EFFECT OF TRATAKA ON COGNITIVE FUNCTIONS IN THE ELDERLY

Submitted by

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Under the guidance of

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Towards partial fulfillment of

Doctor of Medicine

In

Yoga & Rehabilitation

MD (Y&R)

SVYASA

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CERTIFICATE

This is to certify that Dr. Shubhada Talwadkar , who registered for the degree of MD (Y&R) with effect from August 12, 2010, at Swami Vivekānanda Yoga Anusandhāna Samsthana University under the Division of Yoga and Life Sciences, has completed the required 'training' in acquiring the relevant knowledge of Yoga therapy and rehabilitation and has successfully carried out the research project titled " EFFECT OF TRATAKA ON COGNITIVE FUNCTIONS IN THE ELDERLY " in partial fulfillment of the course as per the regulations of the University.

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Place:

DECLARATION

I hereby declare that the work presented in this dissertation is done by me under the guidance of Dr. Aarti Jagannathan.

I also declare that this work entitled, 'Effect of trataka on cognitive functions in the elderly' has not been previously formed as the basis of any degree, diploma, membership or similar titles.

Place-Praśānti Kutīram

SVYASA University

Bangalore

Date **Dr Shubhada Talwadkar**

ACKNOWLEDGEMNT

I am thankful to all the *Gurus*, who directly or indirectly enlightened my path through their words of wisdom and blessings in this journey.

I am thankful to the almighty, who is the *Guru* of all the *Gurus*, for selecting me to perform this work at this esteemed institute.

I am very much thankful to my respected Guide Dr. Aarti Jagannathan for giving me full support and guidance throughout my study, and for giving her valuable time, to correct my dissertation.

I am thankful to Dr. R Nagarathna for her support and providing her expertise in improvising the dissertation to its present form.

I would also like to extend my heartfelt gratitude to Dr. Hemant Bhargav for giving his valuable suggestions for the completion of the dissertation.

I am very much thankful to the participants for providing their consent and presence for the study.

Finally, I am extremely thankful to my family and friends for their kind and warm support that they bestowed me throughout.

Standard International Transliteration Code
(used to transliterate Sanskrit words in the text)

अ	=	**a**	ड	=	**ḍa**
आ	=	**ā**	ढ	=	**ḍha**
इ	=	**i**	ण	=	**ṇa**
ई	=	**ī**	त	=	**ta**
उ	=	**u**	थ	=	**tha**
ऊ	=	**ū**	द	=	**da**
ऋ	=	**ṛ**	ध	=	**dha**
ए	=	**e**	न	=	**na**
ऐ	=	**ai**	प	=	**pa**
ओ	=	**o**	फ	=	**pha**
औ	=	**au, ou**	ब	=	**ba**
अं	=	**m**	भ	=	**bha**
अः	=	**ḥ**	म	=	**ma**
क	=	**ka**	य	=	**ya**
ख	=	**kha**	र	=	**ra**
ग	=	**ga**	ल	=	**la**
घ	=	**gha**	व	=	**va**
ङ	=	**ṅa**	श	=	**śa**
च	=	**ca**	ष	=	**ṣa**
छ	=	**cha**	स	=	**sa**
ज	=	**ja**	ह	=	**ha**
झ	=	**jha**	क्ष	=	**kṣa**
ञ	=	**ña**	त्र	=	**tra**
ट	=	**ṭa**	ज्ञ	=	**jña**
ठ	=	**ṭha**			

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ABSTRACT

Background: Trataka, a type of yoga practice is considered to improve cognitive functions. The aim of this study was to test the effect of trataka on cognitive functions of elderly.

Methods: 60 healthy elderly subjects were selected based on inclusion and exclusion criteria. The subjects were administered MMSE and those scoring 26 and above were selected for the study and randomly divided using randomized block design into 2 groups- Trataka and wait list control group. Trataka was given for a period of 1 month (26 days). The subjects in both groups were assessed on Day 1(pre and post intervention in trataka group and after quite sitting in control group), Day 30 on digit span test, Six letter cancellation test (SLCT), and Trail making test B (TMT B).

Results: Friedman's Test and Wilcoxon Sign Rank Test showed that, at the 2nd follow up, there was significant improvement in digit span scores ($z=-3.35$, $p< 0.01$) in the trataka group. SLCT scores ($t =5.08$, $p<0.01$) and TMT B scores ($t= -4.26$, $p< 0.01$) improved immediately after the practice of Trataka (when baseline compared to 1st follow up). At 1 month follow-up, Trataka group showed significantly better performance in the SLCT test compared to baseline ($t= -3.93$, $p< 0.01$) and TMT B scores ($t=7.09$, $p< 0.01$). RMANOVA results also reiterated that there was significant interaction effect at the end of one month of trataka intervention as compared to control group on TMT-B and SLCT scores.

Conclusion: The results of this study establish that Trataka can be used as a technique to enhance cognition in the elderly.

Keywords: Trataka, elderly, cognitive functions

CHAPTER 1

INTRODUCTION

1.1. AGING AND ELDERLY

Aging is a normal process in the life of all living beings. It is a multidimensional process of physical, psychological, and social change. Some dimensions of ageing grow and expand over time, while others decline. Reaction time, for example, may slow with age, while knowledge of world events and wisdom may expand. Research shows that even late in life, physical, mental, and social growth and development is possible[1]. Senescence is another term for ageing. Senescence occurs both on the level of the whole organism (organismal senescence) as well as on the level of its individual cells (cellular senescence). After 20 and 35 years of age in humans, organismal senescence is characterized by the declining ability to respond to stress, increasing homeostatic imbalance and increased risk of disease. Old age consists of ages nearing or surpassing the average life span of human beings. Terms for old people include seniors, senior citizens, older adults, the elderly, and elders[2]. The age of 60 or 65, roughly equivalent to retirement ages is said to be the beginning of old age[3].

Populations around the world are rapidly ageing. According to WHO, between 2000 and 2050, the proportion of the world's population over 60 years will double from about 11% to 22%. The absolute number of people aged 60 years and over is expected to increase from 605 million to 2 billion over the same period[4].

An analysis based on Global demographic estimates undertaken by the 'Population Division of Department of Economic and social affairs of United Nations (UN) Secretariat' has provided percentage distribution by age and in different geographic locations[5]. Over the last five decades, life expectancy at birth has increased globally by almost 20 years, from 46.5 years in 1950-1955 to 66.0 years in 2000-2005. On average, the gain in life expectancy at birth was 23.1 years in the less developed regions and 9.4 years in the more developed regions. Apart from the Eastern European countries, where life expectancy at birth is currently, on average, lower than 69 years, the range in life expectancy within the more developed regions is only 11 years, from 71 years in Latvia to 82 years in Japan. Over the next 50 years global life expectancy at age 60 is expected to increase from 18.8 years in 2000-2005 to 22.2 years in 2045-2050 (an 18 per cent gain), from 15.3 to 18.2 years (19 per cent) at age 65 and from 7.2 to 8.8 years (22 per cent) at age 80.

In 1950, there were 205 million persons aged 60 or over throughout the world. At that time, only 3 countries had more than 10 million people 60 or older: China (42 million), India (20 million), and the United States of America (20 million). Fifty years later, the number of persons aged 60 or over increased about three times to 606 million. In 2000, the number of countries with more than 10 million people aged 60 or over increased to 12, including 5 with more than 20 million older people: China (129 million), India (77 million), the United States of America (46 million), Japan (30 million) and the Russian Federation (27 million). Over the first half of the current century, the global population 60 or over is projected to expand by more than three times to reach nearly 2 billion in 2050. By then, 33 countries are expected to have more than 10 million people 60 or over, including 5 countries with more than 50 million older people: China (437 million), India (324 million), the United States of America (107 million), Indonesia (70 million) and Brazil (58 million). Currently, the growth rate of the older population (1.9 per cent) is significantly higher than that of the total population (1.2 per cent). In the near future, the difference between the two rates is expected to become even larger.

The decline of intellectual functions is a characteristic of old age and it is much more rapid in those with lower intellectual capacities; those with higher intellectual potentials lose their mental abilities much slower – that is what is termed "knowledge crystallization"[6]. A high level of intellectual abilities provides a desirable level of spiritual potential. The people who were occupationally exposed to intense intellectual efforts retain the intellectual abilities well into their old age. Those who stopped to be intellectually challenged and stopped learning long before old age are thus in an unfavorable situation[7].

1.1.1. Health Problems in the Elderly

Many of the serious public health problems of the day relate to the later years of life[8]. Chronic illnesses that most frequently strike in late life are now the most common forms of illnesses. Alzheimer's disease and related dementias, cerebrovascular disease, vision and hearing loss, type 2 diabetes mellitus, and altered glucose metabolism, osteoporosis, hip fracture, Parkinson's disease, specific infections such as pneumococcal pneumonia, constipation, incontinence, depression, social isolation are the common conditions in the

elderly population[9]. Cerebral metabolism and circulation have generally been regarded as declining with advancing age; senility, regression, and rigidity are often regarded as unavoidable concomitants of growing older[10]. Perceptual sensitivity is usually diminished especially visual and auditory perceptions as a natural consequence of aging[11]. Aging is the single biggest risk factor for developing cancer. Aging is known to affect immune function, a phenomenon known as immunosenescence, which compromises the ability of the immune system to fight infections and respond to vaccines[12].

1.1.1.1. Physical problems:

Solar-induced cutaneous changes are more prevalent and profound in older persons. Structurally the aged epidermis likely becomes thinner, the corneocytes become less adherent to one another, and there is flattening of the dermoepidermal interface. The number of melanocytes and Langerhans cells is decreased. The dermis becomes atrophic and it is relatively acellular and avascular. Dermal collagen, elastin, and glycosaminoglycans are altered. The subcutaneous tissue is diminished in some areas, especially the face, shins, hands, and feet, while in others, particularly the abdomen in men and the thighs in women, it is increased. Sebaceous glands tend to increase in size but paradoxically their secretory output is lessened. The cutaneous immune and inflammatory responses are impaired, particularly cell-mediated immunity. Clinical correlates of these intrinsic aging changes of the skin include alopecia, pallor, xerosis, an increased number of benign and malignant epidermal neoplasms, increased susceptibility to blister formation, predisposition to injury of the dermis and underlying tissues, delayed onset and resolution of blisters and wheals, persistent contact dermatitis, impaired tanning response to ultraviolet light, increased risk for wound infections, prolongation of therapy necessary for onychomycosis, and thermoregulatory disturbances[13]. About one third of the elder population over the age of 65 falls each year, and the risk of falls increases proportionately with age. At 80 years, over half of seniors fall annually[14]. Falls are a significant cause of morbidity and mortality among the elderly. The most common precipitating factors include gait and balance disorders, weakness, dizziness, visual impairment, confusion and postural hypotension[15]. Age-related eye diseases -- macular degeneration, cataract, diabetic retinopathy, and glaucoma affect more than 119 million people aged 40 and older.

1.1.1.2. Psychological problems:

The elderly are subject to acute brain syndromes caused by physical illness or drug toxicity. The chronic brain syndromes include Alzheimer's disease, multi-infarct dementia, and dementia from other causes. The most common functional illness in old age is depression. Other functional psychiatric disorders common in old age are depression, mania, late paraphrenia, and personality disorder. Most surveys have shown that 20% of those over 80 years old suffer from a chronic organic brain syndrome[16]. Based on ECA (Epidemiologic catchment Area study) data, the most prevalent disorders in old age are anxiety, phobia, and dysthymia (5.5%, 4.8%, and 1.8%, respectively)[17]. OCD (Obsessive compulsive disorder) and OCS (Obsessive compulsive syndrome) are common among the elderly. Both conditions are related to depression and poorer mental and social functioning. The one-month prevalence of OCD is 2.9%; a further 21% have OCS. Among 70-year-olds, the prevalence of OCD is 1.3% in men and 4.5% in women. Depression is more common among those with OCD (34.6%) than among those with (12.7%) and without (8.0%) OCS[18].

1.1.1.3. Cognitive problems:

In normal aging, decreased ability to retrieve information can cause annoying memory lapses that do not impair the ability to perform activities of daily living[19]. These changes are largely the result of declines in frontal lobe function, which is measured as executive function (the ability to organize, plan, and focus on a topic)[20]. In contrast, memory loss that impairs the ability to perform activities of daily living strongly suggests neurodegenerative dementia. Dementia is generally defined as a progressive decline in two or more cognitive domains that is severe enough to interfere with the performance of everyday activities[21]. The most likely causes of dementia are, in order of likelihood, Alzheimer disease, frontotemporal dementia, and dementia with Lewy bodies[22].

Age-related changes to the brain have been shown to occur earliest in the prefrontal cortex (PFC)[23]. The PFC has been associated with memory, attention, executive function and emotion, as well as playing a role in a variety of other complex cognitive functions[24] [25] [26]. Memories for perceptual, spatial, and temporal source are affected by aging. It has been well established that working memory abilities decrease with advancing age;

however, the specific time point in the adult life span at which this deficit begins and the rate at which it advances are still controversial[27]. Discrimination in the visuospatial tasks starts to decline earlier in women than in men; however, discrimination is equal between the sexes in the verbal tasks. Visuospatial memory show more pronounced decline than the verbal domain. Referencing the self is known to enhance accurate memory, but adults are more prone to false memories, particularly for information that is strongly related to the self[28]. An Associative Deficit hypothesis attributes a substantial part of older adults' deficient memory performance to their difficulty in merging unrelated attributes-units of an episode into a cohesive unit. Although each of the components can be memorized to a reasonable degree, the associations that tie the attributes-units to each other grow weaker in old age[29]. Memory decline in aging, results from multiple factors that influence both executive function and the medial temporal lobe memory system. In advanced aging, frontal-striatal systems are preferentially vulnerable to white matter change, atrophy, and certain forms of neurotransmitter depletion[30].

Research findings have supported the view that executive cognitive functions, which are relevant for the control of goal-oriented actions and adaptive behaviors, are strongly impaired by aging[31 32]. Different components of executive function such as working memory, attention, and cognitive flexibility can be dissociated behaviorally and mechanistically[33]. Change in frontal-striatal circuits is the most likely significant cause of reduced executive function in non-demented older adults[34]. Reduced executive function influences memory because acts of remembering often rely on controlled processing, such as strategic elaboration during memorization and guiding search at retrieval. Remembering source information and temporal details of past episodes appears to be particularly dependent on executive processes that are disrupted in aging [35 36 37]. Age-related degradation in anterior brain areas is associated with decreased processing speed and poorer working memory, whereas reduced inhibition and greater task switching costs are linked to decline in posterior areas. Executive functions that require at least some memory support, i.e., working memory span or capacity, is linked to the middle cerebral white matter integrity. Other executive functions that require little memory support but are focused on response selection and inhibition as well as management of conflicting task demands shows no temporal lobe involvement and is correlated with the integrity of

posterior brain regions[38].

Frontal-striatal change may underlie mild memory difficulties in aging that are most apparent on tasks demanding high levels of attention[39]. Leukoaraiosis (white matter changes) could be the reason of some of the intellectual impairment in the elderly, especially that of slowing of distinct motor and attentional functions, as well as slowing of mental processing[40].

Let us now understand the process of cognition and look at each of the cognitive processes in detail.

1.2. COGNITION refers to the mental process by which external or internal input is transformed, reduced, elaborated, stored, recovered, and used. As such, it involves a variety of functions such as perception, attention, memory coding, retention, and recall, decision making, reasoning, problem-solving, imaging, planning and executing actions[41]. The varied processes under cognition are:

1.2.1. Memory:

The term memory implies the capacity to encode, store, and retrieve information[42]. Otherwise it's also referred to the process of recalling a specific experience or the total recollection of the remembered experiences stored in an individual's brain[43].

Stages in the formation and retrieval of memory:

- *Encoding* or registration: receiving, processing and combining of received information
- *Storage*: creation of a permanent record of the encoded information
- *Retrieval*, *recall* or *recollection*: calling back the stored information in response to some cue for use in a process or activity.

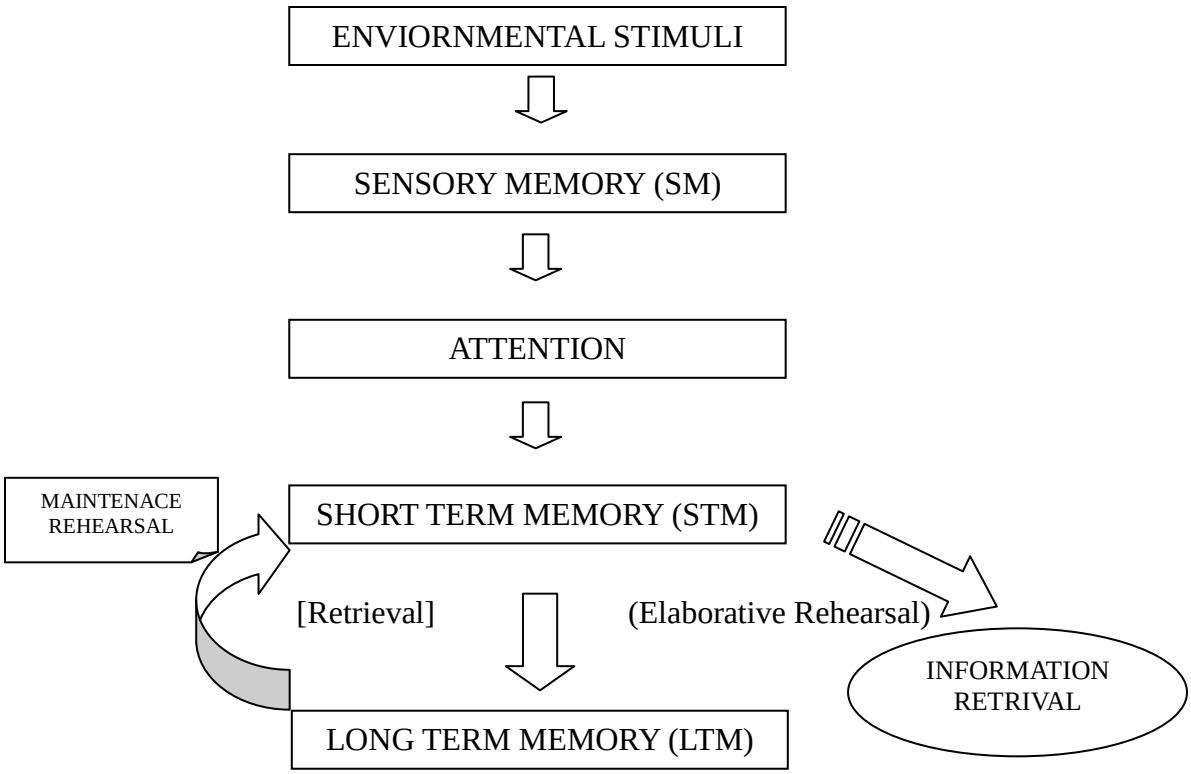

Fig 1.1 Flowchart depicting memory storage and retrieval

Types of memory*:*

Atkinson and Shiffrin (1968) have described three distinct memory systems that allow an individual to process store and recall information.

- *Sensory memory:* Sensory memory holds sensory information for a few seconds or less after an item is perceived. The ability to look at an item, and remember what it looked like with just a second of observation, or memorization, is an example of sensory memory. There are three types of sensory memories. Iconic memory is a fast decaying store of visual information, a type of sensory memory that briefly stores an image which has been perceived for a small duration. Echoic memory is a fast decaying store of auditory information, another type of sensory memory that briefly stores sounds which has been perceived for a small duration. Haptic memory is a type of sensory memory that represents a database for touch stimuli. Itching and pain are a form of haptic memory.
- *Short term memory:* Short-term memory allows recall for a period of several seconds to a minute without rehearsal. Its capacity is also very limited typically of the

order of 4–5 items(Cowan, N. (2001). Short-term memory is believed to rely mostly on an acoustic code for storing information, and to a lesser extent a visual code. Working memory is a form of STM that allows us to hold an idea in mind long enough to carry out an action such as calling a telephone number we just looked up, working out the steps of a mathematics problem, or searching for a lost set of keys while remembering where we have already looked. These short-term memory tasks may be carried out by reverberating circuits of neurons.

