Chapter -II

REVIEW OF RELATED LITERATURE
2.1 Introduction: Processing deficits in LD

LD is a central nervous system dysfunction. Owing to the heterogeneous nature of LD, several neuropsychological theories like; double deficit theory, magnocellular deficit theory, temporal processing deficit theory, cerebellar theory, etc have been proposed to explain the causes of LD. Different theory explains different cognitive, functional and structural deficits exhibited in LD. In the present study, Planning, Attention, Simultaneous & Successive processing (PASS), and Phonological Processing are seen as the underlying cognitive functions involved in the acquisition of literary skills in children. Hence the following literature review revolves around the relationship between these cognitive processes in children with LD.

2.1.1 Planning, Attention, Simultaneous & Successive processing in LD

One of the perspectives for understanding LD is the PASS theory of cognitive processing. The PASS theory holds the view that the PASS cognitive functions, particularly successive and simultaneous processes, have a bearing on the reading, spelling and writing tasks while planning process is related to problem solving capacities in children. A below average functioning ability in all or some of these four cognitive processes are known to be the reason for the poor processing skills in children with LD. The validity studies for the PASS theory with children with LD have shown that successive process is associated with word attack skills in children and planning is associated with mathematical computation (Naglieri & Gottling, 1997).

PASS theory of intelligence is an information processing theory based on the ingenious work of A.R Luria (Luria, 1973). Luria’s theory of functional units
proposed that, all cognitive functions fall within the framework of three separate but related brain systems or functional units. The first unit provides regulation of cortical arousal and attention, the second, receives codes and stores information and the third provides strategy development, self monitoring and cognitive control. Luria proposed that attention is a mental process that is closely related to orienting response which allows the organism to direct focused selective attention toward a stimulus over time and resist loss of attention to other stimuli. This according to Luria forms the first unit of the brain, the attention-arousal system, and is located in the brain stem, the diencephalon, and the medial regions of the cortex. This unit is responsible for the appropriate level of arousal or cortical tone, and for selective attention. The second unit is the simultaneous and successive processing unit. The simultaneous processing is essential for organization of information into groups or a coherent whole while successive processing is involved when the stimuli are processed in a specific serial order. This includes for example serial organization of sounds and movements in order and therefore it is integral to working with sounds in sequence and early reading. This second functional unit is associated with the secondary and tertiary zones of occipital, parietal and temporal lobes posterior to the central sulcus of the brain. This unit is responsible for receiving, processing, and retaining information a person obtains from the external world. The third functional unit is planning. Planning helps in achieving selection and development of plans or strategies needed to complete tasks for which a solution is needed and is critical to all activities where one has to determine how to solve a problem. This includes generation, evaluation, and execution of plan as well as self-monitoring and impulse control. This functional unit associated with the prefrontal areas of the frontal lobes of the brain.
Luria expressed that every conscious activity is always a complex functional system and takes place through the combined working of all three brain units, each of which makes its own contribution (Luria, 1973). The relationship between the third and first functional units is particularly strong. The first functional unit works in cooperation with, and is regulated by, higher systems of the cerebral cortex, which receive and process information from the external world and determine individual’s dynamic activity. The unit has a reciprocal relationship with the cortex. It influences the tone of cortex and is influenced by the regulatory effects of the cortex. This is possible through the ascending and descending systems of the reticular formation, which transmits impulses from the lower parts of the brain to the cortex and vice versa.

This theory of functional units by A.R. Luria formed the basis of a subsequent theory of Intelligence; Planning, Attention, Simultaneous and Successive theory of intelligence (Das, Naglieri & Kirby, 1994). According to its proponents, Das, Kirby & Jarman (1975), intelligence is the sum total of all cognitive processes and that it entails planning, coding of information and attention as well as arousal. The model proposes that information in the cognitive system are processed by the four main units namely Planning, Attention, Simultaneous and Successive processes which are broadly associated with the frontal lobe, brain stem and lower part of cerebral cortex, occipital and parietal lobes and frontal-temporal lobes respectively. When the information arrives at the senses, these four cognitive processes are activated to analyze its meaning within the context of individual’s knowledge base. Planning processes involves making some decisions about how to solve a problem, setting goals, anticipating consequences, using feedback and carryout an activity. Attention-Arousal involves the ability to selectively attend to stimuli while ignoring other
distracters. It is a simple process to keep one awake and alert. Simultaneous process involves the ability to integrate separate stimuli into a cohesive, interrelated whole. Successive process involves the ability to integrate stimuli into a sequential order.

The PASS theory suggests that successive processing is the underlying cognitive process that is responsible for phonological skill and word reading. PASS theory is operationalized using the tool Cognitive Assessment System which can be regarded as neuropsychological assessment tool useful in the assessment of LD.

