although LDs may occur concomitantly with other disabilities (for example, sensory impairment, mental retardation, serious emotional disturbances) or with extrinsic influences (such as cultural differences, insufficient or inappropriate instruction), they are not the result of those conditions or influence”, (National Joint Committee on Learning Disabilities, 1988).

Specific learning disability means “a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include learning problems that are primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbances, or of environmental, cultural, or economic disadvantage”, (Individuals with Disabilities Education Improvement Act of 2004).

Learning disability is an ‘invisible’ disability. Children with LDs appear with average or even above average intelligence. They have had normal exposure to school or academic training. There is no evidence of any physical or sensory handicaps, mental illness, mental retardation, organic pathology and other psychological disorders. They are good in many aspects of day to day life. Yet these children have
difficulty in dealing with one or more areas like reading, writing, spelling or arithmetic (Venkatesan, 2004).

1.1.3 Epidemiology

Gowramma (as cited in Basavaraj, 2009) stated that learning disability was thought to be a rare disorder, but current statistics in the West and India show that 10 percent of children are affected by this handicap. It is an alarming thought that in a school of 1,000 children; at least 100 could be learning disabled. Various studies indicate the prevalence of LDs in specific areas to be 5-7% and all together at 10%. Mild forms of LDs are more common than severe forms. Boys are affected three times more than girls. Das (2009) has defined that there can be several reasons for this:

i. There may be some biological factors that make male children more prone to learning disability.

ii. Girls generally possess superior language skills and these skills develop more quickly than they do in boys. This may compensate for any initial handicap girls might have in learning to read.

iii. Boys are often harder to handle in the class than girls, so the teacher is more likely to notice them.

iv. Boys tend to be less interested in reading and much more interested in acquiring physical skills, such as cycling or cricket, because culturally, in many communities, reading is an activity for girls.

Venkatesan (2012) found that more boys than girls are referred with academic problems for detailed assessment. In the sample size of 115 out of 2100 (Referral Rate: 5.5%), there were 81 boys (Referral Rate: 3.9%) and 34 girls (Referral Rate: 1.6%). Previous studies have implicated more boys in special education programmes compared to girls (Coutinho & Oswald, 2005). However, the ratio of boys to girls, having a LD is reported to be equal (Hampton & Mason, 2003). Zabel and Nigro (1999) study found that if LDs were identified by general education teachers, there was likelihood that boys were identified as having twice the academic problem than
the girls. This gender bias in screening, assessment or identification of children with LDs is supported by literature (O’Hara & Martin, 2003; Young, 2005).

Suresh and Sebastian (2003) reported that research on the prevalence of LDs in India is limited and there is certainly no data that can be quoted about the pan-Indian situation. There has been no prospective longitudinal study, and there is little information on the prevalence of SLD with other psychiatric disorders like ADHD, among Indian children and adolescents. They have, however reported a ‘large incidence’ of LDs in rural areas in Kerala. Arun, Chavan, Bhargava, Sharma, and Kaur (2013) found a prevalence of 1.58 per cent of specific developmental disorder of scholastic skill in school students in Chandigarh.

1.1.4 Diagnostic Nomenclature and Classification

Learning disabilities are currently classified as “Specific Developmental Disorders of Scholastic Skills” (SDDSS), in International Classification of Mental and Behavioural Disorders Diseases-10 (WHO, 1992). Whereas, it is classified as “Specific Learning Disorder” (SLD) in Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) (APA, 2013). There are four criteria in diagnosing SLD as per DSM-5. The main feature is a persistent problem in learning or using academic skills as quickly or as accurately as peers during the developmental period (Criterion A). Thus, the individual’s academic skills are below the average range for his or her age, gender-based peers and cultural group (Criterion B). The clinical expression of the specific learning difficulties occurs during the school-age years, and therefore these difficulties may not be apparent until demands on the affected skills exceed the individual’s abilities (Criterion C). The learning difficulties cannot be accounted for by intellectual difficulties, uncorrected visual or auditory problems, psychosocial adversity, poor proficiency in the language of academic instruction, or inadequate educational instruction (Criterion D). It includes three categories of specific learning disorders like impairment in reading, impairment in written expression, impairment in mathematics (APA, 2013). However, among the professionals the term specific learning disorder and learning disability are interchangeably used. The common types of learning disabilities are given below.
a) **Reading disorder:** It is defined as reading achievement below the expected level of a child’s age, education, and intelligence, with the impairment interfering significantly with academic success or the daily activities that involve reading. It is characterized by an impaired ability to recognize words, slow and inaccurate reading, and poor comprehension. Historically many words have been used to describe reading disabilities, including word blindness, reading backward, learning disability, alexia, and developmental word blindness. The term *developmental alexia* was accepted and defined as a developmental deficit in the recognition of printed symbols. This term was simplified by adopting the term *dyslexia* in the 1960s. Dyslexia often includes speech and language deficit and right-left confusion. Reading disorder is frequently accompanied by disabilities in other academic skills, and the term dyslexia has been replaced by broader terms, such as learning disorder (Sadock & Sadock, 2007).

While discussing the problems and prospects in the study of LDs, Torgesen (1975) described the issues involved in the measurement of reading failure. “The conceptual definition of reading disability usually describes it as a failure to learn to read despite normal intelligence and adequate instructions” (p.415). According to Torgesen, problems in defining reading disability operationally result from difficulties in deciding on the level of deficit which can be called a disability and from verification in the measures used to assess reading level.

The level of deficits is often measured by two methods. The first method is reading grade level measurement i.e. if the reading grade level is behind their actual grade level by a specified number of years (generally a discrepancy of two years) children will be called reading disabled. The second method frequently being used is the deviation scores. Here those who score below one or two standard deviations (SDs) from the group mean are arbitrarily designated as reading disabled (Kavale, 2002).

b) **Mathematics disorder:** Children with this disorder have difficulty in learning and remembering numerals. And they also cannot remember basic facts about numbering, and are slow and inaccurate in computation. Basically, children
have difficulty in four groups of skills, they are linguistic skills (those related to understanding math terms and converting written problems in math symbols), perceptual skills (the ability to recognize and understand symbols and cluster of numbers), mathematical skills (basic addition, subtraction, multiplication, division, and following sequencing of basic operations), and attentional skills (copying figures correctly and observing operational symbols correctly). Various terms have been used over the years to denote the difficulties present in mathematics disorder such as dyscalculia, congenital arithmetic disorder, acalculia, Gerstmann syndrome, and developmental arithmetic disorder (Sadock & Sadock, 2007). Mathematics disorder can occur in isolation or in conjunction with language and reading disorder.

c) Writing disorder/disorder of written expression: It is characterized by writing skills that are significantly below the expected level of a child’s age and intellectual capacity. These difficulties impair the child’s academic performance and writing in everyday life. Components of writing disorder include poor spelling, errors in grammar and punctuation, and poor hand writing. Spelling errors are commonly found in children with writing disorder. Spelling mistakes often include phonetic errors; it refers to an erroneous spelling that sounds like the correct spelling. For instance fone for phone and beleev for believe (Sadock & Sadock, 2007). Historically, dysgraphia (i.e., poor writing skills) was considered to be a form of reading disorder but evidence indicates that disorder of written expression can occur on its own. The term like spelling disorder and spelling dyslexia are used to describe writing disability. Writing disabilities are often associated with other learning disorders, but they may be diagnosed later because expressive writing is acquired later than language and reading.

d) Non verbal learning disability (NLD): It refers to a subtype of learning disability. Children with NLD have deficits in visual-spatial organization, organization and planning skills, flexible concept formation,
study skills, specific academic areas, social judgment and interpersonal relationships.

1.1.5 Diagnostic Criteria

ICD-10 – DCR diagnostic criteria for SDDSS/LD (WHO, 1993)

Inclusion criteria

a. There must be a clinically significant degree of impairment in the specified scholastic skills such as reading, spelling and arithmetic.
b. The impairment must be specific in the sense that it is not solely explained by mental retardation or by lesser impairments in general intelligence.
c. The impairment must be developmental, in the sense that it must have been present during the early years of schooling and not acquired later in the educational process.
d. There must be no external factors that could provide a sufficient reason for scholastic difficulties.
e. School experiences within the average expectable range.
f. The impairment significantly interferes with academic achievement or activities of daily living that require scholastic skills.

Exclusion criteria

a. IQ below 70 on an individually administered standardized test.
b. Extreme inadequacies in educational experiences.
c. Scholastic difficulties due to a defect in visual or hearing acuity, or neurological disorder.

1.1.6 Comorbidity with Other Disorders
Learning disabilities co-morbidly occur with other diagnoses including attention-deficit/hyperactivity disorder (ADHD), anxiety, and depression (Martinez & Semrud-Clikeman, 2004). ADHD has been found to co-occur in approximately 20% to 50% of children with reading difficulties, depending on the method of calculating a learning disability (Semrud-Clikeman et al., 1992). ADHD has also been found to co-occur with difficulties in mathematics (Semrud-Clikeman, 2003), written language (Hargrave, Corlett, & Semrud-Clikeman, 2002), and social-emotional learning disabilities (Semrud-Clikeman, 2003).

High rates of co-morbidity of LD and ADHD (15% to 40%) made it extremely difficult to obtain an adequate sample size using these exclusion criteria. Furthermore, the inclusion of ADHD as co-morbidity enhances the generalizability of this sample (Gilger, Pennington, & DeFries, 1992; Shaywitz, Fletcher, & Shaywitz, 1995; Willcutt & Pennington, 2000).