- *Long-term memory:* long-term memory can store much larger quantities of information for potentially unlimited duration (sometimes a whole lifespan). While short-term memory encodes information acoustically, long-term memory encodes it semantically. Another part of long-term memory is episodic memory "which attempts to capture information such as “what”, “when” and “where”. With episodic memory individuals are able to recall specific events such as birthday parties and weddings.

There are two forms of long-term memory—declarative and procedural. Declarative memory is the retention of events and facts that you can put into words—numbers, names, dates, and so forth. Procedural memory is the retention of motor skills—how to tie your shoes, play a musical instrument, or type on a keyboard.

Classification by information type

- *Topographic memory* involves the ability to orient oneself in space, to recognize and follow an itinerary, or to recognize familiar places. Getting lost when traveling alone is an example of the failure of topographic memory.
- *Flashbulb memories* are clear episodic memories of unique and highly emotional events.

Classification by temporal direction

A further major way to distinguish different memory functions is whether the content to be remembered is in the past, retrospective memory, or whether the content is to be remembered in the future, prospective memory. Retrospective memory as a category includes semantic, episodic and autobiographical memory. Prospective memory is memory for future intentions, or *remembering to remember*. Prospective memory can be

further broken down into event- and time-based prospective remembering. Time-based prospective memories are triggered by a time-cue, such as going to the doctor (action) at 4pm (cue). Event-based prospective memories are intentions triggered by cues, such as remembering to post a letter (action) after seeing a mailbox (cue).

Consolidation of Memory

For short-term memory to be converted into long-term memory that can be recalled weeks or years later, it must become "consolidated." That is, the short-term memory if activated repeatedly will initiate chemical, physical, and anatomical changes in the synapses that are responsible for the long-term type of memory. This process requires 5 to 10 minutes for minimal consolidation and 1 hour or more for strong consolidation brain concussion, sudden application of deep general anesthesia, or any other effect that temporarily blocks the dynamic function of the brain can prevent consolidation.

Memory—Roles of Synaptic Facilitation and Synaptic Inhibition

Physiologically, memories are stored in the brain by changing the basic sensitivity of synaptic transmission between neurons as a result of previous neural activity. The new or facilitated pathways are called memory traces. They are important because once the traces are established; they can be selectively activated by the thinking mind to reproduce the memories. Most memory that we associate with intellectual processes is based on memory traces in the cerebral cortex.

The brain has the capability to learn to ignore information that is of no consequence. This results from inhibition of the synaptic pathways for this type of information; the resulting effect is called habituation. This is a type of negative memory. Conversely, for incoming information that causes important consequences such as pain or pleasure, the brain has a different automatic capability of enhancing and storing the memory traces. This is positive memory. It results from facilitation of the synaptic pathways, and the process is called memory sensitization.

Role of Specific Parts of the Brain in the Memory Process

Hippocampus-The hippocampus is the most medial portion of the temporal lobe cortex.

The two hippocampi have been removed for the treatment of epilepsy in a few patients. After removal, these people have virtually no capability thereafter for storing verbal and symbolic types of memories (declarative types of memory) in long-term memory, or even in intermediate memory lasting longer than a few minutes. Therefore, these people are unable to establish new long-term memories of those types of information that are the basis of intelligence. This is called anterograde amnesia. The hippocampi especially and to a lesser degree the dorsomedial nuclei of the thalamus, another limbic structure, have proved especially important in making the decision about which of our thoughts are important enough on a basis of reward or punishment to be worthy of memory. In some people who have hippocampal lesions, some degree of retrograde amnesia occurs along with anterograde amnesia, which suggests that these two types of amnesia are at least partially related and that hippocampal lesions can cause both. The hippocampus is also important for memory consolidation.

- *Thalamus*-Damage in some thalamic areas may lead specifically to retrograde amnesia without causing significant anterograde amnesia. A possible explanation of this is that the thalamus may play a role in helping the person "search" the memory storehouses and thus "read out" the memories.
- *Cerebral cortex*-Long-term memories are stored in various areas of cerebral cortex.
- *Temporal lobe*-Our vocabulary and memory of faces and familiar objects, for example, are stored in the superior temporal lobe. Recent functional imaging studies detected working memory signals in both medial temporal lobe (MTL), a brain area strongly associated with long-term memory, and prefrontal cortex[44], suggesting a strong relationship between working memory and long-term memory.
- *Prefrontal cortex*-memories of our plans and social roles are stored in the prefrontal cortex. the substantially more working memory signals seen in the prefrontal lobe suggest that this area play a more important role in working memory than MTL.
- *Cerebellum*-has a role in learning motor skills.
- *Amygdala*- the more emotionally charged an event or experience is, the better it is remembered; this phenomenon is known as the memory enhancement effect. Patients with amygdala damage, however, do not show a memory enhancement effect. It is well

established that electrical stimulation of the amygdala modulates memory storage and that the effect is influenced by adrenal hormones. In animals, infusions of β-adrenergic and glucocorticoid antagonists into the amygdala impair memory, whereas infusions of β-adrenergic agonists (e.g., norepinephrine) and glucocorticoid receptor agonists into the amygdala after training enhance memory. However, it is also clear from the findings of many studies that the amygdala is not the neural locus of long-term memory.

1.2.2. Attention

Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things. Attention has also been referred to as the allocation of processing resources[45].

Exogenous-endogenous attention

The first aspect of how our minds come to attend to items present in the environment is called bottom-up processing, also known as stimulus-driven attention or exogenous attention. These describe attentional processing which is driven by the properties of the objects themselves. Some processes, such as motion or a sudden loud noise, can attract our attention in a pre-conscious, or non-volitional way. We attend to them whether we want to or not. These aspects of attention are thought to involve parietal and temporal cortices, as well as the brainstem.

The second aspect is called top-down processing, also known as goal-driven, endogenous attention, attentional control or executive attention. This aspect of our attentional orienting is under the control of the person who is attending. It is mediated primarily by the frontal cortex and basal ganglia as one of the executive functions. Research has shown that it is related to other aspects of the executive functions, such as working memory and conflict resolution and inhibition.

Overt and covert attention

Overt attention is the act of directing sense organs towards a stimulus source. Covert attention is the act of mentally focusing on one of several possible sensory stimuli. Covert attention is thought to be a neural process that enhances the signal from a particular part of the sensory panorama. (e.g. While reading, shifting overt attention

would amount to movement of eyes to read different words, but covert attention shift would occur when you shift your focus from semantic processing of a word to the font or color of the word you are reading.

Clinical model of attention

This hierarchic model is based in the recovering of attention processes of brain damage patients after coma. Five different kinds of activities of growing difficulty are described in the model; connecting with the activities those patients could do as their recovering process advanced.

- *Focused attention:* The ability to respond discretely to specific visual, auditory or tactile stimuli.
- *Sustained attention (vigilance):* The ability to maintain a consistent behavioral response during continuous and repetitive activity.
- *Selective attention:* The ability to maintain a behavioral or cognitive set in the face of distracting or competing stimuli. Therefore it incorporates the notion of "freedom from distractibility."
- *Alternating attention:* The ability of mental flexibility that allows individuals to shift their focus of attention and move between tasks having different cognitive requirements.
- *Divided attention:* This is the highest level of attention and it refers to the ability to respond simultaneously to multiple tasks or multiple task demands.

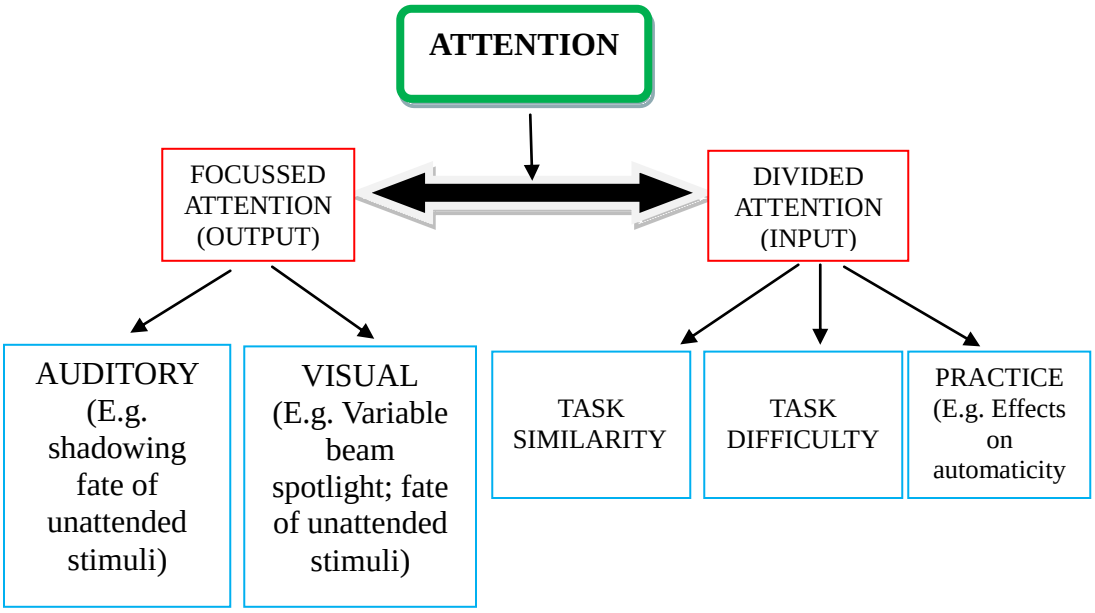

Fig 1.2 Flowchart showing different topics in attention and its relation to each other

Focused attention is studied by presenting people with two or more stimulus at the same time and instructing them to process and respond to only one. Work on focus attention can tell us how effectively people can select certain inputs rather than others and it enables us to investigate the nature of the selection process and fate of the unattended stimuli. Divided attention is also studied by presenting at least two stimulus inputs at the same time but with the instructions that the entire stimulus inputs must be attended to and responded to. Studies of divided attention provide information about individuals processing limitations, and may tell us something about attentional mechanisms and their capacity.

When a person is confronted with two stimuli at a time, one of them is attended and the other is ignored (shadowed). The shadowed stimuli have practically no stored memory; for e.g. in case of auditory stimuli, the unattended words even though they might be presented several times to the person, remains ignored. It has been argued that focused visual attention is rather like a spotlight: everything within a relatively small area can be seen clearly but it is much more difficult to see anything not falling within the beam of

the spotlight. According to the zoom lens model, there is an attentional spotlight, but this spotlight has an adjustable beam so that the area covered by the beam can be increased or decreased.

Task similarity-Pairs of activities that are performed well together in everyday life, usually involve rather two dissimilar activities. Two tasks interfere to the extent that they have the same stimulus modality (e.g. visual or auditory), make use of same stages of processing (input, internal processing and output) and rely on related memory codes (e.g. verbal or visual). Response similarity is also important.

The ability to perform two tasks together undoubtedly depends upon their difficulty (Task difficulty). One of the key phenomenon in the studies of divided attention is the dramatic improvement that the practice has on performance. The commonest explanation for this is that some processing activities become automatic as a result of prolonged practice. Automatic processes do not reduce the capacity for performing other tasks (i.e. they demand zero attention). They are fast, unavailable to the consciousness and are unavoidable (when an appropriate stimulus is presented).

1.2.3. Executive functions:

The term 'executive functions' refers to those abilities that enable a person to determine goals, formulate new and useful ways of achieving them, and then follow and adapt this proposed course in the face of competing demands and changing circumstances, often over long periods of time.

Executive functions is an umbrella term for cognitive processes that regulate, control, and manage other cognitive processes[46], such as planning, working memory, attention, problem solving, verbal reasoning, inhibition, mental flexibility, task switching[47], and initiation and monitoring of actions[48].

Neuroanatomy

The frontal lobes need to participate in basically all of the executive functions, but it is not the only brain structure involved. Neuroimaging and lesion studies have identified the functions which are most often associated with the particular regions of the prefrontal cortex.

- The dorsolateral prefrontal cortex (DLPFC) is involved with "on-line" processing of information such as integrating different dimensions of cognition and behaviour. As such, this area has been found to be associated with verbal and design fluency, ability to maintain and shift set, planning, response inhibition, working memory, organisational skills, reasoning, problem solving and abstract thinking.
- The anterior cingulate cortex (ACC) is involved in emotional drives, experience and integration. Associated cognitive functions include inhibition of inappropriate responses, decision making and motivated behaviors. Lesions in this area can lead to low drive states such as apathy, abulia or akinetic mutism and may also result in low drive states for such basic needs as food or drink and possibly decreased interest in social or vocational activities and sex.
- The orbitofrontal cortex (OFC) plays a key role in impulse control, maintenance of set, monitoring ongoing behavior and socially appropriate behaviors. The orbitofrontal cortex also has roles in representing the value of rewards based on sensory stimuli and evaluating subjective emotional experiences. Lesions can cause disinhibition, impulsivity, aggressive outbursts, sexual promiscuity and antisocial behavior.

Development

Executive functions, mature at different rates over time. Some abilities peak in late childhood or adolescence while others progress into early adulthood.

- *Early childhood:* Inhibitory control and working memory are among the earliest executive functions to appear, with initial signs observed in infants, 7 to 12-months old. Then in the preschool years, children display a spurt in performance on tasks of inhibition and working memory, usually between the ages of 3 to 5 years. Also during this time, cognitive flexibility, goal-directed behavior, and planning begin to develop.
- *Preadolescence:* During preadolescence, children display major increases in verbal working memory goal-directed behavior (with a potential spurt around 12 years of age); response inhibition and selective attention; and strategic planning and organizational skills. Additionally, between the ages of 8 to 10, cognitive flexibility in particular begins to match adult levels.
- *Adolescence:* During adolescence the different brain systems become better

integrated. At this time, youth implement executive functions, such as inhibitory control, more efficiently and effectively and improve throughout this time period. Just as inhibitory control emerges in childhood and improves over time, planning and goal-directed behavior also demonstrate an extended time course with ongoing growth over adolescence .Likewise, functions such as attention control, with a potential spurt at age 15, along with working memory, continue developing at this stage.

- *Elderly:* During old age, working memory and cognitive flexibility can be dissociated behaviorally and mechanistically. Cognitive flexibility (shifting between multiple tasks or mental sets), behavioral inhibition (suppression of dominant and automatic responses when necessary), and updating of working memory (substitution of old information by new more relevant information in working memory), all these three executive functions are constantly impaired in older people[49].

1.3. TREATMENT OPTIONS FOR VARIOUS COGNITIVE PROBLEMS OF ELDERLY:

There are varied treatment options for cognitive impairment in the elderly. We have detail a few in the coming paragraphs.

1.3.1. Drug treatment

At present, no established treatment exists for cognitive impairment. However, donepezil has been found to delay the progression to Alzheimer's in Mild Cognitive Impairment (MCI) patients with depression without affecting their symptoms of depression[50]. There is some evidence to suggest that cognitive interventions may have a positive effect[51].

1.3.2. Diet

Roberts et al found that the risk of developing mild cognitive impairment (MCI) is lower in individuals who consume a Mediterranean diet, which is high in vegetables and unsaturated fats[52]**.** A randomized, double-blind, placebo-controlled trial involving 25 elderly subjects with MCI determined that dietary supplementation with an oily emulsion of docosahexaenoic acid (DHA)-phospholipids containing melatonin and tryptophan yielded significant improvements in several measures of cognitive function as compared

with supplementation with the placebo[53]. In a two-year randomized trial of 168 people with MCI given either high-dose vitamins or placebo, vitamins cut the rate of brain shrinkage by up to half. The vitamins were the three B vitamins folic acid, vitamin B6, and vitamin B12, which inhibit production of the amino acid homocysteine, high levels of which are associated with cognitive decline[54].

1.3.3. Activity

Many experts have suggested that mentally challenging activities (eg, crossword puzzles and brain teasers) may be helpful for patients with MCI. Such exercises should be kept to a level of difficulty that is reasonable for the patient. Ideally, they should be interactive rather than passive, and they should be administered in a fashion that does not cause excessive frustration. If an activity is not enjoyable or stimulating for the patient, it is unlikely to offer much cognitive benefit. In such cases, searching for other similar cognitive activities may be beneficial. Social isolation can be minimized through referral to senior community centers or a day treatment program. Cognitive retraining and rehabilitative strategies offer considerable promise in MCI[55]. Physical Activity (PA), aimed at improving cardiorespiratory health, has been proposed to be a good, practical, and powerful candidate to overcome cerebral and behavioral declines[56]. In recent years, using various methodologies, several studies have shown that older adults who maintain a physically active way of life by participating in regular PA or chronic exercise outperform their sedentary counterparts in cognitive performance, exhibit higher brain plasticity[57 58] and are more efficiently protected against neurological diseases and dementia[59 60].

1.3.4. Tai chi

In a 10-week interventional study, researchers found that participants in the experiment group who practiced Tai Chi during the study had significant improvement in executive function based on their performance in Trail making B Test and Clock Drawing Test[61]. In a cross-sectional study, it was seen that among 42 older adults, based on their scores of color trail test A and B, MB exercise practitioners had better attention than their counterparts who did not practice MB exercise[62]. In a cross-sectional study, memory function was compared between MB exercise practitioners who were older adults and older adults without regular exercise habit[63]. Based on participant's score of The Hong Kong List Learning Test, they found a strong association between MB exercise practice

and better memory function.

1.3.5. *Yogā*

Yogā is a state of complete absorption, union (*Yogā stithi*) with absolute Reality i.e., Universal Consciousness. The word *Yogā* comes from the *Saṁskṛt* root word '*yuj*' which means integration, or a meeting with the true Self[64]. *Yogā* is also an art of living and a systematic process to reach the state of *mokṣa*, endowed with perfect silence, knowledge, power and bliss[65]. *Yogā* is both, the goal as well as the means to achieve a state of perfect harmony.

Yogā has considered internal purification of the human body in depth. The Cleansing Processes have been planned with a view to have total purification of the body. There are three humours in the body: *Kapha* 'mucus', *Pitta* 'bile' and *Vāta* 'wind'. In *Yogā* and *āyurvedā* they are called *Tridoṣa*. A balanced proportion of these three facilitates body functions, but if there is an excess of one and a shortage of another, ailments develop due to overheating or not enough heat in the body. Before commencing *Prāṇāyāma*, any imbalance in the *doṣa*'s should be removed, gas in the stomach and intestines eliminated, etc. in *Haṭa Yogā* there are six particular practices which were specifically designed for this purpose. They are called *Ṣaṭakarma*. These techniques regulate the production of the *doṣa*.

Ṣaṭakarmas

Ṣaṭakarma is a compound word consisting of two components: *Ṣaṭa* meaning 'six' and *karma* meaning 'art' or 'process'. The word *kriyā* or *karma* is used in *Haṭa Yogā* regarding the techniques of cleaning. *Ṣaṭakarma* is a *Saṁskṛt* word that refers to the *Yogī* c practices involving purification of the body. These practices, outlined by *Yogī svātmārām* in the *Haṭa Yogā Pradipikā*, include *Neti*, *Dhauti*, *Nauli*, *Basti*, *Trāṭak*, *Kapālabhāti*.