Naglieri and Gottling (1997) expressed their view that the PASS theory, operationalized by the tool CAS, is helpful in identifying specific cognitive weakness in children and is appropriate for successful aptitude by treatment interaction if the specific and relevant aptitude is identified and a particular treatment pertaining to that specific aptitude is applied. In a study they grouped 12 students with LD from schools that specialized in the treatment of students with significant learning problems, into two groups as low and high planning groups on the basis of cognitive assessment system. They theorized planning to be important for mathematical computations. Students with LD in math lack effective use of problem solving strategies and hence the interventions particularly addressed their inefficient planning strategies. Following the intervention the students with low planning scores showed significantly better performance than those with high planning scores. The researchers concluded that to design an appropriate academic instruction that meets the students cognitive needs, professionals require a complete and accurate picture of a person’s level of cognitive processing in specific areas and that PASS model helps meet this needs.

Das, Mishra, and Pool (1995) proposed that, word decoding which is a basic reading skill is linked primarily with successive process than with any other cognitive process. They conducted a study with 51 children aged between 8 years 9 months and
11 years 11 months who demonstrated word decoding problems. The subjects were assessed in successive and planning processes using cognitive assessment system. Their word decoding ability was also tested using two subtests from WRMT-R. Following the intervention which addressed their cognitive deficit, a significant improvement in the successive processing as well as in the word decoding test was observed.

A study conducted by Van Luit, Kroesbergen, and Naglieri (2005) examined the utility of the planning, attention, simultaneous, successive (PASS) theory of intelligence as measured by the cognitive Assessment system (CAS) for evaluation of children with attention deficit hyperactivity disorder (ADHD). The CAS scores of 51 Dutch children without ADHD were compared to the scores of a group of 20 Dutch children with ADHD. The scores of the Dutch children were also compared to American standardization samples of children with and without ADHD. The findings showed that children with ADHD in both the countries demonstrated relatively low scores on the planning and attention scales of the CAS, but average scores on the simultaneous and successive scales. They concluded that the findings are similar to previously published research suggesting that the PASS theory, as operationalised by the CAS, has sensitivity to the cognitive processing difficulties found in children with ADHD.

Hayward, Das and Janzen (2007) conducted experiment in order to find the effectiveness of two cognitive enhancement programs (COGONT and PREP developed particularly to enhance PASS processes) on variables such as phonological awareness, rapid naming speed, word reading ability, listening comprehension and also on the four cognitive processes planning, Attention, successive and simultaneous processes, which are thought to be the underlying factors contributing effective
reading skills. Forty five grade 3 children from a reservation school in Western Canada were selected for the study. They were divided into two remedial groups and a non-risk control group. The group means across the four scales did reveal differential improvements following intervention but there were no significant group differences.

2.1.2 Phonological Processing in LD

LD is predominantly a language related problem. Research states that most reading difficulties stem from deficits in phonological processing. (Bradley & Bryant, 1978; Bryant, Bradley MacLean & Crossland, 1990; Bryant & Goswami, 1986; Wagner & Trogesen 1987. Phonological processing is generally defined as the conscious use of phonological or speech sound knowledge in processing written and oral language (Wagner & Torgesen, 1987). Children as young as 2-3 years of age, start picking up sound units in spoken language which progress during their preschool and early years in school. Studies have shown that the phonological skills possessed at an early age is significantly predictive of later phonemic ability and hence reading ability (Muter, 2000; Muter & Snowling, 1998; Wagner, Torgesen & Rashotte, 1994).

According to the phonological deficit hypothesis, phonological awareness (PA) is the key to learn to read languages that have alphabetic spelling systems. Phonological awareness is related to accurate identification of words and to applying letter/sound knowledge to decode unfamiliar words. Failure to discover the underlying sound structure of written language is a major cause of problems in LD. Correlation studies show that phonological processing and its relationship to reading are concomitant. Intervention studies have shown that children with low phonological awareness demonstrate improved reading performance after phonological awareness
intervention (Sodoro et al, 2002). PA facilitates the development of reading skills in early readers and the development of reading skills reciprocally facilitate the development of phonological awareness in later years of reading. There is a general sequence in the development of phonological awareness. Children become increasingly sensitive to smaller and smaller parts of words as they grow older. They first learn to detect or manipulate syllables and then become sensitive to onsets and rimes, and finally can attend to individual phonemes within intra-syllabic word units. Children are able to blend phonological information before they are able to segment phonological information (Anthony & Francis, 2005).