Malmgren, Abbott, and Hawkins (1999) conducted a seven year prospective longitudinal study to investigate whether the presence of learning disabilities increases a youth's risk of becoming a juvenile delinquent. The sample included 515 students enrolled in the fifth grade in the fall of 1985, 51 (9.9%) of whom were youth with LD. Self-report and court records on delinquent activity were collected. The results of this study did not confirm the presence of a direct relationship between LD and delinquency and suggest that the finding of a direct relationship in other studies may have been due to confounding of the LD status with age, ethnicity, or socioeconomic status.

1.1.7 Theories of Learning Disabilities

a) The double deficits theory

The double-deficit theory of dyslexiapostulates that rapid automatized naming is an independent core deficit that can cause reading difficulties, in addition to or in the absence of the phonological processing deficits seen in many individuals with developmental dyslexia. According to this theory, impairments in either rapid automatized naming or phonological awareness
can cause reading difficulties, and individuals with a “double-deficit” have more severe deficits in reading than those with single deficits (Wolf & Bowers, 1999).

b) The phonological theory

This theory proposes that children with dyslexia have a specific sound manipulation impairment, which affects their auditory memory, word recall, and sound association skills when processing speech. The phonological theory explains a reading impairment when using an alphabetic writing system which requires learning the grapheme/phoneme correspondence, the relationship between the graphic letter symbols and speech sounds which they represent (Ramus et. al., 2003).

Support for the phonological theory comes from evidence that dyslexic individuals perform particularly poorly on tasks requiring phonological awareness, i.e. conscious segmentation and manipulation of speech sounds.

However, evidence for poor verbal short-term memory and slow automatic naming in dyslexics also points to a more basic phonological deficit, perhaps having to do with the quality of phonological representations, or their access and retrieval (Snowling, 2000).

c) The rapid auditory processing theory

The rapid auditory processing theory is an alternative to the phonological deficit theory, which specifies that the primary deficit lies in the perception of short or rapidly varying sounds. Support for this theory arises from evidence that people with dyslexia show poor performance on a number of auditory tasks, including frequency discrimination and temporal order judgment (Ramus et. al., 2003).
d) The visual theory

The visual theory represents a traditional perspective of dyslexia, as being the result of a visual impairment creating problems when processing information from letters and words from a written text. This includes visual processing problems such as binocular, poor convergence, and visual crowding. The visual theory does not deny the possibility of alternative causes of dyslexia (Ramus et. al., 2003).

e) The cerebellar theory

The problems faced by many children with LDs are not only confined to reading and spelling. There appears to be a general impairment in the ability to perform skills automatically, an ability thought to be dependent upon the cerebellum. Specific behavioural and neuroimaging tests indicate that dyslexia is indeed associated with cerebellar impairment in about 80% of cases. Disorders of cerebellar development can in fact cause the impairments in reading and writing characteristic of dyslexia, a view consistent with the recently appreciated role of the cerebellum in language-related skills (Nicolson, Fawcett, & Dean, 2001).

f) The magnocellular (auditory and visual) theory

This theory attempts to unify the cerebellar theory, the phonological theory, the rapid auditory processing theory, and the visual theory. The magnocellular theory proposes that the magnocellular dysfunction is not only restricted to the visual pathways but also includes auditory and tactile modalities (Ramus et. al., 2003; Ray, Fowler, & Stein, 2005).

Research support for the magnocellular theory includes magnocellular abnormalities in the medial as well as the lateral geniculate nucleus of dyslexics’ brains (Livingstone, Rosen, Drislane, & Galaburda, 1991), poor performance of dyslexics in the tactile domain (Stoodley, Talcott, Carter,
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Witton, & Stein, 2000), and the co-occurrence of visual and auditory problems
in certain dyslexics (Van Ingelghem et al., 2001).

1.1.8 Etiology

a) Neuroimaging studies

Growing research body evidence suggests neurological etiology for different
types of learning disabilities. Research indicates that in using technologies
such as positron emission tomography (PET), magnetic resonance imaging
(MRI), functional magnetic resonance imaging (fMRI), and magneto
encephalography show successful reading which involves the left hemisphere
posterior reading system that consists of both ventral and dorsal components
and frontal regions (e.g., the inferior frontal gyrus) (Hickok & Poeppel, 2004;
Pugh et al., 2000).

b) Genetic studies

Many studies support that a genetic factor plays a major role in the presence of
reading disorders (RD). Studies indicate that 35 to 40 percent of first-degree
relatives of children with reading disorder also have some RD. Many studies
have indicated that phonological awareness (i. e., the ability to decode sounds
and sound out words) is linked to chromosome 6; the ability to identify single
words has been linked to chromosome 15. Impairment in reading and spelling
has been now linked to susceptibility loci on multiple chromosomes, including
chromosomes 1, 2, 3, 6, 15 and 18 (Sadock & Sadock, 2007).

c) Prenatal, perinatal and postnatal events
Sometimes, biological factors such as alcohol or drug use that affect a developing foetus, impact brain development and can lead to LDs.

d) Environmental factors

Other factors in an infant’s environment may play a role as well. Such as poor nutrition and exposure to toxins such as lead in water or paint. In addition, children who do not receive the support necessary to promote their intellectual development early on may show signs of LDs once they start school (National Center for Learning Disabilities, 2012).

LDs are not caused by factors such as cultural or language differences, inadequate or inappropriate instruction, socio-economic status or lack of motivation, although any one of these and other factors may compound the impact of LDs.

1.1.9 Psychosocial Aspects

Several studies have been conducted on psychosocial problems. A sample of 20 children with scholastic skill difficulties and age range 5 to 8 years were compared with normal controls. Results showed greater number of externalizing, internalizing and learning problems in the children. The need for management of behavioural problems along with remediation of scholastic difficulties was highlighted (Hirisave & Shanti, 2002).

Executive function is associated with academic achievement. The prefrontal cortex is highly plastic and undergoes a long period of post-natal development (Casey, Giedd, & Thomas, 2000), it may be particularly susceptible to influences of childhood experience. Indeed, a growing body of behavioural and neural imaging evidence suggests that executive function varies along socioeconomic gradients, showing stronger associations with socioeconomic status than many other neurocognitive
systems. Importantly, executive function in early childhood is highly predictive of later academic achievement (Blair & Diamond, 2008; Buckner, Mezzacappa, & Beardslee, 2009), suggesting that differences in executive function in preschool and beyond may powerfully affect the life trajectories of children growing up in poverty.

Lawson, Hook, Hackman, and Farah (2014) suggest that socioeconomic status (SES) is systematically related to executive function, with low-SES children showing worse performance across many tasks, ages, and methodological approaches. Evidence from a wide range of methodologies suggests that environmental factors related to SES account for at least part of this disparity, and recent mediation analyses suggest that the home environment may be a particularly important factor mediating the relationship between socioeconomic status and executive function. This field of research informs and refines societal policies and programmes designed to address the urgent challenges faced by low income families and children.

Self esteem and self perceptions has been studied in children with learning disabilities in a purposive sample of 40 children in the age range of 8-13 years, with IQ over 80. The sample had 20 children with specific developmental disorders of scholastic skills and 20 age, gender matched normal achievers. Two groups were assessed on the Culture-specific self esteem inventory for children. Self perception of learning disability scale was administered to the children with SDDSS. Results indicated that learning disabled children had significantly lower academic skills, social, parental and general self-esteem. The child’s perception of learning disability had significant positive associations with academic, social, general and total self-esteem levels but not significantly associated with parental self-esteem (Bhola, Hirisave, Kapur,&Subbukrishna , 2000).

Growing body of research evidence suggest that the academic deficits inherent to LD put students at risk of poor academic performance and failure (Kavale & Forness, 1995; Pearl & Bay, 1999). Many children and youth with LD have social problems (Cosden, 2001; Kavale & Forness, 1995; McIntosh, Vaughn, & Zaragoza, 1991), which are diverse (Pearl & Bay, 1999).
Research findings indicate that the cause of the social problems in children with LDs are more likely to be rejected, not accepted, and neglected by peers (Greenham, 1999; Kuhne & Wiener, 2000; Nabuzoka & Smith, 1993; Wiener, 2002). Approximately 25% to 30% of children with LDs are socially rejected, in comparison to 8% to 16% of their peer without LDs (Greenham, 1999).

### 1.1.10 Neuropsychological Aspects

Since various types of children with LDs have distinct neuropsychological profiles, neuropsychological study of children with LDs plays an important role from both the diagnosis and intervention perspectives. Thus neuropsychological assessment can help in ascertaining diagnosis and planning an intervention accordingly.

Kumar and Sukumaran (2009) compared two matched groups of adults, LDs and normal controls using Wechsler Adult Intelligence Scale-III. Results showed a significant difference, with normals obtaining a higher score, and adults with LDs obtaining a lower score on verbal IQ compared to performance IQ.

