CHAPTER 5: DISCUSSION

5.1 SOCIO-DEMOGRAPHIC AND CLINICAL VARIABLES:

The sample consisted of 40 children, 20 each in the E and C groups. The 2 groups were initially compared to establish homogeneity with respect to their socio-demographic background and clinical profile. The tool used was the DPCL.

The results indicated that most children were boys, with an average age of 9.6 years, first born, with at least 1 sibling, of non-consanguineous parentage, from middle socio-economic backgrounds. Most of the children were from std 4. In most families, the level of education in mothers was higher than that of father. On each of these variables, the chi-square value obtained was greater than 0.05, indicating that the E and C groups were comparable with respect to their socio-demographic background.

On the clinical factors of the DPCL also, there was no significant difference in the profiles obtained. The clinically relevant findings that have emerged are as follows:

1. Children with average scholastic performance are a heterogeneous group, with a majority (80%) of them perceived by their parents as having problems in attention.

2. These children are coping with their current academic load, but at least 25% are perceived by their parents as having problems in academic skills such as reading, writing and mathematics.

3. Emotional problems have been reported in at least 30% of the sample.

Attention problems have been found to consistently predict academic achievement at the end of primary school (Duncan, Dowsett, Claessens, Magnuson, Huston, Klebanov, Pagani, et al, 2007). Longitudinal studies suggest
that under-performance at school can send a signal of reduced potential for success in academic pursuits, lower motivation for success and interest in proscribed alternatives including substance abuse and delinquency (Breslau, Miller, Breslau, Bohnert, Lucia & Schweitzer, 2009) to the child and the family.

The above findings are of clinical significance, because it highlights problems in behaviour that are largely unidentified, and possibly, not enough to meet the criteria for a clinical diagnosis. These problems however, have the potential to disrupt the child’s routine at home and at school.

Sub-threshold and under-identified conditions can, later in life, emerge into full fledged disorders (Shankman, Lewinson, Klein, Small, Seeley & Altman, 2009, Leach, Scarborogh & Rescorla, 2003). These parental reports therefore, can be taken as indicators of potential problems and the children can therefore be considered as a group at risk.

Average scholastic performance in the younger classes, can therefore, be the first visible sign of inadequacy in the child’s repertoire of coping skills (Morgan, Singer-Harris, Bernstein & Waber, 2000) and should therefore be considered a risk factor for future learning problems.

5.2 COGNITIVE FUNCTIONS, AS OBTAINED ON THE MISC: Intelligence has been regarded as one of the most reliable measures that can predict educational attainment and everyday behavior (Gottfredson, 2002). Children with learning problems generally possess at-least average intelligence, but have difficulties processing information or generating output in certain sensory modalities (Handler, Fierson 2011). The correlation between intelligence and academic performance has ranged from 0.40 to 0.63 (Jencks, 1979). It had also been understood as a stable, fixed ability that is unlikely to change with intervention (Buschkeuhl & Jaeggi, 2010).

Working memory is closely related to intelligence (Ackerman, Beier & Boyle, 2005; Kane, Hambrick & Conway, 2005; Kyllonen & Christal, 1990) and underlies performance in most complex intelligence tasks. Other functions such as attention are required in almost all tasks. Response inhibition, planning, visuo-
spatial integration and memory are other functions that would contribute to good performance in this battery. The performance is timed; hence speed and efficiency are also important.

The results indicate that training in tasks that target the factors mentioned earlier do have an effect on overall cognitive functioning of the individual. The C group had significantly higher scores on the verbal scale and total scale on the first assessment. Following intervention, however, the E group was able to match the C group on most sub-tests. The correction for the initial difference resulted in the score of the E group scoring significantly higher than the C group, following intervention. This implies that when the co-variance is accounted for, there is a significant impact of intervention on the cognitive functioning of children, which was reflected in the improved scores on the MISIC.

Intervention studies (Klingberg, 2010; Klingberg, Fernell, Olesen, Johnson, Gustafsson, Dahlstrom, et al 2005; Holmes, Gathercole & Dunning, 2009; Westerberg et al, 2007; Thorell, Lindqvist, Nutley, Bohlin & Klingberg 2009) using working memory and attention have proved that improvement in these fundamental pre-requisites that form the basis of intelligent behaviour, also leads to improvement on standardised tasks of intelligence. The task used in most studies is the Coloured Progressive Matrices test, which is primarily visuo-spatial in nature. This study is probably one of the few that has used an entire battery of verbal and non-verbal tasks of intelligence to assess the impact of training.