Phonological awareness of a child is assessed using tasks that require accessing and manipulating sounds in words. Phonological awareness is thus operationally defined as unified ability that manifests itself in different skills such as one’s ability to recognize, discriminate, and manipulate the sounds in one’s language (Anthony, & Francis, 2005). It has been measured by using many different tasks that range from recognition of rhyme and sound-to-word matching to isolating single sounds from words, blending, deleting phonemes, and other even more complex manipulations, such as children's secret languages. According to Adams, 1990 the tasks used to measure phonological awareness fall into five levels of difficulty. The first level consists of having an ear for the sounds of words, which is revealed by the ability to remember familiar rhymes. A second level consists of the ability to recognize and sort patterns of rhyme and alliteration in words, which requires more focused attention to sound components; this ability is revealed in oddity tasks. A third level requires familiarity both with the idea that syllables can be divided into phonemes and with the sounds of isolated phonemes; this level is indicated by blending tasks and by syllable-splitting tasks, for example, isolating initial phonemes.
A fourth level of difficulty is encountered in tasks that require full segmentation of component phonemes, e.g., tapping tests. Most difficult of all are tasks that require children to add, delete, or otherwise move phonemes and to regenerate the resultant word or pseudoword.

Functional neuroimaging studies involving various PA tasks have indicated activation of regions in the prefrontal and temporal cortex of the brain. With proficiency in reading and PA, activation in left temporo-parietal and temporo-occipital regions are reported. Studies using visually presented PA tasks in typically developing children have indicated involvement of left inferior frontal gyrus, superior temporal gyrus, middle temporal gyrus, and fusiform gyrus (Temple et al. 2001; Booth et al. 2004; Bitan et al. 2009). In older and proficient readers increased activations in left posterior temporal and parietal regions are reported (Hoeft et al. 2006; Shaywitz et al. 2007), and reduced activation in these areas are reported in children with dyslexia relative to age- or ability-matched typical readers (Temple et al. 2001; Cao et al. 2006). With remediation for dyslexia increased activation in left posterior temporal and parietal regions are reported (Simos et al. 2002; Meyler et al. 2008). Kovelman et al (2011) reported that typically developing children, but not children with LD, recruited left dorsolateral prefrontal cortex (DLPFC) when making explicit phonological judgments. In their study LD children who exhibited weakness in phonological awareness as assessed by standardized test of phonological awareness (CTOPP) showed reduced activation in left DLPFC. They concluded that left DLPFC may play a critical role in the development of phonological awareness for spoken language critical for reading and in the etiology of dyslexia. Katzir et al. 2005, suggested that phonological awareness without print engages the frontal lobe, whereas the engagement of left posterior regions may reflect the integration of printed and
auditory information during reading (Pugh et al. 2000; Booth et al. 2004; Shaywitz et al. 2007). Many studies have reported that left middle frontal gyrus (MFG) may support both verbal and nonverbal auditory processes important for reading acquisition (Gaab et al. 2007; Poldrack et al. 2001). Some studies have implicated different networks in posterior left-hemisphere regions, including posterior temporal and parietal regions as being important for reading due to their engagement for tasks involving phonological analysis of print. (Pugh et al. 2000; Temple et al. 2001; Cao et al. 2006; Hoeft et al. 2006; Shaywitz et al. 2007). Activations in posterior left hemisphere regions, including posterior temporal, temporoparietal, and temporooccipital regions are reported with increased phonological awareness competence (Temple et al. 2003; Frost et al. 2009).

2.1.3 Phonological processing in Kannada

It is now found that the scripts or orthographies of a language also influence the ability to learn to read them. Orthographies or scripts differ from one another in terms cognitive challenges they place in representing and decoding them. In India, children learn two to three languages; one or two Indian languages and English. English is an alphabetic script where as Indian languages are alphasyllabary scripts. Studies in phonemically represented scripts or alphabetic scripts like that of English for example, report phonological awareness as a very important predictor of reading ability in children, i.e, in such scripts phonological awareness precedes and determines the reading acquisition in children. In contrast, studies in alphasyllabic scripts suggest that phonological awareness does not precede or predict reading acquisition but is in fact the product of practice and successful reading skill (Nag, 2007).
Kannada is an alphasyllabic script. It is both phonemically as well as syllabically represented in the script and is called as an alpha syllabary script or abugida. This characteristic enables mapping or representation both at the phonemic as well as at the syllabic levels. This in other words means both smaller as well as larger units are available for mapping. For example letters can be recognized by the phoneme markers present in it or can be recognized as a whole letter. The primary mapping happens at syllable level but each syllable is constructed by stacking many phoneme markers (Nag, 2007).