Sadock and Sadock (2007) support that encoding processes and working memory are areas of weakness for children with reading disorder. Rourke, Hayman-Abello, and Collins (2003) have identified two major subtypes of learning disabilities: Basic phonological processing disabilities (BPPD) and Nonverbal learning disabilities (NLD) and have discussed the neuropsychological deficits associated with these subtypes. In the cases of BPPD, impairments are seen in the areas of attention and memory for auditory-verbal material, verbal repetition and storage. Phonemic hearing, segmenting and blending are highly impaired. These impairments manifest in poor reading and spelling as well as the reading and writing aspects of arithmetic performance. However, visuo-spatial ability, non-verbal problem solving and concept formation abilities are unaffected. Whereas, in NLD deficits are seen in the areas of tactile perception, visual perception, complex psychomotor skills, memory for tactile perception, visual input, concept formation and problem solving, and speech and language (Table 1.1).

### Table 1.1: Description of deficits in major subtypes of learning disability

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<th>Subtype</th>
<th>Deficits</th>
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<td>Basic phonological processing disabilities (BPPD)</td>
<td>Impairments are seen in the areas of attention and memory for auditory-verbal material, verbal repetition and storage. Phonemic hearing, segmenting and blending are highly impaired. These impairments manifest in poor reading and spelling as well as the reading and writing aspects of arithmetic performance. However, visuo-spatial ability, non-verbal problem solving and concept formation abilities are unaffected.</td>
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<tr>
<td>Nonverbal learning disabilities (NLD)</td>
<td>Deficits are seen in the areas of tactile perception, visual perception, complex psychomotor skills, memory for tactile perception, visual input, concept formation and problem solving, and speech and language.</td>
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<td>1.</td>
<td>Basic phonological processing disabilities</td>
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<td>Nonverbal learning disabilities</td>
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### 1.2 Executive Functions

Executive Functions (EFs)(also called, Cognitive Control Functions) refer to a broad range of cognitive, behavioural and adaptive competencies, such as, creative and abstract thought, ability to effectively regulate and direct self-behaviour, verbal reasoning, problem-solving, planning, sequencing, sustaining attention, showing resistance to interference, utilization of feedback, multi-tasking, cognitive flexibility, ability to deal with novelty, introspection, and forming a plan based often on recollections of past experience (see Figure 1.1). These abilities play a critical role in
complex social behaviour. They help suppress improper actions and focus on purposeful information (Burgess, Veitch, De Lacy Costello, & Shallice, 2000; Grafman & Litvan, 1999; Smith & Jonides, 1999). These EFs are critical for success in school as well as in daily life (Diamond, Barnett, Thomas, & Munro, 2007).

**Figure 1.1 Executive Function Processes**

1.2.1 Development of Executive Functions

The maturation of EFs is essential to psychological adaptation and adjustment across the life span (Eslinger, Biddle, & Grattan, 1997). Research studies (Levin et al., 1991; Welsh, Pennington, & Groisser, 1991) suggest that basic EFs develop early in life and follow a protracted, multistep trajectory to maturity in adulthood. The early appearance of rudimentary/fundamental EFs and the later development of more complex functions, such as abstract reasoning and judgment, parallel the lengthy development of the prefrontal cortex. Interestingly, the emergences of rudimentary...
EFs correlate with the periods of maximum synaptic density of the frontal lobes. However, more complex functions continue to evolve long after maximum synaptic density is reached, and reflect a host of other developmental advances such as synaptic pruning and sculpting, axonal myelination, and neurochemical and neurophysiologic changes. Important advances in understanding the development of EFs are due to the remarkable investigations of Diamond (1991), Goldman-Rakic (1987a, b), and others.

Goldman-Rakic (1987a, b) has studied the relation of prefrontal development to the emergence of the cognitive operation of object permanence. Whereas, Diamond (1991) has adapted a number of tasks that Jean Piaget initially used in studying cognitive development to investigate EFs. In her study of infants, Diamond attempted to relate the development of EFs to the maturation of the underlying frontal circuitry. Snow and Iversen (1995) reported marked increase of developmental patterns of EFs for children and adolescents with LDs from the 7 to 11-12 year level with subsequent levelling.

Welsh et al. (1991) have traced the development of EFs in healthy children, aged 3 to 12, and young adults. They determined that subjects achieved adult-like performance at three different age levels: 6 years old, 10 years old, and during adolescence. Simple functions, such as visual search (searching an array of stimuli for targets), emerge early, followed by the more complex inhibitory skills, and finally, the most advanced abilities as demonstrated in complex planning. Age-related changes in the development of the EFs of working memory, inhibition, and cognitive flexibility have been identified for healthy preschool (Espi, Kaufmann, Glisky, & McDiarmid, 2001) and elementary school (Archibald & Kerns, 1999) children.

Anderson (2002) reviewed factor analytic studies pertinent to the development of executive functioning of childhood and adolescent populations. Despite differences in executive measures used, participants sampled, and ages represented, similar executive factors were identified to include planning, impulse control, concept reasoning, and response speed. Integrating these findings with the recent conceptualizations of executive functioning reported by Alexander and Stuss (2000),
Anderson proposed four developmentally sensitive executive function domains: attention control (selective attention, inhibitory control, sustained attention, and monitoring of executed plans), information processing (fluency, efficiency, and speed of output), cognitive flexibility (shifting between response sets, profiting from mistakes, developing alternative strategies, dividing attention, and multi-tasking), and goal setting (planning, organization, conceptual reasoning, and strategic problem-solving).

Zillmer, Spiers, & Culbertson, (2008) reported that attention control undergoes significant maturation during infancy and early childhood, with adult levels of functioning reached by middle childhood. Despite somewhat different trajectories, information processing, cognitive flexibility, and goal-setting functions achieve maturation by the end of middle childhood. However, developmental refinement continues into mid-adolescence and early adulthood.

1.2.2 Classification/Types

A typical list of EFs includes initiation, sustained attention, planning, organization, set-shifting, conceptual functioning, awareness, and insight. However different researchers and practitioners have their own favourite lists of EFs, although the overall concept is basically the same. Gioia, Isquith, Kenworthy, and Barton (2002) have proposed a list of EFs. Some of EFs are presented below.

a) **Inhibition** - The ability to stop one's own behaviour at the appropriate time, including stopping actions and thoughts. The flip side of inhibition is impulsivity; if you are weak to stop yourself from acting on your impulses, then you are "impulsive."
b) **Shift** - The ability to move freely from one situation to another and to think flexibly in order to respond appropriately to the situation.
c) **Emotional control** - The ability to modulate emotional responses by bringing rational thought to bear on feelings.
d) **Initiation** - The ability to begin a task or activity and to independently generate ideas, responses, or problem-solving strategies.
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e) **Working memory** - The capacity to hold information in mind for the purpose of completing a task. It involves three EFs like set shifting, inhibition, and monitoring/updating (Berninger et al., 2006).
f) **Planning/Organization** - The ability to manage current and future-oriented task demands.
g) **Organization of materials** - The ability to impose order on work, play, and storage spaces.
h) **Self-monitoring** - The ability to monitor one's own performance and to measure it against some standard of what is needed or expected.

1.2.3 Brain Mechanism of Executive Functions

The executive system is mediated by various networks in the frontal, parietal and occipital cortices, the thalamus and the cerebellum (Jurado & Roselli, 2007). It is linked through a series of circuits connecting every region of the central nervous system. The circuits originate in the dorsolateral prefrontal cortex/orbitofrontal cortex, project through the striatum, synapse at the level of the globus pallidus, substantia nigra and the thalamus and finally return to the prefrontal cortex (PFC) forming closed loops (Narushima, Paradiso, Moser, Jorge, & Robinson, 2007). Each circuit regulates specific functions. The circuit that is most responsible for coordinating executive function is located primarily in the frontal lobe. Functional imaging studies have implicated the PFC as the primary site of cortical activation during tasks involving executive function (Elliott, 2003).

1.2.4 Causes of Executive Dysfunctions

Psychologists are interested in EF because it is critical for self-directed behaviour, so much so that the greater the decrement in EF, the poorer the ability to live independently (Hanks, Rapport, Millis, & Deshpande, 1999). To regulate and guide behaviour through a constantly changing environment, the brain requires a central coordinating system. The ES is responsible for the simultaneous operation of a number of cognitive processes in charge of goal-directed, task-oriented behaviours, self-regulation and behaviour inhibition as well as planning, working memory, mental flexibility, response inhibition,
impulse control and monitoring of action (Robinson, Goddard, Dritschel, Wisley, & Howlin, 2009). It is important to recognize that, because of the interconnectivity between the lateral frontal and posterior regions, diffuse pathology can cause executive dysfunction.

Dysfunction of the frontal lobe and disruption in fronto-subcortical pathways from chemical imbalances have been strongly associated with dysfunction of the executive system as demonstrated through neuroimaging studies using PET and fMRI scanning (Elliott, 2003). Executive dysfunction indicates some malfunction in the circuits that connect the subcortical areas with the frontal lobes. Both genetic and environmental factors can interfere with executive system efficiency (Hosenbocus & Chahal, 2012).

1.2.5 Relation between Attention and Working Memory

The capacity to perform some complex tasks depends critically on the ability to retain task-relevant information in an accessible state over time (working memory; WM) and to selectively process information in the environment (attention). An example, consider driving a car in an unfamiliar city. In order to get to your destination, directions have to be retained and kept in working memory. In addition, one must be able to selectively attend to the relevant objects because there is more information in a scene than can be processed by our perceptual systems. In fact, the contents of WM and attention often overlap. If the directions stored in WM instruct you to turn left after the yellow tower, then attention may be guided towards objects that resemble a yellow tower. Although the contents of working memory and attention are often the same but the exact relationship between these two constructs is not fully understood (Fougnie, 2008).