Ṣaṭakarma according to *haṭa yogā pradipikā*:

मेदश्लेष्माधिकः पूर्व षट्कर्माणि समाचरेत।

अन्यस्तु नाचरेत्तानि दोषाणां सम्भावतः॥२१॥

medaśleṣmādhikaḥ pūrva ṣaṭkarmāṇi samācareta |

anyastu nācarettāni doṣāṇāṁ sambhāvataḥ ||21||

Meaning: When fat or mucus is excessive, *Ṣaṭakarma*: the six cleansing techniques should be practiced before (*Prāṇāyāma*). Others, in whom the *doṣa*s, i.e. phlegm, wind and bile, are balanced, should not do them.

धौतिर्बस्तिस्तथा नेतिस्त्राटकं नौलिकं तथा।

कपालभातिश्चेतानि षट् कर्माणि प्रचक्षते॥२२॥

dhautirbastistathā netistrāṭakaṁ naulikaṁ tathā |

kapālabhātiścetāni ṣaṭ karmāṇi pracakṣate ||22||

Meaning: *Neti*, *Dhauti*, *Nauli*, *Basti*, *Trāṭaka*, and *Kapālabhāti*; these are known as *Ṣaṭakarma* or the six cleansing processes.

कर्मषट्कमिदं गोप्यं घटशोधनकारकम्।

विचित्रगुणसंधायि पूज्यते योगिपुंगवैः॥२३॥

karmaṣaṭkamidaṁ gopyaṁ ghaṭaśodhanakārakam |

vicitraguṇasaṁdhāyi pūjyate yogī puaṁgavaiaḥ ||23||

Meaning: These *Ṣaṭakarma* which effect purification of the body are secret. They have manifold, wondrous results and ate held in high esteem by eminent *yogī* s.

***Ṣaṭakarma* according to *gheraṁḍa saṁhitā*:**

धौतिर्बस्तिस्तथा नेतिलौर्लिकी त्राटकं तथा।

कपालभातिश्चैतानि षट्कर्माणि प्रचक्षते॥१२॥

dhautirbastistathā netilaurlikī trāṭakaṁ tathā |

kapālabhātiścaitāni ṣaṭkarmāṇi pracakṣate ||12||

Meaning: The six purificatory processes are: *Neti*, *Dhauti*, *Nauli*, *Basti*, *Trāṭaka*, and *Kapālabhāti*.

1.3.5.1. *Trāṭaka*:

Trāṭaka* according to *gheraṁḍa saṁhitā:

निमेषोन्मेषकम् त्यक्त्वा सूक्ष्मलक्ष्यम् निरिक्षयेत्।
यावदश्रुन पतति त्राटकं प्रोच्यते बुधैः॥५३॥
एवमभ्यासयोगेन शाम्भवी जायते ध्रुवम्।
नेत्ररोगा विनश्यन्ति दिव्यद्रुष्टिः प्रजायते॥५४॥

nimeṣonmeṣakam tyaktvā sūkṣmalakṣyam nirikṣayet |
yāvadaśruna patati trāṭakaṁ procyate budhaiaḥ ||53||
evaṁabhyāsayogena śāmbhavī jāyate dhruvaṁ |
netrarogā vinaśyanti divyadruṣṭiaḥ prajāyate ||54||

Meaning: Gaze steadily without winking at any small objects, until tears begin to flow. By practicing this, *śāmbhavi siddhi*s are obtained; and certainly all diseases of eye are destroyed and clairvoyance is obtained.

Trāṭaka* according to *haṭa yogā pradipikā:

निरिक्षेन्निश्चलद्रुशा सूक्ष्मलक्ष्यम् समाहितः।

अश्रुसम्पातपर्यन्तमाचार्यैस्त्रटकम् स्म्रुतम्॥३१॥

nirikṣenniścaladruśā sūkṣmalakṣyam samāhitaḥ |
aśrusampātaparyantamācāryaistraṭakam smrutam ||31||

Meaning: Looking intently with an unwavering gage at a small point until tears are shed is known as *Trāṭaka* by the *Ācārya*s.

मोचनम् नेत्ररोगाणाम् तन्द्रादीनाम् कपाटकम्।

यन्ततस्त्राटकम् गोप्यम् यथा हाटकपेटकम्॥३२॥

mocanam netrarogāṇām tandrādīnām kapāṭakam |
yantatastrāṭakam gopyam yathā hāṭakapeṭakam ||32 ||

Meaning: *Trāṭaka* eradicates all eye diseases, fatigue and sloth and closes the doorway creating these problems. It should be carefully kept secret like a golden casket. Other meaning: Being calm, one should gaze steadily at a small mark, till eyes are filled with

tears. This is called *Trāṭaka* by *Ācārya*. *Trāṭaka* destroys the eye diseases and removes sloth, etc. It should be kept secret very carefully, like a box of jewellery.

In *haṭaratnāvali* text *yogī Śrinivāsa* has explained *aṣṭakarma*s (eight purificatory procedures)[66].

Trāṭaka* according to *haṭaratnāvali :

चक्रिनौलिर्धौति र्नेति बस्ति र्गजकरिणी

त्रोटनं मस्तकभ्रन्तिः कर्माण्यष्टौ प्रचक्षते ॥२५॥

cakrirnaulirdhauti rneti basti rgajakariṇī
troṭanaṁ mastakabhrantiḥ karmāṇyaṣṭau pracakṣate ||25||

The eight *Karma*s (purificatory processes) are chakri, *nauli*, *dhauti*, *neti*, *basti*, Gajakarni, *trāṭaka* and mastak bhranti.

कर्माष्टकमिदं गोप्यं घटशोधनकारकम्।

कस्यचिन्नैव वक्तव्यं कुलस्त्रि सुरतं यथा ॥२७॥

karmāṣṭakamidaṁ gopyaṁ ghaṭaśodhanakārakam |
kasyacinnaiva vaktavyaṁ kulastri surataṁ yathā ||

The eight *karma*s are to be kept secret, as they are effective in cleansing the body (*ghaṭa*).These should not be disclosed to anybody, like a noble woman who would not disclose her sexual pleasures to anybody.

अथ त्रोटकं

निरीक्ष्य निश्चलदृशा सूक्ष्मलक्ष्यं समाहितः।

अश्रुसम्पातपर्यन्त माचार्यैस्त्रोटकं स्मृतम् ॥५२॥

atha troṭakaṁ
nirīkṣya niścaladṛuśā sūkṣmalakṣyaṁ samāhitaḥ |
aśrusampātaparyanta mācāryaistroṭakaṁ smṛtam ||52||

One should constantly gaze at a very minute object, remaining one-pointed, until tears roll down. According to the adepts this is *Trāṭaka*.

स्फ़ोटनं नेत्ररोगाणां तन्त्रादीनां कवाटकम्॥

प्रयत्नात्रोटनं गोप्यं यथारत्नं सुपेटकं॥५३॥

sfoṭanaṁ netrarogāṇāṁ tantrādīnāṁ kavāṭakam ||

prayatnātroṭanaṁ gopyaṁ yathāratnaṁ supeṭakaṁ ||53||

This technique removes eye diseases, drowsiness and the like. Therefore, it should be carefully guarded like a casket of jewels.

Note: The technique described in *ṣaṭakarma saṁgraha* requires the *bija* mantra *vaṁ* and *glaṁ* to be accompanied during this process for the manifestation of the inner light.

शोधनं कर्यमाज्ञायां नेतित्रोटन कर्मणा॥६४॥

śodhanaṁ karyamājñāyāṁ netitroṭana karmaṇā ||64||

Ājñā chakra is purified by *neti* and *trāṭaka karma*.

Trāṭaka is one of the most direct, simple and effective technique for attaining concentration of mind[67]. It is a method of focusing the eyes, and in turn the mind, on one point to the exclusion of all else. The object can be either external, in which case the practice is called *bahiraḥ trāṭaka* (outer gazing) or internal , in which case the practice is called *antaraḥ trāṭaka* (inner gazing). Through this method all the attention and power of the mind is channeled into one continuous stream, allowing the latent potential to arise spontaneously.

Trāṭaka forms a bridge between *haṭa Yogā* and *rāja Yogā*. When you practice until the tears roll down then it is a part of *haṭa Yogā*, but when you practice with inner visualization then it is part of *rāja Yogā*. Through the practice of *trāṭaka* one can develop the ability to focus the mind at any time. This is necessary in the higher practices of *Yogā*. *Pataṁjali*'s *Yogā sutras* declare that even in the highest state of *Samādhi* or meditation, there are certain impressions, ideas or experiences which remain in our consciousness. Those ideas and impressions can also be experienced in the state of *Samādhi*, and thus

they disturb the concentration of mind. These deep impressions or ideas are known as *pratyaya*. When the mind has not been taught to concentrate, and meditation has been practiced only superficially, then in deep meditation states the pull or attraction of these *pratyaya* is very powerful, because there is no means of balance. Therefore the ability that is gained through the *trāṭaka* becomes useful at that moment. When the visual distraction is stopped, we are able to experience a frame of mind that is quiet like a still pond or lake. The different forms of *trāṭaka* also help to channel or focus the *prāṇa*ic energies.

Physiological and mental functions

Physiologically *trāṭaka* relieves eye ailments such as eye strain and headache, myopia, astigmatism and even early stages of cataract. The eyes become clear and bright, able to see reality beyond appearences. *Trāṭaka* benefits not only the eyes, but a whole range of physiological and mental functions. It is therapeutic in depression, insomnia, allergy, anxiety and postural problems. Its most important effect is on *ājñā* chakra and the brain. *Trāṭaka* unlocks the inherent energy of the mind and channelizes it in the dormant areas of consciousness. Further results of one-pointedness of mind are strong will power, improved memory and concentration.

Trāṭaka is a process of concentrating the mind and curbing its oscillating tendencies. The purpose is to make the mind completely one-pointed and to arouse inner vision. One-pointed concentration of mind is called *ekāgratā*. There are numerous distractions which obstruct *ekāgratā*. In fact, distraction only occurs when the senses are tuned to the external world, which means an energy leakage is occurring. Association and identification through the eyes are major contributing factors to this leakage.

Furthermore, the eyes constantly move either in large movements-saccades, or tremors-nystagmus. Even when the eyes are focused on an external object, the view perceived is always fluctuating because of these spontaneous movements. When the same object is constantly seen, the brain becomes accustomed or habituated and soon stops registering that object. Habituation coincides with an increase of alpha waves indicating diminished visual attention to the external world. When alpha waves are produced, particular areas of the brain cease functioning.

When the awareness is restricted to one unchanging sensory stimulus, like touch or sound, the mind is turned off. Complete absorption in a single perception induces withdrawal of contact with the external world. In *trāṭaka* the result is blanking out of visual perception and in the wake of this suspension, the central nervous system begins to function in isolation. This experience is known by *yogī* s as *suśumnā* awakening. When the brain is isolated from the sense modalities and the associated mental processes, ideas, memories, etc. triggered by these thought impressions, the spiritual consciousness emerges. The higher mind, liberated from time and space, is experienced. *Suśumnā* is awakened.

Modes of practice

Trāṭaka consists of five different modes of practice:

- *Bāhya dṛṣṭi* (outer *trāṭaka*)
- *Bāhya-antaraḥ dṛṣṭi* (outer and inner *trāṭaka* combined)
- *Antaraḥ dṛṣṭi* (inner *trāṭaka*)
- *Śunya dṛṣṭi* (gazing into the void)
- *Nirantar dṛṣṭi* (continuous gazing)

In outer *trāṭaka*, or external gazing, the eyes remain open and focused on any steady object. Techniques of outer *trāṭaka* include *agocarī mudrā* (nose tip gazing) and *śambhavi mudrā* (eyebrow centre gazing). This form of *trāṭaka* can also be practiced by focusing the gaze on objects such as the flame of the candle, a dot, the rising sun and so on. By steadying the eyes in this manner you are automatically concentrating the mind.

When outer and inner *trāṭaka* are combined, first you gaze at an external point or object for some time, then you close your eyes and gaze at the after image or inner reflection of the same object. Any object can be used for concentration. A luminous object such as a candle flame is often used by the beginners because the brightness attracts the eyes and holds the gaze. It also imprints a clear image on the retina of the eye which can be seen clearly when the eyes are closed. The inner image becomes the object of concentration during *antaraḥ trāṭaka*. In inner *trāṭaka* awareness is focused only on an internal image, therefore this practice is more difficult than outer *trāṭaka* alone or outer and inner *trāṭaka* combined.

Gazing into the void should be practised after internal *trāṭaka* has been mastered. This practice is also known as *śunya dṛṣṭi*. *Śunya* means the 'void' or 'formless state'. It is not *cidākāśa*. In *śunya* there is no object of awareness. This form of *trāṭaka* is to be done with the eyes open, gazing at nothingness. It takes a long time to get into this state. Your eyes are open, but you are unable to see anything because the mind has become introverted. After some time the eyes become dim. They are half open and you can see nothing. Continuous gazing is looking at any point without blinking the eyes for hours together.

Objects of awareness

The object should be something which naturally attracts your attention and holds your gaze. You must decide what is most suitable for yourself. To give you an idea, we have given a list of commonly used objects: candle flame, *śivaliṁga*, cross, nose tip, Om symbol, eyebrow centre, sky, another person's eyes, water, yin yang symbol, *iṣṭa*, *devatā*, *yantra* or *maṁḍala*, flower, one's own shadow. Black dot, darkness, rising sun, reflection in a mirror, moon, crystal, star, *śunya*, reflection of sun or moon in clear water.

Multi-purpose practice

Trāṭaka develops the power of concentration as the conscious energy is directed toward one point of attention. The practice automatically leads to meditation. There are also many methods of *trāṭaka* by which different purposes can be achieved. If you want to practice *trāṭaka* for the purpose of telepathic communication, there is one method. If you want to practice in order to influence the minds of others, there is another method. If you wish to practice in order to improve your eyesight, then the method will differ again. In order to obtain different results, different methods are followed. There is a particular practice called *chāyā upāsanā* (shadow gazing), concerned with reading the aura and obtaining knowledge of the exact time of death. Any imminent danger can be foretold. *Trāṭaka* is the main component of this practice. *Trāṭaka* also awakens the faculties of clairvoyance, telepathy and telekinesis. A person can be summoned by using the method of *trāṭaka* on the psychic eye. The psychic language which is spoken by the eyes compels the other person to come. There are certain forms of *trāṭaka* used to detect the whereabouts of lost or stolen articles, and to find the thief. Healing can also be done through *trāṭaka*.

Guidelines

Trāṭaka can be done any time, but it is more effective, when practiced on an empty stomach. The most suitable time is between four and six in the morning. It should be done in absolute silence, without a fan. If you want to delve deeper into the mind, *trāṭaka* should be practiced late at night before going to bed and before *japā* or meditation. If there is an uncontrollable flow of thoughts during the practice of *trāṭaka*, mantra *japā* can be added at the same time.

Trāṭaka is a heat producing practice. Therefore, it should be done after bathing, when you are feeling fresh. If you practice *surya namaskār* before *trāṭaka*, the body becomes heated and at the time of *trāṭaka* you will feel discomfort. Try to keep your body cool before the practice. If you go into meditation after the practice of *trāṭaka*, the body will again become cool and refreshed. If you practice *trāṭaka* on rising sun, you must never look at the sun directly. This harmful to the eyes and may cause cataracts. Gaze upon the sun's reflection on clear water. When the reflection is disturbed by heavy wind or storm, then you should not practice this form of *trāṭaka*.

Always practice *trāṭaka* on steady object, never on a moving object. Be careful if practicing *trāṭaka* on metal, there may be reaction on the eyes.

Trāṭaka must be practiced in the steadiest possible posture. Although it can be done sitting in a chair or in *sukhāsana*, it is far better to practice it in *siddhāsana* or *padmāsana*. Once the practice begins there should be absolutely no movement of the body.

In both the external and internal forms of *trāṭaka*, the eyes should not blink or move in any way. Stillness of the eyeballs and eyelids is essential in order to attain clarity of the inner image. If the eyes feel strained, imagine that you are breathing through the mid-eyebrow Centre to and from *ājñā* chakra. If the mind wanders or starts to think about the other things, you should bring it back to the object of concentration.

If you are using a candle flame, there should be no other light. If you are using a black dot or any other object, there should be a good light. Crystal gazing is done in dim light. *Trāṭaka* on a candle flame must be practiced in a room without a fan, where there is no breeze. The candle flame should not flicker. The candle should be placed on a firm stand at eye level, about an arm's length away. *Trāṭaka* on any object should be practiced with-

out the eyeglasses or contact lenses. If you have defective vision, position the object so that you do not see double or the object is not blurred.

To have control over the visual sensory perceptions and to channel the impressions received through them is the aim of *trāṭaka*, control over the aspect of form, the awareness of form. *Trāṭaka* is a way of achieving optimum concentration of awareness and mind. Changes take place at the level of *ājñā* chakra (*Bodha*, enlightenment, mental awakening, take place at the level of *ājñā* chakra). Through the practice of *trāṭaka* one can develop the ability to focus the mind at any time[68]. This practice is thus believed to improve attention, memory and develop intense concentration[69].

In this context, as *Yogā* and especially *trāṭaka* is seen to be beneficial (according to classical texts in improving cognition; and elderly are known to experience cognitive deficits - we decided to undertake this study to assess the effect of *trāṭaka* on cognitive functions of the elderly. For this we shall first look the available literature in this area in the next chapter titled, 'Review of Literature'.

CHAPTER 2

REVIEW OF LITERATURE

2.1. PROCESS OF REVIEW

The objective of this systematic review is to assess the effectiveness of *Yogā* as a preventive measure for cognitive decline. For this purpose, we have searched three data bases (PubMed, Cochrane Reviews and Google Scholar) for peer-reviewed articles that have been published in indexed journals in the last one decade (2001 – 2013).We could not find any article related to the topic in Cochrane. We came across two types of studies: 1) review studies, 2) intervention studies. In the following pages, we shall first summarize the main findings of the *Yogā* studies on cognition in healthy subjects and review studies of *Yogā* on cognition in the elderly, before going on to a tabular presentation of the Intervention studies on elderly subjects.

2.2. STUDIES ON *YOGĀ*

There are many studies which have looked at the effect of *Yogā* on cognitive functions in the healthy subjects.

- **Breathing and cognition**

  In a study, spatial memory was seen to improve immediately after left nostril breathing. Spatial memory which is considered hemisphere specific, improved corresponding to the cerebral hemisphere contralateral to the patent nostril[70]. The letter-cancellation task (left-hemisphere dominant task) scores also improved after right and alternate nostril *Yogā* breathing[71]. *Kapālabhāti*, a *yogī*c breathing technique is seen to improve selective and sustained attention as well as ability to shift attention in 3 age groups (medical students, middle aged and older adults)[72].

- **Relaxation techniques and cognition**

  In a study, P300 amplitude increased immediately after *yogī* c relaxation technique, Cyclic meditation[73].Selective attention, concentration, visual scanning abilities, and a repetitive motor response have been seen to improve immediately after two *Yogā* based relaxation techniques, Cyclic meditation[74](both in adults as well as children)[75], and Deep relaxation technique[76] as compared to supine rest. Same variables also improve after dharana, a meditative technique[77]. In subsequent study it was seen that a cyclical combination of *Yogā* postures and supine rest in CM improved memory

scores immediately after the practice and decreased state anxiety more than rest in a classical *Yogā* relaxation posture (*shavasana*)[78].DLST scores improved after two relaxation techniques, cyclic meditation and supine rest in teenagers. Subjects consisted of 253 school students, 156 boys, 97 girls, in the age range 13–16 years, and they acted as their own controls. DLST which is a measure of selective attention and memory was tested before and immediately after relaxation practice[79].In another study, attention, speed of information processing and motor speed increased after two relaxation techniques, cyclic meditation and supine rest[80].

