3. SCIENTIFIC REVIEW

Effective learner, it is vital that attention is maintained on the task in hand and other distracting information is filtered out. The consequences of inattentive and distractive behaviour cause the children ability to learn and remember information's. The concept of working memory has been extensively researched over several decades. Working memory is one of the extensively explored areas in cognitive psychology. It is recognized that working memory is a vital component in children ability to acquire information (Gathercole et al., 2008). Working Memory (WM) is the ability to store and manipulate information over short periods of time. Although a number of theories of working memory have been explored, one of the most prominent was put forward by Baddeley and Hitch in 1974. This ability to focus on important stimuli is essential, as all aspects of working memory have limited capacity (Baddeley, 2006).

We need to keep certain bits of information accessible in mind, but also we need to perform cognitive operations on them, mulling them over, manipulating or transforming them. These short-term mental storage and manipulation operations are collectively called working memory. WM comprised a single unitary store, proposing instead the three-component system shown in this Figure 3.1 (Baddeley & Hitch 1974). Baddeley-Hitch model there is an integral relationship between a control system a central executive, that governs the deposition and removal of information from short-term storage and the storage buffers themselves. This tight level of interaction is what enables the short-term stores

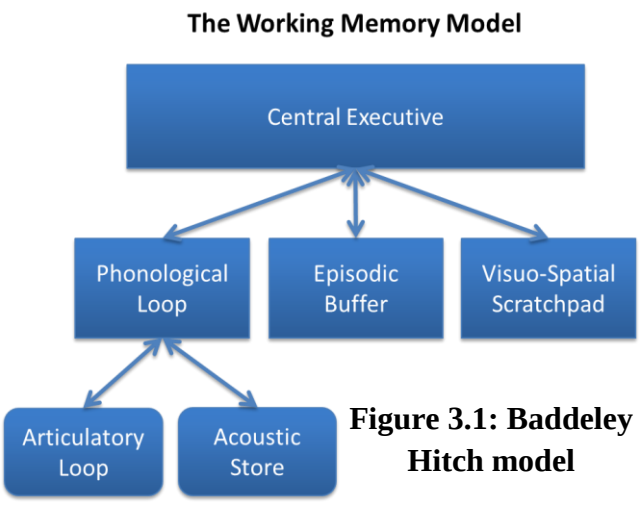

Figure 3.1: Baddeley Hitch model

to serve as effective work- places for mental processes. Third, the model proposes at least two distinct short-term memory buffers, one for verbal information (the phonological loop) and the other for visuo-spatial information (the visuo-spatial scratchpad). Because these short-term stores are independent, there is greater flexibility in memory storage. Thus, even if one buffer is engaged in storing information, the other can still be utilized to full effectiveness. The supervision of these storage systems by a central executive suggests that information can be rapidly shuttled between the two stores and coordinated across them. The three components of the Baddeley-Hitch model interact to provide a comprehensive workspace for cognitive activity

3.1 WORKING MEMORY AND ITS RELEVANCE TO ADOLESCENTS

The central executive is supported by two sub-systems. First, the phonological loop enables the storage and manipulation of verbal information and second, the visuo-spatial sketchpad provides the same facility for visual information (Gathercole & Alloway, 2009). Visual information is often converted into verbal information by verbalising or naming items (Baddeley, 2006), which could lead to the assumption that adequate verbal memory skills are of particular importance. Assessments aimed at measuring verbal short-term memory capacity measure the ability to temporarily store information, such as a list of numbers. There has been found to be a close and specific link between verbal short-term memory capacity and the ability to learn sound patterns in new words (Gathercole & Alloway, 2006). Hence poor verbal short-term memory skills will impact on children ability to learn new spoken vocabulary and on their reading and spelling skills. This evidence is reflected in the recent independent report on dyslexia commissioned by the Secretary of State for children, Schools and Families (Rose, 2009) which clearly states that poor verbal memory is one of three markers of dyslexia. In order to assess verbal working memory rather than short-term verbal

memory, pupils would be expected to complete tasks that involve both storing and manipulating information (Gathercole & Alloway, 2009), for example by presenting children with a list of digits and asking them to repeat the digits in the reverse order. Many classroom activities require pupils to store and manipulate information, an obvious example being mental arithmetic tasks.