1.2.6 Relation among Memory, Attention and Executive Function

Zillmer et al. (2008) explained that memory, attention, and EF represent relatively distinct processes, although in some cases, there is disagreement that
a particular attentional or memory process is better classified as an EF (for example, working memory). Clearly, these processes are interrelated, but specifying the exact nature of this interrelation is hindered by our limited understanding of these domains, divergent definitions and conceptualizations, and varied theoretical perspectives. When experts from the fields of memory, attention, and EF were asked to specify the behaviours denoted by the term executive function, no less than 33 different terms were generated with only 40% agreement for 6 of the terms (self-regulation, sequencing of behaviour, flexibility, response inhibition, planning and organization)(Eslinger, 1996).

Zillmer et al. (2008) reported that EFs represent overarching, controlling, organizing, integrating, and supervising computations. Attention and memory processes are subject to varying degrees of executive orchestration depending on the nature and type of attention and memory processes involved. From a neuroanatomic perspective, memory, attention, and executive functions are served by relatively distinct, yet interconnected and overlapping, neural systems. Neuroimaging investigations demonstrate that different neural systems support executive, attention, and memory functions; yet, these neural systems coactivate in the performance of many executive, attentional, and memory tasks, indicating shared or distributed processing. Furthermore, the interrelation of these functions is evident when one realizes that EFs would be of little value if memory systems did not operate to register, store, and enable the retrieval of life experiences and knowledge, and if attentional systems did not support the processing of relevant or critical environmental and body events. Jointly, attention, memory and executive functions play a central role in thinking, reasoning, planning, problem solving, language, and socio-emotional behaviour. Finally, human experience involves the capacity to represent and relate past, present, and future events. Attentional systems are necessary for the processing of relevant ongoing and novel events, memory systems for the symbolic maintenance of these experiences over time, and EFs for the generation, guidance, and evaluation of behaviour necessary to attain future goals (Eslinger, 1996).
1.2.7 Relation between Executive and Metacognitive Functions

Executive functions are commonly defined as interrelated abilities in self-monitoring, initiation, planning, goal setting and self-awareness (Adamovich, Henderson, & Auerbach, 1985; Ben-Yishay & Diller, 1993; Van Reusen, 1987; Ylivasaker & Szekeres, 1989). Similarly metacognitive skills are denoted to include the process of awareness, evaluation, prediction, anticipation and self-control (Brown, Bransford, Ferrara, & Campione, 1983; Flavell, 1985).

Metacognition refers to a higher order thinking that involves active control over the thinking processes involved in learning. The term “metacognition” is attributed to Flavell (1971) who defined metacognition as thinking about one’s own thinking. He described metacognition from a developmental perspective; with reference to learn how monitoring our cognitive processes, setting goals for understanding and activating strategies.

Metacognitive processes, which foster knowledge about one’s own performance, are representative of the core of executive functioning. Thus a paradigm was presented here (see Figure 1.2), which incorporated metacognition with executive functions. Malia and Bewick (1996) advocated the importance of these skills as reciprocal interchangeable processes, which are integral to achieving a comprehensive therapy/training programme.
Figure 1.2: A circular paradigm representing executive and metacognitive components

1.3 Executive Function Deficits in Children with Learning Disabilities

Children with LDs are characterized by specific processing problems. For example, students with reading disability (dyslexia) are shown to have impairments in single word reading, word fluency and reading comprehension usually resulting from deficient phonological processing (Pennington et al., 1993). Neuropsychological, structural, functional imaging and electrophysiological studies have evidenced central nervous system dysfunction in these children (McCrorry, Mechelli, Frith, & Price, 2005) as against age or grade matched unaffected peers (Lyon, Newby, Recht, & Caldwell, 2011). The role of frontal lobe (PFC) is especially implicated for their poor executive functions (Elliott, 2003).

Specific EF impairments appear to affect particular disabilities such as children with LDs having difficulty in EFs. These include self-regulatory activities
such as checking, monitoring, and revising when learning as well as weakness in cognitive flexibility, sorting, organizing, and prioritizing information. Their strong conceptual reasoning abilities may not match their output and productivity because of their difficulties in organizing and prioritizing numerous details, juggling these details in working memory, and shifting flexibility between abstract concepts and literal details as well as from major themes to the details (Meltzer, 2007). There is evidence to suggest that children with LDs show poor academic performance and have difficulties/deficits in various EFs, such as, attention, working memory, set shifting and inhibition (Meltzer, 2007; Wilcutt, Pennington, Olsen, Chhabildas,&Hulslander, 2005). These empirical studies highlight difficulties/deficits in EFs indicating a dire need to have an individualized training programme to improve EFs in children with LDs.

Attention

Tarver and Hallahan (1974) reviewed 21 experimental studies of attention deficits in LDs. The review studies were related to distractibility, hyperactivity, impulsivity, vigilance, and intersensory integration. From the accumulated evidence, the following conclusions were drawn:

i. Children with LDs exhibit more distractibility than controls on tasks involving embedded contexts (figure-ground perception tasks) and on tests of incidental vs. central learning. They are not differentially distracted by other types of distracters such as flashing lights and extraneous colour cues.

ii. Hyperactivity of children with LDs may be situational-specific, with higher levels of activity being exhibited in the structured situation.

iii. Children with LDs are more impulsive, i.e. less reflective, than controls.

iv. Children with LDs are deficient in their ability to maintain attention over prolonged periods of time.

A growing body of literature clearly shows typical LD children have trouble directing their attention to the central features of an externally-provided task. Further, LD children perceive the consequences surrounding their behaviour to be more externally-controlled than does the average learner. This inactive, externally-controlled learning style is well documented. Further research needs to isolate the
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...subgroups which may exist within the broader characterization and examine the effectiveness of remedial techniques with the various subgroups (Hallahan, Gajar, Cohen, & Tarver, 1978).

Vrana and Pihl (1980) investigated selective attention in learning disabled and normal children aged 8 years to 10 years 6 months. Patterned stimulus configurations requiring selective attention to one of two types of stimuli were given. Immediate recall measures on one or both types of stimuli were recorded under two conditions - (1) in which stimuli were close together and (2) in which they were separate. Results indicated that normal children selectively attended significantly better than learning disabled children under condition 1 but not in condition 2, in which both groups were equal. These results are interpreted as supporting a cognitive explanation for attentional deficits in learning disabled children.

Eliason and Richman (1988) studied the performance of 90 children with LDs on two measures of behaviour and attentional skills (a) the Revised Behaviour Problem Checklist is a parent-rated multivariate behaviour scale; and (b) the Continuous Performance Test (CPT) is a laboratory vigilance/impulsivity measure. As a group, the LD subjects exceeded normative standards on every measure of both scales. However, when the data were examined individually, approximately 30% of the children accounted for the majority of behavioural problems. The most common difficulties were noted on attention, cognitive processing, anxiety, and excessive motor activity. Whereas, Richards, Samuels, Turnure, and Ysseldyke (1990) studied sustained and selective attention of 30 students with LDs in the fourth, fifth, and sixth grade and compared with 20 control. A CPT yielded no differences for students with LD and controls, suggesting similar ability for both groups in sustaining attention and inhibiting impulsive responding.

Facoetti et al. (2003) suggested that several studies provided evidence for a phonological deficit in developmental dyslexia. However, recent studies provide evidence for a multimodal temporal processing deficit in dyslexia. In fact, children with dyslexia show both auditory and visual abnormalities, which could result from a more general problem in the perceptual selection of stimuli. Authors report the results of a behavioural study showing that children with dyslexia have both auditory and...
visual deficits in the automatic orienting of spatial attention. These findings suggest that a deficit of selective spatial attention may distort the development of phonological and orthographic representations that is essential for learning to read.

Visser et al. (2004) compared the magnitude of the attentional blink (AB) in children with developmental dyslexia to reading-matched and age-matched control groups. In Experiment 1, when two targets were presented in the same spatial location, the AB deficit was similar in the reading-matched and dyslexic groups, but greater in the dyslexic group than in age matched controls. In Experiment 2, when targets were presented in different spatial locations, performance in the dyslexic group was worse than the age-matched controls and marginally worse than the reading-matched controls. Taken together, the results argue for developmental delays in the ability of children with dyslexia to allocate attention to rapidly-sequential stimuli, as well as some evidence for difficulties that are unique to this group. On the other hand, Buchholz and Davies (2005) compared the performance between a group of adults with developmental dyslexia (specifically phonological difficulties) and a group of age and IQ matched controls. The findings indicate that adults with dyslexia have difficulty in both the space-based and the object-based components of covert visual attention, and more specifically to stimuli located in the periphery in comparison to normal controls.

Moores, Nicolson, and Fawcett (2003) explained that both attentional difficulties and rapid processing deficits have recently been linked with dyslexia. They reported two studies comparing the performance of individual with dyslexia and control teenagers on attentional tasks. The two studies were based on two different conceptions of attention. Study 1 employed a design that allowed three key components of attention focusing, switching, and sustaining to be investigated separately. In study 2, they explored an alternative interpretation of the Study 1 results in terms of the classic capacity limited models of "central" attention. The results suggest that individual with dyslexias suffer from a general impairment in the ability to automatise skills in this case the skill of automatic shape recognition.

