Chapter -V

DISCUSSION
5.1 Planning

Planning is a higher cognitive process which involves formulation, evaluation and selection of a sequence of thoughts and actions to achieve a desired goal. The capacity to generate and organize the necessary step sequence to carry out a goal-directed behavior develops throughout childhood and even during the first years of adolescence (Ricle, et al 2014). Studies have shown positive correlation between planning and mathematical ability in children (Nagleri, & Gottling, 1997). Children with LD show poor planning ability that reflects in their academic performances especially in arithmetic problem solving ability.

Previous studies have shown improvement in tower of London test following yoga intervention for a period of 30 days in children (Manjunath, & Telles, 2001). Schmalzl 2015, hypothesizes that movements involved in yoga involve executive functioning, procedural learning and planning which is mediated by basal ganglia via loops with cortico-striatal proections from the dorsolateral prefrontal cortex, the orbitofrontal cortex and anterior cingulated cortex.

In the present study, children have shown large (effect size= -0.88) improvement in planning subtest from pre to post intervention assessment but the control group has also showed significant (effect size= -0.76) improvement from pretest to posttest scores in the planning. Hence it is difficult to conclude whether yoga intervention improved children’s planning ability in the preset study.

5.2 Attention

Attention involves selectively focusing on a discrete aspect of subjective or objective information, while ignoring other perceivable information. All of the yoga practices involve attention to bodily and mental states. Attention to interoceptive,
proprioceptive, kinesthetic, tactile, spatial information, breath, thoughts are intrinsic in all yoga practices. Structural changes in the brain areas like insular cortex, primary and secondary cortices, and anterior precuneous, reported in the yoga practitioners have been associated with introceptive, tactile and proprioceptive sensations. (Fox et al, 2014; Villemure et al, 2014; Tomasino et al, 2013; Frolinger et al, 2012). Kerr et al, 2013 showed that body focused attention elicit 7-14 Hz alpha rhythm which is associated with inhibition control. Long term changes in the prefrontal cortex activation due to body focused mindfulness practices have been reported by Davidson et al, 2003; Farb et al, 2013. The alpha rhythm in occipital regions is associated with state of relaxed wakefulness. The defocus and relaxation of ocular convergence in eye exercises and gaze training seem to produce these activation (Schmalzl, 2015). Inhibiting saccades and redirecting gaze to a target involves inhibition and performance monitoring which enhances attentional control in practitioners. Behavioral studies have also show improvement in attention in children with attentional disorders (Jensen, & Kenny, 2004; Harrison et al, 2004)

In the present study, children have shown large (effect size= -0.88) improvement in attention subtest from pre to post intervention assessment and have shown greater improvement compared to other groups. Even in the follow up studies Y&AA group had highest scores compared to the other groups. Hence the result seems to be consistent with the previous studies. It can be concluded that yoga practice improved attention in children with LD in the present study.

5.3 Simultaneous processing

Simultaneous processing is the process of combining unconnected and discrete information into a coherent whole to assist in comprehension and interpretation. The secondary and tertiary zones of occipital, parietal and temporal lobes posterior to the
central sulcus of the brain are the units responsible for simultaneous processing and they involve receiving, processing, and retaining information. It is hypothesized that yoga practice enhances neural circuits involved in the integration of top down and bottom up information. Yoga practice involves processing of bottom-up sensation and metabolic related information and top down attention and metacognition related processes. As a result of this, the bidirectional neurocircuitry in the hippocampus and the amygdala with the prefrontal areas involved in attentional control seem to enhance (schmalzl et al, 2015). Structural changes in the white matter pathways in rostro-caudal fiber pathways that connect dorsal temporo-parietal regions with prefrontal region have been observed following yoga practice (Fox et al, 2014). These pathways play important role in connecting parietal body awareness regions and prefrontal executive regions. Functional brain changes associated with meditation practices have shown changes in the areas like superior parietal lobule, inferior parietal lobule and supramarginal gyrus which have been involved in integrating multimodal spatial information in body centered coordinates, computation of size and shape of body parts and disembodiment and altered integration of multisensory information respectively. Studies have shown that age related decline in fluid intelligence were smaller in yoga practitioners and meditators compared to controls (Prakash et al., 2012; van Leeuwen et al., 2009)

