WORKING MEMORY ASSESSMENT IN HEALTHY ELDERLY INDIVIDUALS WITH THE DIFFERENT EDUCATIONAL BACKGROUND USING DISTINCT [SEMBACK] LINGUISTIC PROCESSING ABILITY

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CERTIFICATE

This is to certify that this dissertation entitles *'**Working Memory assessment in healthy elderly individuals with the different educational background using distinct [semback] linguistic processing ability**'* is a bonafide work submitted in part fulfillment for the degree of Master of Science (Speech-Language Pathology) of the student Registration No: 18SLP015. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any diploma or degree.

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CERTIFICATE

This is to certify that this dissertation entitles ***'Working Memory assessment in healthy elderly individuals with the different educational backgrounds using distinct [semback] linguistic processing ability'*** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other university for the award of any diploma or degree.

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DECLARATION

This is to certify this Master's dissertation entitled ***'Working Memory assessment in healthy elderly individuals with the different educational backgrounds using distinct [semback] linguistic processing ability''*** is the result of my study under the guidance of Dr. Hema. N, Assistant Professor of Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysuru and has not been submitted to any other university for the award of any Diploma or Degree.

Myuru Register No. 18SLP015

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What shall I render unto the LORD for all His benefits toward me?

I will take the cup of salvation, and call upon the name of the LORD.

I will pay my vows unto the LORD now in the presence of all his people.

Precious in the sight of the LORD is the death of his saints.

O LORD, truly I am thy servant; I am thy servant, and the daughter of thine handmaid: thou hast loosed my bonds.

PSALM: 116: 12-16

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I would tell GOD is my ***FRIEND****, who sits and patiently listens to all of my problems and petitions and finally, he tells, "be still and know that I am with you even to the ends of this earth"*

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At the end of this study I would tell – ''I am more than a conqueror In Christ''

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The process of aging involves altered cognitive functioning, especially in memory aspects. N – Back assess the memory component and can process the ability of the person to keep in store the memorized components. Usually to test a person's working capacity N- Back uses digit span, lexical categories, and syntactic aspects of the sentence. The current study aimed to assess working memory capacity and its effect on linguistic processing ability in the elderly population with different educational backgrounds using Sem–back task programmed with E Prime 2.0 software. A total of 50 age-matched participants were involved in the study with Group I and Group II consisting of 25 healthy elderly individuals with Higher education and 25 healthy elderly individuals with secondary education respectively. The Sem-back task was a replicate of the N-back task using three semantic categories like "fruits", "common objects" and ''vehicles" as linguistic markers, and the pictures of the same were used as test stimuli. In the present study, the observation made was, the mean reaction time taken to execute Sem-back tasks by individuals with secondary education was higher when compared with the reaction time taken by individuals with higher education. Hence in the present study, it could be stated that concerning the individual with secondary education the variables like the poor language processing ability, poor working memory, and training on sentence repetition, sentence comprehension as well as attentional control could have contributed in exhibiting enhanced or comparable performance on Sem-back task as that of the individual with higher.

Keywords: Elderly, Education, Working memory, N-back, Sem-back, E Prime 2.

CHAPTER I

INTRODUCTION

Aging is defined as the biological process of growing old regardless of chronological age. Intrinsic (nature) extrinsic (nurture) factors and their interactions influence the degree and the rate at which we age. The aging process affects each of the individuals separately. People over 65 years have at least any one of the chronic health issues, which leads to full of self-contradictory findings in the literature (Tremblay & Burkard, 2007). The government of India adopted 'National Policy on Older Persons' in January 1999 which defines 'senior citizen' or 'elderly' as a person who is of age 60 years or above (Khan& Itrat, 2016). Cognitive impairment is estimated to exist in 17–36% of adults over the age of 65 (Steffens & Potter, 2008).

Aging and the process of cognitive decline are well explained in scientific research. Abilities such as conceptual reasoning, memory, and processing speed, decline gradually over time. Other cognitive abilities such as vocabulary are not much affected but instead grow as the age improves. As the definition states, normal age-related cognitive changes do not affect a person’s ability to perform daily activities (Harada, Natelson Love & Triebel, 2013).

1.1 Cognitive Processes and aging

Cognition is defined as all processes, by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used (Neisser, 1967). Cognition is a group of mental processes that includes attention, memory, producing and understanding language, learning, problem-solving, and decision making. The cognitive abilities of elderly individuals keep changing during their lifespan. Among the set of cognitive mental processes, attention and memory are the most affected by age even though they are the most basic cognitive functions. These two processes don’t have the same function but still, there is evidence that some part of attention and memory is left unaffected in geriatrics while others decline significantly. Perception (a precognitive function, as considered by many) shows a decreasing pattern as age increases due to a decline that is also seen in sensory capacities.

When there is a perceptual processing deficit in the early processing stage there is a high chance of having a processing deficit in the later stage. Therefore, age may also affect language processing and decision making which are some of the higher cognitive functions. The deficit on the performance of these cognitive function tasks is based upon the fundamental process impaired (Riddle, 2007). To explain in detail, cognitive abilities tend to increase as age increases and attain a plateau during adulthood, as an individual enters into elderhood there is a decline in cognitive abilities. Cognitive abilities apart from perception, the usually assessed process during this period are spatial abilities, reasoning, verbal fluency, working memory (WM), recall memory, performance speed, and attention (Drag & Bieliauskas, 2010).

The neuro-physiological changes associated with aging and cognition can be explained concerning healthy individuals. Despite the absence of cognitive impairment in these healthy individuals, about 20–40% of 60–90 years old healthy individuals exhibit high levels of Ab (amyloid-beta peptide) deposition in the brain and will develop dementia in the coming years (Bateman et al., 2012; Villemagne et al., 2013), exhibiting impairments in several cognitive functions, such as processing, memory, attentional control, motor, and sensory abilities (Jackson & Owsley, 2003; Tales et al., 2004).

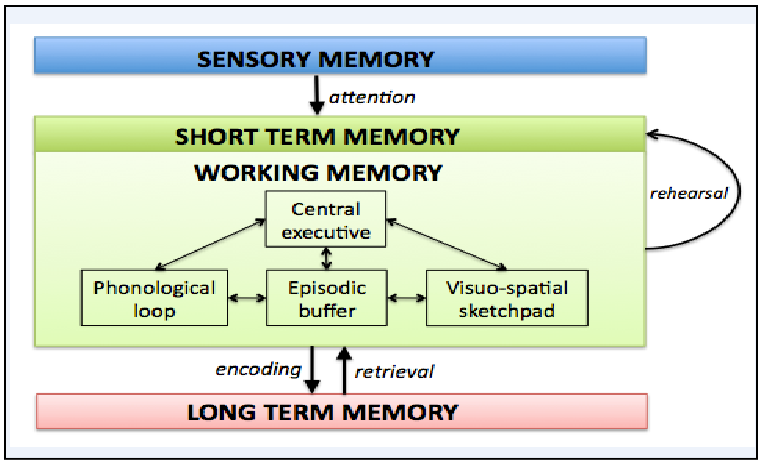
The additional point is the presence of depression is more prevalent in the elderly population and later stage has been proved to progress to mild cognitive impairment (MCI) or dementia. Prevalence and incidence of depressive symptoms or syndromes in MCI vary depending on the diagnostic criteria and the assessment procedure (Panaza et al, 2010). Thus, the cognitive processes like attention and memory functions need to be checked in geriatrics especially to know the age-related changes as the individual's progress into elder hood acquiring deficits in any cognitive processes. In multiple aspects of cognition in everyday life, working memory (WM) helps in the temporary storage and manipulation of information. And also this capacity plays a major role in mediating between the processing of stored and incoming information and its use for specific cognitive goals, as diverse as orientation, reasoning, language processing, planning, and spatial processing (Cansino et al., 2013; D'Esposito, 2007) the working memory is conceptualized as involving various components that work together.

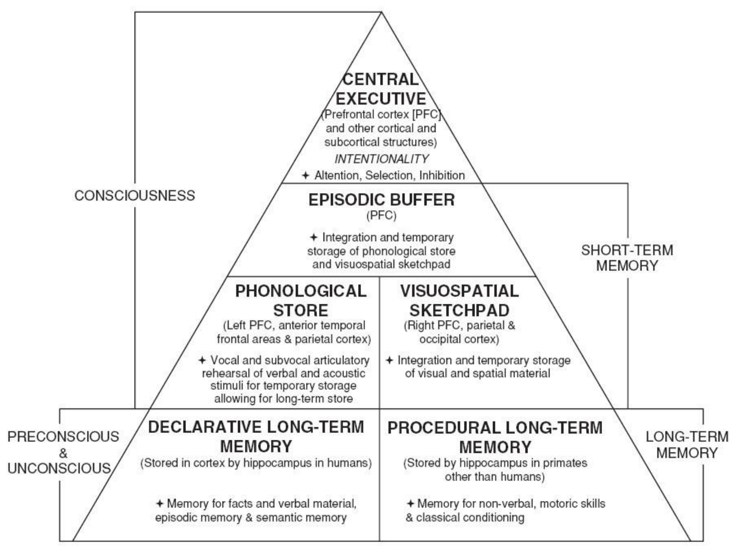
1.2 Working memory

According to Baddeley & Hitch (1974), the working memory model was earlier referred to as a verbal model. To be specific and concerning Figure 1.1, "an articulatory loop" is the first component in the model. This is believed to be associated with sub-vocal rehearsal. But, later it was termed as "phonological loop" which emphasize on storing the information rather than rehearsal, which is considered as the second component. There is head among all these components known as "Central executive" (CE) which controls all the activities. The third component considered was the visuospatial sketchpad which constitutes visual, spatial or combination of both. In the original WM model, as there were limited capacities in the phonological and visuospatial sketchpad subsystem, the model failed to explain the results of various experiments. Baddeley (2000) added a fourth component called "episodic buffer" which acts as backup storage and thus interacts with short-term memory, long-term memory, and working memory.