The characteristic nature of Kannada orthography is that it is a transparent script i.e., it has consistent grapheme to phoneme correspondence unlike the English script. It has extensive set of symbols or phoneme markers to master and recall them. There are primary and secondary vowels and consonants which cluster around a base consonant. It is syllabically represented but each syllabic representation is clustered by phoneme markers (Nag et al, 2011). This nature of the script makes it a dense unit for the extraction of visual information. In terms of visuo-spatial organization, it is non-linear. Kannada script is nonlinear and require mapping from left to right, right to left as well as up and down. Phonemically represented scripts rely on phonological processing skills while visually complex scripts must rely on visual analysis for decoding (Yeh et al, 2003). Therefore, Kannada script with extensive symbol set and dense visual information, necessitate visual analysis for effective reading acquisition.
2.1.4 Emotional and Behavioral Problems in LD

Children with LD develop emotional and behavioral problems due to the incompetence in academic and cognitive abilities they face more than their non LD peers. This leads to lack of motivation, poor self-efficacy, internalization and externalization problems. They generally exhibit poor self efficacy ad lackbeliefs in one's capabilities to organize and execute the courses of action required to produce given attainments. The self-efficacy is the vital element in influencing the line of thinking and executing the one’s responsibilities. (Bandura,1997). One’s belief about their self-efficacy has a direct impact on one’s performance. Many researchers noted that the children with LD make poor judgment when it comes to their self-knowledge, the motivation and the knowledge towards their task (Butler, 1998; Meltzer et al., 1998).The students with fully developed Meta cognitive skills possess the ability to evaluate and understand their strength, weakness, and cognitive abilities which are much necessary to become successful in the academic setting. This becomes difficult for the children with LD because they exhibit deficiencies in analyzing their own skills and monitoring their tasks (Flavell, 1976).

The children with LD exhibit different behavior problems in social as well as academic settings. They generally show deficits in social competence when comparing to their peers without LD. The LD students exhibit low level of peer acceptance than the non LD students. Gresham (1986) in their comparative study between LD and non LD children reported that the LD children were .75 standard deviations below the non LD children in peer acceptance. Many researches suggest that the children with learning disability express the negative social behaviors like problems in inter personal relationships with their peers, which leads to the reduced level of acceptance. Studies reveal that the socio-metric status of students with LD is
one half to a full standard deviation below of the non LD students (Bryan, 1982; La Greca & Mesibov, 1981). In class room and home setting children with LD are known to demonstrate poor social skills towards their peers, teacher and parents. The social skill deficit is consistent in both school and home settings and also its same irrespective of the teachers, and peers. The parent and teachers recognize that they exhibit poor social skills such as greeting others, conversing, listening to others, smiling and laughing, and complimenting others. Gresham reported that children with LD are two standard deviations below the non LD students in the behavioral area.

2.2 Introduction: Yoga as intervention

When viewed from psychotherapeutic interest, yoga is nothing but techniques to develop attention, concentration, introspection, volition and metacognition. Yoga intrinsically has qualities of biofeedback therapy with techniques for greater awareness to body and mental states with the goal of being able to manipulate them at will.

Regardless of the schools, there are some core components that provide psychotherapeutic values to yoga. As explained by (Schmalzl et al. 2015) movement and the execution of specific physical postures or movement sequence in yoga, fine-tune interoceptive and proprioceptive awareness, and provide a context for training attention. These slow, controlled and rhythmic movements synchronized with breath, train one to balance, coordinate, and constantly track ones of the body positions in space, postural alignment, fluidity and fine tune the movement. The postures are characterized by a hypertonic (e.g., arm balances that require a high level of muscle tension) or hypotonic (e.g., a supine relaxation pose) states provide balanced muscle tone. The overall aim of the practice is to create a state of well-balanced muscle
tension which allows the movement to feel stable, well rooted, light and effortless. These practices provide submaximal levels of load on the joints which are said to be beneficial for bone remodeling and osteogenesis. The intensity employed in these movements increase parasympathetic tone as opposed to sympathetic nervous activation as in other forms of exercises and consequently promote down-regulation of stress levels. The postures are taught using precise alignment cues. The postures are designed to expand range of motion, strength and flexibility of the body. The belief is that physical and emotional stress over time manifests as stiffness and blockages in our muscles, joints and connective tissue. Therefore the aim of posture practice is to release this tension by directing attention to the physical limitation, while directly moving towards and breathing into it. There are practices of interior muscle activations which are called “bandhas”. These are static and soft contraction of interior muscle groups at pelvic floor, the lower abdomen and the throat. The contraction of these muscle groups aid breathing practices and facilitates the maintenance of strong core musculature while moving through the postures.