In the present study, There was significant and large (effect size= -0.88) improvement in Y&AA and N&AA group (effect size= -0.88) in the posttest assessment, while AA group improved moderately (effect size= -0.71). Hence the large improvements in Y&AA ad N&AA groups as compared to AA and C groups can be attributed to the cognitive specific intervention these groups received. Hence it
can be said that yoga has shown positive influence in improving simultaneous processing in children with LD.

5.4 Successive processing

Successive processing is involved with the use of stimuli arranged in a specific serial order. It involves serial organization of information like sounds or movements in order. It is integral to working with sounds or phononological processing in early reading. It also involves attentional and working memory components. The procedural learning of motor sequence and working memory to hold instructions in mind and select specific sequential motor activation may have potentiality to facilitate successive processing ability.

In the present study, both Y&AA and &NAA groups have shown large improvement in post assessment (effect size=-.088, -0.89 respectively). Where as AA group has not shown significant improvement in posttest assessment. Hence the improvement can be attributed to cognitive specific interventions and it can be said that yoga practice has resulted in improved successive processing in children with LD.

5.5 Phonological processing

Phonological processing consists of short-term maintenance of sound sequences in auditory memory during analysis of their auditory, somatosensory, and motor properties to support phonemic categorization. Categorization of ambiguous syllables engages a dorsal pathway, from primary auditory cortex to posterior temporal gyrus and ventral parietal regions, associated with auditory short-term memory and interaction with somatosensory and motor areas. (Liebenthal et al, 2013)
Phonological processing also involves rapid temporal processing characterizing phonological inputs which is same as sequential/ successive processing ability.

In the present study, Phonological processing in English has improved largely in all the groups Y&AA, N&AA and AA. Reading and phonological processing have reciprocal influence on each other. The reading training given in AA intervention may have an effect on the phonological processing in English. Since children have shown improvement in successive processing in Y&AA and N&AA groups, this may have also influenced their phonological processing in English.

Phonological processing in Kannada has shown interesting results though. Y&AA group predominantly showed large improvement in post intervention assessment. The phonological processing tasks involved high attentional control, working memory and visual representation. A study conducted by the researcher showed that children when given phonological tasks in Kannada prefer visually processing the phoneme markers within the Kannada letters and mentally manipulate them, then to auditorily process them. (Poonacha, S & Salagamme, K.K, 2014). Studies related to visual sequential processing have reported that children with LD take longer to process spatial-temporal order judgment tasks (Liebenthal et al, 2013).

Yoga techniques like eye exercise and visualization techniques alpha rhythm and state of wakeful relaxation. The Basal ganglia loops with cortico-striatal projections from frontal and supplemental eye fields via the superior culliculus are known to be involved in voluntary eye movements. They seem to control saccadic eye movements, prevent from distracting visual inputs and improve spatial orientation. Behavioral researches have shown improvement in visual selective attention (Telles et al., 1995), and decreased visual reaction time (Narayana, 2009) found and have
attributed the results to increased alertness and visuospatial attention promoted by the yoga practice.

5.6 Reading efficiency

Word Reading skills involve capability to convert graphemes to phonemes and to quickly recognize the word’s structural and phonological features. In reading tasks speed does matter because speed determines one's mastery over the acquired skill. Reading is influenced by phonological processing skills, successive temporal processing, and automaticity. One of the theories for deficits in reading, the magnocellular hypothesis attributes impaired reading to impaired monitoring of ocularmovements, leading to visual confusion, superposition and distortion during reading.