Neural plasticity is more prevalent in younger ages, than in later life (Garlick, 2002) and the possibilities for training basic functions that ultimately add to the efficiency of intelligence in childhood are hence, immense.

The results obtained, indicate that in young children with average scholastic performance, a brief cognitive intervention can have a significant impact on intellectual functioning. **Thus the hypothesis made, has been accepted.**

**5.3 SCHOLASTIC PERFORMANCE:** The children included in the study, had obtained average marks in the school examinations. They were scoring above the cut-off of 40% and hence were not considered by teachers or parents as possibly
having difficulties in learning. However, about 75% of the E and C groups were studying in classes 3, 4 and 5, where reading, writing and mathematical skill requirements would have just begun to challenge the language abilities of the child. Average performance in these classes, irrespective of the subject, has remained average, throughout the year, indicating a consistency of ability (or inability) in these children.

Maths is the only subject that has shown an improvement, following intervention in the E group. It is a subject that relies less on language skills and more on abstract reasoning, unlike English and Science, where dependence on language is greater. The intervention programme with its focus on speed, attention and working memory, among other functions, appears to have made a significant impact on the performance on this subject, in the E group.

The effect of intervention on academic performance has been analysed in some of the studies reviewed (Holmes, Gathercole & Dunning, 2009, Shalev, Yehoshua, & Mevorach, 2007). However, these have been laboratory based assessments, using standardized measures of academic skills such as reading, writing and arithmetic. This study, however, has used curriculum based measure- performance in school examination- as an outcome variable. While this measure may be influenced by several factors such as pedagogy of the respective schools, variations in individual teachers (strictness or leniency in assessment) and several psychosocial variables that may have affected an individual child’s performance in a certain exam, it is nevertheless, a real world measure that has more representative than a measure taken in controlled conditions.

The intervention programme consisted of tasks that were primarily visuo-spatial in nature. There were no tasks that involved language, of a level required in the classroom- i.e. complex vocabulary, compound sentences and paragraphs, all of which require comprehension skills. The tasks used by Klingberg, Forssberg, & Westerberg (2002); Klingberg, Fernell, Olesen, Johnson, Gustafsson, Dahlstrom, et al (2005); Holmes, Gathercole & Dunning (2009) and Thorell, Lindqvist, Nutley, Bohlín, & Klingberg (2009) included tasks of verbal working memory, unlike the set of tasks in the BFT that were selected for the present study. It is possible that
this focus on visuo-spatial tasks has not aided improvements in language, which in turn might have led to improvements in academic performance.

The duration of training could have also contributed to the mixed results. In the follow up immediately after intervention, there was significant improvement in the marks of the E group, in English, Science and Maths, implying that improved neuropsychological functioning did have an impact on the marks obtained in school evaluation. 3 months later, with no booster session or other follow up; there was improvement in absolute scores from the baseline, which however, did not reach statistical significance. It is possible, that the twenty sessions of training did initiate a process of change, but the absence of such an input subsequently, led to a plateauing of improvement. It is perhaps possible, that with continued training, either in spaced sessions (once a week for 10 weeks) or a massed session (3 sessions a week for 3 weeks) the initial improvement could have been consolidated and reflected in significant improvement in marks.

It is also possible, that certain children would have benefitted from additional training, while others do not need it. Being a small group, an extreme score in one or two children, could have affected the average score of the group.

Thus, the hypothesis made has been partially accepted, because there was a significant increase in the marks of the E group, immediately after intervention, but this effect was not sustained at the next follow up assessment.

5.4 BEHAVIOUR OF THE CHILDREN: Ratings of behaviour by teachers and parents were analysed for individual children, as well for the group as a whole. Teachers reported greater behaviour problems than parents. Neither perceived significant reduction in reported problem following intervention in the E group. Improvement in pro-social behaviour too was marginal.