Figure 1.1

Schematic representation of the Working Memory Model





The working memory (WM) is a complex system, in which incoming information is maintained and processed despite interference and distraction (Diamond, 2013). Information relevant for goal-directed behavior is stored and updated in working memory. Baddeley's (1986) working memory model a two-way model accounting the phonological loop and the visuospatial sketchpad. The incoming information is controlled by the central executive. Visuospatial sketchpad deals with visual stimuli, the phonological loop deals with temporary speech-based inputs. Therefore, the deficit may be with the visual loop or the phonological loop. Thus, working memory capacity has been related to several cognitive tasks, such as language processing, math skills, learning abilities and verbal reasoning skills, (Baddeley, 2003; Conway et al., 2005; Conway & Engle, 1996; Cowan, 1999; Engle, Tuholski, Laughlin, & Conway, 1999; Just & Carpenter, 1992) since 40 years.

The behavioral approach to measuring the cognitive aspects of any individuals about working memory will be the use of the n-back task. In recent studies, many researchers proved that the n-back task can assess and index Working Memory (WM) in individuals with cognitive communicative disorders (aphasia) in comparison with the neuro-typical individuals (Wright & Fergadiotis, 2012). N- Back being a parametric task aids in deciding if a current stimulus matches with prior stimulus sequentially which comes in 'n' place. It is thus considered to have a strong idea that helps invalidity and its structure is consensus with the definition of WM, wherein it requires temporary storage and manipulation of stored information along with continuously revising WM components (Wright & Fergadiotis, 2012).

Few functional neuroimaging studies suggested stimulation of frontal and other cortical areas implicated in the WM network constantly through the performance of n-back tasks by healthy adults (Cohen et al., 1997), and have evidenced that this task is answerable for the central executive component of WM (Smith, Jonides, Marshiest, & Koeppe, 1998). There is a reduction in the performance of a cognitive related task in elderly participants, especially with depression. The information processing speed and working memory are reduced in the elderly with depression (Nebus et al., 2000). A large sample of people was tested from early to old age, grouped in 5 year age per group, and found that there is a decline in the task involving long term and short term memory. Evidence also states that as the age increases there is a decline in the visuospatial working memory, which is worse than the verbal working memory (Logie & Brockmole, 2010).

A sample of 199 individuals with the age range of 19 to 68 years was considered in a study where the ability to learn new things was measured and checked in this population and how the prior knowledge helped them to perform better. The learning module was a 30 mins video about cardiovascular disease and xerography. Each of the modules had 100 videos. They were divided into three groups as young, middle-aged, and old age. The old people with more access to the internet were able to perform better because they had good prior knowledge than the young individuals, the results also suggested for better learning experience the prior knowledge and the ability to access the internet had contributed more (Beier & Ackerman, 2005).

A longitudinal study was conducted for a span of 13 years and the age range of participants was 70 to 100 years. The effect of education in these individuals along with sex-related changes for 368 individuals was considered. The data was collected from 1990 to 2005 as a cross-sectional study and the attrition of the performance was recorded. Most of the attrition was due to the mortality of the participants. Women performed better in all the four cognitive-based tasks which included perceptual speed, episodic memory, fluency, and knowledge. The men in this study had education for 11.7 years mean and women had education for a span of 10.4 years mean. The results found that men performed better who had better education but still it was masked by gender differences. When the gender variable was not considered the educational variable stood out and proved that to do the cognitive-based task there is always the best support from the education that was taken in the earlier days by the elderly individuals (Gerstorf, Herlitz & Smith, 2006).

In the year 2018, a study was conducted to know the age and education effects in 189 participants between the ages range of 20 to 80 years. The age decline was related directly to the poorer neural activation. The education in these individuals provided a cognitive reserve through neural compensation to do the task in a better way. This study was an f MRI study that tested the spatial addition task which is a visuospatial working memory task that needed processing. As the age increased the mean reaction time also increased. A certain area in the brain got activated only when the task got started but before it was inactive. The education accounted for a strong association with the neural network and neural activation. The decreased activation is correlated with lesser education. The results suggested that for the better performance of older individuals equal to young people is associated with increased neural network recruitment. The people with less education were not able to activate the neural network in the elderly individuals and thus the author supports that a good education will help people to support the cognitively loading tasks. The grey matter in higher educated brain has a dense volume than in lower education it is sparsely distributed. The more neural recruitment also happens when there is higher education and thus helps in better performance. (Archer et al., 2018). We can see that educational status makes a significant change in the working memory task. The age-wise decline is also seen but the current area of interest to know even in the elderly individuals the presence of education is a support for the working memory task. If the cognitive reserve is helping them to perform better.

The cognitive process is still affected to a certain extent in Healthy Elderly Individuals. In normal cognitive aging, there are two types of concepts called crystallized and fluid intelligence. The skills, ability, knowledge when it is overlearned, well – practice, and familiar vocabulary and general knowledge come under the category of crystallized intelligence. Harada (2013) suggests that crystallized abilities remain the same or gradually improve at a rate of 0.02 to 0.003 standard deviations per year during the ’60s and ’70s. Because it is based on one’s own life experience, older adults tend to perform better in these tasks than younger adults. Fluid intelligence is when it is more of independent to what is learned and includes problem-solving and reasoning. It is mostly connected with the innate ability of the person to learn new things, solve problems, and manipulate one's environment. Under cognitive domains, abilities such as executive function, processing speed, memory, and psychomotor ability are then known to decline at an estimated rate of 0.02 standard deviation per year according to Harada (2013).

The speed with which the cognitively related activities are performed is called processing speed. This ability starts to decline in the ’30s of life and keeps declining. The cognitive changes in elderly individuals who are healthy leads to a decline in this processing speed and there is a slowing in this process. As the processing speed is slowed there will be poorer performance in the cognitive domains. The language mostly consists of both crystal and fluid cognitive abilities. The language ability in the elderly remains the same in the overall language domain. After 70’s some ability like visual confirmation naming and object naming will decline. Word searching and generating words of a certain category will decline with aging. (Salthouse, 2010).

1.3 Need for the study

Brain reserve is defined as a neurological phenomenon where (1) the available brain volume affects the development of brain diseases and injuries (i.e., neurological brain reserve) and (2) mental activity across the life-span allows flexible cognitive resource allocation despite the occurrence of neural dysfunctions (i.e., behavioral brain reserve) (Beurskens & Dalecki, 2017). The concept of cognitive reserve and the protective role it plays during aging (Christensen et al., 2008) is another important point to be considered concerning elderly individuals. Kramer et al. (2004) have provided support for the cognitive reserve hypothesis by showing a greater synaptic density and more complex brain networks in higher educated individuals. Alternatively, Park and Reuter-Lorenz (2009) hypothesized that older adults with a higher cognitive reserve can compensate for neurocognitive deficits by recruiting alternate brain networks and in this way enable them to perform a task with similar accuracy.

Based on previous evidence, it is expected to see differences in cognitive, structural characteristics between age groups, sex, and educational level. Furthermore, it can be hypothesized that significant correlations exist N-back task of working memory tasks in these individuals.

Along with this important clinical implication, from the research point of view, there is also a great scope to study working memory capacity using n-back tasks in elderly individuals with different educational backgrounds.

1.4 Aim of the study

The aim of the present study was to assess the working memory capacity and its effect on healthy elderly individuals with different educational backgrounds using the Semback task programmed in E-Prime software.

Objectives of the study:

1. To examine the reaction time and accuracy score of the Sem-back level in healthy elderly individuals with secondary education and age-matched individuals with a higher educational background using the Sem back task programmed in E-Prime software.

2. To study the effect of different educational background on reaction time and accuracy score of Sem-back level of healthy elderly individuals in processing distinct linguistic information (semantic) in the Semback task.

Research design:

The present study is a comparative study with two groups – one group would comprise elderly individuals with secondary education and the other group would comprise of elderly individuals with higher education.

CHAPTER II

REVIEW

2.1 Working memory assessment

The cognitive processes may include attention, memory, perception, and problem-solving. One cognitive system believed to be involved with language processing includes working memory (WM). Working memory capacity has been conceptualized as a single "resource" pool for attention, linguistic, and other executive processing (Just & Carpenter, 1992).

The ability to concentrate and focus on one thing is called attention. On more complex task there is much age-based effect is seen particularly on selective attention and divided attention tasks. Selective attention is focusing on one thing when ignoring others. Divided attention is when focusing on multiple tasks at the same time. Elderly individuals perform poorer in working memory tasks; they are unable to momentarily hold the information in working memory (Harada, 2013).

The stages of memory can be split into a few steps. Ability to encode new information is called acquisition. The rate of acquisition declines in life as a person ages. But the retention of the learned information is retained better in the elder healthy individuals. Retrieval of the newly learned information declines faster in elderly individuals. Whiting and Smith (1997) in their study they found that age difference was high for the recall task rather than a recognition task. The regression analysis has explained that due to the processing speed and the working memory the elderly population was not able to perform better. As reported, most of the time, more complaint in the elderly people is in the domain of the memory. A group of elderly do not perform better in learning and memory tasks when compared with young adults. Reduced processing speed reduced the ability to ignore irrelevant information and decreased use of strategies to improve learning and memory leads them to perform poorer in the tasks (Woods, Delis, Scott, Kramer & Holdnack, 2006).