Ruffino et al. (2010) studied 28 children with dyslexia and 55 normally reading children by measuring attentional masking (AM). AM refers to an impaired
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identification of the first of two sequentially presented masked objects (O1 and O2). In this study, O1 was always centrally displayed, whereas the location of O2 (central or lateral) and the O1–O2 interval were manipulated. Children with dyslexia showed a larger AM at the shortest O1–O2 interval and a sluggish AM recovery at the longest O1–O2 interval, as well as an abnormal lateral AM. More importantly, these spatio-temporal deficits of attentional engagement were selectively present in children with dyslexia with poor phonological decoding skills. The results suggest that an inefficient spatio-temporal distribution of attentional engagement probably linked to a parietal lobule dysfunction, might selectively impair the letter string passing mechanism during phonological decoding.

The selective attention task has been extensively studied and demonstrates the difficulty of selective visual attention. MacLeod (1991) has shed light on the varied explanations of stroop effect. Stroop effect refers to the much longer time individuals take to observe and name the colour of a stimulus when printed as an incongruent word, than when it appears as a solid colour square. MacLeod reported that the most promising account is provided by a parallel distributed processing approach. Here, the stroop task activates two pathways at the same time. Thus interference occurs when two competing pathways are active simultaneously (Cohen, Dunbar, &McClelland, 1990).

Depending on the processes involved, attentional impairment can lead to a wide range of problems e.g., problem in focusing attention on selective stimuli, difficulty in sustaining attention for required period of time, impaired capacity to shift attention, difficulty in dividing attention between two stimuli etc. Thus an important feature of executive functions is the ability to focus attention over time and to shift attention according to a behavioural programme. Thus attention is a basic feature of executive functions. Prominent models of attention demonstrate this (Halperin, 1996; Hugdahl, 1995; Mirsky, 1996). Lately, the attentional model of Mirsky (1996) has been both validated and applied to clinical populations (Ewing-Cobbs et al., 1998; Loss, Yeates, &Enrile, 1998).

According to Mirsky model, attention can be subdivided into five distinct functions, each associated with different regions of the brain: the capacity to
focus/execute, to encode, to shift, to sustain, and to stabilize attention. The organization of the attentional system implies both specialization and interaction. Executive task functions are focused on the sustain function (the limbic system and midbrain), which is defined in terms of vigilance or the capacity to maintain focus and alertness over time; the focus/execution function (prefrontal cortex), which involves the ability to select relevant stimuli from a broad array and to complete tasks involving those stimuli in an efficient manner; and the shift functions (midbrain, prefrontal cortex), which involves the ability to change the focus of executive functions in a flexible and adaptive manner (Helland, & Asbjørnsen, 2000).

Disorders of selective attention commonly appear in literature and are one of the most frequently cited problems of children with learning disorder (Lazarus, Ludbig, & Aberson, 1984). There is substantial evidence suggesting that learning and attention, particularly selective attention, are intimately tied for meaningful performance to take place (Schworm, 1979).

Attentional dysfunction is an important core deficit in dyslexic individuals (Vidyasagar, & Pammer, 2010). An attentional deficit reduces the success of traditional dyslexia treatments, because learning ability is hampered by spatial and temporal attention dysfunction. Thus, treatment of attentional deficits could be crucial in dyslexia remediation.

Working memory

Working memory may serve as a mechanism for higher cognitive processes, such as problem-solving, reasoning, decision-making, and language comprehension (Jonides, 1995). Baddeley’s tripartite model of WM posits that it is not a unitary system, and instead proposed two separate “slave systems” for short-term maintenance of information (one for verbal information and one for visual information) and one central executive system for the supervision and information integration of the other systems (Baddeley, 1992, 1996). The articulatory loop is one of the “slave systems” that uses primarily phonological information (verbal) and prevents its decay by refreshing its contents through articulatory rehearsal (sub vocal repetition). The visuo-spatial sketchpad is the second “slave system”. Its purpose is to store visual and spatial information.

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It is posited that children with RD have impairment in the articulatory loop component of WM, and therefore show deficit in VWM tasks (Kibby, Marks, & Morgan, 2004). In general, marked deficits have been found in children with RD in VWM (Jeffries & Everatt, 2004; Kibby et al., 2004; Lezak, 1995; Reiter, Tucha, & Lange, 2005; Wilcutt et al., 2002). The capacity to hold information in mind for the purpose of completing a task is low for them. It involves three EFs like-set shifting, inhibition, and monitoring/updating (Berninger et al., 2006).

Several recent studies suggest that WM capacity plays a significant role in reading comprehension (Berninger et al., 2006; Swanson & Ashbaker, 2000; Swanson, Howard, & Saez, 2007; Swanson & Siegel, 2001). Children with Math LD often demonstrate procedural impairments in counting; arithmetic strategy use; and the EFs of organizing, monitoring, and sequencing the steps required in more complex problem solving (Bull, 2007; Geary, 2004, 2007). And writing involves EFs like-activating (starting), organizing, prioritizing and sequencing.

Working memory has been the focus of many studies of children with LDs. Research examining specific subtypes of LDs has found that WM deficits underlie the difficulties of students with reading and mathematical disabilities (Siegel & Ryan, 1989; Swanson, 1993). It has been widely reported that learning disability population exhibit serious deficits in memory, which may be language based, word finding problems or semantic memory problems (Swanson, 1987).

Reiter et al. (2005) explored a variety of aspects of executive functioning in children with dyslexia. Forty-two children with dyslexia and 42 normal controls were examined using a neuropsychological test battery. The test battery consists of standardized tests examining the assessment of WM, concept formation, inhibition, flexibility, problem solving and fluency functions. The findings suggest that children with dyslexia demonstrate impairments in a variety of EFs in comparison to normal controls.

Digit forward is a task of short-term auditory memory, sequencing, and simple verbal expression (Hale, Hoeppner, & Fiorello, 2002), while Digit backward involves WM, and mental flexibility (Lezak, 1995). In the context of attention, the digit span...
tests have been suggested to tap more complex attention or information processing (Larrabee & Curtiss, 1995).

Learning disabilities, when combined with ADHD, have a specific role in school failure (Faraone, Biederman, Monuteaux, & Seidman, 2001). This is because LDs without ADHD can also manifest neuropsychological deficits in attention and in components of memory (Benezra & Douglas, 1988).

Seidman, Biederman, Monuteaux, Doyle, and Faraone (2001) studied the effect of comorbid reading or arithmetic LDs in young males diagnosed with ADHD. LD was defined by combined regression based and low achievement classifications. Analysis was adjusted for the effect of psychiatric comorbidity, age, and socioeconomic status on neuropsychological functions. Result indicated that children with both ADHD and LD were significantly more impaired on both executive and non-executive functions than ADHD children with LD. Neuropsychological performance was most impaired in ADHD with combined arithmetic and reading disability. These data indicate that comorbid LD, especially arithmetic disability, significantly increases the severity of EFs impairment in ADHD.

O’Shaughnessy and Swanson (1998) synthesized research that directly compares children with and without LDs in reading on immediate memory performance. Forty-one studies were included in the synthesis, which involved 161 effect sizes. Results from the full regression model indicated that children with LDs were distinctly disadvantaged compared to average readers when memory manipulations required the naming of visual information and task conditions involved serial recall. Age, IQ, and reading scores were not significant predictors of effect size estimates. Most importantly, nonstrategic (type of task and materials) rather than strategic factors best predicted effect size estimates. The results also indicated that memory difficulties of readers with LDs persisted across age, suggesting that a deficit model best captures the performance of children with LDs.

Dahlin (2011) examined the relationship between WM and reading achievement in 57 Swedish primary-school children with special needs. The results show that WM can be seen as a crucial factor in the reading development of literacy among...
children with special needs, and that interventions to improve WM may help children becoming more proficient in reading comprehension.

**Set-shifting**

Successful set-shifting involves the disengagement of an irrelevant task set or strategy and the consequent activation of a more appropriate one (Van der Sluis, De Jong, & Van der Leij, 2004). Task switching is sub served by other executive functions, particularly inhibition and working memory (Aron, Robbins, & Poldrack, 2004; Baddeley, 1996), and has been shown to have overlapping neutral activation pathways utilized by working memory and inhibition (Aron et al., 2004; Bushbaum, Greer, Chang, & Berman, 2005; Demakis, 2003). Task-switching paradigms focus on the switching process by providing cues that inform the subject when to shift tasks, such as in the Wisconsin Card Sorting Task (Bushbaum et al., 2005).

Lazar and Frank, (1998) and Zhang, Su and Li (2004) found that a reading disability group performed significantly worse than the controls on this task. However, several studies have failed to find deficits in this sub-domain in children with reading disability. However, these findings have not been consistently demonstrated on several scoring variables of the WCST-64 (Narhi, Ransanen, Mesapelto, & Ahonen, 1997; Sengstock, 2001; Willcut et al., 2005). There remain equivocal findings within this population as to whether impairments exist in this domain. Perhaps the difficulty lies in the failure to separate out the underlying deficit that may be causing the impairment because of the overlap in task specificity.