- **Meditation and cognition**

  Practitioners of Buddhist meditation were divided into two groups: Deity *Yogā* or Open Presence). Both groups of meditators completed computerized mental-imagery tasks before and after meditation. Deity *Yogā* practitioners performed better on imagery tasks compared with the other groups, suggesting the enhanced visuospatial processing efficiency through Buddhist Deity meditation[81].Meditation practices have various health benefits including the possibility of preserving cognition and preventing dementia[82].Mindfulness meditation is believed to promote alterations in trait affectivity and attentional control with resultant effects on well-being and cognition[83]. Long-term Vihangam *Yogā* meditation has shown to improve various domains of attention like attention span, processing speed, attention alternation ability, and performance in interference tests[84].In the Commentary on the AHRQ (Agency for Healthcare Research and Quality) report on research on meditation practices, it has been suggested that meditation has implications on health, cognition, and behavior[85]. In one of the studies it has been seen that concentrative meditation practice enhances pre attentive perceptual processes, enabling better change detection in auditory sensory memory. The mismatch negativity (MMN) paradigm that is an indicator of pre attentive processing was used to study the effect. Meditators were found to have larger MMN amplitudes than nonmeditators. The meditators also exhibited significantly increased MMN amplitudes immediately after meditation[86].In another study, sustained attention was better in concentrative and mindfulness meditators then control subjects and it was more in long term meditators then short term meditators[87]. Mindfulness-based interventions particularly integrative body-mind training (IBMT) has

shown to improve specific aspects of EF, including attention, cognitive control, and emotion regulation[88]. It is seen in one of the studies, that practice of Tai Chi, *Yogā*, meditation, and Reiki improves problem solving abilities as well as ability to focus on patient needs in nurses[89]. Executive function (EF) improved after program of mindful awareness practices in school children. 64 second- and third-grade children ages 7–9 years were selected for the study. The program was delivered for 30 minutes, twice per week, for 8 weeks[90], greater EF improvements were found in initially-poorer EFs than those with initially-better EFs, compared with controls. In one of the studies, the *Yogā* meditation group exhibited greater gray matter volume in frontal, limbic, temporal, occipital, and cerebellar regions; whereas the matched control group did not show any greater regional gray matter volume[91]. Fourteen (7 *haṭa Yogā* meditation practitioner (YMP), 7 *haṭa Yogā* and meditation-naive control subjects, between the ages of 18 and 55 years were included in the study. The *Yogā* meditation group also reported significantly fewer cognitive failures on the Cognitive Failures Questionnaire (CFQ), the magnitude of which was positively correlated with gray matter volume in numerous regions identified. GMV was positively correlated with the duration of *Yogā* practice. Study suggested that *haṭa Yogā* practice may be associated with the promotion of neuroplastic changes in executive brain systems, which may confer therapeutic benefits that accrue with repeated practice.

- **Integrated approach of *Yogā* therapy and cognition**

  A study showed that cognitive performance after the *Yogā* exercise bout was superior (i.e., shorter reaction times, increased accuracy) as compared to the aerobic exercise for inhibition and working memory tasks [92]. The verbal and spatial memory was tested in children (aged 11 to 16 years), three groups were assessed before and after 10 days. *Yogā* group showed increase in spatial memory scores, while there was no change in fine arts and control groups[93].6 months of *Yogā* practice has shown to improve the memory, as well as psychophysiological parameters such as salivary cortisol levels, anxiety, and depression scores[94]. In a study done on schoolchildren with socioeconomically disadvantaged background showed that *Yogā* is as effective as physical activity in improving cognitive performance in schoolchildren. Two hundred (200) schoolchildren of 7-9 yrs of age were selected for the study. Cognitive func-

tions (attention and concentration, visuo-spatial abilities, verbal ability, and abstract thinking) were assessed using an Indian adaptation of the Wechsler Intelligence Scale for Children at baseline, after 3 months of intervention, and at a 3-month follow-up[95].Another study has suggested *Yogā* training as one of the programs to help young children develop EF's. EF was seen to improve in girls aged 10-13yrs, with improvements most evident when EF demands were greatest[96].

In a comparative study, it was found that *yogīc* system of education improves sustained attention, visual as well as verbal memory[97] more than modern system of education. Forty nine boys aged 11-13 years were selected from two residential schools, one MES (modern education system) and the other GES (*gurukula* education system), matched for age and socio-economic status. Sustained attention was assessed using the SLCT at the start and end of an academic year[98].

A review article suggested different health benefits of *Yogā*, including improved cognition, respiration, reduced cardiovascular risk, BMI, blood pressure, and diabetes mellitus[99]. A study by Khemka et al showed that single month of integral *Yogā* practices imparts significant benefits to healthy volunteers in all psychological and health variables. It improves sustained attention and EQ. The *Yogā* intervention comprised of *Yogāsanas* (postures), *prāṇāyāma* (breathing exercises), relaxation techniques, meditation, chanting and lectures[100] *Suryanamaskār* (sun salutations) improved sustained attention in school children. 64 healthy school children aged 12-14yrs of age were selected and were randomly allocated to 2 groups with 32 students each (Experimental group and Control group). Assessment was done using digit letter substitution task, before and after 30 days of *Suryanamaskār* practice[101]. In a study, twenty girls between 10 and 13 years of age, were randomly assigned to two groups, *Yogā* and physical exercise group, assessment was done using tower of London task, before and after 1 month of practice of *Yogā* and physical exercise respectively. *Yogā* training for a month reduced the planning and execution time in simple as well as complex tasks and facilitated reaching the target with a smaller number of moves in a complex task, whereas no change was seen in physical exercise group[102].In another study, 20-minute *Yogā* session resulted in superior memory performance compared to acute aerobic exercise. Thirty female college-aged participants completed three counterbalanced test-

ing sessions: a *Yogā* session, an aerobic exercise session, and a baseline assessment. The state sub-form of the Spielberger's State Trait Anxiety Inventory and a free recall and a recognition task was used for assessment. Improved memory was attributed to decreased anxiety levels[103]. *Yogā* has shown to improve academic achievement, Reasoning ability and Short-term Memory of the students. Total 40-40 students of 11th commerce were selected from two schools for the study and "complete experimental simple equivalent group pretest-posttest experiment design" was used for study[104.] In another study done on adolescent school children, students, who practiced *Yogā* module yielded higher concentration levels and exhibited better short term memory[105.]

As observed there are many studies conducted on normal healthy individuals to test the effect of *Yogā* on cognition. However there are only a few studies (review and intervention) that have been conducted to test the effect of *Yogā* on cognition of elderly. The next two sections would focus on (a) review studies and (b) intervention studies conducted on the effect of *Yogā* on cognition in the elderly.

2.3. REVIEW STUDIES

One of the review studies included 15 studies with cognitively healthy elders and 8 studies with cognitive decline. Improvement in cognitive functions was seen in most of the studies with cognitively healthy subjects as well as subjects with cognitive decline. Interventions used were aerobic exercise, strength exercise, balance exercise or all-round exercise including aerobic, strength, balance and flexibility training. Effect was seen on information processing, general cognition, executive function, or memory[106]. Another review of nine studies including three RCTs and six NRCT's suggested that *Yogā* can improve physical well-being, including balance, range of motion, blood pressure, pain, fatigue, and general health as well as cognitive and mental health of older adults. *Yogā* also improved sleep quality and depression[107].

2.4. INTERVENTION STUDIES

Table 1 depicts 3 studies that have been conducted at Ranchi Institute of Neuropsychiatry and Allied Sciences, Psychiatry, Ranchi and Oregon Health and Science University (OHSU), Portland. All 3 studies have used controlled designs. Outcome measures mostly used are neuropsychological tests such as the Digit Span test, (2) the Stroop Color Word test, (3) the Trailmaking test, (4) the Letter Cancellation Task, (5) the digit symbol substitution test. Salivary cortisol, EEG and inventories are also used.

Author (year)	Method	Results	Comments
Barry S. Oken et al(2006)[108]	135 subjects were randomized into *Haṭa Yogā* class, walking exercise class, or wait-list control. Outcome assessments were performed at baseline and after the 6-month period and included a battery of cognitive measures on the Stroop Test and a quantitative electroencephalogram (EEC) measure of alertness; SF-36 health-related quality of life; Profile of Mood States; Multi- Dimensional Fatigue Inventory; and physical measures related to the interventions.	There were no effects from either *Yogā* or exercise group on any of the cognitive and alertness outcome measures.	This study is a randomized controlled study with a large sample size and long intervention period (6 months, once a week class). However its results may not be culturally valid for the Indian population
Jennifer A. et al (2006)[109]	15 adults (Mean age-71.3 years, mean education level -17.9 years) randomly assigned to a Relaxation response (RR) training or control groups. RR training group received 5 week programme of relaxation response training. Assessment done using simple attention/psychomotor task, complex tasks of attention, verbal, or visual declarative memory tests, Self-reported state anxiety levels, salivary cortisol levels assessed	Reaction time on simple attention/psychomotor task improved with RR training, whereas there was no improvement on complex tasks of attention, verbal, or visual declarative memory. State anxiety levels showed marginally significant reduction. Performance on simple attention task improved.	Though this is a controlled study, it a non-Indian study. Hence the generalizability of the results to Indian population in limited. Further the sample size is low. Follow-up may have been useful to see the effect of long term practice and also the sustainability of results.

Prakash R et al (2012)[110]	Cross-sectional study comparing the cognitive performance of 20 meditators (long-term practitioners of Vihangam *Yogā* meditation) and 20 non-meditators in the geriatric age group. Six paper-pencil neuropsychological tests to assess short-term memory, perceptual speed, attention, and executive functioning, included (1) the Digit Span test, (2) the Stroop Color Word test, (3) the Trailmaking test, (4) the Letter Cancellation Task, (5) the digit symbol substitution test, and (6) the Rule Shift Card Test.	Vihangam *Yogī* s performed better on all the tests of attention except for the digit backward test.	This is a controlled, culturally valid study which has used assessment standardized measures. However due to the low sample size the results of the study may not be generalizable to the population.

Table 2.1: Intervention studies on *Yogā* and cognition in elderly (Indian and Non-Indian)

2.5 STUDIES CONDUCTED IN SVYASA

- Kadambini et al., (2005) studied 60 subjects aged 10-12yrs were selected for the study, subjects were randomly divided into physical activity and *Yogā* group. Assessment was done before and after 9 days of practice of physical exercise and *Yogā* respectively. Tower of London test was used for assessment. The subjects were assessed based on planning time, execution time and number of moves. *Yogā* group showed improvement in planning execution and number of moves, in simple as well as complex tasks where as physical activity group showed improvement in planning, execution and number of moves in simple tasks and no improvement in complex tasks[111].

- Ravanth et al. (2010) studied 138 students in the age range of 12-15yrs were selected for the study. Assessment was done immediately before and after 10 mins. of experimental (*Bhramari prāṇāyāma*) and control sessions using SLCT. Net scores increased and errors reduced significantly after the practice[112].

- Naorem et al.(2009) studied 79 young adults were selected and divided into *bhastrika* and control group. Wechsler's memory scale subtests- memory for digits and memory for letters was used for assessment. Personality was assessed using Eysenck's Personality inventory. *Bhastrika* group was given 10 mins of *bhastrika prāṇāyāma* session every day for 21 days. Immediate memory was seen to improve in *Bhastrika* group[113].

- Dr Majunath (2005) studied 59 elderly subjects were selected for the study, and randomized into *Yogā*, *Āyurvedā* and wait list control group. Assessments were done pre, after 3 and 6 months. Assessments were of 3 categories i) Measures of general health ii) Neurological and iii) Psychological status. *Yogā* group received IAYT for sixty minutes, six days a week. *Āyurvedā* group received preparation called Rasayana 10 grams per day. At the end of three months *Yogā* group showed improvement in semantic, primary, and working short term memory and at the end of six months improvement was seen in semantic primary, and working short term memory and episodic memory[114].

The above review shows that there are very few studies that have looked at the effect of *Yogā* on cognition in the elderly subjects. Further no study has looked at the effect of *Trāṭaka*, on cognitive function of the elderly (even though literature shows that *trāṭaka* is an effective intervention for improving cognition). Therefore, we designed a study to test the effect of *Trāṭaka* (a *yogī*c cleansing technique) on cognitive functions in the elderly. We have described the methodology that we have used to conduct the study in the next chapter (Chapter 3) – Methodology section.

CHAPTER 3

METHODOLOGY

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. We shall now look at the methodology that we have employed in the current study.

3.1 AIM OF THE RESEARCH:

To study the effect of *trāṭaka* on cognitive functions in the elderly

3.2 OBJECTIVES OF THE RESEARCH:

3.2.1. To study the effect of *trāṭaka* on attention and concentration (Six letter cancellation test)
in the elderly

3.2.2. To study the effect of *trāṭaka* on working memory (Digit span forward and backward) in the elderly

3.2.3. To study the effect of *trāṭaka* on Executive functions (Trail making test: B) in the elderly

3.3 SAMPLE

27 patients in each group was required to detect a clinically significant difference equivalent to an effect size of 0.75 (Cohen's d) in total memory score between the groups. A sample of 27 had 80% power to detect this difference with an alpha of 0.05 for a between-groups analysis. To account for a dropout of about 10%, a sample of 30 patients in each group was decided. In this manner, a total of 60 healthy elderly sample were recruited for the study using purposive sampling. The researcher approached all old age homes in Goa. Those old age homes which provided consent were included in the study. All the elderly in the old-age home who fulfilled the inclusion and exclusion criteria were selected to participate in the study. The researcher followed this procedure of recruitment till a sample size of 60 was reached. Only after all 60 participants were recruited into the study, were the old age homes randomized into different treatment groups.

3.4 INFORMED CONSENT

Written informed consent was taken from all 60 subjects.

3.5 INCLUSION CRITERIA

- Healthy subjects
- Age between-60-80 yrs.
- Education: 5thstd and above
- Willing to participate by giving a written informed consent.
- Those knowing Konkani, Hindi, English, Marathi.

3.6 EXCLUSION CRITERIA

- Those having neurological and psychiatric disorders (based on case history)
- Those who have practiced *Yogā* for the last 3 months.
- Those who have major eyesight problems (in vision)

3.7 SOURCE OF SUBJECTS:

Subjects were obtained from Old age homes in Goa and from individuals staying in and around Ponda and Margao areas in Goa.

3.8 DESIGN OF THE STUDY

Randomized block design was used for the study. Subjects were divided into 4 blocks (2 old age homes comprising of one block each and two blocks of individual elderly participants from Ponda and Margao area of Goa), a sample of approximately 15 subjects comprised of one block. The lottery method of manual randomization was conducted due to the small number of blocks (N = 4). 2 blocks were randomized into *trāṭaka* group (intervention group) and two blocks were randomized into wait-list control group.

For the convenience of conducting the intervention, each group had not more than 10 members.

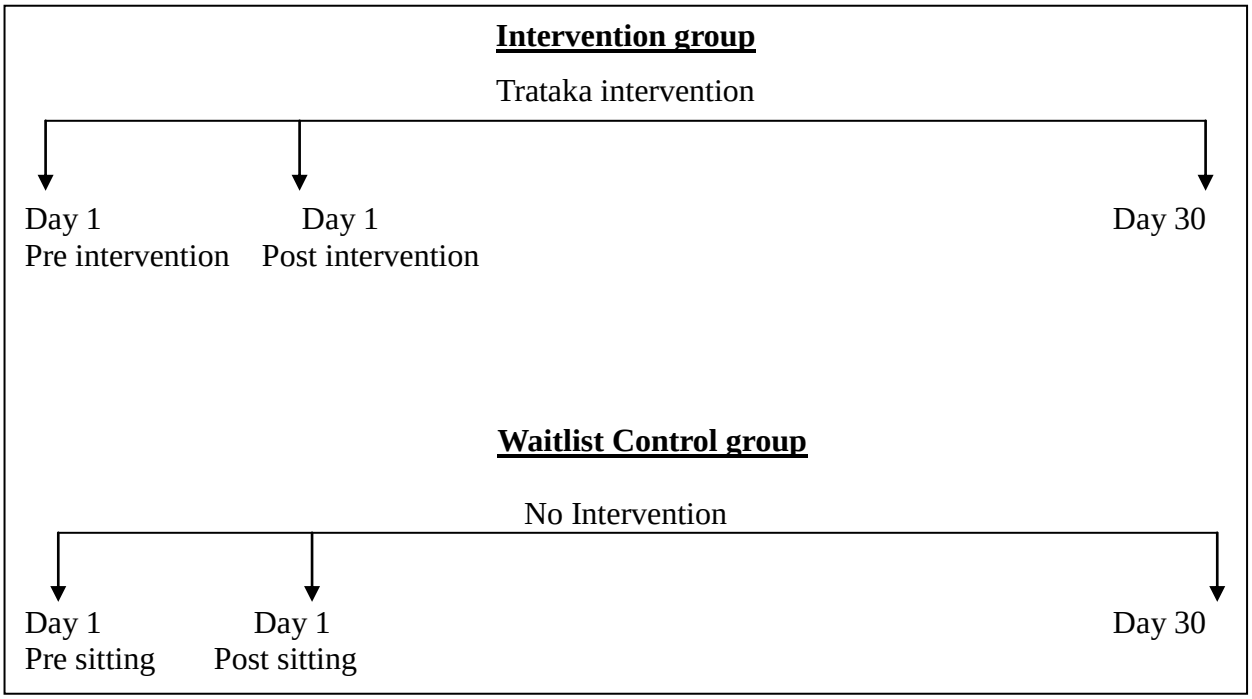

Figure 3.1 – Assessment timelines for intervention and control group

3.9 VARIABLES STUDIED

For the intervention group, assessments were conducted on Day 1 before intervention, immediately after *trāṭaka* intervention on Day 1, and after 27 days of *trāṭaka* intervention (on 30th day). In the wait-list control group, data was taken on Day 1 before the quite sitting and after 30 mins of quite sitting and on 30th day. The variables used in this study were:

- Working memory (Digit span forward and backward Test, Wechsler, 1997)
- Attention and concentration (Six letter cancellation test[115])
- Executive functions (Trail making test B[116])

Six letter cancellation test and Trail making test B were transliterated into Marathi for the ease of application of the tests to the local population in Goa. A detailed explanation of the tests used to study each of these variables is given below:

1. **Digit span forward and backward:** Digit Span (DS) is a subtest in Wechsler Adult Intelligence Scale-third edition (WAIS-III)[117]. Digit Span, which has two subsections (DS-F and DS-B), evaluates short-term memory and working memory. DS-F measures

short-term memory simply by requiring participants to repeat numbers. DS-B measures working memory by requiring participants to memorize numbers and to repeat the numbers in inverse order. For DS-F, participants repeat numbers in the same order as they were read aloud by the examiner. For DS-B, participants repeat numbers in the reverse order of that presented aloud by the examiner. In both, the examiner reads a series of number sequences which the examinee must repeat in either forward or reverse order. DS-F has 16 sequences. DS-B has 14 sequences. The primary measures of this test are raw scores that reflect the number of correctly repeated sequences until the discontinue criterion (that is, failure to reproduce two sequences of equal length) is met. The maximum raw score of DS-F is 16. The maximum raw score of DS-B is 14.