The most frequently used and objective method of assessing memory is the working memory assessment. This can be assessed in both ways either using simple span tasks or complex span tasks. Forward digit, backward digit, ascending, and descending digit and visual, spatial spans can be used as a simple span. Reading span, operational tasks, rhyme judgment; visual letter monitoring and n-back task can be used as complex span tasks.

Forward digit is a task that requires registration of verbal or visual information and remembers passively of that information to repeat it immediately at the end of the stimulus presentation. For example, one has to observe a series of numbers for a brief interval of seconds and has to recall orally in order wise as they appeared on the screen. The forward digit usually tests the phonological loop for verbal and the visuospatial sketchpad for visuospatial data. It is usually studied to know the fashion of decline as age increases in typically developing individuals and clinical populations like Alzheimer's, Mild cognitive impairment, and also in special cases like the educational status of the individual in this specific task.

Backward digit task is also similar task like forwarding digit after registration, the information, has to be manipulated actively and formulate a response immediately at the end of the stimulus presentation. For example one has to observe a series of numbers for a brief interval of seconds, then remember the numbers and has to manipulate actively (backward) after the presentation. Marco et.al (2012) studied the forward and backward span task in individuals between the ranges of 20 – 90 using numbers and found there was a significant difference between the young and elderly individuals in terms of age and there was a decline in the span of the digits as the age advanced. He has also found that there is a significant difference based on education, higher educated has performed better in this task than the less educated. There was no significant difference in this task based on gender across the age.

The reading span task was first published by Meredyth Daneman and Patricia Carpenter (1980). In this task, a series of unconnected sentences are read aloud and the individual has to recall the final word of each sentence being presented and there will be increased increment until the errors made by an individual. This task mainly tests two functions like processing and storing information, it is more of a complex cognitive task than simple storages which are more connected to daily activities. 71 adult English speakers were tested for reading span task on the specific basis of linguistic experience and unexpected events in syntax, the results suggest individual differences in sentences processing can focus on experimental factors, especially when learning abilities were considered (Killer et.al. 2009).

Operational task, in which the participant will be asked to check the correct mathematical equation and read out the words in between along with the recall of those numbers verified after the stimulus presented. This task was studied from 18 to 80 yrs for 90 individuals 45 males and 45 females by Salthouse (1992). All the participants were asked to keep in memory the words or numbers along with solving arithmetic problems in between. The age correlation showed that the younger adults performed better than the elderly individuals in terms of speed of the task there was slower performance. And lower scores on the working memory tasks.

Pair of real words and pseudo-words will be presented and the subject has to verify whether a pair of stimuli rhymes with one another is called the rhyme judgment task (Marslen-Wilson, 1980). Studied the rhyme judgment task, the subjects were presented with sentences auditory. The sentence may or may not be meaningful. The target rhyme word may be present in any part of the sentences. Results showed that rhyme monitoring is sensitive to semantic and syntactic information derived from the cue word.

Visual attention task is in which, the subject has to identify the stimulus by pressing the button when the stimulus is presented along with distracters simultaneously. Bleckley in 2003 studied the visual attention task with 20 participants out of which participants with high working memory capacity were significantly different from those with low working memory capacity. Less memory capacity participants were less flexible for the visual attention task than the high memory capacity individual.

N-back task, the subject will be presented with stimulus one at a time and has to recognize and recall the items that appeared "n" items at the end of its sequence. This task was developed by Kirchner (1958), which is a continuous performance task and helps in assessing a part of working memory and its capacity. Also as working memory requires storage and manipulation of information at the same time, in n-back tasks similar procedure is carried out. Therefore, to assess WM capacity in individuals with elderly n-back tasks with different types of stimulus either linguistic or non-linguistic may be suitable and suitably used one.

2.2 Working memory assessment in neuro-typicals

Cerebral activity by giving working memory tasks in the n-back task especially on load-sensitivity and load-insensitivity was studied by Jansma, Ramsey, Coppola, and Kahn (2000). The participants were 12 healthy participants’ eight males and four females with an average age of 27 years, the participants were eve trained 1 hour before the actual testing phase. They were tested with 4 levels in the n-back task and found the load-sensitive and load-insensitive cortices in the brain. Using FMRI voxel by voxel analysis was made, and the areas identified using n-back tasks were bilaterally in dorsolateral prefrontal cortices, parietal cortices, and anterior cingulate. They have also found that the highly complex task that increases working memory demands also increases cerebral activity. In this particular study, all the individuals were very active for all the complex tasks which were compared to the increased activity in the anterior cingulate gyrus. Authors have also found for the load-insensitive task the right parietal cortex was active. More demand for the working memory was created when the task was complex. They identified three different processes when doing n-back tasks which are active temporary retention of information, rehearsal of information held in temporary detention, and retention of the temporal characteristics of the stimulus. In this study, three items at most can be retained for a working memory task in the temporal retention of information. There was also an increase in the reaction time as the complexity of the task increased – they attribute this to the delay in the motor response and stimulus perception because there was a delay in the response to the task. When a mental load is given the frontal and parietal area of the brain stays active whereas other areas of the brain stay constant even after a mental load was given. They also found responses in visual presentation mode being faster than auditory presentation mode at all levels.

The construct validity for n-back as a testing procedure for working memory assessment was done by Kane, Conway, Miura, and Colflesh (2007). 132 undergraduates were taken and they performed n-back tasks and operational span tasks. The result from this study suggests that the capacity of the working memory should not be drawn from the n-back task alone but along with its operational span task should also be done together. The authors' discussed that n-back is an important piece of the prefrontal puzzle and becomes a problem sometimes. It is less clear to rely on the working memory theory by simultaneous processing. In n-back the demand is recognition and in operation span task the demand is interference. So in operation task span the interference often leads to failure in recognition. The n-back and similar recognition tasks are more associated with the familiarity effect and recollection-based process. The n-back demands free recall but the different processes from complex span tasks and is better in assessing the working memory.

The validation of computerized tasks like n-back and attentional network task (ANT) which tests the working memory and attention was done by Guzman, Mikel, Vicente, and González (2014). This was a longitudinal study from January 2012 to March 2013, the participants were 2,904 children between the age group of 7 to 9 yrs. In the n-back task, the outcome that was measured was the score and the hit reaction time. The hit reaction time showed acceptable internal consistency, reasonable factorial structure, as well as good criterion validity and statistical dependencies. Between the stimuli, there was no statistical difference found for color, letters, numbers, and words, and also for the load difference 1-back, 2-back, 3-back has had no significant difference between the loads. Thus the authors suggest this n-back as the valid, objective, and easy-to-apply measures of neuropsychological development. To measure the individual differences the extensively used tool is n-back especially in assessing the working memory. The psychometric properties of the n-back task were studied by the authors using three different tasks with different load levels to measure the inter individuals' differences. The authors suggested that for the higher-level complex tasks such as fluid intelligence tasks. Along with it n-back is useful in experimental research in working memory (Jaeggi, Buschkuehl, Perrig & Meier, 2010).

From the above-given studies, it is evident for us, to study the working memory in participants the better computerized neuropsychological test is n-back which is clear and easy to understand and to administer. As the current study mainly focuses on the elderly individuals, a test that has instructions easy to understand was preferred and the ‘n-back’ task was used as the working memory assessment as mentioned in the following review.

For a working memory task based on visual performance. There are contributing factors such as semantics and functional relationship of the stimulus, the complexity arises with the perceptual grouping of the stimulus. In this study, the authors arranged 8 stimuli on pairs of 2, the functional, and the semantic relations were altered in the pair of the stimulus. There was a better performance by the participants when there was a semantic relationship between the pair of stimuli. There was much better performance when they were placed with interaction with each other. Both the functional and the semantic relationships thereby helped in the better performance of the participants. The results of the current study stated that the visual working memory capacity can be improved by increasing the interaction either functionally or semantically (O'Donnell, Clement, & Brockmole, 2018). Keeping all of these reviews in mind the semantic categories were selected for the current study which was all semantically related under three categories ‘fruits’, ‘common objects’, ‘vehicles’.

Verbalization is an underlying process that helps in visual working memory tasks. 40 healthy individuals were considered for the study of 29 females and 11 males. This experiment studied the difference between the performance when considering the articulatory suppression and also low and high verbal coding. When there was articulatory suppression seen there was poorer performance and when the high and low verbal coding strategies were used there was an outstanding performance in both the cases. The results of this study suggest that the use of the strategy of verbal coding influenced the visual working memory task. The participants who combined the verbal and the visual strategies performed very well than those who did not combine. The author suggests that the use of the central executive will surely enhance the visual working memory task. The high verbal coding was better in performance which suggested that higher verbalization, which was the innate ability due to the semantic knowledge of the individuals helped in better performance.

From the above review it is very sure that the language part of the brain is also involved in doing the working memory task. It's not only the visual part of the brain active but also the language part since the stimulus which is presented will always have a semantics connected to it. More the experience of the person more will be the semantic network created for a single picture. The higher education and more exposure is connected directly with the better semantic content in the brain.

2.2.1 Working memory assessment in elderly individuals

Kirchner in the year 1958 studied the working memory using n-back utilizing a visual display involving rapidly moving light the older individuals had more omissions and random responses when compared to younger individuals. And suggested that was because of the inability to organize incoming and outgoing information.

Concerning working memory assessment only in elderly individuals, it is reported that the females have better memory capacity scores when compared to males (Stevens, Kaplan, Ponds, Diederkiks & Jolles, 1999). The working memory was studied in geriatrics in the Asian population (Taiwan) and the gender variation is highlighted here even though there was an age-wise decline in the performance in the n-back task within the age range from 55 – 85 years. In men, there were no greater differences in verbal and visual tasks in both 1 and 2 back tasks when compared to women. From the population, the gender-wise variation was found in 60 – 70 yrs. All the male participants were able to perform better in the age range between 60 – 70 yrs. After the age of 71, there were no gender differences.