Breathe awareness is a very important component in yoga. Breath is precisely coordinated with movements so that specific movements help enhance the breath and vice versa. The breath are used as a tool to direct attention to specific body parts while holding a posture or performing a movement, and to consequently increase interoceptive and proprioceptive awareness. There is the practice of consciously altering breathing patterns which have a number of different effects depending on their characteristics. Slow and rhythmic breathing is said to promote a shift to parasympathetic dominance via vagal afferent stimulation and consequently reduces stress, whereas more forceful breathing practices promote sympathetic activation. In some practices the focus is on cultivating an even rhythm of inhalations and
exhalations, with no specific emphasis on linking movement with breath. There is a relationship between breathing and emotional states. Emotional states are expressed in breathing patterns, and subsequently that voluntary change of the breathing patterns can alter emotional states. A typical autonomic reaction to stressful situations is rapid thoracic breathing, which in turn leads to hyperventilation, altered tidal volume and hypocapnia. These symptoms are frequently observed as chronic manifestations in individuals with anxiety and depressive disorders and may be alleviated by the types of breathing techniques. The breath also serves merely as an object of attention in many meditation practices. A fundamental aspect of yoga is paying attention to interoceptive, proprioceptive, kinesthetic and spatial sensations, and using that information to adjust and fine-tune one’s movements. These lead to body awareness. Interoceptive awareness refers to the awareness of internal bodily states and sensations, including heart rate, respiration, as well as several autonomic nervous system responses related to emotional states. The processing of bodily sensations is also a key for our sense of bodily self, which originates through the integration of interoceptive, proprioceptive, kinesthetic, tactile and spatial information. Meditation practices are often classified as engaging focused attention (FA) or open monitoring (OM) techniques. FA techniques involve directing and sustaining attention on a single selected object, whereas OM techniques emphasize non-reactive metacognitive monitoring of perceived sensory, emotional or cognitive events that may arise from moment to moment during one’s practice. The beginners tend to primarily engage in FA, where as advanced practitioners gravitate more toward an OM approach. Individuals engaging in yoga gradually transition from a FA to a more OM attentional orientation. Novice practitioners may only be able to provide their attention to one single element of the practice at the time, but as their practice advances they are likely
to become increasingly skilled at simultaneously monitoring movement, breath, and any concomitant interoceptive and exteroceptive sensations that may arise. Hence, in more advanced practitioners, primarily engage an OM type of attention. Another component is gaze.

Gaze, like breath are used as a tool for training attention and inducing a calm state of mind. Some use eye exercises including gazing techniques in which the eyes are held in a particular position (e.g., upward, inward or downward). These exercises are recommended to aid powers of concentration and prevent one’s attention from being distracted.

Finally, metacognition is the conscious and mostly intentional monitoring of our own mental processes and behaviors. It is the action of “stepping back” to observe ones own inner sensations and thoughts. This aspect differentiates yoga from many common forms of exercise, which are often practiced without a primary goal of paying attention to bodily or mental states. Mindfulness-based practices represent interplay between metacognition and mind-wandering (MW), which refers to spontaneous and undirected thought processes that mostly occur without our volition. In FA, metacognition has the “suppressive” function of noticing drifts of attention from a selected object, and subsequently redirecting attention towards it. In OM, metacognition has the more “integrated” function of monitoring one’s stream of thought, while attempting to maintain detachment and refrain from any cognitive elaboration or judgment.

2.2.1 Allostatic regulation and Polyvagal theory for Yoga

Yoga has a place in complementary and alternative medicine. It is an evidence based practice. The exact mechanisms of how it brings about clinically significant
changes are not clearly known yet. But it has been recommended and practiced based on clinically relevant research, experiences of patients and expert practitioners. The popular theories proposed to account for the wellbeing promoted by yoga are the allostatic regulation and polyvagal perspective. It is believed that yoga has intrinsic properties to promote vegal tone and facilitate decrease of allostatic load. Allostatic load is the ability of an organism to maintain homeostasis by actively adapting to both predictable and unpredictable event in the environment. This adaptation is mediated by the hormones in the hypothalamo-pituitary-adrenal (HPA) axis. An imbalance in these mediators results in allostatic state and cumulative effect of sustained state over time result in allostatic load. The regulation of allostatic load is done by the vegal nerve, the 10th cranial nerve. Its axons emerge from and converge into brain stem nuclei and it regulates several visceral organs as well as muscles of face, head and neck. The parasympathetic activation brought about by yogic slow and rhythmic breathing, postures that enhance the depth of breath and postures that emphasize abdominal tone through activation of interior muscles are know to stimulate vagal nerve and regulate the vegal tone. This theory is accounted for the hormonal balance, positive cardio pulmonary functioning and body-mind integration brought about by yoga.