Working memory assessments mean that it is possible to formally identify pupils with poor working memory skills. Evidence shows that working memory skills are closely linked to performance on scholastic tests and are highly predictive of measures of literacy, mathematics and language comprehension (Gathercole & Alloway, 2006).

Working memory studies from life span developmental perspective to specific role in various conditions, including major deficit areas were elaborately done. Working memory development across early childhood to early adolescent years were investigated in children 4-15 years of age. The results indicated that the basic modular structure of working memory is present from 6 years of age and possibly earlier, with each component undergoing sizable expansion in functional capacity throughout the early and middle school years to adolescence (Gathercole, Pickering, Ambridge & Wearing, 2004).Working memory seemed to put constraint on the acquisition of skill and knowledge in reading and mathematics. In a study it was found that there may be an association between working memory (measured by complex memory tasks) and both reading and mathematics abilities, as well as the possible mediating factors of fluid intelligence, verbal abilities, short-term memory (STM), and phonological awareness (Gathercole et al., 2006). Complementing this evidence, relationship between working memory and academic attainment were also investigated and it was found that working memory is a powerful predictor of subsequent academic success than intelligence quotient (Alloway, 2009).

3.2 YOGA AND ITS RELEVANCE TO ADOLESCENTS

Yoga is known to be beneficial for various people across the age, across the type, both healthy and unhealthy. This focus of the current study being yoga for adolescent children, the literature has been organized into categories like, yoga for children, mindfulness and its influences, and a special attention on yoga for memory in children. There has been an increasing interest to introduce yoga to children both at schools and at homes, as it offers a good technique to calm the mind and increase health and wellbeing. White (2009) has attempted to describe the philosophical basis of yoga, the basic components of a yoga practice, safety concerns, and how to locate and evaluate a yoga program for children. It has been shown that if yoga is introduced at quite a young age, before 12 years, report says that in later years that can help in managing anxiety and other worry symptoms during musical performances (Khalsa, 2013; Noggle et al., 2012). Such yoga programs are evaluated for feasibility and qualitative evaluation has been attempted by Conboy (2013). A blend of qualitative interview study and a randomized, controlled trial study design, this study has shown various aspects of benefits of yoga for children.

Patil et al. (2013) have shown that in sub-junior athletes, integrated yoga module decreases sympathetic activity and causes a shift in the autonomic balance towards parasympathetic dominance indicating a reduction in stress. Further, indicating highly beneficial aspects of yoga for mental and physical fitness. A similar study done earlier (Dash & Telles, 1999) on 152 children shows increase in motor speed for repetitive finger movements following yoga training, however, not in strength or endurance, as the increase was not sustained over 30 sec.

Yoga has been found to be beneficial for even mentally challenged adolescents. Once in a week yoga training for more than 3 years has shown improvement in neuromuscular abilities in mentally challenged adolescents (Bhavanani, 2012). Not only in this domain, in many other clinical domains also, has yoga been found very

effective in both management and prevention of various conditions. In a study to evaluate Yoga for anxiety Williams-Orlando (2012) has shown clinical efficacy of yoga therapy in the treatment of anxiety and panic disorder (PD) in an adolescent girls. Treatment consisted of 4 wks of individual sessions (60-min session/wk) and 6 wks of group sessions (90-min session/wk) with daily home practice. Also hospitalized condition of oncology, the quality of life has been shown to significantly influence by yoga (Geyer et al., 2011). Further, in 12 to 21 years old group has shown positive response towards yoga intervention in handling traumatized conditions (Spinazzola et al., 2011). Another study to evaluate the effect of yoga exercises on pain frequency and intensity and on quality of life in children with functional abdominal pain (Brands, 2011), has shown significant reduction of pain intensity and frequency after a 10 yoga lessons in 20 children, aged 8-18 years, with irritable bowel syndrome (IBS) or functional abdominal pain (FAP). Yoga has been found to be beneficial in exercise-induced bronchoconstriction (EIB) in children. This shows better control of asthma in children (Tahan, Eke, Bicici, 2014). Yoga has also been found useful in eating disorders like anorexia nervosa and bulimia nervosa. Individualized yoga treatment decreased eating disorder examination scores at 12 weeks, and significantly reduced food preoccupation immediately after yoga sessions (Carei, Fyfe-Johnson, Breuner & Brown, 2010).