The SDQ is a widely used tool that is used not only for screening, but also to measure the impact of intervention. Increased hyperactivity and decreased pro-social behaviour was commonly reported by teachers, for both E and C groups. This indicates that children with average scholastic performance do have behavioural risk factors in the school environment. In contrast, parents perceived
mild problems only on the hyperactivity sub-section in the E group and emotional problems in the C group. This indicates that in this group of children with average scholastic performance, behaviour problems were more evident in the school rather than the home environment.

There is greater stability in the temperament of children within a situation, rather than across situations (Henderson & Wachs, 2007), with greater agreement between mother-father ratings than mother and teacher ratings. The most likely explanation, therefore, is that the expression of temperament in children is different in the home and school.

Computer-based intervention had led to decrease in the symptoms of hyperactivity and improvement in the ratings by teachers and parents (Klingberg Forssberg, & Westerberg al, 2002). Children with attention and conduct problems are also likely to have problems in learning. Early pro-social behaviour, such as co-operativeness, empathy, sharing and helpfulness, strongly predicts later academic achievement, while physical and verbal aggression have a negative association with both pro-socialness as well as academic achievement (Caprara, Barbaranelli, Pastorelli, Bandura & Zimbardo, 2000).

In this study, the intervention did not appear to have made a significant impact on the observed behaviour of the child in 2 significant learning environments, the home and school. Biases common to the use of rating scales cannot be controlled for and hence, while there were qualitative reports of improvement- less anger, friendlier, these were not reflected in the quantitative rating of individual child behaviour.
5.5 CASE STUDIES

5.5.1 Case 1: D was an 11 year old boy; the youngest of 3 children, studying in the 5th standard was brought by his mother with complaints of poor concentration and decline in marks since 1 year. There were frequent complaints of headache and feeling tired due to which attendance in school had come down. He did not like the second language class (Hindi) and often complained that it was difficult.

D came from a nuclear family, with 1 elder sister and 1 elder brother. The father was employed in a factory and also ran a small shop in his spare time. The mother was also involved in managing the shop and on weekends and holidays D too would help, whenever his mother was otherwise occupied.

The history given by the parents revealed that there were no problems in birth and early development. He was active, responsible boy, well liked by peers and teachers. Apart from fussy food habits, the parents had no other complaints about him. There was a history of mental illness in the paternal granduncle and bedwetting in paternal aunt.

On the DPCL, he had a high score on the ADHD subscale. Parents also reported fear of darkness and frequent stomach aches. There were no scores above the cut-off on any other subscale.

On the SDQ (parent version), his score on the emotional disorder scale was above the cut-off. His teacher however rated him higher on the Hyperactivity scale and low on pro-social behaviour. Thus, even though parents reported features of ADHD in the initial interview, their rating of the problem was below cut-off levels.

IQ on the MISIC was in the average range, with a total IQ of 106, verbal IQ of 107 and performance IQ of 106. The marks obtained in English, Science and Maths was 57%, 63% and 57% respectively.

Following intervention, parents did not perceive any discernable change in his behaviour; the score on the Emotional problems scale remained at 5, hyperactivity
was rated marginally higher. According to the teacher, pro-social behaviour had improved, while there was only a marginal decline in hyperactivity.

The IQ scores on the performance scale had improved to 126 (which is in the superior range), leading to an increase in the total IQ to 117 (above average range). There was no change in the verbal IQ, which remained at 107.

Marks obtained in English, Science and Maths were 77%, 80% and 70% respectively, all of which were higher than the marks he obtained, prior to intervention. The boy reported that he was able to concentrate well in the classroom and understand lessons better.

Thus, there were measurable differences in cognitive functions and academic performance and self-report of improvement following intervention, but no changes were perceived in his everyday behaviour at home and at school.

**5.5.2 Case 2:** J was an 8 year old boy, studying in the 3rd standard, the second of 2 children, brought by his parents with complaints of behaviour problems and average marks. He would become very angry, throw tantrums and occasionally disobey his mother. Teachers had often complained to the parents about his frequent quarrels with his classmates.

J lived with his mother, elder sister and grandmother. His mother worked in the Court and was often busy with her work. His father stayed at his place of work and would come home only occasionally. Apart from school, J attended several classes in different activities such as karate, religion, drawing on Saturdays. His mother reported that he was very angry about having to attend these classes; he often expressed the need to go with his father and spend time with his grandparents, playing with his cousins, taking part in the temple festival and other such activities.