The positive effects of yoga are reported on endocrine system, nervous system, physical health, metabolism, circulatory system, cognition and behavior are reported following the practice of yoga. Decreased salivary cortisol levels, enhanced serotonin, melatonin, and oxytocin (Vera et al, 2009; Brotto, 2009; Oswal et al, 2011; Kinser et al, 2012) production are reported following yoga. These changes in hormones are believed to be responsible for the observed decrease in stress and anxiety, improved immunity and sleep in practitioners. On the nervous system, yoga
is known to influence sympathetic and parasympathetic activity of the ANS. Respiratory effects of breathing exercises, visualization and calming techniques in meditation as well as physical movements are known to produce sympathetic activation, increased levels of gamma aminobutyric acid (GABA) (Streeter et al, 2012), regulated hypothalamic-pituitary-adrenal (HPA) axis (Kiecolt-Glaser et al, 2010) to produce improved outcomes in mood disorders, stress, well-being and provide an anxiolytic effect. Lowered resting heart rate, oxygen consumption rate, decreased basal metabolic rate (BMR) and decreased body mass index (BMI) (Bera et al, 1993; Innes et al, 2005) and fat mass are reported which indicate preventative effects for cardiovascular disease, diabetes and obesity and promote physical health. Improved glucose tolerance and insulin sensitivity following yoga are reported which suggests that regular practice may replace drug therapies in type 2 diabetics (Innes et al, 2005). Clinically significant improvements after yoga intervention are noted in fasting plasma glucose (FPG) and postprandial plasma glucose (PPPG) (Sahay, 2007). Increased hepatic lipase and lipoprotein lipase at the cellular level and subsequent increase in uptake of triglycerides by adipose tissues (Balaji et al, 2012) suggest positive effects of yoga on metabolism. In the circulatory system health-related outcomes included lowered blood pressure and improved arterial function, enhanced cardiovagal function and slowed atherosclerosis to prevent cardiovascular disease, increased blood flow and restored baroreceptor sensitivity (Innes et al, 2005). Numerous findings provide evidence for increased levels of total antioxidant status (TAS) and other naturally occurring antioxidants in human cells such as glutathione (GSH) and plasma vitamin E (Dun et al, 2008) following yoga intervention.
2.2.2 Yoga for children

Of the 312 studies reviewed in 2014 only 9.9% of the studies were done with children (Cramer et al, 2014). A review of literature of randomized controlled trials of yoga on children suggests that yoga has positive impact on the general health and physical fitness of children. Increased muscular fitness (Moorthy, 1982), improved tweezer dexterity (Telles et.al, 1993), grip strength (Raghuraj, 1997; Madanmohan, 2003), motor speed (Dash & Telles, 1999) were reported. Physical fitness in terms of body composition (Seo, 2012), muscular strength, cardiopulmonary functions (Udupa et al, 2003, Chen et al, 2009), abdominal strength (Komathi et al, 2011), vital capacity (D'Souza & Avadhany 2014) had improved. Decreased heart rate, improved cardiac function, improved lipid profile and insulin resistance, increasing parasympathetic activity and decreasing sympathetic activity (D'Souza & Avadhany 2014; Seo, 2012) were also observed following the practice of yoga in children. On psychological wellbeing, children showed reduced levels of fear and anxiety (Rauhala, 1990; Berger & Owen, 1999), improvements in self image (Clance, 1990), behavioral adjustments (Telles, 1997), and increased emotional balance in terms of healthy stress management (Stueck & Gloeckner, 2005) following yoga intervention.