The western study by Schmidt in the year 2009 was done with an n-back task. The study comprised of 50 healthy individuals within the age range of 18 to 58 years and they were divided based in the gender-matched group. This study was fMRI study along with n-back and proved there were no gender differences in terms of accuracy and reaction times and there is no change in the brain areas which were activated.

Normal adults, when compared with normal elderly individuals, are characterized by a reduction in working memory. As the relocation of resources takes place in both young and older there is an increase in the demands on working memory. Older adults were not able to perform in 2-back than compared to 1-back behavioral testing when compared with young adults. Older adults were able to maintain their performance by brain maintenance and compensatory process. (Lubitz, Niedeggen & Feser, 2017).

In the group, 71 to 85 yrs females performed better than males, in this study as an overall the females performed better than males (Pliatsikas, 2018). Memory performances in the different age ranges are changing due to intellectual activities, educational level, declining cognitive abilities. It can relate to two views cognitive style (attitudinal and motor cognitive) and specific lifestyle variables (absence of an active lifestyle and breakdown of family ties). Many studies compared the younger adult with an older adult but within old age is a recent area of interest. This study consisted of 754 individuals within the age range of (aged 58-89) on a verbal n-back task there was a significant difference between the age groups. They have also specifically suggested that the working memory doesn't only affect the young and old age but also within the old age group there is a significant difference between the performances. There is the only evidence in the Asian and western population and not much of Indian studies were done which compares the age variation in the working memory assessment in the geriatric population.

The study was conducted by Gajewski, (2018) using the N-back task at the level of n-0 back and n-2 back tasks between the young middle-aged and the elderly individuals. Results showed younger and middle-aged individuals performing better than the elderly individuals and the reaction time was 1590 ms. For n-0 back and n-2 back, the reaction time was with the difference of 123ms between the younger and the older individuals. Pliatsikas when studied 764 individuals with working memory assessment and found that there is a difference between the task load i.e. when doing an n-back task, 1- bask task meantime was better than the 2-back task and as the load increased to 2-back the accuracy was also poor in the elderly individuals. Specifically in this study when accuracy was taken for 1-back the accuracy was better when compared to the 2-back task.

The span of information the working memory can store is very limited, restricted, and relatively little (Pliatsikas, 2018). People with more health problems considered to have less memory capacity than with the people who have fewer health problems. Persons who had a good social life and perceived themselves as having a good social life had better memory capacity. The memory of an individual is strongly related to how they perceive themselves. If they think they are physically and socially active they can perform better. The theory of social networks suggests that peer group interaction will improve cognitive performance (Stevens, Kaplan, Ponds, Diederkiks & Jolles, 1999). When 39 individuals with depression were tested for working memory assessment using n–back task, all the participants in the study had either bipolar or nonbipolar disorder which is a major depressive disorder. The poor performance by the individuals with depression was explained by the author as a decrease in the processing resource in the patient's brain as they were going through depression. Even after a 12-week treatment, the same testing was carried out but still, the reports were similar suggesting the resource decrement even after treatment.

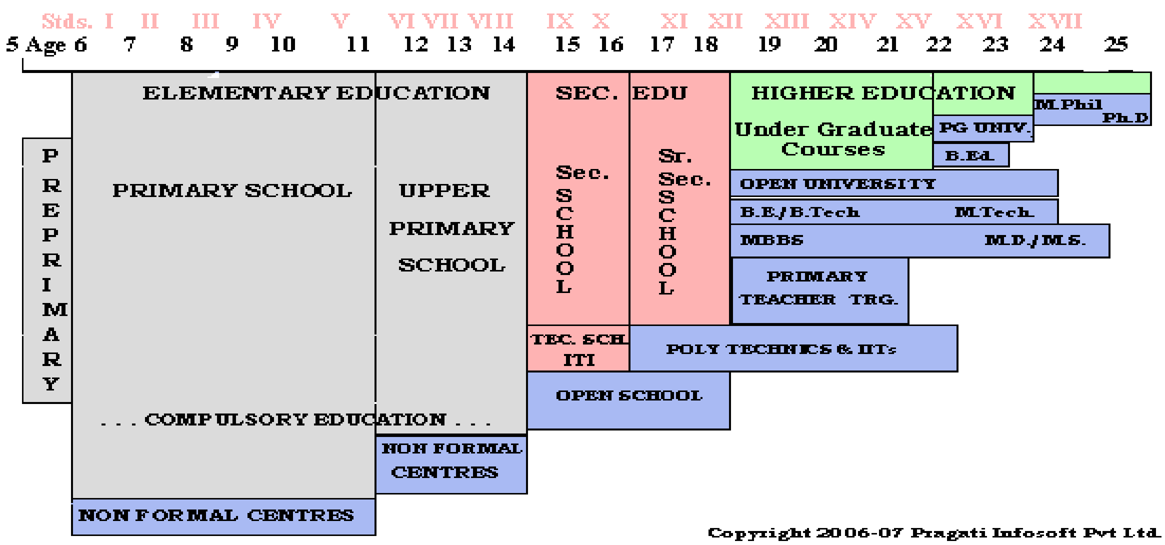
From all the above-given research studies there is not much rich content regarding the working memory especially in case of the n-back task in Indian studies and most of it is Asian and western and not considering the educational status of elderly individuals. Thus it led to the need for the present study in the Indian population especially concerning elderly people with different educational statuses.

2.2.2 Working memory assessment in elderly individuals with different educational status

According to Govinda & Bandyopadhyay (2008), the Indian education system is very complex and is varied from state to state based on the facilities available for education. At one end we have Kerala where the literacy rate is very high and every child is compulsorily completing the elementary education and on the other end, we have Bihar where 1 in 2 children is uneducated and there is no compulsion for education. The central government and the State government are together responsible for education in India. Through the National Policy on Education (NPE), the common pattern adopted at the national level commonly known as 10 +2 + 3. The first ten will be broad-based general education for all children. The bifurcation of the course happens only at the higher secondary level (Grade 11 and Grade 12) and it is based on completing 10^{th} grade. The first eight years of education are termed as 'elementary education'. Elementary education is divided into primary (Grade 1-5) and middle school (Grade 6 – 8). The secondary education is (Grade 9 – 10) and higher secondary (Grades 11 -12). The higher secondary school is also called a junior college in some of the sates in India. The diploma is also considered as the higher secondary education when pursued after secondary education. The structure if the education system is given in Figure 2.

Figure 2.1

Schematic representation of the education system in India



When education was considered females show greater response than in males with increased educational experience. This was tested in both 1-back and 2-back testing across verbal and visuospatial domains. To measure the working memory performance on elderly individuals the n-back task correlates well on tasks that were specially designed for working memory (e.g., counting, reading, or rotation span tasks). In contrast, in older age, mainly attentional, verbal memory, and updating and to lesser extent executive processes seem to play a crucial role in the n-back task, suggesting a shift of processing strategies across the lifespan (Gajewski, Hanisch, Falkenstein, Thones, & Wascher, 2018). However, no studies have been reported in brief regarding the variable, ‘education level’ of elderly individuals. Pliatsikas (2018) study suggests that a person with 18 years of education performed better when compared to people with only 6 to 10 yrs of education. Therefore along with age and gender, the author has also studied the difference in education and found that more the number of years in education better the performance in the working memory task using n-back.

Therefore at the end of the review, we can see that n-back is the better option to study the working memory in any individual. Especially in the case of geriatrics also n-back has shown better sensitivity. The age-wise study was made in western studies and the life span was considered mostly from a younger age. The elder people have not been studied alone in any other study and especially in the Indian context this type of study is very minimal. Only the educational status was not taken as a separate variable in any of the mentioned studies it was combined and studies. The current interest will be an education in elderly individuals and its effect on the working memory task.

CHAPTER III

METHOD

3.1 Participants

A total of 50 healthy elderly individuals aged between 55 and 90 years was considered as a participant for the present study and defined them as ‘senior citizen’ or elderly’ according to Khan and Itrat (2016). They were divided into two groups based on their educational status, 25 elderly individuals who had completed Higher Education (HE) formed Group I and 25 elderly individuals who had taken Secondary Education (SE) formed Group II based on the description of Govinda and Bondopadhyay (2019).

The exclusionary criteria for these two groups were as follows: (1). Elderly individuals with any history of any sustained head injury, neurological issues, psychiatric disorders, or fatal illness were excluded. (2). Moreover, those who had drug abuse or alcoholism, or the presence of severe physical impairment were also excluded. (3). Elderly individuals with progressing conditions like mild cognitive impairment (MCI), dementia, and Alzheimer’s were excluded from the study. (4). Overall, their general health condition was assessed using a General Health Questionnaire - 28 (Goldberg & Hillier, 1979) **(APPENDIX A).**

The inclusionary criteria for both groups were as follows: (1). All the elderly individuals obtained a score of 25.2 – 29.6 or a cutoff score of less than or equal to 26 in Montreal Cognitive Assessment (MoCA- Nasreddine, et al, 2005) administered by an experienced Speech-Language Pathologist. (2). General demographic information regarding their educational status and their professional role was documented. (3). All elderly individual was a native speaker of the Tamil language. (4). The handedness of these elderly individuals was right hand only and had sufficient dexterity control to make responses using a computer keyboard. Along with these inclusionary criteria, for the recruitment of the present study, the participants also satisfied the following special inclusionary criteria. (5). On administration of the socio-economic scale (NIMH-SES scale-Venkateshan, 2009), all the elderly individuals belonged to middle or high socioeconomic status. **(APPENDIX B).** The specific assessment criteria which were performed are as follows:

1. No complaint or history of otological problems, occupational noise exposure, or ototoxicity. And have normal or corrected to normal visual acuity. This was ascertained through a structured interview with the participant.