Yoga practice, including physical postures, yoga breathing, meditation and guided relaxation have been shown to improve delayed recall of spatial information (Manjunath & Telles, 2004). A study evaluating the impact of a meditation program on resting and ambulatory blood pressure and heart rate in youth has shown potential beneficial impact of meditation on blood pressure and heart rate in the natural environment in healthy normotensive youth (Barnes, 2004). The effect of *Bhastrika*, *Anulom Vilom Prāṇayāma* and *yogāsana* on heart rate variability, general wellbeing, anxiety levels and cognition of the medical students were studied. The results showed

highly significant increase in high frequency (HF) components of heart rate variability and decrease in low frequency (LF) components and LF/HF in the group practicing *prāṇayāma*. There was also highly significant improvement of cognition, general well being and anxiety as shown by the PGI memory scale, Hamilton- anxiety scale and psychological general well being schedule scores in this group. In the yogasana group no significant changes were observed in the heart rate variability, cognition and anxiety although psychological general well being schedule scores significantly improved after six weeks practice of *yogāsana*. The study shows that practice of slow breathing type of *prāṇayāma* for six weeks improves cognition, anxiety and general well being and Increases the parasympathetic activity. There was no effect of *yogāsana* on the above parameters except improvements in the general well being (Chandla et al., 2013). Healthy life style like getting up in the early morning also has shown to be influence in cognitive tasks. A study was undertaken to assess the influence of early rising (during Brahma-muhurtha) on tasks requiring attention and the ability to recall. Fifty four normal healthy male volunteers, with ages ranging from 16-22 years from a residential school were selected. They were randomly allocated to two groups (Brahma-muhurtha and control). They were assessed on day 1, day 10 and day 20 of the intervention, using a digit letter substitution task and verbal and spatial memory task. The Brahma-muhurtha group was asked to rise before 4:30 am in the morning based on the traditional Indian astrological calculations, while the control group was allowed to wake up just before 7 am which was their regular timing for waking. Brahma-muhurtha group after 20 days showed a significant improvement in the net scores for digit letter substitution task as well as scores for verbal and spatial memory tasks. The control group also showed an improvement in the memory task but not in the task requiring attentional processes. This study suggests that rising early in the morning as described

in ancient Indian tradition influences the process of attention and can improve the ability to recall (Kumaran, Raghavendra & Manjunath, 2012).

3.3 CYCLIC MEDITATION (CM) AND COGNITIVE FUNCTIONS:

Cyclic (CM) meditation is a unique practice which incorporates mind and body movements, along with awareness. An effective practice especially for novices, has been scientifically evaluated to a greater extend. Cyclic meditation is a technique which combines "stimulating" and "calming" practices, based on a statement in ancient yoga texts suggesting that such a combination may be especially helpful to reach a state of mental equilibrium (Sarang & Telles, 2006). CM has shown to improve mindfulness in experienced practitioners of CM using a Mindfulness Attention Awareness Scale (MAAS). CM can lead to development of higher levels of mindfulness and may have the ability to positively impact mental states and attention, thereby offering the potential for prevention of clinical levels of psychopathology and improving overall psychological well-being in healthy individuals (Vinchurkar, Singh & Visweswaraiah, 2014).