2.2.3 Yoga and cognitive functions

Studies on the effect of yoga on cognition have reported improvement in some cognitive functions. A study by Naveen KV, et al (1997) involving 108 school children aged 10 to 17 years who practiced four types of yoga breathing; right nostril breathing, left nostril breathing, alternate nostril breathing, and breath awareness without manipulation of nostrils, in four independent groups for 10 days. Verbal and spatial memory was assessed. All 4 trained groups showed a significant increase in spatial memory test scores at retest, but the control group did not show change. They
concluded that yoga breathing improves spatial memory in children. Similar results were showed by Manunath&Telles (2004). Manjunath&Telles (1999) studied the effect of yoga on the visual perceptual sensitivity in children. The experiment included 14 children, aged between 12 to 17 years, who were given training in Yogasanas, Pranayama, and Kriyas which included eye-cleansing techniques, meditation and Bhajans, 8 hours per day for a period of 10 days. The children were assessed on for visual perceptual sensitivity through an apparatus called Critical Flicker Fusion Frequency which recorded the binocular responses of the children. The degree of optical illusion was also measured using Muller-Lyer apparatus. At the end of 10th day, the subjects were assessed. The results revealed significant increase in the CFF and significant reduction in the degree of perceived optical illusion in the experiment group. They concluded that training through yoga to focus and defocus might influence cognitive judgmental factors of subjects to significantly reduce the degree of illusion perceived. The effect of yoga on maze learning task was studied by Telles, Ramaprabhu& Reddy (1999). They reported that Following 30 days of Yoga training in asanas, Pranayama, Kriya, Meditation, devotional sessions, guided relaxation and lectures on the theory and philosophy of yoga for approximately 6 hrs a day, the experiment group showed significant decrease in the time taken to trace the maze and also reduction in the number of errors they made. They concluded that yoga helps in improvement of higher levels of mental functioning, including the process of choosing, trying and rejecting or adopting alternative courses of conduct or thought. Manjunath and Telles, 2001 reported improvements in problem solving ability in a group of female school children after 7 days of yoga practice, who were compared to a group of children performing the same amount of regular physical exercise. Children in the yoga group showed significant reduction in planning time, execution
time and in the number of moves in both simple and complex tasks in Tower Of London. Children participating in the yoga classes were reported to have come up with more efficient solutions (planning time, execution time and number of moves) on the Tower of London Task. Decreased visual and auditory reaction time in 22 healthy schoolboys following practice of yoga was reported by Bhavanani et al 2003. They reported that yoga has the potentiality to improve sensory-motor performance and enhance processing ability of the central nervous system. Jensen P, Kenny D (2004), Peck HL, (2005), Harrison, Manocha & Rubia (2004) reported improved attention in children with Attention Deficit Hyperactivity Disorder. Subramanya and Telles (2009) showed the effect of cyclic mediation on improved performance in memory scores. Narayana, 2009 found that yoga group compared to non yoga group performed faster in a visual color discrimination task. He attributed it to increased alertness and visuospatial attention due to the practice of yoga. Gothe and colleagues (Gothe et al., 2013) found greater improvements in working memory in novice practitioners after a single session of yoga compared to a single session of general aerobic exercise. Verma (2014) studied the effect of yoga practices on cognitive development variables in 82, 11-15 years adolescents in rural residential school children. Cognition Function tests, an Indian adaptation battery based on Guilford’s Structure of Intellect Model was administered at the baseline and at the end of 12 weeks of yoga training in both groups. Results showed significant improvement in measures of mental ability and memory in experimental group. No statistically significant changes were observed in measures of mental ability and memory tests in control group. They concluded that yoga training has effect on primary cognitive processes such as attention, perception and observation and that yoga, being a simple and inexpensive health regimen, can be
incorporated as an effective adjuvant therapy to governmental child health initiatives in school curriculum.