2. **Six-letter cancellation test (SLCT)**: for adults is a paper-and pencil test that uses a letter cancellation task that measures cognitive functions such as selective and focused attention, concentration, visual scanning as well as activation and inhibition of rapid responses. For others, they are measures of efficiency and speed of visual scanning[118], or selective attention[119 120] For yet others, they are administered primarily to assess potential hemispatial inattention and visual neglect, [121,122] or motor perseverative behaviour[123]. However, they have also been utilized in neuropsychological test batteries for the assessment of the effectiveness of treatment for adult patients with anorexia nervosa and bulimia nervosa[124], and for the assessment of illiterate individuals to determine if education affected performance in a neuropsychological battery[125]. They have also been employed to assess cognitive impairments in alcoholic cirrhotic patients[126], and to evaluate target detection deficits in patients who have undergone frontal lobectomy surgery[127]. It consists of a test worksheet that specifies six target letters to be cancelled and has a 'working section', which consists of letters of the alphabet, arranged randomly in 22 rows and 14 columns. The participants are asked to cancel as many of the six target letters as possible in a specified time of 90 seconds[128]. The total number of cancellations and wrong cancellations are scored, and the net scores are calculated by deducting wrong cancellations from the total attempt. This test has been evaluated for its reliability and validity based on standard criteria. Reliability has been ascertained based on (a) temporal stability and (b) internal consistency[129]. The content validity of this test is adequate for

the purpose for which it is intended[130]. The normal value for healthy Indian adults for SLCT is 38 ± 6.

3. **The Trail Making Test (TMT**) is one of the most popular neuropsychological tests and is included in most test batteries. It is a measure of visual scanning, complex attention, psychomotor speed mental flexibility, and executive functions. The TMT is an adaptation of John E. Partington's Test of Distributed Attribution, which was originally developed in 1938 to assess intellectual function. It was later renamed Partington's Pathways Test and was used to examine the effects of opiate use on brain function. Subsequently it was incorporated into the Army Individual Test Battery (1944) where it received its current name. It was incorporated into the Halstead–Reitan Battery [131].TMT-B requires an individual to draw lines sequentially connecting encircled numbers and letters distributed on a sheet of paper. The person must alternate between numbers and letters (e.g., 1, A, 2, B, 3, C, etc.). The score represents the amount of time required to complete the task. The TMT is sensitive to a variety of neurological impairments and[132],[133].TMT-B reflects primarily working memory and secondarily task-switching ability[134].

3.10 OPERATIONAL DEFINITIONS

- *Trāṭaka*: *Trāṭaka* means to gaze steadily. It is one of the *ṣaṭakarma*s (cleansing process) described in *Haṭa Yogā pradipikā* and *GherandaSamhita*.
- Cognitive functions: Working memory, attention and concentration and executive memory, as tested using the assessment scales in this study
- Elderly: Participants between age 60 to 80 years from Goa city were considered as elderly in this study

3.11 PROCEDURE

Subjects were recruited for the study, if they fitted the inclusion-exclusion criteria. Subjects were grouped based on the old age home/ area they stayed in and the complete group was randomized as a whole by the guide of the researcher into any of the 2 interventions (*Trāṭaka* or control). Pre data was taken of all the subjects. For the intervention group, *Trāṭaka* was given every day 30 mins for 1 month, and the data was taken on Day

1 (pre and post intervention) and on Day 27 of the intervention (end of the month, excluding Sundays). The wait list control group was not given any intervention but data was taken before and after 30 mins of quite sitting on Day 1 and on 30th day. As the intervention was provided to a group of maximum 10 participants: two groups were provided the intervention in the morning and another two groups were provided the intervention in the evening/ late afternoon.

Some of the subjects experienced eye irritation within 2 days of practice. On expert's advice, chanting was included, focusing time was reduced and defocusing time was increased to twice of that of focusing time. Timing of focusing and defocusing was also increased gradually over the days, till they reached same ratio (i.e. 1:1, Focusing: Defocusing). Concept of *dhyana* was introduced and subjects were asked to feel the expansion at the time of palming.

3.12 INTERVENTION

The procedure used for *Trāṭaka* session was adapted from the book '*Yogā* for promotion of positive health'[135].

Procedure:

1. Starting Prayer:

ॐ सह नाववतु। सह नौ भुनक्तु।

स ह वीर्यं करवावहै। तेजस्वि नावधीतमस्तु मा विद्विषावहै।

ॐ शान्तिः शान्तिः शान्तिः॥

om saha nāvavatu | saha nau bhunaktu |
sa ha vīryaṁ karavāvahai | tejasvi nāvadhītamastu mā vidviṣāvahai |
om śāntiaḥ śāntiaḥ śāntiaḥ ||

Meaning: May he protect us both (i.e. Teacher and student). May he nourish us both. May we both work together with great energy. May our study be enlightening and fruitful. May we not hate each other. Om Peace, Peace, Peace.

2. Preparatory eye exercises: *Trāṭaka* has many steps to be followed. First are the preparatory eye exercises. For this, the first step is the up and down or vertical movement

of the eyes. In all the practices one has to open the eyes and move the eyeballs gently. It has to be smooth and continuous without any jerky movement. This has to be repeated for ten rounds. After this practice, to relax the eyes, simple palming is instructed (that is, rub the palms and then make a cup of it and cover the eyeballs). The second step is right and left or horizontal movements of eyeballs. Here, after opening the eyes one has to move the eyeballs to left and right. Again this also has to be repeated for ten rounds. Here too simple palming is provided at the end of the exercise. The next step is diagonal movement of the eyeballs. Here the eye balls have to be moved to the extreme right up and extreme left down for ten rounds. Subsequently press and release palming is provided (as one inhales press the palms around the eyes and as one exhale release the pressure). It has to be continued for 5 rounds. Fourth practice is diagonal movement in the opposite direction. The relaxation is conducted using the same press and release palming exercise as before. Next step is the rotational movement of the eyeballs that is clockwise and anti-clockwise. Here after the practice for relaxation the constant pressure palming is provided (press constantly around the eyeballs with the palms with inhalation and release with exhalation).

3. ***Jyoti Trāṭaka*****:** After the preparatory exercises, the next practice is *jyoti trāṭaka*, and it has three steps. The first is focusing, that is effortless gazing or focusing at a flame. One has to look at it for 30 seconds. At the end of the practice for relaxing the eyes, press and release palming is provided. Next step is intensive focusing at the tip of the wick of the flame. Here constant pressure palming is provided at the end of this step. The next step is de-focusing. The procedure includes first looking at the flame, then slowly widening the vision and defocusing the gaze on the flame with expansive awareness and collecting the details of the flame. After one minute again focusing on the flame followed by slowly closing the eyes and visualizing the flame between the eyebrows, collecting all the details with eyes closed is instructed. When the image disappears, palming with chanting of *Bhrāmari* is instructed. The last step is silence. The participants are instructed to feel the silence and relax for a while. After sufficient relaxation, they are asked to gently drop down their hand, sit quietly for some time and feel the deep comforting effect of the practice. They are asked to be aware of the changes taking place inside, recognize that the

mind has become completely calm and that the concentration, willpower and sharpness of eyesight have improved.

4. Closing prayer:

ॐ सर्वे भवन्तु सुखिनः सर्वे सन्तु निरामयाः।

सर्वे भद्राणि पश्यन्तु मा कश्चित् दुःखभाग् भवेत्॥

om sarve bhavantu sukhinaḥ sarve santu nirāmayāḥ |

sarve bhadrāṇi paśyantu mā kaścit duaḥkhabhāg bhavet ||

Meaning: Let all be happy, free from diseases. Let all align with reality, let no-one suffer from miseries. Om peace peace peace.

Table 3.1: Details of *Trāṭaka* practice

S.NO	NAME OF THE PRACTICE	DURATION
1	**Starting Prayer**	**1 min**
2	**Preparatory eye exercises**	**9 mins**
	Up and down or vertical movements-10 rounds	30 secs
	Simple palming	1 min
	Right and left or horizontal movements-10 rounds	30 secs
	Simple palming	1 min
	Diagonal movements -Right up-left down-10 rounds	30 secs
	Press and release palming	1 min
	Diagonal movements -Left up-right down-10 rounds	30 secs
	Press and release palming	1 min
	Rotational movements-clockwise-10 rounds	30 secs
	Constant pressure palming	1 min
	Rotational movements-Anticlockwise-10 rounds	30 secs
	Constant pressure palming	1 min
3	**Jyoti *trāṭaka***	
	Effortless gazing or Focusing	**4 mins**

	'A'kara chanting	**1 min**
	Intensive focusing	**4 mins**
	'U'kara chanting	**1 min**
	BREAK	**1 min**
	De-focussing	**4 mins**
	Bhramari	**1 min**
	Silence	**4 mins**
4	**Closing prayer**	**1 min**

3.13 TREATMENT FIDELITY

The *Trāṭaka* was practiced in a group and was provided by a trained *Yogā* instructor. The *Yogā* instructor monitored the attendance of the subjects for the sessions, noted the accuracy with which they were able to do the practices as instructed and their overall involvement.

3.14 ETHICAL CONSIDERATIONS

The research work was carried out in a free and fair environment. The study was free from plagiarism and data collection and analysis was done with present data collected without any fabrication. The entire study was carried out by one person and no untrained research assistants were involved in the study. The rule and regulations laid down by the university were strictly followed and publication of only the data collected was brought forth. The whole work was carried out under the guidance of law abiding and ethically bond experts in the field of research. At most care has been taken to protect the human rights of human subjects. The informed consent of the subjects was taken and confidentiality of the information collected from them was maintained.

CHAPTER 4:

RESULTS

Results are an outcome of the research conducted by performing various experiments and tests on the data collected - using the designed methodology, representing the facts and figures with relevant tables and diagrams.

The aim of the study was to examine whether *Trāṭaka* practice has any effect on cognitive functions in the elderly. A block randomized controlled design was used to compare the effectiveness of *Trāṭaka* as compared to the wait list control group. For this purpose, 60 subjects who agreed to participate in the study were randomized into two groups: *Yogā* (N = 34), wait list control (N = 26).

A total of 136 subjects were screened for the study. Out of this sample, 76 subjects were excluded because a) they were disabled (n = 57); declined to participate in the study (n = 15) or d) they did not meet the inclusion criteria (n = 4). The remaining 60 subjects were randomized using block randomization (2 old age homes comprising of one block each and two blocks of individual elderly participants from Ponda and Margao areas of Goa) into two groups: a) *Trāṭaka* intervention (n = 34) and b) wait-list control group (n = 26). After randomization, 5 of the subjects dropped out. 55 subjects completed the 1st follow up on Day 1 (pre and post intervention). However, only 48 subjects completed the 2nd follow up, which was conducted at the end of 1 month (*Trāṭaka* group n = 26, Wait list control n=22). A diagrammatic representation of this CONSORT[136] has been provided in Figure 1.

We shall now analyze the results of the study under the following sections: 4.1) Demographic details; 4.2) Baseline comparison of characteristics of completers and non-completers; 4.3) Tests of normality; 4.4) Outcome variables at baseline, 4.5) Outcome variables at 1st, and 2nd follow-up, 4.6) Time effect on outcome variables: paired sample t-test , 4.7) Outcome variables over the period of 1 month of the study (RMANOVA – group x time effect) , 4.8) Sub group analysis.

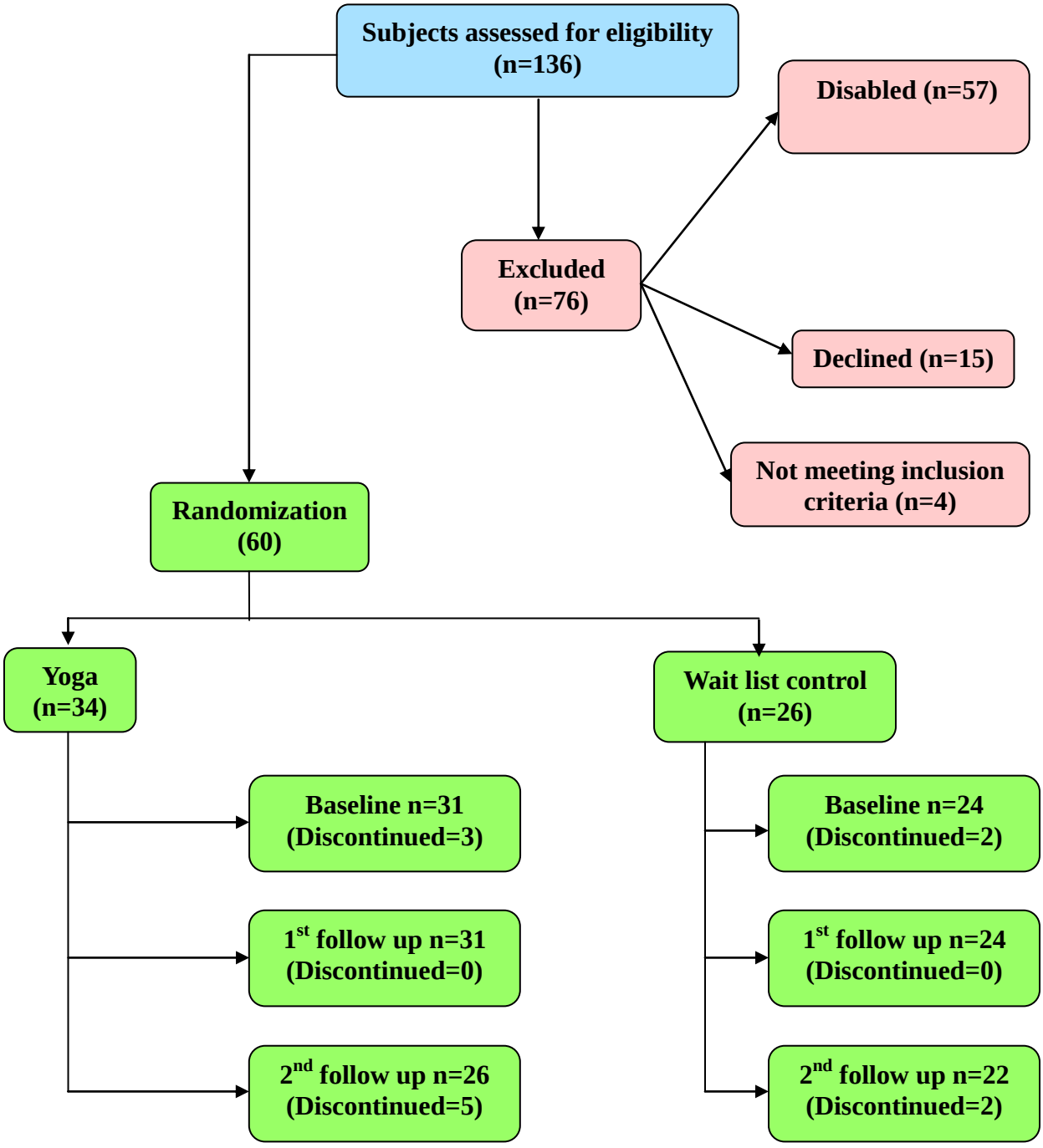

Figure 4.1: The CONSORT (Consolidated Standards of Reporting Trials, Altman et al., 2001) diagram of flow of participants through each stage of the randomized trial.

4.1 DEMOGRAPHIC DETAILS:

Table 1 shows the socio-demographic details of the subjects in the two groups at baseline (N = 60). To analyze the baseline characteristics of the subjects, independent sample t test was used for all continuous variables and 'chi-square test' was used for all categorical variables.

Table 4.1: Age and Education of subjects (n = 55)

Variable	*Trāṭaka* (n = 31)	Wait-list control (n = 24)	t-value	p-value
	Mean (SD)	Mean (SD)		
Age (years)	67.7 (7.4)	71.2 (6.6)	-1.83	0.07
Educational status(years)	11.8 (3.6)	11.6 (3.8)	0.15	0.88

Table 4.1 depicts, the mean age (SD) for *Trāṭaka* group was 67.7 (7.4) and for the wait list control group was 71.2 (6.6) years. With respect to education, the mean years of education (SD) was similar in both groups [*Trāṭaka*: 11.8 (3.6) years; wait-list control: 11.6 (3.8)]. The independent t test values and p values showed that there was no significant difference between the two groups in education (p = 0.88). There was a trend of wait-list control group subjects being older than the subjects of *trāṭaka* group (p=0.07).

Table 4.2: Gender of the subjects (n=55)

Variable		*Trāṭaka* (n=31)	Wait-list control (n=24)	Chi-Square	p-value
		n (%)	n (%)		
Gender	Male	8 (25.8)	9 (37.5)	0.87	0.35
	Female	23 (74.2)	15 (62.5)		

Table 4.2 shows the gender distribution of subjects in the two groups. Majority of the subjects in the *Trāṭaka* and waist-list control group were females (74.2% in *Trāṭaka* group and 62.5% in wait-list control group). The chi-square value depicts that there is no significant difference in gender distribution in the two groups.

4.2 BASELINE COMPARISON OF CHARACTERISTICS OF COMPLETERS AND NON-COMPLETERS:

The next table will depict the baseline characteristics of the subjects who completed as against those who did not complete the study. As mentioned in the earlier paragraphs, the total number of subjects who completed the intervention and the follow-ups assessments were considered as 'completers' (n = 48) and those who either did not complete all the sessions of the intervention or dropped out at the follow-up phase were considered 'non-completers' (N = 7). To compare the baseline characteristics of completers and non-completers, t test was used for all continuous variables and chi-square test was used for all categorical variables.

Table 4.3: Demographic details of completers and non-completers

Variables		Completers (n=48)	Non-completers (n=7)	t-test / Chi-sq*	p-value
		Mean (SD)/n (%)	Mean (SD)/ n (%)		
Age in years		69.0 (7.4)	70.7 (5.8)	-0.58	0.57
Education in years		12.0 (3.7)	10.0 (3.4)	1.33	0.18
Gender*	**Male**	17 (35.4)	0 (0.0)	3.59	0.06
	Female	31 (64.6)	7 (100)		

Table 4.3 depicts the baseline characteristics of subjects who completed/ did not complete the study. It can be observed that there is no significant difference in mean age and education between those who completed the study and those who did not. However all the participants who were non-completers were females ($X^2 = 3.59$, $p = 0.06$).

4.3 TESTS OF NORMALITY

Table 4 shows the group-wise normality values. Data at baseline for subjects were assessed for normal distribution using Shapiro Wilk test.

Table 4.4: Tests of normality-Shapiro-wilk

		STATISTIC	Df	Sig
Digit span test	*Trāṭaka*	.845	31	0.00
	Control	.972	24	0.72
TMT B	*Trāṭaka*	.931	31	0.05
	Control	.929	24	0.09
SLCT	*Trāṭaka*	.957	31	0.24
	Control	.946	24	0.22

The baseline values for Trail Making Test – Part B (TMT B) and six letter cancellation test (SLCT) for both groups are normally distributed ($p > 0.05$). However the baseline values for digit span test for the *trāṭaka* group was not normally distributed ($p<0.00$). The Shapiro-wilk value for digit span, control group was normally distributed.