2. No history or complaints of forgetfulness and a score of 25.2 – 29.6 or a cutoff score of less than or equal to 26 in MoCA (Montreal Cognitive Assessment) was considered as inclusion criteria (Nasreddine, et al, 2005) **(APPENDIX C).**

3. Each participant was taken in for research only if they accept and were willing to sign the informed consent of the AIISH ethical committee **(APPENDIX D).**

4. Each individual was screened for reading and writing informally by the researcher before taking considering them for the study. The informal profiling of reading, writing, phoneme-grapheme correspondence, dictation, arithmetic skills, and visual and auditory discrimination skills of these elderly individuals was assessed based on the principles of informal reading and writing assessment batteries.

The demographic details of the participants are as follows (Table 3.1).

Table 3.1

Demographic details of the participants

GROUP I – HIGHER EDUCATION			GROUP II – SECONDARY EDUCATION		
Participant Name	**Age/ Gender**	**Education**	**Participant Name**	**Age/ Gender**	**Education**
P1	55/F	B.Sc Nursing	P26	63/M	SSLC
P2	63/F	B.Sc Nursing	P27	65/F	SSLC
P3	58/F	B.Com	P28	62/F	SSLC
P4	76/M	BABL	P29	62/F	SSLC
P5	73/F	B.Com	P30	62/M	9th std
P6	55/F	M.Sc Phy	P31	61/M	SSLC
P7	67/M	MBA	P32	66/M	9th std
	65/F	BA His	P33	69/M	9th std
P9	68/F	BSc.Spl.Ed	P34	70/F	9th std
P10	70/M	ITI	P35	75/M	9th std
P11	72/M	BE	P36	65/M	II PUC
P12	66/F	B.Com	P37	67/F	SSLC

P13	71/M	BA Eco	P38	63/M	SSLC
P14	66/F	BSc. Zoo	P39	61/F	II PUC
P15	59/F	MEd	P40	65/M	SSLC
P16	58/F	BSc. Bot	P41	67/M	9th std
P17	65/M	Dip. Ele	P42	66/F	II PUC
P18	57/F	Dip. Nursing	P43	62/M	9th std
P19	66/M	BE	P44	27/F	SSLC
P20	71/F	M.Com	P45	63/M	II PUC
P21	66/M	BE	P46	68/M	9th std
P22	63/F	BSc. zoo	P47	65/F	9th std
P23	58/F	MSc. Math	P48	62/M	II PUC
P24	67/M	BE	P49	63/F	SSLC
P25	66/M	Dip. Shipping	P50	68/M	9th std

Note: ABBREVIATIONS: MBA*- Master of Business Administration,* ***MSc -*** *Master of Science,* ***MEd-*** *Master of Education,* ***BE****- Bachelor of Engineering,* ***BSc -*** *Bachelor of Science,* ***BABL-*** *Bachelor of Arts Bachelor of Law,* ***B.Com****- Bachelor of Commerce,* ***BA****- Bachelor of Arts,* ***BSc.Spl.Ed****- Bachelor of Education(Special Education),* ***Dip****- Diploma,* ***SSLC****- Secondary School Leaving Certificate,* ***PUC****- Pre-university course.*

3.2 Procedure

3.2.1 Behavioural experimental paradigm: N-Back task with the linguistic process (Semantics) as Sem-back

3.2.1.1 Stimulus preparation. To perform the N-back task the individual had to store the 'n' number of information in his working memory and update the content of working memory by avoiding the unnecessary information and keep updating the new information. The N-back task at phonological, semantic, syntactic aspects of language with the category called shape was assessed as part of the working memory to check an individual's executive function level in a study by Wright et al, (2007). With this reference of Wright et al study, few lexical categories were chosen and the stimuli were considered under each Sem-back category Fruits, Common Objects, and Vehicles for the present study. The list of stimuli taken under each category is given in Table: 3.2.

Table 3.2

Stimuli taken under each Sem-back category Fruits, Common Objects, and Vehicles

S.No	STIMULUS - SEM-BACK CATEGORIES		
	FRUITS	COMMON OBJECTS	VEHICLES
1.	Apple	Cup	Aeroplane
2.	Pineapple	Pencil	Auto
3.	Banana	Comb	Bike
4.	Mango	Knife	Bus
5.	Pomegranate	Flower	Car
6.	Watermelon	Match stick	Cycle
7.	Grapes	Chair	Lorry
8.	Pear	Table	Train

9.	Orange	Fan	Jeep
10.	Papaya	TV	Scooter

Regarding the study of Wright et al (2007), a Sem-back task was created which replicates the N-Back using lexical items as the stimuli (Example: **Table 3.3).** These lexical items include fruits, common objects, and vehicles, each lexical item consists of three/four/five or more stimuli for 1- back, 2- back, 3- back, and 4 - back task. For example, in **Table 3.3**, lexical items – Fruits, common objects, and vehicles are given for a trial 1- back and 2-back.

Table 3.3

Sem-back stimulus

Lexical Items (Non-Randomized)	**1 – Back task**	**2 – Back task**
I. Fruits	1. apple, banana, orange, **mango – mango**	1. papaya, apple, **orange,** mango – **orange**
	2. grapes, papaya, pineapple, **watermelon**– **pears**	2. pear, grapes, **papaya,** banana **– apple**
	3. banana, mango, pomegranate, **grapes**– **grapes**	3. apple, banana, **pineapple,** orange **– pineapple**
	4. orange, pear, papaya, **banana** – **banana**	4. watermelon, papaya, **pomegranate,** banana – **pomegranate**
	5. watermelon, grapes, mango, **orange - apple**	

		5. banana, apple, **watermelon**, papaya – **mango**
II. Common objects	1. cup, pencil, comb, **knife – knife** 2. flower, chair, table, **computer** – **fan** 3. chair, comb, flower, **pencil** – **pencil** 4. match stick, computer, fan, **chair – chair** 5. cup, pencil, match stick, **chair - comb**	1. Flower, table, **comb**, fan – **comb** 2. Table, chair, **knife,** flower – **cup** 3. Knife, cup, **match stick**, pencil – **match stick** 4. Chair, computer, **table**, match stick – **flower** 5. Table, knife**, computer,** flower **– computer**
III. Vehicle	1. Train, bus, bike, **aeroplane – aeroplane** 2. Jeep, car, train, **bike –bus** 3. lorry, aeroplane, scooter, **cycle – cycle** 4. Car, bus, bike, **auto – auto** 5. Train, bus, car, **jeep – bike**	1. Auto, car**, lorry**, aeroplane – **lorry** 2. Train, lorry, **auto,** auto – **bus** 3. Lorry, auto, **train**, car – **train** 4. Aeroplane, train, **aeroplane**, lorry – **car** 5. Car, aeroplane, **scooter,** train – **scooter.**

The Sem-back task of working memory assessment was programmed and ran using Psychology Software Tool's E-Prime software on a Lenovo G40 series desktop computer. In E-

Prime, the module called E-Studio was used to design stimulus with specific fixed stimulus duration with interstimulus duration and response time, for stimulus duration it was 4000ms and for the interstimulus duration, it was 1000ms as shown in Figures 3.1, 3.2 & 3.3.

Figure 3.1

Module E-Studio for selection of the stimulus

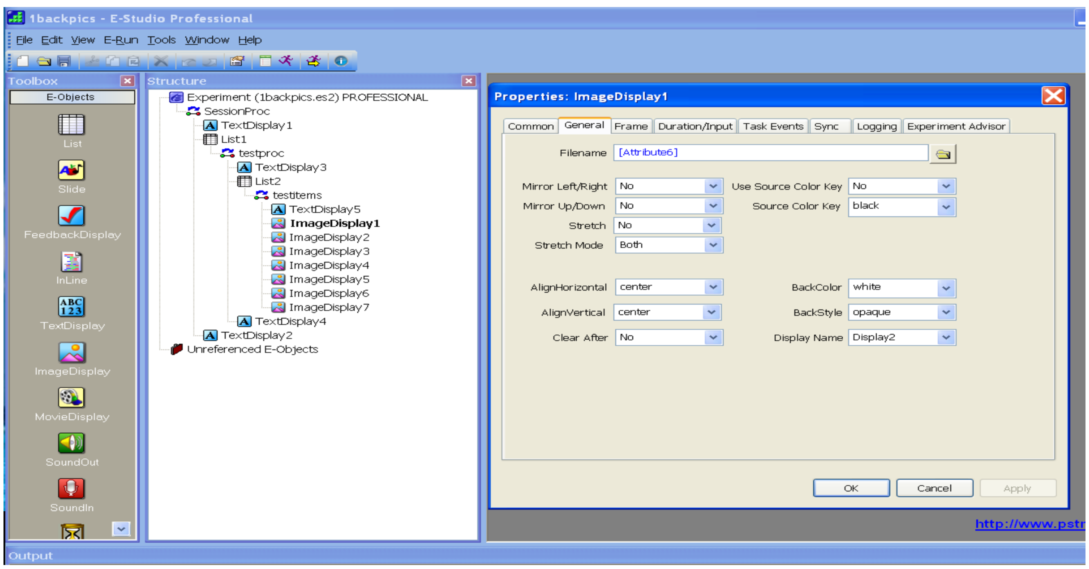
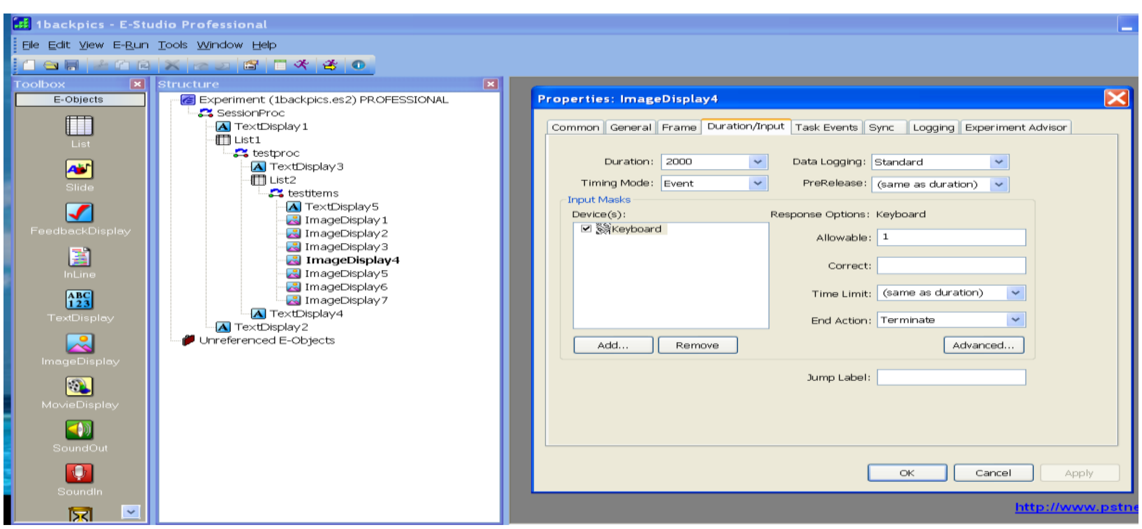