The effect of two yoga-based relaxation techniques, namely, cyclic meditation (CM) and supine rest (SR), using the six letter cancellation task was done. The subjects were assessed on SLCT before and immediately after both yoga-based relaxation techniques. Both CM and SR led to improvement in performance, as assessed by SLCT, but the change caused by CM was larger than SR (Pradhan & Nagendra, 2010). Previously cyclic meditation and supine rest have been shown to improve performance in a letter cancellation task requiring attention, visual scanning, and motor speed. The DLST assessed attention and speed of information processing, while the other 2 tests assessed motor speed. Each participant was assessed before and after three types of sessions: Cyclic Meditation, Supine Rest, and Control (no intervention). DLST scores and scores

for letter-copying and circle-dotting tasks improved significantly after cyclic meditation; the same scores also improved after supine rest (Subramanya & Telles, 2009). CM improved memory scores immediately after the practice and decreased state anxiety more than rest in a classical yoga relaxation posture (*Śavāsana*) (Subramanya, & Telles, 2009).

The performance in a six-letter cancellation task was assessed with 69 boys volunteers, ages 18 to 48 years, immediately before and after two yoga-based relaxation techniques and a control session of equal duration. The results suggest that Cyclic Meditation brings about a greater improvement in performance in this task, which requires selective attention, concentration, visual scanning abilities, and a repetitive motor response (Sarang & Telles, 2007). Day time activities are known to influence the sleep on the following night. Cyclic meditation (CM) has recurring cycles. Hence yoga practice during the day appears to shift sympatho-vagal balance in favor of parasympathetic dominance during sleep on the following night (Patra & Telles, 2010). Practicing cyclic meditation twice a day appeared to improve the objective and subjective quality of sleep on the following night (Patra & Telles, 2009). Cyclic meditation enhances cognitive processes underlying the generation of the P300 (Sarang & Telles, 2006). The effect of practicing meditation while focusing on a sound or a symbol has shown influence on midlatency auditory evoked potentials (MLAEPs). Following CM the latencies of neural generators corresponding to cortical areas is prolonged, whereas following SR a similar change occurs at mesencephalic-diencephalic levels (Subramanya & Telles, 2009).

3.4 MINDFULNESS AND ITS RELEVANCE TO ADOLESCENTS

The effects of a school-based mindfulness-based stress reduction (MBSR) program for young urban males were evaluated for psychological functioning and MBSR

participants showed less anxiety, improved coping, and a possible attenuation of cortisol response to academic stress (Sibinga et al., 2013). Acceptability and efficacy study was also conducted in a schools-based universal mindfulness intervention to enhance mental health and well-being (Kuyken et al., 2013). Mindfulness-based meditation intervention on quality of life, sleep, and mood in adolescents with cancer showed improvement compared to a control group (Malboeuf-Hurtubise, Achille, Sultan, & Vadnais, 2013). Mindful attention was successful in helping children focus attention on experimental pain without increasing pain intensity or decreasing tolerance compared with a well-established intervention for acute pain reduction (Petter, Chambers, & Mac Laren, 2013). Mindfulness-based intervention program was found to be beneficial for adolescents with psychiatric disorders (Tan & Martin, 2013). In a study to explore test anxiety in adolescent students, a comparative study revealed that adolescents with high test anxiety scored significantly higher in negative forms of self-criticism, social anxiety and lower in self-reassurance, acceptance and mindfulness, compared to those with low test anxiety (Cunha & Paiva, 2012). Inducing distress and measuring state rumination showed that a brief period of mindfulness was found to be helpful in getting youth out of their ruminative state (Hilt & Pollak, 2012). In a study to assess potential effect of a mindfulness-based stress reduction (MBSR) program for human immune deficiency virus (HIV)-infected and at-risk urban youth, MBSR was shown to have a positive effect on hostility, interpersonal relationships, school achievement, and physical health (Sibinga et al., 2011). Socially and economically less privileged youth are at risk for a range of negative outcomes related to stress, including social-emotional difficulties, behaviour problems, and poor academic performance. Mindfulness-based approaches may improve adjustment among chronically stressed and disadvantaged youth by enhancing self-regulatory capacities (Mendelson et al.,

2010). A RCT was designed to assess the effect of the MBSR program for adolescents. MBSR group showed a higher percentage of diagnostic improvement over the 5-month study period and significant increases in global assessment of functioning scores relative to controls, as rated by condition-naïve clinicians (Biegel, Brown, Shapiro & Schubert, 2009).