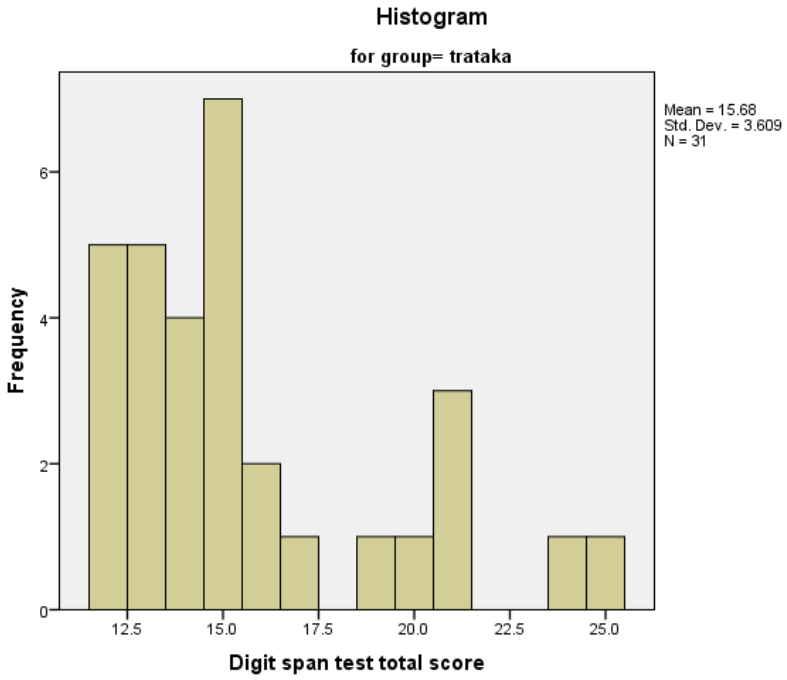

Figure 4.2: Histogram of baseline Digit span test scores-*Trāṭaka* group

A look at figure 4.2 shows that the digit span test scores for the *trāṭaka* group is not normally distributed across the sample. A further look at the graph also shows that there are

no outliers in the data; however the data has distinct two peaks at the higher and lower range of scores. If we had divided the digit span scores using the median values into two groups, we could have possibly got two independent normal distributions. However as we did not have any rationale for dividing the group based on the median values, we have not conducted this analysis.

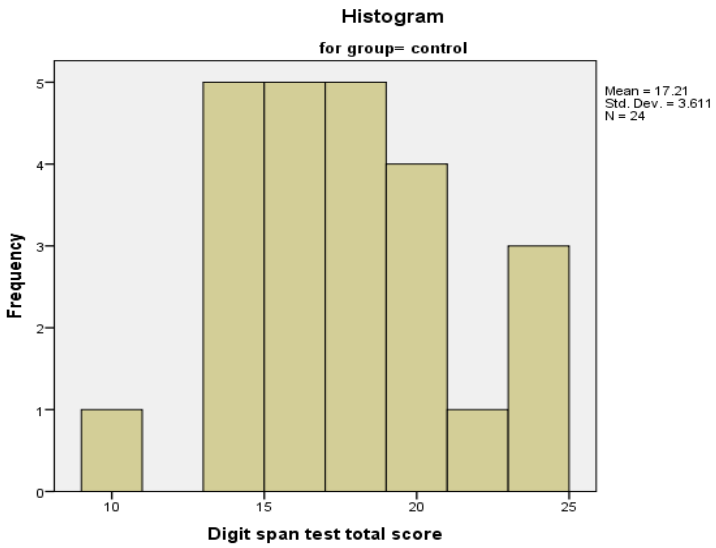

Figure 4.3: Histogram of baseline Digit span test scores-Control group

Figure 3 (histogram) shows that the digit span test scores for the control group is normally distributed across the sample.

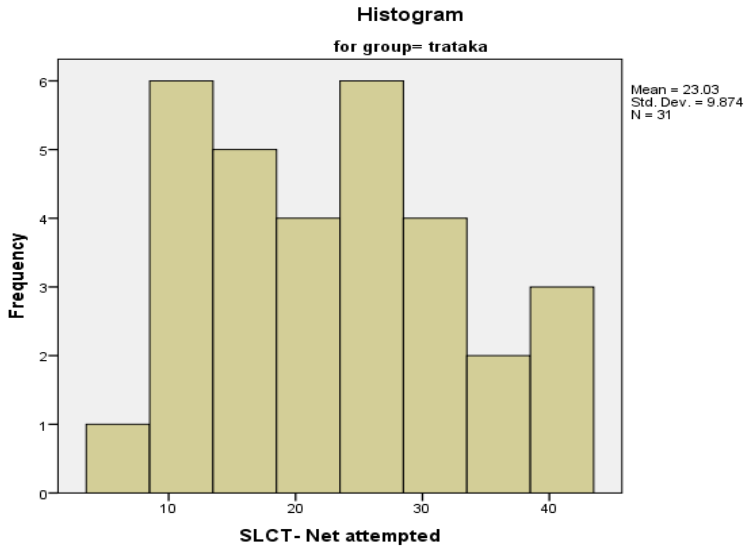

Figure 4.4: Histogram of baseline SLCT scores-*Trāṭaka* group

Figure 4 (histogram) shows that the SLCT test scores for the *trāṭaka* group is normally distributed across the sample.

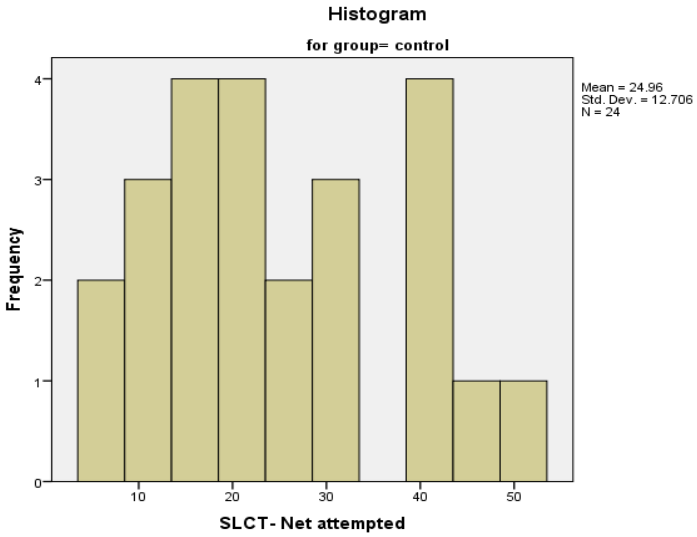

Figure 4.5: Histogram of baseline SLCT scores-Control group

Figure 4 (histogram) shows that the SLCT test scores for the control group is normally distributed across the sample.

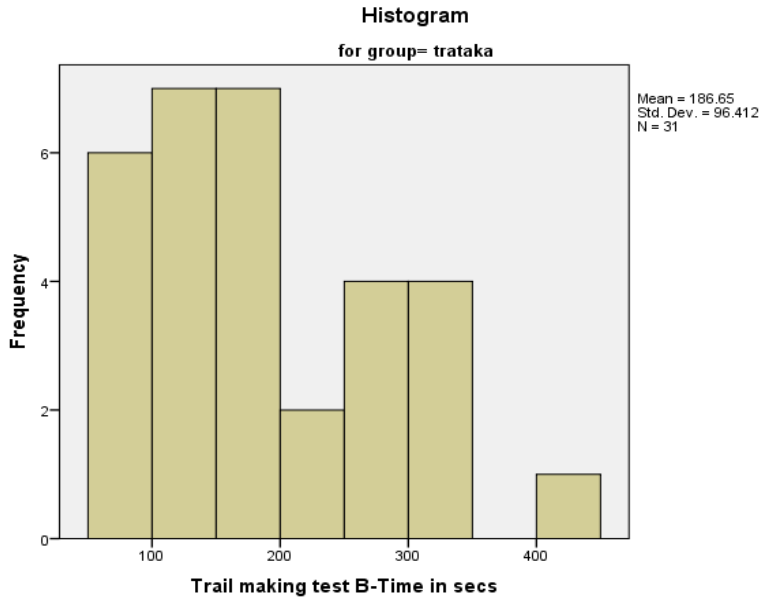

Figure 4.6: Histogram of baseline TMT B scores-*Trāṭaka* group

Figure 4 (histogram) shows that the TMT test scores for the *trāṭaka* group is normally distributed across the sample.

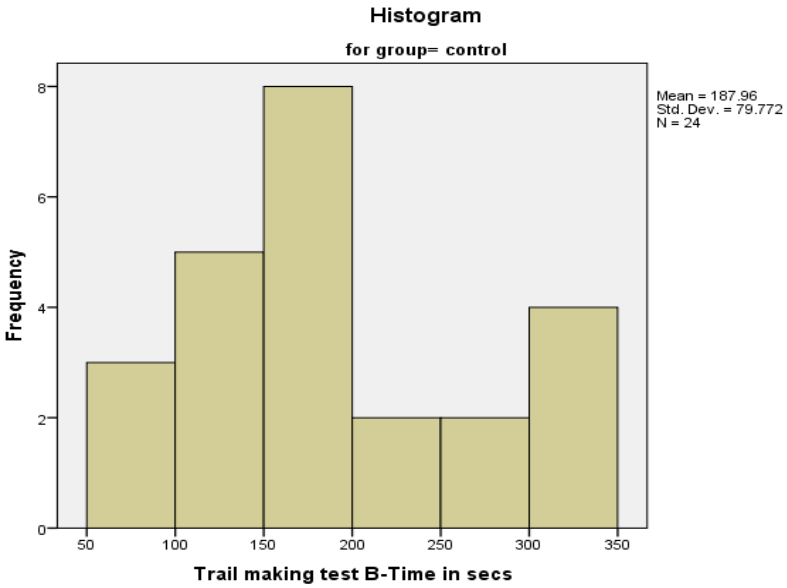

Figure 4.7: Histogram of baseline SLCT scores-Control group

Figure 4 (histogram) shows that the TMT test scores for the control group is normally distributed across the sample.

Based on the above normality test values, parametric tests such as independent sample t test, paired sample t test and RMANOVA was used to analyze TMT –B and SLCT test scores and non-parametric tests such as Mann –Whitney, Wilcoxon Sign Rank test and Friedman's test was used to analyze the digit span test scores.

4.4 OUTCOME VARIABLES AT BASELINE:

Tables 4.4-4.7 will give a preview into the baseline scores of the outcome variables used in this study (Digit span test, Trail making test B, SLCT). To analyze the baseline outcome variables between 2 groups for TMT-B and SLCT test scores, Independent sample t-test was used. However as baseline scores of digit span test were found to be non-normal, non-parametric test of Mann Whitney was used to analyze the difference between groups at baseline.

Table 4.5: Mann Whitney test for digit span test-At Baseline

Variable	***Trāṭaka* (n=31)**	**Wait-list control (n=24)**	**Mann-Whitney**	**p value**
	Median(range)	**Median(range)**		
Digit span test	15(13)	17(14)	261.50	0.06

Table 4.5 depicts the baseline scores of digit span test. The Mann-whitney and p value show that there is a trend towards wait-list control group scoring more in digit span test.

Table 4.6: Independent sample t-test-At Baseline

Variable	***Trāṭaka* (n=31)**	**Wait-list control (n=24)**	**T**	**p value**
Trail making test B	186.65(96.41)	187.96(79.77)	-0.05	0.96
SLCT	23.03(9.87)	24.96(12.71)	-0.63	0.53

Table 4.6 shows baseline scores of Trail Making Test – B (TMT B) and Six Letter Cancellation Test (SLCT). It can be observed that there are no significant differences be-

tween the *trāṭaka* group and wait list control group at baseline for scores of TMT B(p=0.96) and SLCT (p=0.53).

4.5 OUTCOME VARIABLES AT 1st & 2nd FOLLOW UP:

Table 4.7 will give a preview into the outcome variables scores used in this study (Digit span test, Trail making test B, SLCT) at the 1st follow-up (immediately after Day 1 session) and at the 2nd follow-up (end of one month). To analyze the outcome variables between 2 groups for TMT-B and SLCT test scores, Independent sample t-test was used. However as baseline scores of digit span test were found to be non-normal, non-parametric test of Mann Whitney was used to analyze the difference between groups at 1st follow-up and 2nd follow-up.

Table 4.7: Digit span test scores at 1st f/up and 2nd f/up: Mann –Whitney Test

Variable	*Trāṭaka* (N=31)	Wait-list control (N=24)	Mann-Whitney	p-value
	Median(range)	Median (range)		
Digit span test – 1st follow-up	16(16)	15.5(14)	355.00	0.77
Digit span test – 2nd follow-up	17.5(15)	14.5(16)	196.50	0.06

Table 4.7 shows that there was no significant difference between *trāṭaka* and wait list control group in digit span test scores at the first follow up and at the 2nd follow-up. The 2nd follow-up p value shows that there is a trend towards significance (p = 0.06) and possibly with a larger sample size we could have observed a significant difference between the two groups at the 2nd follow-up.

Table 4.8: Trail Making Test (TMT –B) and Six Letter Cancellation Test (SLCT) test scores at 1st f/up and 2nd f/up: Independent sample t-test

Variable	*Trāṭaka* (N=31)	Wait-list control (N=24)	t value	p value
	Mean (SD)	Mean (SD)		
TMT-B: 1st follow-up	151.45(88.0)	191.70(91.98)	-1.63	0.11
TMT- B: 2nd follow-up	111.27(71.63)	151.76(80.67)	-1.8	0.08
SLCT: 1st follow-up	31.48(14.68)	29.33(14.61)	0.54	0.59
SLCT: 2nd follow-up	31.04(13.31)	26.23(13.53)	1.2	0.22

Table 4.8 depicts that there was no significant difference between *trāṭaka* and wait list control group in TMT-B and SLCT scores at the first follow up and at the 2nd follow-up. The 2nd follow-up p value shows that there is a trend towards significance (p = 0.08) in TMT-B scores and possibly with a larger sample size we could have observed a significant difference between the two groups at the 2nd follow-up.

4.6 TIME EFFECT ON OUTCOME VARIABLES: PAIRED SAMPLE T-TEST

To understand the time effect over the one month period of study (across baseline, 1st and 2nd follow-up) we conducted the Wilcoxon Sign Rank test for the Digit span test scores (as data was not normally distributed). However as the Wilcoxon Sign Rank test gives only pair wise comparisons we also conducted the Friedman's test to understand the time effect across the follow-ups over the one month study period for the Digit Span test scores. As data was normally distributed at baseline for the TMT-B and SLCT test scores, the paired sample t test was conducted to understand the time effect for these outcome variables.

Further due to multiple comparisons with baseline, Bonferroni correction was also conducted using the formula 0.05/n (where alpha = 0.05; n = 3, as there were 3 pair wise comparisons). Though Bonferroni correction is usually used with ANOVA, statistical experts have opined that in case of multiple baseline comparisons with t test, this method could be used to increase the power of the test used and to determine the significant re-

sults[20]. The Holm–Bonferroni method, a uniformly more powerful test procedure (i.e. more powerful regardless of the values of the unobservable parameters) was also considered as an effective alternative power test. However, as current methods for obtaining confidence intervals for the Holm-Bonferroni method do not guarantee confidence intervals that are contained within those obtained using the Bonferroni correction[21], the researcher has analyzed the data using only Bonferroni correction.

The following tables (Table 9 -16) show the time effects analysis which was done using Wilcoxon Sign Rank test/ Friedman's test/ Paired sample test.

Table 4.9: Friedman's Test – *Trāṭaka* group

	Baseline	**1st follow-up**	**2nd follow-up**		
Variable	**Median (Range)**	**Median (Range)**	**Median (Range)**	**Chi-sq**	**p value**
Digit span	15 (13)	16(16)	17.5(15)	15.44	0.000*

*Bonferroni adjusted p value = 0.016

Table 4.9 shows the time effect across follow-ups, using the Friedman's test for the digit span test for the *trāṭaka* group. Digit span test scores (used for assessment of memory) are hypothesized to increase with intervention at each follow-up. The table shows that there was increase in digit span scores with each follow up, and p value (0.000) suggests that there is a significant increase in the digit span test scores across time points in the *Trāṭaka* group.

Table 4.10: Wilcoxon Signed Ranks Test-*Trāṭaka* group

Variable	**Median (Range)**	**Median (Range)**	**Z**	**p value**
Digit span (Baseline – 1st follow-up)	15 (13)	16(16)	-1.91	0.06
Digit span (Baseline-2nd follow-up)	15 (13)	17.5(15)	-3.35	0.001*
Digit span (1st follow up-2nd follow up)	16(16)	17.5(15)	-3.17	0.002*

*Bonferroni adjusted p value = 0.016

Table 4.10 shows the pair wise time effect using the Wilcoxon signed ranks test for digit span test scores for the *trāṭaka* group (used for assessment of memory). There was no significant change in the digit span test scores from baseline to immediate effect (1st follow-up; p=0.06). But significant increase in digit span scores was seen from baseline to 2nd follow up (p = 0.001) and also from 1st follow up to 2nd follow up (p=0.002).

Table 4.11: Paired sample t test-TMT B for *Trāṭaka* group

Variable	Mean (SD)	Mean (SD)	T	p-value
TMT B (Baseline – 1st follow-up)	170.58(92.43)	151.45(88.0)	-4.26	0.00*
TMT B (Baseline-2nd follow-up)	170.58(92.43)	111.27(71.63)	7.09	0.00*
TMT B (1st follow up - 2nd follow up)	133.62(78.63)	111.27(71.63)	3.35	0.003*

*Bonferroni adjusted p value = 0.016

Table 4.11 shows the pre/post assessment done using paired t test for TMT B for the *trāṭaka* group (used for assessment of executive functions). The decrease in the mean difference (SD) values indicates that there has been a reduction in time taken to complete TMT B test. There is a significant reduction in TMT test scores from baseline to 1st follow up (p =0.00). The reduction in scores from baseline to 2nd follow (p =0.00) and from 1st follow up to 2nd follow up (p=0.003) is also significant.

Table 4.12: Paired sample t test-SLCT for *Trāṭaka* group

Variable	Mean (SD)	Mean (SD)	T	p-value
SLCT (Baseline – 1st follow-up)	23.88(10.07)	31.48(14.68)	5.08	0.00*
SLCT (Baseline-2nd follow-up)	23.88(10.07)	31.04(13.31)	-3.93	0.001*
SLCT (1st follow up-2nd follow up)	34.23 (13.71)	31.04(13.31)	2.21	0.037

*Bonferroni adjusted p value = 0.016

Table 4.12 shows the pre/post assessment done using paired t test for SLCT for the *trāṭaka* group (used for assessment of attention and concentration). The increase in the mean difference (SD) values indicates that there has been increase in the SLCT (attention and concentration) values. There was significant increase in the SLCT scores from baseline to 1st follow up (p < 0.02). The table also shows that there was significant increase in

the SLCT scores from baseline to 2nd follow up ($p < 0.02$), but the difference between 1st follow up and 2nd follow up was not significant ($p=0.03$).

Table 4.13: Friedman's test-control group

	Baseline	1st follow-up	2nd follow-up		
Variable	**Median (Range)**	**Median (Range)**	**Median (Range)**	**Chi-sq**	**p value**
Digit span	17(14)	15.5(14)	14.5(16)	1.3	0.52

*Bonferroni adjusted p value = 0.016

Table 4.13 shows the time effect across follow-ups, using the Friedman's test for the digit span test (for control group). Digit span test scores (used for assessment of memory) are hypothesized to increase with intervention at each follow-up. The table shows that there is a decrease in digit span scores with each follow up which is not significant ($p<0.52$).

Table 4.14: Wilcoxon Signed Ranks Test-Control group

Variable	Median (Range)	Median (Range)	Z	p value
Digit span (Baseline – 1st follow-up)	17(14)	15.5(14)	-0.57	0.57
Digit span (Baseline - 2nd follow-up)	17(14)	14.5(16)	-1.49	0.14
Digit span (1st follow up-2nd follow up)	15.5(14)	14.5(16)	-1.51	0.13

*Bonferroni adjusted p value = 0.016

Table 4.14 shows the pair wise time effect using the Wilcoxon signed ranks test for digit span test scores for the control group. Digit span test scores (used for assessment of memory) are hypothesized to increase with intervention at each follow-up. The decrease in the median (range) values indicates that there has been a reduction in the digit span scores. The table also shows that there was no significant changes in the digit span scores from baseline to 1st follow-up/2nd follow-up ($p>0.05$) or from 1st follow-up to 2nd follow-up.