**Inhibition**

Inhibitory processes are also important for the development of cognitive abilities such as learning, memory, and motor activity (Johnston & Blue, 2006). The domain of inhibition is most often assessed using a go/no-go paradigm or Stroop colour-word task, which measures the ability of a participant to inhibit a well-learned response. Helland and Asbjornsen (2000) and Willcutt et al. (2005) found marked deficits in a group of children with reading disability on the Stroop colour-word task and a Stop signal task. However several studies have failed to replicate these findings (Reiter et al., 2005).
Individuals with LDs have been shown to demonstrate deficits in EFs and decreased performance on the WCST (Lazar & Frank, 1998; Snow, 1998). Helland and Asbjørnsen (2000) suggested that large effect sizes were obtained on three WCST variables: number of categories, total errors and non-perseverative errors. However such a link has not been definitive. Other research has not found significant differences on the WCST by children with LDs (Barkley, Grodzinsky, & DuPaul, 1992). Snow (1998) found that the development trend of performance on the WCST by children/adolescents with LDs and normal controls is similar, but the overall performance of children with LD at each age level is below that of normal children.

1.4 Neuropsychological Intervention

The research evidences provides a number of cognitive rehabilitation models (Averbach & Katz, 2011; Bracy, 1986; Diller, 1976, 1981, 1987; Luria, 1963, 1973a; Reitan & Wolfson, 1985, 1988). All of these models involve the systematic use of exercises aimed at retraining/remedying perceptual-motor, cognitive and executive function deficits (Talbot, Pepin, & Loranger, 1992). Neuropsychological models of developmental disorders conceptualize a child’s learning strengths and weaknesses as manifestations of efficient or inefficient brain regions and/or systems (Rourke, Bakker, Fisk, & Strang, 1983). Neuropsychological intervention/training follow idiometric or ipsative approaches to identify specific areas of neuropsychological functional assets and deficits for inter-comparisons and for evolving tailor-made structured and need-oriented training programme for individuals with disability/dysfunction (Venkatesan, 2010).

1.4.1 Theories of Neuropsychological Intervention
The Individualized Training Programme on Executive functions (ITPE) involves training mind/brain and modifying EFs of children with LDs. Thus, a good ITPE requires a foundation of strong theoretical framework.

a) The Role of Neuroplasticity

The environment can alter the organization and functioning of the normal and injured brain through the mechanism of neuronal or brain plasticity (Kolb & Whishaw, 2003). Plasticity refers to the modification of neural activity in response to the changing pattern of stimulation. Enriched environments have been demonstrated to be associated with greater levels of dendritic growth, particularly in the hippocampus. This ability of the human brain to adapt itself is what makes neuropsychological intervention possible (Rajeswaran, Bennett, & Shereena, 2013).

Training programmes, which are designed to remediate LDs, tend to promote experience-dependent plasticity in the brain. Individualized training programmes, irrespective of their level, modality and content, are believed to cause modification of the brain activity. Brains of younger children are plastic and clearly localized therefore more likely to recover from a damage or functional impairment than the adult brain. Individualized training programmes makes a lot of difference in overcoming or compensating the deficits. Systematic training, needless to say, would make it happening faster than an unsystematic one (Jena, 2013). It is also noted that the recovery for language development is much better than other areas (Beamount, 1983).

b) The Role of Restitution, Substitution, and Compensation

Zangwill (1947; as cited in Wilson, 2009) reported that there are three processes of neuropsychological interventions. They are restitution, substitution and compensation. The first “restitution”, refers to a process of restoration of the lost or impaired function. Second “substitution”, involves the replacement of impaired functions by alternate strategies that prove to be
functional. This may also involve the reorganization of cortical networks associated with the task. And the last, “compensation”, which requires an artificial source that typically, requires more effort and time.

c) The Role of Diaschisis

Diaschisis is a Greek word meaning “shocked throughout”. It refers to the excitatory and inhibitory effects following brain injury that affect areas remote to the site of injury. These effects were used to explain the sequelae following the injury. Although diaschisis was originally used to explain the deficits following head injury, it may indeed work as a blessing in disguise. In a normal uninjured brain, there exist certain pathways that are ineffective and inactive. Diaschisis may indeed inhibit this original suppression thereby rendering these alternate pathways functional (Christensen& Uzzell, 2000).

1.4.2 Methods of Neuropsychological Intervention

Neuropsychological intervention methods typically involve massed practice (learning with no intervals or short intervals between successive periods of learning), drill practice of isolated cognitive skills (Delahunty, Morice, & Frost, 1993), and restorative or remedial or corrective approaches (such as, word-list learning, paragraph listening, visual imagery and use of mnemonic strategies) (Sohlberg, White, Evans, & Mateer, 1992). The compensatory approaches use environmental manipulations in child’s home and school setting by facilitating adjustment to the disability by increasing awareness and acceptance. These practices are often combined to optimize the effects of intervention (Cicerone et al., 2000).

1.4.3 Approaches of Executive Function Training in Children with Learning Disabilities
Executive function training involves simple strategies to improve self-control, organization, memory and time management. Executive functions are the processes in our brain that control planning, managing tasks, transitioning to different activities and prioritizing. Research evidences revealed that various approaches/techniques are commonly used in the training of EFs. These are as follows.

a) Attention Training

It is based on the concept that efficiency increases after repetitive practice of specific cognitive operations of attention because practice produces adaptations in underlying neuro-anatomical networks linked to these processes (Kerns, Eso, & Thompson, 1999). This concept has origins in the field of cognitive rehabilitation where attention process training uses tasks such as listening for descending number sequences, shifting set and visual cancellation has been used to activate and train sustained, alternating and divided attention (Sohlberg & Mateer, 1989).

Bracy et al. (1999) used computerized cognitive skills training programme which focused on attention, executive, visuo-spatial and problem solving skills in 12 to 14 year old children and reported significant increase in intellectual functioning. Studies have also reported significant improvement in attention after 10 training sessions by using computer-assisted instruction approach for enhancing attention in elementary school children (Navarro et al. 2003).

b) Working Memory Training
Working memory is a core cognitive ability and can be increased through systematic exercises. One of the early reading intervention studies proposed that WM deficits in children with reading disabilities stem from an inefficient use of information processing strategies (Torgesen, Murphy, & Ivey, 1979). Researchers tested children with and without reading disabilities on a free-recall memory task, following either a free study period, or an "orienting task" which required participants to engage in a complex conceptual analysis of the stimuli to be remembered. Children who did the orienting task performed equally on the free-recall memory test, regardless of whether they had a reading disability or not. This supports the hypothesis that WM deficits in children with reading disabilities stem from inefficient information processing, which can be eliminated with strategy training (Torgesen et al., 1979).

Kipp and Mohr (2008) explored the intervention for an 8-year-old boy who was initially unable to develop letter-sound associations due to a severe phonological memory deficit. The intervention, which involved verbal repetition and identification of spoken letters, produced a limited but significant improvement in letter-reading skills. However, no improvement was seen for more complex reading experiences. Although improvement in complex reading skills was not observed, letter reading improvement was still significant at 5 months, suggesting that the intervention was successful in training letter-sound associations.

In addition to difficulties with phonological processing, children with reading disabilities are also thought to have deficits in attention processing (Swanson, 1993) that can make it difficult to determine which information is relevant to keep in mind. Swanson, Kehler, and Jerman (2010) suggested that children with reading disabilities have trouble preventing extraneous information from entering working memory, therefore, are more likely to consider alternative interpretations or strategy choices that are not central to the task at hand. These researchers designed a study to examine the effect of rehearsal strategy training on WM performance in children with and without reading disabilities. They found that rehearsal training significantly improved WM performance of children with reading disabilities, but did not account for
the variance between children with and without reading disabilities. Only measures relating to demands on processing capacity contributed significantly to the variance in reading skill, providing evidence for the role of attention processing in reading ability. The authors concluded that strategy training may have provided improved working memory by encouraging focus on the relevant aspects of the task. However, it remains unclear if improvements in WM directly influence higher order skills such as reading comprehension.

c) **Goal Management Training** (GMT; Levine et al., 2007; Robertson, 1996)

Based on Duncan’s theory of “goal neglect”, goal management training provides a direct focus on difficulties in goal-directed behaviour of daily life (Duncan, 1986; Duncan, Emslie, Williams, Johnson, & Freer, 1996), which addresses dysexecutive self-regulatory deficits (i.e., failure to carry out intentional and apparently well-memorized actions). The theory of goal neglect maintains that any activity requires a list of goals that are used to impose coherence and structure to behaviour and to create a plan of action, allowing one to achieve goals. During task execution, actual situation and stated goal are compared, and appropriate actions are then selected and activated in order to reduce discrepancy. Inhibition of actions not contributing to the achievement of a goal and selection of new actions when anterior actions fail to attain the goal (flexibility ability) are two other important aspects of the theory. According to Duncan, much of the disorganized behaviour in people with frontal cortex dysfunction can be attributed to difficulties in elaborating and implementing such lists of goals.

The GMT procedure encompasses 5 steps, each emphasizing one important aspect of goal-directed behaviour: (1) stop: orient awareness toward the actual state of the situation; (2) define: the goal of the task; (3) list: the tasks into sub-steps; (4) learn: the steps; and, (5) check: if the result of an action corresponds to the stated goal. In case of a discrepancy, the 5 steps are repeated. Therefore, the strategy consists of taking pauses during a current task to “stop and think”, selecting and maintaining the goal in memory. While
the task is executed, the goal is subdivided into more simple and controllable sub goals, setting priorities for their execution, and using mental imagery or check lists. Exercises are administered in order to train people to use the strategy as a basis to evaluate their proper performance in activities of daily life, implement new actions, and continuously monitor their success.