Figure 3.2

E-Studio stimulus presentation duration

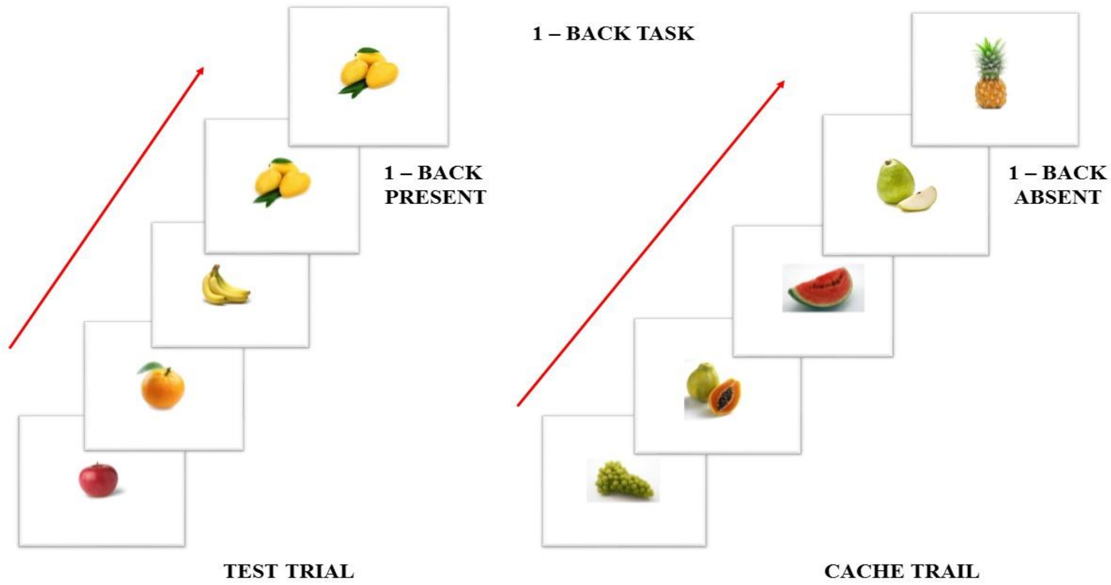


3.2.1.2 Stimulus presentation. Visual stimuli were presented to the individuals via a flat-screen monitor. Participants were seated approximately 50 cm from the computer screen. The administration of the set of Sem-back materials for both the groups began with practice items followed by 20 experimental items for each subcategory mentioned in **Table 3.3.** Besides, the stimulus was prepared until the 4-back for each semantic category.

For elderly individuals with different educational backgrounds, the stimulus was presented in serial order, where all the for 1-back picture stimuli will be presented one by one followed by five 2-back picture stimulus, five 3-back picture stimulus, five 4-back picture stimulus, and five 5-back picture stimulus (Appendix A). For each back there were five trails, Eg. 1 – Back for the subcategory fruits will have 2 cache trail and 3 test trial which was randomized for each back. This cache trail and test trail are differentiated in **Table 3.3.** For a set of five trails in 1 back task, the progression of the task will be as (T1, C1, T2, T3, C2) - T as Test trial and C as Cache trail. So totally there will be three tests and two catch trials. Therefore for each category, there will be two trails for the individuals accounting five for each back (5 trials x 4 back = 20). The cache trail was added so that the sensitivity of the test will be more and the response of the patient will be more accurate. The 1 - back task with the trail and the cache trail is explained in Figure 3.4.

Figure 3.3

1 – Back task test trial and cache trail in the semantic category 'Fruits'



NOTE: *The arrow indicates the progression of the stimulus*

Thus, the task was the sem-back matching task, items were presented centrally following a fixation cross for the duration of 4000msec for each picture (lexical category) and the participants were asked to match for 1-back, 2-back, 3-back, 4-back. In the matching task of this 1-back, 2-back, 3-back, and 4-back participants were presented with a target picture in visual (for a limited duration of 4000msec each picture) image forms. The trial and the target stimuli were presented center of fixation to the computer screen. For example, the picture 'apple', 'banana', 'orange', '**mango' (test stimuli) – 'mango' (target stimuli)**. Thus, the stimulus was followed by a series of 5 pictures of the lexical items. Participants had to indicate their response for the match as 1-back or 2-back or 3-back or 4-back using a keypress (Number Key -1) on a standard US keyboard. If there was no match or no N – back found they had to press (Number Key - 2) on a standard US keyboard. Thus, the stimuli were distributed equally across the participants (two groups). For this task, stimuli would remain on the screen for the duration of 4000 msec until a response would be given.

3.2.1.3 Scoring. RT and accuracy data were recorded in the E-Prime software itself for the correct and wrong trials of the E-Data module of E- Prime the same is depicted in Figure 3.4. Out of 5 trials under each back the two cache trials were ignored and out of the other three correct trials, the best trail out of three was considered for statistical analysis. Following this, later imported to Microsoft Excel and SPSS spreadsheets for data analysis. The response of all the participants was taken as mean and individual scores to discuss further. The data of each participant was then examined by hand to record the reaction times (RT) associated with correct and wrong responses so that the mean RT of one participant representing accurate responses were considered for comparison amongst the other participants.

Figure 3.4

E-Data module of E- Prime depicting the RT and accuracy

Note Pad file N-Back Task (1-Back task)
Reaction Time: 520 msec Accuracy 1

CHAPTER IV

RESULTS

The present study aimed to assess the working memory capacity and its effect on healthy elderly individuals with different educational backgrounds using the Semback task programmed in E-Prime software. The N-back task was carried out for 50 individuals and their behavioural samples were recorded and the age-wise comparison was made for the age range from 55 to 75 year. . A qualitative procedure was applied to the analysis of the N- Back task in the categories – Fruits, Common objects, Vehicles with the accuracy '1' or '0'. For each accurate response '1' was marked, for every inaccurate response '0' was marked and thus the inaccurate score was not considered as the working capacity and the accurate score was only considered as working memory capacity and the same was considered for statistical analysis. No one in the present study had an incorrect response instead they had an inaccurate response. Hence in the present study, all participants had either accurate '1' or inaccurate '0' responses.

The working memory assessment was carried out for the N-back task. The working memory capacity of healthy elderly individuals with different educational background was measured in terms of a level (working memory capacity) regarding accuracy and reaction time. Similarly, the working memory assessment score of 50 healthy elderly individuals was considered for analysis. Which was bifurcated as two groups, the first group comprises of Healthy Elderly Individuals with Higher Education (HE) (Group I) and the second group comprised of Healthy Elderly Individuals with Secondary Education (SE) (Group II). Thus, all the totals of each section were computed in terms of percentage and subjected to statistical analysis of the data using *the Statistical Package for Social Sciences (SPSS) software (version 23.0).* Initially, the data were subjected to the test of normality.

On administration of Kolmogorov–Smirnov, and Shapiro–Wilk tests for the parameters of working memory assessment in the N-back task, none of the parameters showed normal distribution at $p > 0.05$. Hence, non-parametric tests were applied for the overall working memory assessment. The complete statistical analysis for working memory assessment in n-back task was done in the following sections: **Section I:** Descriptive statistics was done to obtain mean, median and standard deviation. **Section II:** Step I- Between-group comparison (Healthy Elderly Individuals with HE versus SE) done using Fisher Exact Test to study if there is any association between the groups and also to see which group was able to perform better in the task with respect to accuracy; Step II- Mann Whitney Test was done to study which group performed better in terms of Reaction time. **Section III:** Step I- Within-group comparison was done using Friedman Test for the n-back levels and Step II for the semantic categories Fruits, Common Objects, and Vehicles.

4.1 Section I: Descriptive Statistics for the reaction time of Sem-back task

The results of descriptive statistics in terms of mean, median, a standard deviation of parameters under accuracy and reaction for healthy elderly individuals with HE and SE on the N-back task are shown in Table 4.1. Mean and standard deviation for Sem–back task for individuals with Higher Education (HE) and Secondary Education (SE). In this, the participants were given five trials of which 2 cache trials for each Sem-back task to account for accurate response. The correct performances of test items were only considered for statistical analysis. Following the administration of 1 – back, 2 – back, 3 – back, 4 – back tasks, mean value for each

Sem-back was obtained by taking the best out of three trials. Subsequent to this all the levels were taken to calculate the total mean value for Sem-back.