2.3.4 Yoga curriculum in schools

Since 2010, some studies have shown interest in using yoga or yoga based intervention within the school settings and exploring its effects on school children. Some authors have speculated the use of having a yoga based curriculum in the school. In the following section some of the studies on yoga that were conducted in the school settings are reviewed. Of the many published articles only a few followed the recommended experimental procedures. In all these studies Yoga or yoga based interventions were given to school age children within the school setting and the effects on psychological well-being or cognitive functions were analyzed. Telles et al. 2013 observed the effects of yoga and physical exercise on physical fitness, cognitive performance, self-esteem, and teacher-rated behavior and performance. 98 children between the ages of 8 and 13 were selected from a primary school in Haridwar. Participants were assessed for physical fitness, performance in the Stroop task (the Stroop color-word naming task), self-esteem, and analog scales (attention, punctuality, behavior with friends, and behavior with teachers) rated by the teachers. Post assessment was done at the end of twelve weeks. Yoga practice involved yoga breathing techniques, loosening exercises, postures, chanting, and yoga relaxation techniques 45 minutes per day, during school hours which lasted three months with a frequency of five times a week. Physical exercise had the same time and frequency and consisted of jogging in place as well as bending and spinal twists. Results indicated significantly higher social self-esteem in physical exercise group. Both groups showed an increased BMI, and number of sit-ups. Balance worsened in the physical exercise group, while plate tapping improved in the yoga group. In the
Stroop task both groups showed improved color, word- and color-word naming, while the physical exercise group showed higher interference scores. Total, general and parental self-esteem improved in the yoga group. Authors concluded that both Yoga and physical exercise are useful additions to the school routine, with physical exercise improving social self-esteem. Noggle et al. (2015) evaluated the effects of a yoga program on psychological well-being, psychological attitudes, and self-regulatory skills in 11\textsuperscript{th} and 12\textsuperscript{th} grade adolescents at a public high school in Massachusetts. They compared a Kripalu based yoga program conducted within the school curriculum for adolescents and compared them to the regular physical education classes. Both the interventions were done two to three times a week for 30 minutes. Yoga practice consisted of 5 minutes of centering and breathing exercises, 5 minutes of warm-up, 15 minutes of yoga postures, and 5 minutes of closing relaxation. After 10 weeks of program, students attending physical education classes showed decreases in primary outcomes like in profile of mood states while Yoga students were maintained or improved. Total mood disturbance improved in yoga students but worsened in controls. Positive affect remained unchanged in both, negative affect significantly worsened in controls, but improved in yoga students. Secondary outcomes, such as the scores in resilience scale, and the child acceptance mindfulness measure were not significant. The authors concluded that Kripalu yoga program at school can have preventive benefits in psychosocial well-being. A study by Butzer 2015 explored the effects of a 12-week school-based yoga intervention on changes in grade point average (GPA) in 9th and 10th grade students. Participants included 95 high school students who had registered for physical education (PE). The class was group randomized to receive either a yoga intervention or a PE control condition. The yoga intervention took place during the entire third quarter and half of the fourth quarter of
the school year, and quarterly GPA was collected via school records at the end of the school year. Results revealed that GPA differed between the yoga and control groups over time. While both groups exhibited a general decline in GPA over the school year, the control group exhibited a significantly greater decline in GPA from quarter 1 to quarter 3 than the yoga group. Both groups showed equivalent declines in GPA in quarter 4 after the yoga intervention had ended. The results suggest that yoga may have a protective effect on academic performance by preventing declines in GPA however these preventive effects did not persist once yoga practice was discontinued. Schonert-Reichl(2015) designed a mindfulness social and emotional learning (SEL) program for elementary school students involving mindfulness and caring for others. 4th and 5th graders (N = 99) were randomly assigned to receive the SEL with mindfulness program versus a regular social responsibility program. Measures assessed executive functions, stress physiology via salivary cortisol, well-being (self-reports), prosociality and peer acceptance (peer reports), and math grades. would enhance cognitive control, reduce stress, promote well-being and prosociality, and produce positive school outcomes. Relative to children in the social responsibility program, children who received the SEL program with mindfulness (a) improved more in their cognitive control and stress physiology; (b) reported greater empathy, perspective-taking, emotional control, optimism, school self-concept, and mindfulness, (c) showed greater decreases in self-reported symptoms of depression and peer-rated aggression, (d) were rated by peers as more prosocial, and (e) increased in peer acceptance (or sociometric popularity). The researchers suggested that mindfulness SEL intervention strategies are good to ameliorate children's problems and to cultivate their well-being and thriving. Daly LA, 2016 evaluated the impact of mindful awareness, self-compassion and body awareness through yoga
effect the emotion regulation of high school students as compared to physical education. The study involved thirty-eight high school students, in good general health from school in Brooklyn New York. Yoga intervention had 42 sessions of 40 minutes yoga classes, approximately three times a week for 16 weeks. Each class included postures, breathing, relaxation and guided meditation techniques. And Control group had common games, such as football and baseball, as well as walking and running, relays and other socially focused activities. Pre-post data analyses revealed that emotion regulation increased significantly in the yoga group as compared to the PE group. Authors concluded that preliminary results suggest that yoga increases emotion regulation capacities of middle adolescents and provides benefits beyond that of PE alone. Folleto, J.C. et al. (2016) investigated the effects of a yoga program in physical education classes on the motor abilities and social behavior parameters of 6–8-year-old children in a public elementary school in the South of Brazil. 16 children from grade 1 of were selected. The children participated in a 12-week intervention, twice weekly, with 45 min each session. The Bruininks-Oseretsky Test of Motor Proficiency, the flexibility test, the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children and semi-structured interviews with children, parents, and classroom’ teacher were used. Results showed that the yoga program was well accepted by children and children demonstrated significant and positive changes in overall motor abilities scores (balance, strength, and flexibility). In addition, the interviews reported changing in social behavior and the use of the knowledge learnt in the program in contexts outside of school.
2.3 Rationale for the study

The prevailing interventions for children with LD are individualized, time and cost effective. The review of yoga literature suggests that yoga brings about biochemical changes, neural activation, improved metabolism and can be regarded as a holistic medicine which operate both on the body as well as on the mind. Its effects on the cognitive system have been demonstrated in many studies. Studies have shown structural and functional changes in the brains of yoga practitioners. Hence it can be hypothesized that the neural activation created by the practice of yoga may result in synaptic proliferation as well as in the resumption of functioning of certain malformed nerve cells and reactivate the circuits that may have pertinence to the acquisition, processing and storage of knowledge. Since it is difficult to pay individual attention to children with LD in the current educational system, the challenges faced by are going unnoticed. In order to overcome, a remedial method which can be given to a group of children is necessary. Hence, the present study was carried out to examine the effectiveness of yoga as an intervention method for the children with LD.