GMT is a top-down approach that focuses on training processes that can be applied across domains and that encompasses different factors such as attention, problem-solving, encoding and retrieval strategies, and monitoring. Thus, GMT aims to promote generalization of the training on activities not specifically addressed in a given intervention. The effectiveness of GMT has been demonstrated on several occasions such as in people with neurological lesions and in healthy elderly adults (Levine et al., 2000; Levine et al., 2007; Schweizer et al., 2008). Children with LDs also manifest goal directed behaviour/academic difficulties in their daily life, GMT could prove beneficial for this clinical population as well.

d) BRAINWAVE-R Rehabilitation Programme (BRAINWAVE-R; Malia, Bewick, Raymond, & Bennett, 1997)

The executive functions module, one of several components in this comprehensive therapy plan and programme merges this three-pronged learning model with meta-cognitive principles, such as: (1) learning knowledge; (2) learning skills and/or strategies; and, (3) learning transfer abilities and internal/external mediation devises in an effort to maximize executive functions of brain injured patients. It covers a knowledge-driven meta-cognitive format. It contains three booklets: (1) Introduction to Executive Functions; (2) Clinician Manual; and, (3) Patient Workbook. All of them provide a ready-made package of information on executive functions geared toward educating patients and family members. It defines and describes executive functions and deficits, their potential impact on activities of daily living, neurologically-related areas and current theoretical concepts (Malia et al., 1997).
e) **Computer-Assisted Instruction (CAI)**

Computer-assisted instruction is considered the solution of children with many learning problems, such as speaking, reading and writing (Jena, 2013). It also appears to be a promising intervention for children with attention problems. CAI and/or computerized interventions have a number of inherent advantages relative to traditional instructional methods for inattentive children, some of which are not unique to that population. First, they are able to immediately adjust to the specific instructional levels of children and provide immediate and specific feedback such that the rate of learning is maximized. Second, instructional features (e.g., animation, interactive features) that are engaging to children may improve time on task which enhances learning (Murray&Rabiner, 2014).

f) **Cognitive Behaviour Therapy (CBT)**

Children with LDs do have cognitive problems such as lack of attention, Poor memory, poor motivation, lack of interest, emotional and behavioural problems, inadequate planning and organization related to academic work. In order to improve their cognitive functioning, CBT can be useful in developing appropriate strategies for academic problem-solving and self-control in children with LDs. CBT includes task description, formulation of strategy, modelling, guided-practice, verbalization, self-monitoring and self-reinforcement. The therapist or clinician acts as a model in demonstrating and introducing the systematic and structured CBT programme and try to sustain the problem-solving skills through reinforcement (Jena, 2013).
g) Neuropsychological Educational Approach to Remediation (NEAR; Medalia & Revheim, 1999; Medalia, Revheim, & Casey, 2001)

This strategy employs commercially available educational software. Designed for use in elementary school classrooms, these tasks are more like games than repetitive exercises, and therefore, are appealing to many subjects. They have built-in feedback mechanisms to guide performance and difficulty levels that can be tailored to the individual. The tasks require use of multiple cognitive processes, with emphasis on higher order, executive functions. It emphasizes self-guided practice, rather than structured training in order to foster intrinsic motivation for learning and to allow persons to enhance their preferred problem solving styles (Medalia & Revheim, 1999; Medalia et al., 2001).

h) Cognitive Remediation Therapy (CRT; Wykes, Reeder, & Corner, 2000)

This intervention focuses on executive functioning (e.g., cognitive flexibility, working memory and planning) and employs a sophisticated training model based on principles of errorless learning, targeted reinforcement and guided practice on cognitive tasks administered in one to one therapy sessions. A preliminary trial yielded improvement on several untrained neuropsychological measures, and modest retention of training effects over a 6-month follow-up interval (Wykes et al., 2000).

i) Computer-Assisted Cognitive Remediation Program (CACR; Bellack, Dickinson, Morris, & Tenhula, 2005)
This application takes into consideration the unique aspects of schizophrenia that may impact cognitive remediation participation and enhance the potential benefit of participants. It embeds computer-based cognitive exercises in a client-centered clinical programme. Importantly, client engagement is enhanced through use of commercially developed educational software. This software is technologically sophisticated with interesting content and audio/visual characteristics, built-in aides and feedback mechanisms and is designed to be intrinsically motivating to use. CACR includes six exercises. One exercise is a speed task that emphasizes rapid assessment, decision-making and response. Two exercises place a premium on use of attention, working memory and learning. The remaining exercises specifically target planning, reasoning and problem solving skills, while also tapping attention, memory and other capacities. Each exercise includes integrated visual and verbal reinforcement for correct responses (Bellack et al., 2005).

j) Recall, Organization and planning, Prioritizing and goals setting, Evaluation and critical thinking skills, and Self-management (ROPES; Schetter, 2004)

This cognitive remediation programme developed exclusively for children on autism spectrum relies on graphic organizers to represent sequential thoughts, elucidate patterns, illustrate problem-solving strategies and model flexible adaptation. This strategy assumes that the visual nature of the programme taps into visual strengths often noted in people with autism spectrum disorders, providing them with a pictorial representation of steps and skills they need to perform.

k) Drive to Thrive Program(DTP; Meltzer, Reddy, Pollica, & Roditi, 2004; Meltzer et al., 2005)
It involves strategies that can be incorporated into daily classroom routine for improving executive functions. Studies of student motivation, effort, and strategy use indicate that students who understand the importance of applying strategies to their schoolwork begin to recognize that their academic struggles are not insurmountable and that they can achieve greater success when they use learning strategies. The DTP builds on results from a 6-month, strategy-based classroom instruction intervention that showed significant improvements for at-risk students with learning and attention problems (Meltzer, Katzir-Cohen, Miller, & Roditi, 2001). These findings emphasize that teaching students how to implement strategies successfully can initiate a positive cycle in which students focus their effort and use strategies effectively, resulting in more efficient performance and improved academic performance.

1) Self Regulated Strategy Development (SRSD; Graham & Harris, 2005a, 2005b)

With this model, students are explicitly and directly taught to apply the target writing strategies and how to use procedures such as goal setting, self-monitoring, self-instruction and/or self-reinforcement to regulate their use of the writing strategies, the writing task, and their behaviour. Content knowledge is increased by teaching students information needed in using the selected writing strategies and self-regulation procedures effectively. Finally, the model is designed to enhance students’ motivation for writing through a
variety of procedures including emphasizing the role of effort in learning, making the positive effects of instruction concrete and visible, and promoting a “can do” attitude. This model supports five aspects of executive functioning: analysis, decision making and planning, execution and coordination of mental and affective resources, attention control, and flexible adaptation. It is shown to be effective in writing interventions (Graham & Perin, 2007).

m) PASS Reading Enhancement Program (PREP; Das, 1999)

The PREP is a remedial programme for primary school-aged children who experience difficulties in reading, spelling, and comprehension. It is based on the PASS (Planning, Arousal-Attention, Simultaneous, and Successive) theory of intelligence (Das, Naglieri, & Kirby, 1994). The training tasks in PREP are aimed at improving the information-processing strategies that underlie reading, namely, simultaneous and successive processing. While avoiding the direct teaching of word-reading skills.

Attention and planning are important aspects of the programme. Strategies such as rehearsal, categorization, monitoring of performance, prediction, revision of prediction, sounding, and sound blending are integral parts of each task. By working through the tasks, children develop their ability to use these strategies. Rather than being explicitly taught, the children are encouraged to become aware of their use of strategies through a discussion of what they are doing. Growth in ability to use the strategies and awareness of appropriate opportunities for use are expected to develop over the course of the remediation (Das, 2009).
n) **Cognitive Enhancement Training Program (COGENT; Das & Denise, 2004)**

COGENT is a cognitive and reading stimulation programme and aims at building the cognitive, language, and phonemic awareness skills that support reading, especially for those children who are at risk for developing reading difficulties. The programme includes “modules” focusing on metalinguistic skills, syllable/phonemic discrimination, onset-rime distinctions, syntactic and semantic comprehension, and rapid automatic naming intertwined with cognitive processes, such as attention, strategy planning, simultaneous, and successive processing. These modules include squeeze and say, clap and listen, funny relatives, name game, and shapes, colors and letters. It is intended for children aged four to seven, preschoolers to children in early school years, who need to be prepared for reading (Das & Denise, 2004).

o) **Response to Instruction/Intervention (RTI; Fuchs & Fuchs, 1998)**

The use of RTI to identify students with LDs is based on a dual-discrepancy model. First, the student must be significantly below same-grade peers on measures of academic performance. Secondly, the student performs poorly in response to carefully planned and precisely delivered instruction. Using RTI in identification process has most frequently been embedded in a multi-tiered model of assessment, intervention, and progress monitoring. This model can be conceptualized as consisting of three phases:

1. Determining whether effective instruction is in place for groups of students.
ii. Providing effective instruction to the target student and measuring its effect on performance.

iii. Referring students whose RTI warrants additional or intensive continuing interventions.

**Phase 1: Active format** - There are two different approaches that can be used in this phase of the model: active and passive. In active format, an entire group of students (most typically a classroom) is screened on a critical measure of academic performance. Students whose scores on these measures place them at risk for not developing requisite skills at an acceptable rate and level are provided with intensive short-term interventions. Students who fail to make progress are referred for further assessment and intervention in phase 2 of the process.