The mean and standard deviation of Sem-back tasks (1 – back, 2- Back, 3 – Back, 4 – Back) with reference to the reaction time in terms of millisecond at the semantic category of fruits for individuals with Higher Education (HE) and Secondary Education (SE) in tabulated in Table 4.1. It is observed that the mean reaction time (in terms of milliseconds) or the time taken to execute Sem-back tasks by SE was greater compared to HE. The reaction time for all the n-back task (1 – back, 2- Back, 3 – Back, 4 – Back) was shorter with better performance for the group with elderly individuals with HE compared to SE in all the semantic categories.

To explain in detail, for the semantic category – Fruits, the healthy elderly individuals with HE had their best performance with reference to short reaction time for the 4-back level followed by 2-back, 3-back, and 1-back. The healthy elderly individuals with SE had their best performance with reference to short reaction time for the 4-back level followed by 2-back, 3-back, and 1-back. The same pattern was observed for the healthy elderly individuals with HE group but however reaction time for SE was higher than HE group.

For the semantic category – Common object, the healthy elderly individuals with HE had their best performance with reference to short reaction time for the 4-back level followed by 3-back, 1-back, and 2-back. The healthy elderly individuals with SE had their best performance with reference to short reaction time for the 4-back level followed by 1-back, 3-back, and 2-back. There was different pattern observed for the healthy elderly individuals with HE group and SE group, but however reaction time for SE was higher than HE group.

For the semantic category – Vehicle, the healthy elderly individuals with HE had their best performance with reference to short reaction time for the 1-back level followed by 4-back, 2-back, and 3-back. The healthy elderly individuals with SE had their best performance with reference to short reaction time for the 4-back level followed by 3-back, 2-back, and 1-back. There was different pattern observed for the healthy elderly individuals with HE group and SE group, but however reaction time for SE was higher than HE group.

TABLE 4.1

Results of Descriptive statistics for Sem-back Task.

Working Memory Sem-Back Task/Level	Healthy Elderly Individuals					
	Higher Education (HE) Group I			Secondary Education (SE) Group II		
	N	Mean	Stand Deviation	N	Mean	Stand Deviation
Fruits						
1 – Back	25	810.52	883.47	24	1006.92	859.17
2 – Back	25	548.60	321.47	24	904.92	909.00
3 – Back	25	654.44	519.67	23	962.70	646.46
4 – Back	25	457.80	226.55	18	717.78	646.50
Common Object						
1 – Back	25	455.68	237.44	23	621.96	412.45
2 – Back	25	506.84	245.26	22	854.41	576.51
3 – Back	25	401.96	228.58	20	772.75	480.38
4 – Back	24	354.46	180.55	16	570.88	313.55
Vehicles						
1 – Back	25	344.44	163.24	25	848.20	605.06
2 – Back	25	422.68	150.93	24	843.21	567.89
3 – Back	25	481.96	342.76	24	795.83	512.87
4 – Back	25	377.20	185.49	21	694.19	523.12

Note: N-number of participants

4.2 Section II: Step I- Comparison between higher and secondary education group (response accuracy)

The performance for the Sem-back task (accurate response) of healthy individuals with higher education as compared with secondary education. For this between-group comparison, the Fisher Exact Test was administered using SPSS (PASW) Version 23. The Fisher Exact Test is a test of significance that is used in place of a chi-square test in 2 by 2 tables, especially in cases of small samples. The *p*-value in this test is especially to find the association between the performance of the task between the HE and SE in all the N-back tasks under the semantic category 'Fruits', 'Common Objects', and 'Vehicles', the results with the *p* value are represented in Table 4.2.

Table 4.2

Results of Fisher Exact Task for between-group comparison *at the N-back task of semantic categories - Fruits, Common Objects, and Vehicles.*

Working Memory Sem-Back Task/Level	**Fruits**	**Common objects**	**Vehicles**
	***P* value**	***P* value**	***P* value**
1 – Back	0.50	0.24	-
2 – Back	0.50	0.11	0.50
3 – Back	0.49	0.02*	0.50
4 – Back	0.00**	0.00**	0.05*

Note: * P <0.05, ** P< 0.01

For the semantic category 'Fruits' there was association between HE and SE for the 4-back level and for the semantic category 'Common objects' the association was found between HE and SE group at the 3-back and 4-back level. For the semantic category 'Vehicle' the association was found at the only 4-back level. At 1-back in this category, the test could not be performed because all the participants of HE and SE group had performed equally.

4.2 Section II: Step II- Comparison between higher and secondary education group (reaction time)

The between-group comparison with reference to reaction time in millisecond was tested using the Mann Whitney Test for 1 – Back, 2 – Back, 3 – Back, 4 – Back level of semantic category Fruits, Common Objects, and Vehicles.

TABLE: 4.3

Results of Mann-Whitney Test between HE and SE for the N-back task of semantic categories

Working Memory Sem-Back Task/Level	**FRUITS**		**COMMON OBJECTS**		**VEHICLES**	
	/Z/	***P* value**	**/Z/**	***P* value**	**/Z/**	***P* value**
1 – Back	-1.49	0.13	-1.15	0.24	-3.91	0.00**
2 – Back	-1.22	0.22	-2.17	0.03*	-2.72	0.00**
3 – Back	-2.03	0.04*	-2.81	0.00**	-2.48	0.01*
4 – Back	-.935	0.35	-1.87	0.06	-2.21	0.02*

Note * P <0.05, ** P<0.01

From the Table 4.3 with the *p* value, there was a significant difference between HE and SE group for the semantic category 'Fruit' was at a 3-back level, for the semantic category 'Common Object' significant difference was at 2-back and 3-back level and for the semantic category 'Vehicles' significant difference was at 1-back, 2-back, 3-back, and 4-back.

4.3 Section III: Step I- Comparison within higher and secondary education group (n-back levels)

Within group comparison was done using Friedman test, a non-parametric test to find the significant difference between the n-back levels for the semantic categories ‘Fruits’, ‘Common Object’ and ‘Vehicles’ by considering the reaction time score. Initially, under each semantic category, all the n-backs (1-back, 2-back, 3-back and 4-back) were compared for both the groups separately HE - Elderly individuals with Higher Education (Group I) and SE - Elderly individuals with Secondary Education (Group II). There was no significant difference between the n-back levels for both the groups as shown in Table 4.4 with the *p* value.

TABLE: 4.4

Results of Friedman Test for within-group comparison (n-back levels).

Semantic categories	GROUP I (HE)	GROUP II (SE)
	***P* value**	***P* value**
Fruits	0.08	0.07
Common objects	0.08	0.21
Vehicles	0.23	0.60

4.3 Section III: Step II- Comparison within higher and secondary education group (semantic categories)

Within group, comparison was done using Friedman test, a non-parametric test to find the significant difference between the semantic categories ‘Fruits’, ‘Common Object’ and ‘Vehicles’ by considering the reaction time score at each n-back levels separately for Group I and Group II.

In Group I, within-group comparison at the semantic categories, there was a significant difference at a 1-back level only. Similar results were obtained for Group II and the same with the *p* value is shown in Table 4.4.

TABLE: 4.5

Results of Friedman Test for within-group comparison (semantic category)

Working Memory Sem-Back Task/Level	**GROUP I (HE)**	**GROUP II (SE)**
	***P* value**	***P* value**
1-BACK	0.03*	0.02*
2-BACK	0.18	0.86
3-BACK	0.14	0.20
4-BACK	0.59	3.95

Note * *P* value <0.05

Since there was significant difference at 1-back and no significant difference at 2-back, 3-back and 4-back among the comparison of the three semantic categories, Wilcoxon signed Rank test was administered to check the pair-wise comparison. The result of this Wilcoxon signed Rank test with the *p* value is shown in Table 4.5. There was significant difference when the semantic category ‘common object’ was paired with ‘fruits’ in Group I and Group II. When the other pair of semantic category ‘vehicle’ was paired with ‘fruit’ the significant difference was found only in the Group I. Other pair was between the semantic category ‘vehicle’ and ‘common object’, where there was no significant difference. All these three pairs were only at the 1-back level.

TABLE: 4.6

Results of Wilcoxon signed the Rank test for 1-back of semantic categories.

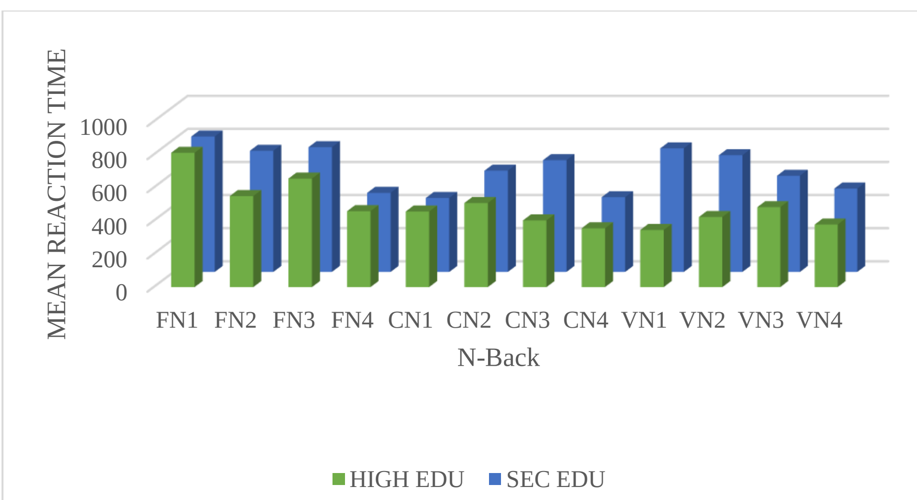
Semantic category pairs for 1-back level	GROUP I (HE)	GROUP II (SE)
	***P* value**	***P* value**
CNI – FN1	0.02*	0.03*
VN1 – FN1	0.00**	0.17
VN1 – CN1	0.15	0.10

Note * *P* <0.05, ** *P*< 0.01

To summarize the results of the present study, from the Figure 4.1, elderly individuals with higher education (Group I) had the mean reaction time lower than the elderly individuals with secondary education (Group II). The better performance in all the backs under each semantic categories 'Fruits', 'Common Objects', and 'Vehicles' was better for HE. All could perform until 4-back levels in all the semantic categories.