The interview with the parents revealed that while birth was normal, he had had 3-4 episodes of febrile seizures; his mother and sister too had a history of febrile seizures in childhood. He was also noticed to fall frequently and mild delays were reported in almost all developmental milestones. Stuttering was noticed earlier
and there were persistent difficulties in articulating certain words. Occasional bruxism was also reported.

On the DPCL, the scores obtained on ADHD, Conduct problems and Learning difficulties were much higher than the cut-off values. Apart from shyness, no emotional problems or somatic complaints were reported. His maternal uncle had seizure disorder, while bedwetting was reported in mother and his sister. The parents reported that they punitive in disciplining.

On the MISC, the Total IQ, prior to intervention were 95, with a verbal IQ of 87 (below average) and performance IQ of 104. The scores obtained in information, comprehension and vocabulary (average 74) sub-tests of the verbal scale were significantly below normal. The marks obtained from school revealed that he was below average in English and average in Science and Maths. Both, teachers and parents rated him as high on hyperactivity, conduct and peer problems.

Following intervention, the Total IQ was 109, with a verbal IQ of 100 (average) and performance IQ of 119 (above average). Score on the vocabulary and digit span sub-tests improved to 89, which is nearly average. Performance in Maths improved; there was no change in Science, while some improvement was noticed in English. Parents perceived a mild change in hyperactivity and peer problems, and no change in conduct problems. Teachers found marginal improvement in conduct problem, no change in peer problems and a worsening of hyperactivity.

On interview, the child said that he hated getting up early on holidays, but was forced to do so by his mother. He liked to spend time at home, drawing, watching TV or playing with children in the neighbourhood. He would therefore resist his mother’s attempts to get him dressed, fed on time and attend all the additional classes. The mother reported that she was trying to keep him occupied and “out of trouble” by filling up the available time on holidays with multiple activities.

This case represents the multi-factorial nature of behaviour problems in children. In this instance, it is obvious that computer-based intervention would have minimal impact on the child’s overall functioning. Developmental delays, psychosocial stressors and high maternal anxiety are variables that are possible
long-term contributors to the present problem and cannot be ignored in therapy. Even if the measurable variables did improve, the change is unlikely to have been perceived, or have an effect on the other factors in the child’s life. Parental counselling aimed at reducing maternal anxiety and behaviour therapy aimed at reducing excess behaviours (anger, fighting, tantrums) and enhancing deficit behaviours (improving attention, language) would be approaches that would be of considerable use in helping this child.
5.6 SUMMARY: Findings from the Neuro-sciences, have helped an understanding that, in the field of cognitive development, biology is not destiny, i.e. that experience can make remarkable contributions to the brain, mind and body (Diamond & Amso, 2008). It has often provided evidence of mechanisms by which behavioural systems operate and also that plasticity operates at all ages.

This study was an exploratory attempt to assess the impact of a cognitive training programme, using a computer, on the cognitive, academic and behaviour of children with average scholastic performance in the lower classes. The research questions it attempted to answer were:

1. Is average scholastic in the younger classes an indicator of risk?

2. What is the profile of children with average scholastic performance?

3. Would a general intervention aimed at strengthening neuro-psychological functions, improve the cognitive, academic and behavioural functioning of children with average scholastic performance?

The introductory chapter tried to understand the complexity of the brain and the multi-factorial approaches that are necessary to understand brain-behaviour relationships. The parallels between brain development and the growth of cognitive functions were explored. Attention, working memory and information processing are some of the well researched neuropsychological variables that have been strongly associated with learning problems. This chapter also touched upon risk factors in children and the usefulness of the Response to Intervention model as a preventive approach in Child Mental Health.

The review of literature looked at mental health in children and the issues of co-morbidity. The multiple networks that govern complex human behaviour were described and the multi-factorial nature of behaviour problems was highlighted. The controversies surrounding description, assessment and diagnosis of learning disability were highlighted and an attempt was made to understand risk factors in children, namely referral, temperament and teacher ratings.
The studies from the Boston group (Singer-Harris et al 2001, Waber et al 2003, Morgan et al, 2000) also drew attention to the fact that children with adequate scholastic performance could have neuropsychological deficits that were similar to children with identified dyslexia. They argued for the concept of Learning Disabilities as a continuum, with dyslexia representing the severe end. The concept of late emerging learning problems (Leach, Scarborough & Rescorla, 2003), also adds weight to the idea that children in lower classes can be perceived as adequate in scholastic performance; their repertoire of skills may not, however be adequate enough to cope with the increasing academic demand in later years.