In the present study, both in English and Kannada sight word reading subtests, which require visual processing of words Y&AA group has shown greater improvement (effect size=-.79, -.088 respectively) in post intervention assessment compared to other groups. In phonological decoding subtests, Y&AA group has showed moderate improvement in English (effect size=-.56) and Kannada (effect size=-.79)

5.7 Arithmetic ability

Arithmetic problem solving skills develop in stages with the development of pre operational, concrete operational and abstract operational skills in children. The development relies on cognitive maturity and development of planning ability in children. Children typically go through developmental stages as explained by piaget before they reach the stage where they can operate with abstract number concepts in arithmetic problem solving. In the present study all the three intervention groups have
shown large improvement in post intervention assessment. Hence it is difficult to say the effect of yoga on arithmetic improvement in Y&AA group.

5.8 Behavioral adjustment

Children with LD, generally show adjustment problems in school environment. Commonly observed behaviors include truancy, being destructive with other’s objects, bullying, frequently engaging in fist fights, disobedience, lying, stealing. Some children show internalized problem behaviors like anxiety, fidgety, worried, tearful, irritability, thumb sucking, nail biting, frequent complaints of aches and pains etc. If unaddressed, these problems can persist through their school life and hamper development of health personality.

The yoga methods provide sensitivity to one’s bodily and emotional states may help one better understand and cope with the problem. While some studies have shown that increased bodily awareness can increase anxiety in children, majority of yoga studies have reported decreased anxiety, depression and better social adjustment.

In the present study, it is difficult to make conclusive judgment about the effect of yoga on behavioral adjustment because children in all the intervention groups have shown increased behavioral adjustment in school environment. It can be said that attention given to children in any form of intervention can help them improve in behavioral adjustments.

5.9 Conclusion

Previous studies have shown enhanced cognitive abilities like planning, attention, spatial and verbal memory, reaction time, cognitive flexibility etc following yoga intervention. Imaging studies have shown increased connectivity and grey matter volume in yoga practitioners. Yoga has consistently shown positive effects on
the body and mind in majority of studies reported. In the preset study also, children who received yoga intervention improved as equally as children in neuropsychological intervention which was developed exclusively for the improvement of PASS and phonological processes. This implies that yoga may have worked as effectively as neuropsychological intervention. But it should also be noted that yoga practiced merely as a physical exercise without internal focus, may not produce the desired effect. The maximum effects of yoga can be reaped only if yoga is practiced with all its components; movement, breath awareness, coordination, internal focus, body awareness, gaze, relaxation, and visualization incorporated coherently. It should also be noted that, yoga teaching methods should be designed keeping children’s age in mind and methods be made comprehensible to them. Since the yoga techniques are very subjective in nature how each individual understands and experiences it is difficult to assess, hence the teaching methods must be made as objective and clear and concrete for children to understand and experience it. From the present study one can conclude that yoga has beneficial effects on cognitive processes and can be used as cognitive focused intervention for children with LD.

5.10 Implications of the study

The aim of the study was to evaluate the effectiveness of yoga as intervention for LD. Because LD intervention is time consuming and individualized program, an effective and alternative remediation method is the need of the hour. A cognition focused intervention which can be given to considerably large number of children would be beneficial in order to deliver service and attention to larger number of children with LD. The present study has shown that yoga can be used as an alterative intervention for neuropsychologically based intervention. Hence yoga based
intervention can be used in schools and special schools as a complementary intervention along with specific academic skill training.

5.11 Limitations of the study

Participant selection and distribution of participants to intervention groups were not randomized. This could have led to biased and homogeneous groups. The participants were mostly those who could commute easily to the place of intervention. Hence the participants were not very good representative samples.

The follow up assessment for control group was not done due to the inability to trace the participants after a period of about two and a half years. Hence the maturation effect post assessment period could not be controlled to make conclusive judgment about the maintenance effect of the intervention.

5.12 Recommendations for further research

Future research can be done with proper randomized control group to evaluate the effect of yoga on cognitive functions of children with LD. Research can be done to exploring individual yoga techniques on specific cognitive skills and yoga based cognitive therapy can be developed to help children with LD.