**Passive format** - The active format in which students are screened and actively instructed is the preferred approach in this phase. However, not all schools have such screening/intervention programmes in place, especially beyond the primary grades. In these cases, a more passive approach is used to determine *post hoc* whether effective instruction has been in place for large groups of students.

**Qualitative procedures** - The appraisal of lack of instruction can be qualitative or quantitative. Qualitatively, the multidisciplinary team would use measures and procedures that assess the instructional environment in classroom, such as, the Functional Assessment of Academic Behaviour (Ysseldyke & Christenson, 2002). These measures reflect whether instructional procedures that have been empirically verified as linked to...
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academic achievement are being used in the classroom. Teams are charged with improving instructional environments prior to further referral of the student to not only improve the overall effectiveness of the classroom but also to rule out whether a lack of instruction is instrumental in producing the student's deficiency.

Quantitative procedures- Vaughn and Fuchs (2003) describe a procedure in which performance measures of individual classrooms are developed to determine if on average, students in a given classroom score at desired levels of proficiency. The implication is that classrooms that produce comparatively low levels of performance among their students are likely to not be providing effective instruction on a systematic and consistent basis.

Phase 2: Problem-solving process- There are students who continue to display academic performance deficiencies after group-based interventions in phase one, or after it has been determined that there are no systemic factors in the instructional environment that are preventing satisfactory academic achievement. They are then referred for more individually tailored interventions. In this phase, a close match is forged between the precisely assessed skills of the target student and the instructional approach. Instruction that is typical for large groups of students is specifically adapted for the target student.

Determining need for referral- It is in this phase that the student's RTI is specifically described and quantified. Students who display acceptable progress during this phase are deemed to have "good" RTI while those who show significantly sub-par progress have "poor" RTI. Students who display acceptable RTI may still need to be considered for further services when the additional aids and services that were required to produce improved performance are so intensive that they are beyond what can reasonably be delivered in general education.
Phase 3: In this phase, the multidisciplinary team is charged with determining whether the student meets the qualifications for special education. As indicated, this determination is based on a dual-discrepancy model. The student needs to be verifiably deficient from grade peers and have demonstrated during earlier phases either poor RTI or the need for demanding intensive levels of continued interventions to ensure ongoing positive RTI.

p) Compensatory Strategies

Compensatory strategies are environmental modifications designed to improve attention, memory, executive-function, and/or other cognitive skills as means to achieve desired training goal. A well-organized, structured environment with clear routine, rules and procedures, minimal distractions, allocated seating arrangements, teachers use of hand gestures, visual aids, frequent feedback and checklists are all effective strategies for maintaining external control (McKloskey, Perkins,&Van Divner, 2008). Additional strategies may include:

Planning explicit teaching of the planning process, breaking tasks into manageable steps and teaching students how to use a planner/organizer.

Prioritizing teaching students how to highlight main points, using visual learning aids and supports such as graphic organizers as well as allocating time frames to specific tasks.

Organizing guided practice, consistent routine, using outlines such as graphic organizers, teaching summarizing skills and note-taking strategies, putting key points on index cards or ‘post-it’ notes, using color coding for organizing tasks, and using files, binders, trays, and boxes to organize the environment and reduce clutter.
Shifting of activities and focus can be supported through ensuring eye contact and attention before giving clear instructions, advance warning of changes, use of predictable routines, and opportunities for small-group work where group roles (leader, note taker, focuser) are clear to each student.

Reducing Demands on Working Memory by using a planner/diary and wall calendars to help in day to day management tasks, implementing a well-structured daily schedule and relying on visual aids to provide reminders for routine and applied strategies. Students should be encouraged to use self-talk to remember steps and guide their actions. For learning, they may use repetition, acronyms, mnemonics, chunking, attaching meaning, reciting/singing, and recording. To assist with deficits in internalization of verbal working memory, visual cues can be linked to verbal prompts. Visual working memory deficits should be supported by adding verbal explanations to visual materials and demonstrations.

Self-monitoring can be managed via aids such as self-assessments, self-recording, clearly defined rubrics, exemplars, feedback, checklists and reinforcers (Meltzer, 2010).

q) Behavioural Strategies

Students with EF deficits struggle with emotional and behavioural control. The value and efficacy of behavioural and academic interventions have been well documented and school focused interventions have been found to be superior to singular behavioural management approaches. Evidence-based behaviour strategies for EF difficulties include creating clear rules and procedures (and enforcing them consistently), providing encouragement, rewards and praise, teaching and modeling modulation and supporting positive self-reflection and self-talk about tasks and achievements (Wicks-Nelson & Israel, 2009). Additionally, successful school intervention strategies to increase appropriate classroom behaviour include knowing students’ weaknesses, equipping them with skills to help them manage situations, and offering coaching and support when needed. Finally, strategies that include social skill instruction, social stories, de-stressing and relaxation strategies,
opportunities for role-play, differential reinforcement, meta-cognitive strategies, such as, self-monitoring strategies, and self-evaluation aligned with positive behaviour reinforcers (Menzies, Lane, & Lee, 2009) have been found to successfully address EF impairments.

Apart from the above stated specific strategies, we can also use other strategies such as restructuring environment, structuring time, externalizing cues for effective processing and improved production, providing feedback, providing rewards, and aligning external demands with internal desires etc.

1.5 Children with Learning Disabilities Benefitted by Individualized Training

Individualized Training Programme on Executive functions (ITPE) comprises a wide range of activities focused on attention, working memory and other executive functions/ skills (Gupta & Venkatesan, 2014a) that help children with LDs to adjust with academic difficulties. Research evidence shows that children with LDs are benefitted by various training programmes like executive function training (Gupta & Venkatesan, 2014b), and cognitive retraining techniques and remedial training (Malhotra, Rajender, Bhatia, Kanwal, & Singh, 2010).

In other studies, Malhotra, Rajender, Sharma & Singh (2009) conducted a pre and post experimental design study with 30 children (between 8-10 years) with diagnosis of mixed disorder of scholastic skills. They concluded that manualized cognitive retraining over thirty six hours can help to partially remediate cognitive deficits in children with LDs and improve their scholastic performance. Whereas, Rozario, Kapur, and Rao (1994) evaluated effectiveness of a 25 sessions remedial package for 25 children with LD, age range 9 to 11 years and reported significant improvement.

The literature also provides a number of studies that Working Memory (WM) training may enhance some aspects of WM in children with LD and ADHD (Gray et al., 2012; Holmes, Gathercole, & Dunning, 2009; Klingberg, 2010; Melby-Lervåg & Hulme, 2013).
1.6 Significance of the Study

Studies suggest that children with LDs have difficulty with numerous facets of EFs such as attention, working memory, set shifting and inhibition (Lazar & Frank, 1998; Meltzer, 2007; Reiter et al., 2005; Snow, 1998; Wilcutt et al., 2005). EFs play an important role in planning, decision making and monitoring academic activities. Thus current research focuses on a better understanding of the nature of EFs in children with LDs. Hence, this study will be helpful to make EF profiles of children with LDs and training on this play an important role in enhancing academic learning in such children.

Executive functions are diverse, yet are related and overlapping, set of skills. In order to understand a child, it is important to look at which executive functions/skills are problematic for her/him and to what degree. Therefore children who have LDs often have difficulties with EFs. Thus, EFs such as attention, verbal and symbolic working memory, set shifting, and inhibition/interference control are investigated in the present study because of the availability, feasibility/practicability, portability, and time convenient of assessment tools. Many studies have been conducted in the area of LDs but these studies have been restricted to retraining in one or two cognitive domains and most Indian studies have restricted their interests to psychosocial issues of LDs (Bhola, 1995; Johnson, 2005; Lal, 1996). There is a dearth of studies and literature pertaining to efficacy of individualized training on EFs in children with LDs. Hence, this study has been taken up to fill the gap and help these children in better coping with academic difficulties as well as in life.

1.7 Need for the Study

As above mentioned studies show that children with LDs have deficits in various EFs (Lazar & Frank, 1998; Meltzer, 2007; Reiter et al., 2005; Snow, 1998; Wilcutt et al., 2005). There are very few studies in the area of EFs training in the present scenario. Therefore the aim of the present study is to improve/enhance EFs in children with LDs through individualized, structured and need based training on EFs. The ITPE may be effective in enhancing EFs skills such as attention, verbal and symbolic working memory and abstract ability that may lead to effective academic learning. It
has a lot of educational implications; recognizing the crucial role of EFs, i.e. education cannot directly affect executive function skills, but also, indirectly, a possibility of using similar or different strategies during executive function tasks.

While there is no gainsay that ITPE improves EFs skills in children and will help them to achieve academic and social success by intrinsically motivating them (Singer & Bashir, 1999), it is seen that such programmes address only typical children (Thorell, Lindqvist, Nutley, Bohlin, & Klingberg, 2009). Despite their day-to-day struggles of coping with academics in their school routines, it is rather unfortunate that exclusive studies on evaluating the efficacy of ITPE in children with LDs are scanty (Akhutina et al., 2003; Meltzer & Krishnan, 2007). Therefore, it is the felt need to undertake this study to explore the efficacy of ITPE on EFs for benefit of children with LDs.

Moreover, training benefits may be transferred to other areas; individualized training on EFs may involve other cognitive domains and may offer interesting implications in the field of educational accommodation of LDs. This study would be helpful in the management of LDs and provide a guideline for further researchers in India, who are currently working or planning to work in the future in the area of executive function/cognitive retraining in such clinical population.