These two streams of findings, along with the results of a survey conducted by the researcher, lend credence to the basic premise of the study that children with average scholastic performance in the lower classes can be at risk for future learning problems. Though relatively unexplored, these findings help understand why children with behavioural problems also have scholastic difficulties, or why children who do well in early school years decline later on. Linking this concept to variations in brain functioning, average level of performance may be understood as a possible inadequacy or inefficiency of neuropsychological functions in the young child’s brain.

The research question then would be, whether intervention would improve the functioning of such children, by improving neuropsychological functions that contribute to effective learning at school. The choice of the computer as a mode of service delivery was made to control for standardisation of administration, flexibility and the control over task complexity. In an Indian environment the cost-effectiveness of this service was an added advantage. However, Indian studies using this approach are few and hence, this approach is an exploratory attempt to find out the feasibility of such a technique.

The review of literature then looked at computer-based interventions in children with learning problems. Much of the work has been in techniques targeting specific functions such as language (reading, phonological processing), attention and working memory. Children with Attention Deficit Hyperactivity Disorder (ADHD) and dyslexia were the two diagnosed groups- most often used for
intervention. There have been few studies on vulnerable children; the reported ones involved a group of pre-schoolers at risk.

The results of the reported work indicated that there was significant improvement in the functions trained. Transfer to untrained tasks has been limited, but reported with the effects persisting over a period. Therefore, computer based intervention appears to be a promising new approach for use in children. The Brain Functions Therapy, indigenously developed and used in India, was therefore chosen as the method of intervention. It is a simple user-friendly software, with minimum reliance on language. The tasks chosen were both verbal as well as non-verbal, focusing on neuropsychological functions such as attention, working memory, speed and response inhibition.

A pilot study was initially carried out, based on which the sample size was estimated to be twenty. An experimental design was chosen with the experimental group undergoing twenty individual sessions of intervention, over three months and a group of matched controls who did not undergo the intervention. The outcome variables were cognitive functions (as measured by MISIC), marks obtained in school and rating of behaviour by teachers and parents. All children underwent the pre-intervention assessment and the immediate post-intervention assessment. A follow up was done, after three months, using only the marks as the outcome measure.

The DPCL, an interview check list for parents was used to study the socio-demographic background of the children. The profile of children with average scholastic performance in the lower classes indicates that they are a heterogeneous group with difficulties in attention and problems in reading and writing. The majority of the group were boys, which is also the trend noticed in child mental health studies, especially in disorders such as ADHD and other externalising disorders. There were no significant differences between the Experimental and Control groups on any of the background variables, indicating that the groups were comparable.
On the MISC, the cognitive profile obtained revealed that intellectual functions were grossly average in both groups. The C group was significantly better than E group on both the verbal scale IQ as total scale IQ, prior to intervention. Both groups had significantly low scores on the Vocabulary sub test, before and after intervention. Following intervention, the performance of the E group was significantly better than the C group on the MISC. Hypothesis 1 was hence, accepted.

On the second outcome variable - academic performance, significant positive difference was noted, in the performance of the E group, on the first follow up (immediately after intervention). This difference, was however, not sustained on the second follow up. Hypothesis 2 was hence, partially accepted.

On the Behavioural ratings by teachers and parents, some differences in behaviour were reported by teachers, in the E group following intervention. There were no significant differences elicited on parental ratings. Hypothesis 3 has therefore, been partially accepted, while hypothesis 4 is rejected.

Thus, of the 3 outcome variables studied, intervention seems to have had a significant impact on cognitive functions, some effect on academic performance and little or no impact on the behaviour of the child.

5.7 CONCLUSIONS:

1. Children with average scholastic performance are a heterogeneous group, with deficits in attention, emotional problems and difficulties in academic skills, according to parents. Despite their being able to cope with their respective academic curricula, this is a group at risk for future scholastic difficulties, and hence, should not be ignored.