Table 4.15: Paired sample t test-TMT B for Control group

Variable	Mean (SD)	Mean (SD)	T	p-value
TMT B (Baseline – 1st follow-up)	182.22(76.33)	191.70(91.98)	-1.10	0.28
TMT B (Baseline-2nd follow-up)	179.38(76.65)	151.76(80.67)	2.17	0.04
TMT B (1st follow up - 2nd follow up)	185.57(93.73)	151.76(80.67)	2.73	0.01*

*Bonferroni adjusted p value = 0.016

Table 4.15 shows the pre/post assessment done using paired t test for TMT B in the Control group. The increase in the mean difference (SD) values indicates that there has been increase in time taken to complete TMT B test. The difference between baseline to 1st follow up is not significant (p >0.05). However there was a trend towards decrease in the mean-time taken to complete TMT B test from baseline to 2nd follow up. But, significant difference is seen in scores from 1st follow up to 2nd follow up (p = 0.01).

Table 4.16: Paired sample t test-SLCT for Control group

Variable	Mean (SD)	Mean (SD)	T	p-value
SLCT (Baseline – 1st follow-up)	24.96(12.71)	29.33(14.61)	-2.18	0.04
SLCT (Baseline-2nd follow-up)	24.96(12.71)	26.23(13.53)	-0.52	0.61
SLCT (1st follow up-2nd follow up)	29.86(15.11)	26.23(13.53)	2.09	0.05

*Bonferroni adjusted p value = 0.016

Table 4.16 shows the pre/post assessment done using paired t test for SLCT in the Control group. The increase in the mean difference (SD) values indicates that there has been increase in the SLCT values. The table shows that there was a significant increase in the SLCT scores from baseline to 1st follow up (p = 0.04). There was no significant difference between baseline and 2nd follow up. However there was a trend towards decrease in the SLCT scores between 1st and 2nd follow up scores (p = 0.05).

4.7 OUTCOME VARIABLES OVER THE PERIOD OF 1 MONTH OF THE STUDY (RMANOVA – GROUP X TIME EFFECT):

To understand the group as well as time effect (interaction effect) over the one month period of study (across baseline, 1st and 2nd follow-up) we conducted the Repeated Measures ANOVA (RMANOVA) on the TMT B and SLCT scores (for data that was normally distributed)

Table 4.17: RMANOVA for TMT-B and SLCT scores

Variable		Baseline	1st follow up	2nd follow up	F	p-value
		Mean (SD)	Mean (SD)	Mean (SD)		
TMT B	*Trāṭaka*	170.58(92.43)	151.45(88.0)	111.27(71.63)	6.67	0.003*
	Control	187.96(79.77)	191.70(91.98)	151.76(80.67)		
SLCT	*Trāṭaka*	23.88(10.07)	31.48(14.68)	31.04(13.31)	3.11	0.05
	Control	24.96(12.71)	29.33(14.61)	26.23(13.53)		

*Bonferroni adjusted p value = 0.016

It can be observed from Table 4.17 that over time TMT B scores reduced significantly in *trāṭaka* group as compared to control group (p = 0.003). Similarly there was a trend towards (p = 0.05) better improvement of scores on SLCT in the *Trāṭaka* group as compared to the control group where scores in SLCT have reduced after the 2nd follow-up.

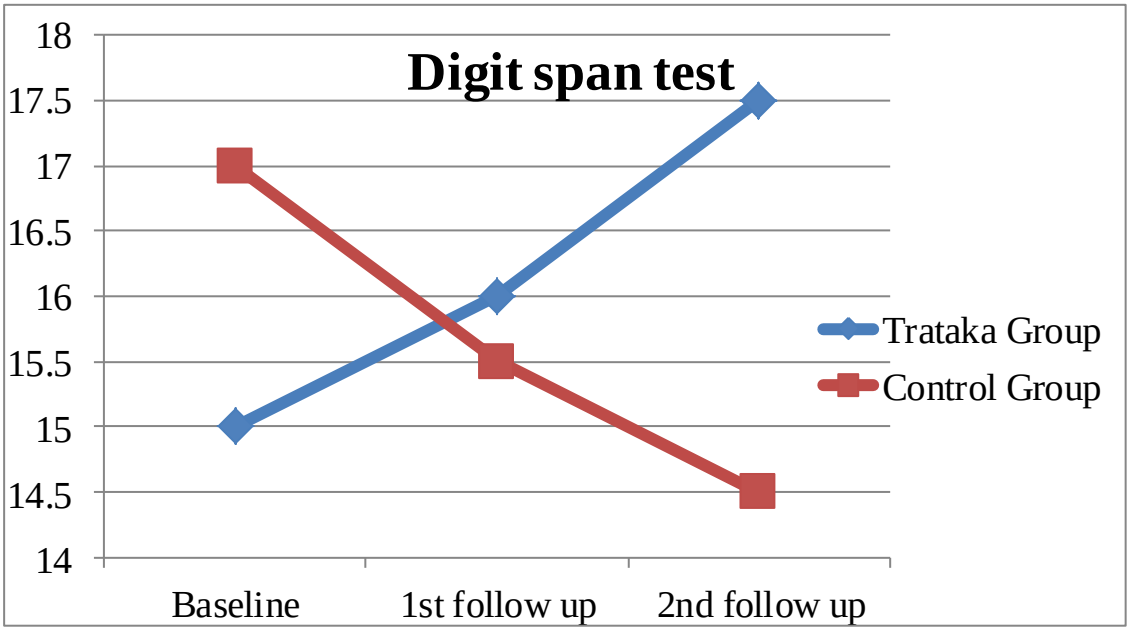

Figure 4.8: Changes in Digit span scores across timeline in *Trāṭaka* and wait list control group

Figure 4.8 shows the median score in Digit span test across timeline (baseline, 1st and 2nd follow-up) in *Trāṭaka* and waitlist group. It can be observed that the *trāṭaka* group has significantly improved in digit span test scores over the period of time (p = 0.000; Friedman's test in *Trāṭaka* group), whereas there was no significant improvements in scores in the control group overt the test period (p = 0.52; Friendman's test in control group)

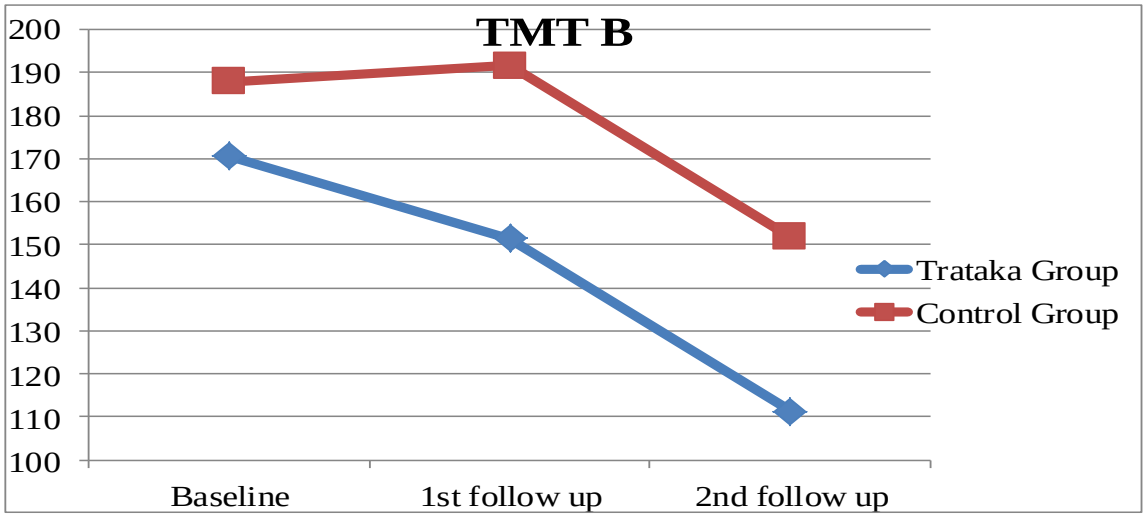

Figure 4.9: Changes in TMT B scores across timeline in *Trāṭaka* and wait list control group

Figure 4.9 shows that mean time taken to complete TMT B test decreased significantly in the *trāṭaka* group as compared to the control group (p = 0.003; RMANOVA).

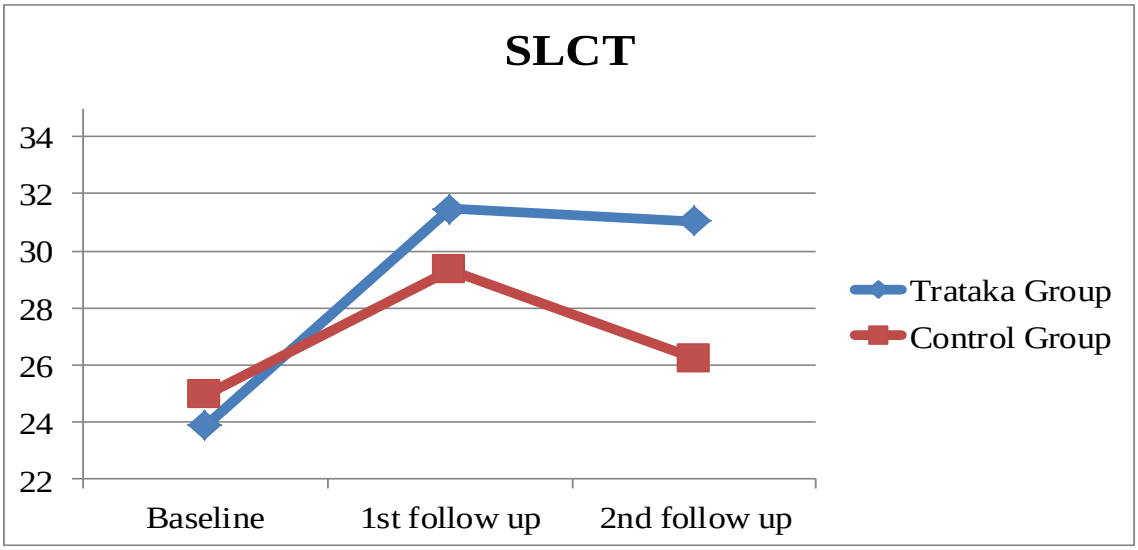

Figure 4.10: Changes in SLCT scores across timeline in *Trāṭaka* and wait list control group

Figure 4.10 shows that the mean SLCT scores increased in *Trāṭaka* group as well as control group and there was a trend towards better improvement in the *trāṭaka* group as compared to the control group (p = 0.05; RMANOVA).

4.8: **SUB GROUP ANALYSIS**:

Half of the subjects in the *Trāṭaka* group were given intervention in the morning and the other half received the intervention in the evening. To understand if there were any baseline differences in outcome variables of the two groups (morning and evening group) for TMT-B and SLCT test scores, Independent sample t-test was used. However as baseline scores of digit span test were not normal, non-parametric test of Mann Whitney was used to analyze the baseline differences between groups.

Table 4.18: Mann Whitney test for digit span test-Between Morning and Evening Group at Baseline

Variable	Morning group (n=16) Median(range)	Evening group (n=15) Median(range)	Mann-Whitney	P-value
Digit span test	15(13)	14(9)	119.50	0.98

Table 4.18 shows baseline scores of digit span test for the morning and evening group of *trāṭaka*. The table shows that there was no significant difference between morning and evening group in the baseline scores of digit span test.

Table 4.19: Independent sample t-test-Between Morning and Evening Group (at baseline)

Variable	Morning group (n=16)	Evening group (n=15)	T	P-value
Trail making test B	226.25(100.27)	144(73.77)	2.57	0.01*
SLCT	19.56(8.25)	26.73(10.37)	-2.14	0.04*

*p value < 0.05

Table 4.19 depicts the baseline scores of the morning and evening *Trāṭaka* group. There was significant difference in TMT B and SLCT scores between morning group and evening group, with the evening group performing significantly better on both tests than morning group (TMT: p=0.01; SLCT: p=0.04).

As there were significant difference at baseline for TMT-B and SLCT test scores between the morning and evening groups of *trāṭaka*, post-hoc test was conducted using RMANOVA -controlling for baseline.

Table 4.20: RMANOVA-for morning-evening groups

Variable		1st follow up	2nd follow up	F	P-value
TMT B	**Morning**	168.64(90.12)	142.79(83.26)	0.5	0.67#
	Evening	92.75(29.26)	74.50(27.05)		
SLCT	**Morning**	31.14(13.13)	26.00(10.79)	1.04	0.36#
	Evening	37.83(14.05)	36.92(13.97)		

 # After controlling for baseline differences

Table 4.20 shows that after controlling for baseline differences, there was no significant difference between the 2 groups (morning and evening group) in both TMT and SLCT test scores over the period of the study (TMT: p=0.67; SLCT: p=0.36).

Based on the above results of the study we shall now discuss the results in the next chapter of ‘Discussion.

CHAPTER 5

DISCUSSION

5.1. INTRODUCTION

Yogā is an art of living and a systematic process to reach the state of *moksha*, endowed with perfect silence, knowledge, power and bliss. While moving along the path of *Yogā*, one gets benefits such as good physical health, a peaceful mind, balanced emotions and in consequence harmonious relations with others and greater efficiency in actions. *Yogā* has various health benefits including ability to improve cognitive functions. Many scientific studies have proven that *Yogā* is effective to improve cognitive functions in neurological disorders, anxiety, depression, schizophrenia, chemotherapy related cognitive impairment, dementia, type 2 DM, multiple sclerosis and in climacteric syndrome[137],[138],[139],[140]. Effect of *Yogā* in improving cognitive functions of healthy subjects has also been studied.

It is a well-established fact that aging is associated with a gradual decline of cognitive functions. But the number of *Yogā* studies looking at the cognitive functions of the elderly is limited. *Trāṭaka* is one of the *Yogā* practices which are considered to improve cognitive functions. But its effect on cognitive functions has not been studied. As this study has not been conducted earlier, the aim of this study was to test the effect of *Trāṭaka* on cognitive functions of the elderly. Effect of *Trāṭaka* was studied as against Wait list control group, in improving attention, concentration, short term memory and executive functions. The following paragraphs will discuss the methodology and the results of the study separately.

5.2. DISCUSSION ON METHODOLOGY:

- **Sample:** The socio-demographic profile of the subjects who participated in the study was consistent with that of the earlier *Yogā* intervention study on elderly[141],[142] but not with that of the general population of India (Census of India, 2011). This could be because half of the sample came from old age homes. Quota sampling was done only in 2 old age homes and surrounding localities. Hence the generalization of this sample would be limited and the results of this study cannot be extrapolated to the community dwelling individuals.

Subjects of the intervention group received *Trāṭaka* practice for 6 days a week (30 mins duration) for 1 month. Only 7 did not complete the study or dropped out during the follow up. It is interesting to note that all the dropouts were females. This low attrition rate in the *Trāṭaka* group (n=5) and wait list control group (n=2) is the strength of the study. Low attrition could be attributed to the classes on the everyday basis as well as motivation on the part of researcher. There was no significant difference in age and education level of subjects who completed the study (completers) and who did not complete the study (non-completers).

- **Design:** Randomized block design (RBD) was used for the study. The study design was one of the main strengths of the study as it enabled the researcher to have a number of treatments and blocks. RBD's are known to provide more accurate results than the completely randomized design due to grouping. The variability within each block is less than the variability of the entire sample. Thus each estimate of the treatment effect within a block is observed to be more efficient than the estimates across the entire sample. Further, this design is relatively easier to conduct statistical analysis on, even with missing data, thus allowing calculation of unbiased error for specific treatments.

  As the groups were randomized based on the popular 'chit system', it avoided any bias recruitment. Further all the groups were simultaneously randomized and the randomization was revealed to the researcher by the guide who was not involved in the data collection process, only after the participants had been recruited in the study. This further reduced the possible bias in group allocation by the researcher.

- **Tools:** All the 3 tests to assess the cognitive functions of the elderly in this study were standardized. For example: The Digit Span (DS) which was used to evaluate short-term memory and working memory, is a subtest in Wechsler Adult Intelligence Scale-third edition (WAIS-III)[143]. The Six letter cancellation test (SLCT) which measures cognitive functions such as selective and focused attention, con-

centration, visual scanning as well as activation and inhibition of rapid responses has been employed to assess cognitive impairments in alcoholic cirrhotic patients[144], and to evaluate target detection deficits in patients who have undergone frontal lobectomy surgery[145]. This test has also been evaluated for its reliability and validity based on standard criteria and has standard norms for the Indian population. Trail making test (TMT-B) which is one of the most popular neuropsychological tests and is included in most test batteries, is a measure of visual scanning, complex attention, psychomotor speed mental flexibility, and executive functions. The TMT is sensitive to a variety of neurological impairments[146 147]. Also, normative data stratified by age and education for TMT B is available. Adequate test-retest reliability was found for both Part A and Part B of the TMT in the healthy control group (r=0.46 and 0.44 respectively), as calculated using Pearson correlation coefficients[148].

All the outcome variables were thus objective measures and there was no question of bias. Hence the method of rater blinding was not adopted in this study.

- **Intervention:** *Trāṭaka* practice involves various steps like preparatory eye exercises, focusing, defocusing, chanting and silence during relaxation. Each component or all of them together could have been responsible for the improvement in the cognitive functions. Preparatory eye exercises improve the stamina of the eye muscles and avoid eye strain. The degree of optical illusion is observed to reduce post a set of yoga practices that included *Trāṭaka* (involving both focusing and defocusing of the gaze and attention), and the researchers hypothesized that this could be due to improved cognitive jugemental factors and may not be due to retinal factors[149]. *Dharana* or focusing improves concentrative attention (‘‘*desha-bandhashchittasya dharanam*’’; Patanjali’s Yoga Sutras, Chapter III, Verse 1)[150]. Focused Attention (FA) is the attention which is restricted to a specific focus[151] such as the breath or the candle flame (*Trāṭaka*). Receptive attention is a kind of attention which is “objectless” and the goal is simply to keep attention fully “readied” in the present moment of experience without orienting, directing, or limiting it in any way.

Research studies have shown that Intense FA meditation effects cortical engagement, as reflected by a concomitant reduction in ERD (event related desynchronization) to target tones in the beta (13–30 Hz) frequency band. Reductions in beta ERD after practice of external tasks is due to the decreased cognitive efforts[152]. There is enhanced processing of task-related auditory inputs during FA meditation. FA meditation training is thought to improve one's ability to remain vigilant and monitor distractors without losing focus. It is proposed that these mental training-related effects might be produced by a reduction in cortical noise and/or by an enhancement of the rhythmic mode of attention.

The second stage of *Trāṭaka* , the phase of defocussing is akin to the stage of *dhyana* effortless attention (''*tatra pratyayaikatanata dhyana*m''; Patanjali's Yoga Sutras, Chapter III, Verse 2)[153]. When *dharana* becomes effortless, it takes the form of *dhyana*, which is defined as the uninterrupted spontaneous flow of the mind toward the chosen object. Vigilance and attention are not required during *dhyana*, which is the actual phase of meditation[154].Though there are different forms of meditation all of them lead to calm yet alert mind[155]. At a more advanced level of training in FA meditation which could be considered a state of *dhyana*, the regulative attention skills are invoked less frequently, and the ability to sustain focus thus becomes progressively "effortless"[156]. *Dhyana* is associated with reduced sympathetic activity and increased vagal tone[157]. The defocussed phase of *Trāṭaka* could be similar to the benefits of dhyana phase of meditation. Multiple studies show that meditation may affect multiple pathways that could play a role in brain aging and mental fitness[158]. For example, meditation may reduce stress-induced cortisol secretion and this could have neuroprotective effects potentially via elevating levels of brain derived neurotrophic factor (BDNF). Meditation processes are linked to GABAergic cortical inhibition, a mechanism implicated in improved cognitive performance and enhanced emotional regulation[159]. Further, meditation may potentially strengthen neuronal circuits and enhance cognitive reserve capacity. Brain regions associated with attention, interception and sensory processing are thicker in meditation practitioners including the prefrontal cortex and right anterior insula[160]. Advanced meditators have higher melatonin levels

(that blocks the build-up of beta-amyloid plaque -a hallmark feature of Alzheimer's disease)[161] than non-meditators[162].