2. Intellectual functioning was in the normal range, in these children. There was a significant impact of the cognitive enrichment programme on the intellectual functioning of the group that underwent the intervention.
3. There was a significant effect on academic performance, immediately, after intervention. This effect was not sustained, 3 months after intervention.

4. Teachers perceived a positive change in the Experimental group, following intervention. This change was not perceived by parents.

Cognition, emotion and temperament are inter-linked concepts that cannot be viewed in isolation. Mechanisms underlying reported problems in attention are embedded in a broader theoretical model that addresses the regulation of goal directed behaviour. This model conceptualises inattention and hyperactivity-impulsivity as relative failures of self-regulation that are equally responsible for interference with adaptive functions as well as production of symptoms (Blair & Diamond, 2008)

Advances in the field of cognition has also helped to understand some of the principles that contribute to effective learning- active engagement, participation in groups, frequent interaction and feedback and connections to real world contexts. Technology based interventions fulfil at-least two of these criteria, especially for children- active participation and instant feedback, thereby making it a very popular and potentially useful tool. Unlike other media, computer technology supports interaction and feedback in 3 ways (Roschelle, Pea, Hoadley, Gordin, & Means, 2001). First, computers themselves encourage rapid interaction – even in routine usage, the child has to “do” things and can see or hear the result immediately. Second, the child can work independently on the tasks, at his own pace, with feedback about success or failure. Third, the child can retrace the route taken, i.e. go back a few steps for retraining or verification, which adds to the strength of the learning and memory processes. Using computers for intervention in children, therefore appears to be an approach that is promising and probably with several advantage over traditional techniques.

Interventions designed to strengthen self-regulatory skills are particularly relevant for children with problems in attention and behaviour, since these abilities are crucial to successful adaptation both in and out of school. Cognitive training for
children with working memory deficits led to sustained enhancement of this skill (Holmes et al, 2009). This training was also associated with improvement in mathematical skills, assessed six months after intervention, indicating that there was enduring transfer of the trained skill to meaningful school function. Klingberg et al (2005) also demonstrated that transfer of training effects does occur, to non-trained skills and to observable behaviour, even 3 months after intervention.

Concerns regarding the usefulness and the transfer effects of computer-based training have been raised (Owen, Hampshire, Grahn, Stenton, Dajani, Burns et al 2010). In a six week online study, that involved training more than 11,000 participants on several related cognitive functions, the authors point out that while improvement on the tasks themselves were noticed, there was no evidence of transfer effects to untrained tasks.

School based screening and mental health treatment can provide viable, much-needed portals and service delivery to children who may not otherwise have access to these services (Watts & Buckner, 2007). There is potential for cognitive training to enhance self-regulatory skills in an enduring fashion and for this kind of effort to lend itself readily for dissemination.

Further, the developing child is an integral part of open dynamic systems, highly receptive to the influence of experience. Cognitive training therefore offers the possibility of stimulating the maturation of fundamental meta-cognitive skills in a naturalistic setting during a period in development, when the plasticity of brain regions critical to self-regulation is high (Mezzacappa & Buckner, 2010).

The study has demonstrated that a computer based intervention programme aimed at improving cognitive functions, has led to significant improvements in these functions. The transfer effect to everyday behaviour and academic performance has been positive, but not statistically significant. The results obtained are mixed, showing improvement within the performance of the experimental group on the cognitive, behavioural and academic variables, and with statistically significant difference only in cognitive functions, when the 2 groups were compared.
At the structural and functional level of the brain, this mixed result is not difficult to understand. Most behaviour is a complex interplay of multiple networks in the brain, especially in children where the pattern of activation is usually diffuse, rather than localised. Intervention, especially a general one can therefore be effective for some of the systems, or parts of a system, rarely the whole. The other reason for this trend could be that the relationship between core neuropsychological tasks and overt behaviour may not be a linear one; several other variables could mediate the final behaviour of the child. Hence an intervention of this nature, may not lead to immediate and observable changes in the overall behaviour of the child.

Individual sessions of computer-delivered training have resulted in observable improvements in the cognitive functioning of children who underwent the intervention. Teachers and parents too, reported some improvements in their behaviour, especially in a reduction in negative behaviours, which were not reported in the group who did not undergo the intervention. Positive changes were noticed in academic performance; however, this was the trend in both groups and not just the one which underwent intervention.

Heterogeneity of age, differences in learning environments and brevity of the enrichment programme are other factors that could have contributed to this mixed trend. This inconsistency is not uncommon in intervention studies with children, probably because of the different growth and development levels which individual children bring to the intervention session. Laboratory based studies should ideally have ecological validity, which can be borne out by experimental studies. This ideal goal is however, difficult to attain.

The changes observed as a result of intervention were not statistically significant; however, the direction of change has been encouraging, implying that further work can be taken up in the area. Overall, for children at risk, intervention may be a better alternative than no intervention; whether a computer-based delivery should be the mode of delivery is an aspect that needs to be studied further.
5.8 LIMITATIONS OF THE STUDY:

1. The size of the group was estimated based on the results of the pilot study with 80% power and 95% confidence limit. Nevertheless, it is possible that the size of the sample was too small for the results to be significant and generalisable.

2. Randomisation was not used while including children in the Intervention and Control groups. Randomisation would have helped control for possible bias and increase the statistical power of smaller trials. In this study, randomisation was not used due to several factors- the study being hospital-based, different times at which parental consent were obtained, different times at which children enrolled in the study, motivation of parents in continuing the intervention. Matching of samples was therefore, opted for.

3. The results of the study would have been more robust, if there had been an active control group who were involved in an alternative computer-based activity. However, studies (Thorell et al, 2009, Klingberg et al, 2002, Gillam et al, 2008) have used such controls and reported no significant difference as a result of this alternative activity, over a sustained period of time. The other reason was the ethics of using such an alternate intervention programme for 20 sessions that could have been perceived as “not meaningful” by parents, teachers and the children. In this study, where no reinforcers were used, children reported for intervention after school hours and on holidays and parents made the effort of the bringing children from school to the hospital for 20 sessions of intervention. All this made the introduction of an alternate, untested intervention, a questionable option. It was therefore decided to use a group of passive controls rather than active ones.

5.9 SUGGESTIONS FOR FUTURE RESEARCH: This study was an exploratory attempt to understand the processes and effects of computer based interventions in children. Future studies could draw upon the findings of this project and explore further research questions in the area. Some of the questions could be:
1. Would the inclusion of an active control group, undergoing an alternative computer-based intervention change the trend of results obtained?

2. Would children with specific function deficits such as attention benefit from this intervention more, as compared to children with more general difficulties in academic skills?

3. Would booster sessions of such intervention strengthen the initial positive trend obtained?

4. Would spaced training, staggered over a longer period lead to greater effectiveness?

5. Would control over age and cognitive abilities yield a different results?

Thus, the findings from this exploratory study suggest that computer-based intervention can be a promising approach to helping children with average academic performance in younger classes. It is not only cost-effective, but also an intervention which can be available and accessible to the child. This is more so in a resource-strapped country such as India, with limited availability of trained personnel and inaccessibility of available services to the average person. Further research based on this study, can add depth to such prevention efforts in the field of child mental health in general and in learning related difficulties, in particular.

5.10 BENEFITS OF THE STUDY: The findings of the study have not had an immediate impact on schools that participated. However, the process of participation has led to increased awareness, greater referrals and active participation of teachers to help children with learning problems. We have helped one of the participating schools to set up a resource room, train volunteer teachers and parents to help children. This programme has been successfully established and is functioning for the last 2 years. At a specific level, components of the BFT can be used in the classroom as exercises to improve attention, concentration, working memory and speed. The logic behind each tasks could be used innovatively to train children in a beneficial manner. Therefore BFT can be a cost-effective purchase that could used in groups to train young children at school.
Such school based programmes provide an accessible and available service, that could go a long way in addressing the gap between the child’s needs and services available.

5.11 IMPLICATIONS OF THE STUDY: This exploratory study has thrown some light on several pathways to understanding learning problems in children. First, that under-identification of children in need of help could be due to sub-threshold symptoms in younger age. Second, that intervention is better than no intervention; even a brief general intervention targeting cognitive functions can be effective. Third, that technology is a viable form of intervention, especially in a school setting. Fourth that training cognitive functions in young children could have a spill-over effect on other behaviour.

This study has proved that technology can be harnessed effectively, in Cognitive Rehabilitation and Child Mental Health, two neglected areas of health. Greater research attempts would help find answers that would ultimately benefit the child at risk.