Relaxation techniques have shown to reduce anxiety and improve memory[163] as well as attention[164,165]. It is already known that reduced anxiety can improve the performance on tasks requiring attention and memory[166]. So the improved performance could also be attributed to the reduced anxiety.

5.3. DISCUSSION ON RESULTS:

- **Normality:** The baseline values for Trail Making Test – Part B (TMT B) and six letter cancellation test (SLCT) for both groups were normally distributed. However the baseline values for digit span test for the *Trāṭaka* group was not normally distributed. There were no outliers in the data; however the data had distinct two peaks at the higher and lower range of scores. If we had divided the digit span scores using the median values into two groups, we could have possibly got two independent normal distributions. However as we did not have any rationale for dividing the group based on the median values, we have not conducted this analysis. The digit span test scores were analyzed using non-parametric test. A look at the normality data of digit spans scores which depicts the memory functions brings out an already known fact that post 60 years, almost 16.8 % of the elderly show poor memory functions whereas others have normal memory capacity[167].

- **Baseline:** There were no group differences at baseline in all three outcome variables. Both the groups were comparable at baseline, on all outcome variables. Hence the final outcome results could be categorical stated to be purely an effect of the intervention

- **Variables at the 1st & 2nd follow up(Group effect and Time effect):**

  - **Digit span test:**

    Digit Span (DS) is a subtest in Wechsler Adult Intelligence Scale-third edition (WAIS-III), which measures short term memory. There was no significant difference between *Trāṭaka* and wait list control group in digit span test scores at the first follow

up. When compared to wait list control group it could be observed that *Trāṭaka* scores were higher and a possible trend towards significance; a larger sample size could have elicited significant differences between the two groups at the 2nd follow-up (Table no-4.7).

When compared within group, digit span scores improved at the 1st follow up in *Trāṭaka* group, but the difference was not significant. At the 2nd follow up, there was significant improvement in digit span scores (table 4.10). While in control group, scores decreased at the 1st and the 2nd follow up, but there were no any significant changes (table 4.14).

The results suggest that long term practice of *Trāṭaka* and not just one day practice is required to improve short term memory. Similar study done on elderly subjects showed that, at the 3 month follow up, *Yogā* group improved in semantic memory, short term primary memory and short term working memory[168]. While, at the 6 months follow up, *Yogā* group improved in semantic, short term primary, short term working memory and associate learning, control group deteriorated in episodic memory. So, the result of our study is consistent with the results of earlier study. We found a trend between the two groups (group effect) at the 2nd follow up, and significant time effect from baseline to 2nd follow-up. Possibly a larger sample could have showed significant results at 2nd follow-up between groups.

- **SLCT (Six Letter Cancellation Test):**

When compared between groups, there was no significant difference between the *Trāṭaka* and wait list control group at 1st and 2nd follow up (table 4.8).

However with respect to time effect, selective as well as sustained attention and concentration (measured using SLCT scores) was seen to improve immediately after the practice of *Trāṭaka* (when baseline compared to 1st follow up). Wait list control group also performed better (may be because of retest effect) but the improvement was not significant. At 1 month follow-up, *Trāṭaka* group showed significantly better performance in the SLCT test compared to baseline. Whereas, scores of wait list control group came back to the baseline scores at the 2nd follow up (table 4.12,

4.16). In a study done on the healthy aging adults, it was seen that performance on a simple attention task improved after 5-week relaxation response training programme whereas, no improvement was seen in complex tasks of attention[169]. In another study net scores on the six-letter cancellation task were significantly higher after a session of *Dharana*[170]. These results are in consistence with our results, as we also observed increased SLCT scores immediately after *Trāṭaka* practice. Since *Trāṭaka* is a type of *dharana* practice this further strengthens that the results are valid and obtained correctly.

- **TMT B (Trail Making Test – B; Executive functions):**

At the 1st follow up, there was no significant difference in TMT B scores between *Trāṭaka* group and Wait list control group. However at the 2nd follow-up, there was a trend towards significance and possibly with a larger sample size we could have observed a significant difference between the two groups (table 4.8).

Trāṭaka group performed significantly better at the 1st follow up in TMT B test (indicative of executive functions). In contrast, in the wait list control group there was increase in time taken to complete the task (suggestive of poor performance) and the change was not significant. At the 2nd follow up, only *Trāṭaka* group showed significantly improved performance when compared to the baseline scores (table 4.11, 4.15). A study done on, long-term Vihangam *Yogā* meditators (> 10 years of practice) showed that meditators have superior cognitive abilities than non-meditators in the old age group[171]. The tests used were: (1) the Digit Span test, (2) the Stroop Color Word test, (3) the Trailmaking test, (4) the Letter Cancellation Task, (5) the digit symbol substitution test, and (6) the Rule Shift Card Test. Meditators showed better performance in all the tests except digit span backward. The results of this study were similar to our results. But, this study had long term meditators, whereas in our study we recruited subjects who were not doing *Yogā*. The study period was only of 1 month; still we could show significant improvement in *Trāṭaka* group. Thus we can make a statement from our results that first time *Yogā* participants, if provided with

just one month of *Trāṭaka* intervention, can improve their executive and cognitive functioning. This claim however needs to be tested in larger samples.

- **Results of RMANOVA:**

  The traditional analysis that is used to detect treatment outcomes in randomized longitudinal clinical trials was used – repeated measures analyses of variance (RMANOVA). RMANOVA results showed that the executive functions in both the groups improved over time (occasion effect). Though there was no significant group effect, *trāṭaka* group showed significant improvement in TMT B scores over a month period of the study as compared to the Wait list control group (Interaction effect).

  With respect to SLCT scores there was a trend towards better improvement ($p=0.05$) in *Trāṭaka* group as compared to the wait list control group over the one month period of the study (interaction effect). Here the SLCT scores SLCT scores reduced at the 2^{nd} follow up (significant time effect but no group effect)

  The above RMANOVA results validate our hypothesis that *Trāṭaka* intervention if provided for a one month period to elderly can help improve their cognitive functions especially attention and concentration and executive functioning.

- **Sub Group analysis:**

  For the convenience of conducting intervention, half of the subjects in the *Trāṭaka* group were provided the intervention in the morning and the remaining half were provided the intervention in the evening. Baseline analysis showed that there was significant difference in TMT B and SLCT scores between morning group and evening group, with scores higher in evening group than morning group. Hence post-hoc test was conducted to check if there was any significant interaction effect (group X time) after controlling for baseline scores using ANCOVA. Results show that there was no significant difference between groups (people who practiced in morning as compared to people who practiced in the evening) over the study period after controlling for baseline differences, possibly because the researcher ensured that the room where the *trāṭaka* intervention was provided was similar in lighting irrespective of the time of

the day (doors closed, curtains pulled) for the participants to see the light of the candle clearly. From this result we can state that if the logistics for conducting *trāṭaka* are carefully maintained, then the time of the intervention does not seem to have a direct effect on the outcome of the *trāṭaka* intervention.

- Other possible reasons for finding differences over the 1 month period could be as follows:
  a) The group was at a stage when cognitive decline was a reality. All the aging individuals (after the age of 60) develop some degree of decline in cognitive capacity as time progresses. Studies show that 16.8% of aged people have some form of cognitive decline without the symptoms of dementia[172]. If the study was done on healthy young subjects then we might not have got the significant difference, because of 'ceiling effect'.
  b) Another reason for the significant result could be that majority of the participants of the study had never been exposed to *Trāṭaka* or any *Yogā* intervention earlier. A few of the participants, who had earlier learnt *Yogā*, had either discontinued or had not practiced it for the past 3 months. In such a case, we believe that the effect of *trāṭaka* was pronounced as there was a not previous or past effect of any similar intervention. , they showed better results.
  c) The fact that we got significant results to show that *trāṭaka* practice for one month is effective in improving cognitive functions was because we believe that the scales used in this study were sensitive enough to tap the cognitive improvement in the elderly after the *trāṭaka* intervention. 3 tests used in this study were digit span test, TMT B, SLCT. Digit span evaluates short-term memory and working memory. SLCT measures selective and focused attention, concentration, visual scanning as well as activation and inhibition of rapid responses. While TMT B is a measure of visual scanning, complex attention, psychomotor speed mental flexibility, and executive functions. Though not developed specifically to test the effect of *trāṭaka*, these widely used tests have shown that they can tap significant changes post *Yogā* intervention.

d) Studies have time and again discussed the importance of the prolonged practice of *Yogā*[173,174,175.] We assessed the cognitive functions immediately after the one session of *trāṭaka* and after one month of continuous daily practice. The results pronounced that there was no significant difference between groups at the end of one session (1st follow-up), however significant group and time differences including interaction effects were observed at the end of one month of intervention. Hence we believe that our study results validate earlier quoted studies which advocate for prolonged duration (number of days) of practice of *Yogā*/*trāṭaka* for desirable effects.

e) Not many studies have been conducted to test the efficacy of *Trāṭaka*, and there was no way of knowing the optimum level of *Trāṭaka* practice that should be provided to participants for desirable effects in cognition. The current study showed that 1 day of practice was not sufficient to produce changes in the cognitive functions, whereas one month follow up showed significant changes. From the results of our study, we can draw the inference that one month of *trāṭaka* intervention is the optimum duration to produce changes in cognitive functions in elderly.

The results of this study establish that Trataka can be used as a technique to enhance cognition in the elderly. The trataka intervention is easy to learn, implement and adhere. Further trataka, after the initial few sessions, can be practiced independently by the participant to achieve desired results. For researchers, this study could provide a substantial base for conducting future trials to test the efficacy of trataka in controlled experiments.

CHAPTER 6

SUMMARY

AND

CONCLUSIONS

6.1. SUMMARY

Cognition refers to the mental process by which external or internal input is transformed, reduced, elaborated, stored, recovered, and used. It is the process by which we understand process information, make judgments and decisions, and communicate knowledge to others[176]. It is well established that aging is associated with a gradual impairment of cognitive functions[177]. Age-related decline in cognitive abilities varies considerably across individuals and across cognitive domains. Various cognitive domains show different degrees of susceptibilities to aging. *Yogā* practices have various health benefits including the ability to improve cognition and thereby preventing cognitive impairments and dementia.

A review of literature [Randomized clinical trials (RCTs) and non-randomized clinical trials (NRCTs)] suggested that various *Yogā* practices improve different cognitive domains. *Yogā* has seen to improve cognitive functions such as remote memory, mental balance, attention and concentration, delayed and immediate recall, executive functions, verbal retention and recognition tests[178]. In this study we attempted to use one of the *Yogā* techniques (*Trāṭaka*) in the elderly subjects. The aim of the study was to evaluate the efficacy of *Trāṭaka* in improving cognitive functions of the elderly subjects.

To achieve the aim of the study, informed consent was taken from 60 subjects, who expressed their willingness to participate in the study. The 60 subjects were randomized into 4 blocks (approximately 15 particiapnts in each block) – two blocks randomized into *trāṭaka* group and two block randomized into wait-list control group. The *trāṭaka* group was provided intervention for 30 mins every day, six days a week for 1 month. Data on the Digit span test (DST; for assessing memory), Trail Making Test (TMT-B; for assessing executive functions and Six letter cancellation test (SLCT; for assessing attention and concentration) was taken on Day 1 (pre and post intervention) and at the end of 1 month. The wait list control group was not given any intervention but data (DST, TMT-B, SLCT) was taken before and after 30 mins of quite sitting on Day 1 and on 30th day. Two groups were provided the intervention in the morning and another two groups were provided the intervention in the evening. Time to conduct the intervention was fixed according to the participant's convenience, either morning or evening. Apart from the inter-

vention in the *Trāṭaka* group, subjects in both the groups were asked to carry on with their daily routine. The procedure used for *Trāṭaka* session was adapted from the book '*Yogā* for promotion of positive health'. On advice of expert *Yogā* consultant, some changes were made in the procedure to suit the elderly population. Chanting was included, focusing time was reduced and defocusing time was increased to twice of that of focusing time. Timing of focusing and defocusing was also increased gradually over the days, till they reached the same ratio (i.e. 1:1, focusing: Defocusing). Concept of dhyana was introduced and subjects were asked to feel the expansion at the time of palming.

The data at baseline was assessed with tests for normality using Shapiro-wilk test. As the data was found to be normal for TMT B (*trāṭaka*: statistics = 0.931, p = 0.05; control: statistics = 0.929, p = 0.09) and SLCT (*trāṭaka* statistics = 0.957, p = 0.24; control statistics = 0.946; p = 0.22) parametric tests such as paired sample t tests, independent sample t test, and RMANOVA was used to analyze the data. In case of the digit span test as the data was not found to be normally distributed (*trāṭaka* statistics = 0.845, p = 0.00; control statistics = 0.931, p= 0.72), non-parametric tests such as Mann –Whitney, Wilcoxon Sign Rank test and Friedman's test were used to analyze the digit span test scores.

There were no group differences at baseline in all three outcome variables. The Mann-Whitney test showed that there was no significant difference between groups at the 1st follow-up; however there was a trend towards improved scores in the *trāṭaka* group at the 2nd follow-up (Mann Whitney value: 196.5; p = 0.06). The independent sample t test analysis showed that there was no significant difference between the groups in the 1st and 2nd follow-up for TMT-B and SLCT test scores. However there was a trend observed in TMT-B scores at the 2nd follow-up in the *trāṭaka* group (t value: - 1.8; p = 0.08).

Bonferroni adjustment was conducted as there were multiple comparisons to analyze the time effect. The Friedman test showed that there was a significant improvement in digit spans scores over time (from baseline to 2nd follow-up; chi sq = 15.44; p = 0.00) after Bonferroni correction. The paired sample t test also showed that there was significant improvement over time (from Baseline to 1st follow-up, baseline to 2nd follow-up and 1st follow-up to 2nd follow-up) in the *Trāṭaka* group for TMT scores (p< 0.01) after bonferroni correction. However the wait-list control group showed no improvement over

time in the (1) Digit span scores on Friedman test (ch sq = 1.3; p = 0.52), and (2) TMT-B and SLCT scores on paired sample ttest (Bonferroni adjusted p value >0.016).

Repeated measures analyses of variance (RMANOVA) showed that *trāṭaka* group had significant lower TMT scores over time (time X group: interaction effect) as compared to the control group and a trend towards significance in SLCT scores. A comparison of those who underwent *trāṭaka* in morning as compared to those who underwent the intervention in the evening showed significant baseline scores in SLCT and TMT B scores. After controlling for baseline differences, it was observed on the ANCOVA that there was no significant difference between the morning and evening group in either TMT-B (f = 0.5; p = 0.67) or SLCT scores (f = 1.04, p = 0.36; interaction effect).

6.2. CONCLUSION

These results establish that *Trāṭaka* can be used as a technique to enhance cognition. Meditation affects multiple pathways that could play a role in brain aging and mental fitness. Meditation practices have various health benefits including the possibility of preserving cognition and preventing dementia. Further, meditation is seen to strengthen neuronal circuits and enhances cognitive reserve capacity. Meditation practitioners are found to have a lower age-related decline in thickness of specific cortical regions. Since, *Trāṭaka* is considered as preparatory practice for meditation (with the same steps involved *dharana*, *dhyana*), it can be inferred from the results of this study that it has similar health benefits for improving cognition in elderly.

Further this study also advocates that if *trāṭaka* is provided to a group which is prone for cognitive decline and to those who have not been exposed to any cognition improving interventions, it can be helpful in improving their cognition. Since the results suggest that there was no significant improvement after one *trāṭaka* session, long term practice of *trāṭaka* (according to this study an optimum duration of one month) is advocated to bring about the required change in cognition.

6.3. STRENGTHS OF THE STUDY:

- Randomized block design (RBD) was used in this study. RBD's eliminates any bias in treatment assignment, specifically selection bias and confounding. It maximizes statistical power, especially in subgroup analyses.
- Scales used were popular and standardized neuropsychological tests which had high reliability and validity. Even though not specifically developed for testing effectiveness of *Yogā* practices, these tests are widely used to analyse the cognitive functions in different conditions.
- Intervention was provided to the sample that needed the intervention. All the aging individuals (after the age of 60) develop some degree of decline in cognitive capacity as time progresses. Subjects had not received any form of cognition enhancing intervention earlier, and were in need of one. Thus the intervention provided was need-specific.

6.4. LIMITATIONS OF THE STUDY:

- Since the sampling was done only in 2 old age homes in Goa, it cannot represent the whole population of elderly subjects in Goa. Generalizability is thus limited because of cultural variations.
- Sample size was small. The total sample was 60 based on earlier sample size calculations and post attrition, the sample size for analysis was reduced to 48. The results of the current study showed that there was a trend towards significance in the *trāṭaka* group in the between group analysis (group effect) for some outcome variables. In this context a larger sample size could have depicted significant differences between groups.
- Only three outcome variables were used in the study. Age related cognitive decline can be seen in different cognitive domains (e.g: speed of processing, spatial ability, reasoning, etc.) and varies individually. Further the effect of *Trāṭaka* could have been observed on many other cognitive functions, which were not evaluated. Further studies can be conducted to test the effect of *trāṭaka* on different neurological test batteries.

6.5. IMPLICATIONS OF THE STUDY:

- At present, no established *Yogā* treatment exists for cognitive impairment for the elderly. Hence *Trāṭaka* practice which shows some promise can be considered as a preventive measure for cognitive decline.
- The *trāṭaka* intervention is easy to learn and implement, as compared to any of the other cognitive therapies, which require the participant to undergone multiple sessions of therapy. Further the *trāṭaka* sessions most often after the initial few sessions, can be practiced independently by the participant, whereas most of the cognitive psychotherapies require the therapist to be directive and guide the participant to achieve desired results.
- As *Trāṭaka* practice requires person to sit at one place and the practice is only of 30 mins, long term adherence of this practice could be higher. Further studies on the adherence and long-term follow-up of *trāṭaka* practice in the community could possibly answer these questions.
- For researchers of AYUSH, this study would provide a substantial base for conducting future trials to try the efficacy of *trāṭaka* in controlled experiments.

6.6. SUGGESTIONS FOR THE FUTURE:

- Study with a larger sample size should be conducted. Since we started the study with 60 subjects and there was attrition of 12, so future studies can be conducted with larger sample size, accounting for attrition.
- Combinations of cognition enhancing *Yogā* techniques can be attempted to test their efficacy in improving cognitive functions. Different *Yogā* techniques have shown the efficacy in improving cognitive functions separately. *Kapālabhāti*, Bhramari, Bhastrika, relaxation techniques are some of the techniques which have shown to improve cognition and can be combined together.
- We studied the effect of *Trāṭaka* on healthy elderly subjects; similarly study can be done on subjects known to have cognitive deficits such as patients with mild cognitive impairment or dementia, schizophrenia, children with attention deficit hyperactivity disorder (ADHD) etc.

- Combinations of *Yogā* and other cognitive interventions (such as Cognitive Behaviour Therapy; neuropsychological retraining etc) can be tried in separate or a combined single design study. This will give a chance to compare between different interventions and to know the effects of each individual and combined treatment.
- Mechanism of how *Trāṭaka* practice improves cognitive function can be studied, by seeing the effect of *Trāṭaka* on electroencephalogram (EEG), structural neuroimaging and BDNF.

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