Figure 4.1

Mean reaction time for N- back levels of semantic categories of Group I and Group II.



In between-group comparisons, there was significant difference between the groups for the 3-back of semantic category ‘common object’ and 4-back back of semantic category ‘fruits’, ‘common objects’ and ‘vehicles’.

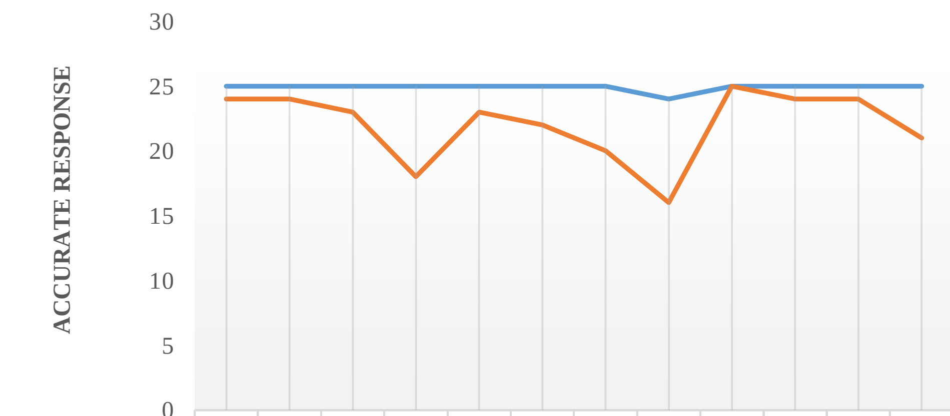
Following this, between group comparison with reference to individual semantic category suggested that the semantic category ‘fruits’, 3-back level showed significant difference between the groups. Similarly the semantic category ‘common object’, 2-back and 3- back showed significant difference between the groups. Finally, the semantic category ‘vehicle’, 1-back, 2-back, 3-back and 4-back showed significant difference between the groups.

Finally, within group comparison was also studied at n-back levels and semantic category. With reference to n-back levels for the semantic categories of ‘fruit’, ‘common object and ‘vehicles’ there was no significant difference within Group I and Group II. With reference to semantic categories at the n-back levels, 1-back only showed significant difference in Group I and Group II. This was further tested by forming pair of two semantic category for Group I and Group II, the semantic pair ‘common object’- ‘fruit’ and ‘vehicle’- ‘fruit’ showed significant difference for Group I. and semantic pair ‘common object’- ‘fruit’ showed significant difference in Group II.

The additional observation of the present study is the frequency distribution of level/accuracy of n-back working memory capacity at 1-back, 2-back, 3-back and 4-back for all the semantic categories ‘fruit’, ‘common object’, ‘vehicle’ of elderly individuals with higher education and secondary education is graphically represented in Figure 4.2. Firstly, in the Group I, for the semantic category ‘fruits’ – there was 100% accuracy for all the back. For the semantic category ‘common objects’ – there was 100% accuracy for all the back except for 4-Back there was 96% accuracy since there was 1 inaccurate response in 4-Back task. For semantic category 'vehicles' – there was 100% accuracy for all the back. Secondly in the Group II, for the semantic category 'fruits' – there was 96% accuracy in 1-Back and 2-Back, 92% accuracy in 3-Back, 72% accuracy in 4-Back. For the semantic category 'common objects' – there was 92% accuracy in 1-Back, 88% accuracy in task 2-Back, 80% accuracy in 3-Back, and 64% accuracy in 4-Back. Thus, the accuracy/level/threshold of n-back task of working memory assessment was relatively standard and same irrespective of the semantic category in Group I whereas it was varied in Group II.

Figure 4.2

Level/accuracy/threshold of working memory of Healthy Elderly Individuals with HE and SE for semantic categories.



	Fruits				Common Objects				Vehicles			
	1 back	2 back	3 back	4 back	1 back	2 back	3 back	4 back	1 back	2 back	3 back	4 back
HIGH EDU	25	25	25	25	25	25	25	24	25	25	25	25
SEC EDU	24	24	23	18	23	22	20	16	25	24	24	21

CHAPTER V

DISCUSSION

The study aimed to measure working memory in healthy elderly individuals with higher education and secondary education and specifically to identify if whether a relationship exists between working memory ability and linguistic (semantic) processing ability in healthy elderly individuals with different educational backgrounds. It is evident that in any individual's aging process there is a decline in the cognitive process and which never leaves alone working memory capacity. But the presence of cognitive reserve which is stronger in the more educated individuals than in the less educated individuals helps the individuals in performing better.

In the present study, the cognitive processes in terms of working memory capacity were assessed using the n-back task in healthy elderly individuals with higher education and secondary education. This working memory task used the lexical category like fruits, common objects, and vehicles as the markers of linguistic skills (Sem-back). This working memory task was administered to find the presence of cognitive impairment and to explore whether there is a possible relationship between poor working memory with reference to individuals' educational status in elderly individuals. The results of this working memory assessment are discussed in the following sections.

5.1 Between-group comparison (Healthy Elderly Individuals with Higher Education- HE and Secondary Education- SE) - Reaction time and accuracy score

The attempt in the present study was made to study the working memory differences between healthy elderly individuals with higher education and secondary education. With reference to mean scores, it was very evident from the present study that there was a better performance by the elderly individuals with HE than the elderly individuals with SE. The reaction time for all the Sem-back categories (fruits, common objects, vehicles) used in the working memory task was better performed by the elderly individuals with HE than with SE. The reaction times were less for higher educated healthy elderly individuals than the secondary educated elderly individual. However, the semantic category ‘vehicle’ is more effective to differentiate the elderly individuals with different education status when compared to ‘fruit’ and ‘common object’. Hence, the semantic category ‘vehicle’ is more effective to differentiate the elderly individuals with different education status when compared to ‘fruit’ and ‘common object’. Because from the 1-back till 4-back there was only a significant difference between the two groups HE and SE for the semantic category ‘vehicle’.

The possible reason for this is the cognitive reserve being higher for highly educated individuals as they were able to compensate well in the task using the cognitive reserve which was well enriched because of their education and the brain networks helped them to perform with correct accuracy (Kramer et al. 2004; Park & Reuter-Lorenz, 2009). To add on the cognitive reserve present for both the elderly group in terms of the neural connections are found to be stronger in the higher educational status of elderly individuals than in secondary educational status (Beurskens & Dalecki, 2017; Christensen et al., 2008).

With reference to the accuracy of the response, the accuracy of the response was better for the higher educational status compared to the secondary educational status. There was 100% response for the category ‘fruits’ and ‘common objects’, whereas for the semantic category ‘vehicles’ it was 99% with one person who responded inaccurately from the elderly individuals' group with higher education. So totally all the responses when combined there was 99%

response in the elderly individuals' group with higher education. The accuracy of response in the group with secondary education for the semantic category ‘fruits’ was 89% and for ‘common objects’ 88% and finally for ‘vehicles’ 94% overall the response was 88%.

In the group with elderly individuals with secondary education, the accuracy of the response was increasing as the task was progressing. Initially, for ‘fruits’, it was around 89%, and then there was a dip due to poor performance by one more elderly individual in the category ‘common objects’ making it much more difficult and finally, in the category ‘vehicles’ there are 94% accurate responses. This change is responses/accuracy scores could be due to as and when one category was getting completed, the group with secondary education had learned to perform better over the experiences in the other two categories and this leads to better performance over time with better accuracy in the ‘vehicles’ category. There was a learning effect seen when elderly individuals with secondary education had performed the task. The other possible reason for the differences between the groups could be the increased cognitive load in the certain semantic category, for example, the semantic category ‘vehicle’ there was poorer response observed in the group with secondary education. This could be due to poor cognitive flexibility and cognitive reserve to act for the semantic category of different cognitive loading tasks.

To support the above finding, it is difficult for elderly individuals for new learning than by young adults (Woods, Delis, Scott, Kramer & Holdnack, 2006). Reduced processing speed, reduced ability to ignore irrelevant information, and decreased use of strategies to improve learning and memory leads them to perform poorer in the tasks. All these above-given strategies by Woods, Delis, Scott, Kramer, and Holdnack (2006) was unused by the healthy elderly individuals even in the current study. As they become stricken in age their ability to apply all of these three different strategies was impossible.

With reference to fluid intelligence, according to Harada (2013), there is always a decline in the processing speed, divided and sustained attention at an estimate rate of 0.02 standard deviation per year. Under cognitive domains abilities such as executive function, processing speed, memory, and psychomotor ability. Therefore, fluid intelligence keeps decreasing as the load of the tasks increases, and also as the age increases. Especially in the population with lesser education or secondary education as in the present study the fluid intelligence is less for the people with secondary education and higher in people with higher education even in an elderly population.

5.2 Within-group comparison- (Semantic category and n-back levels)

When there was a comparison made within the category 'fruits' and under it, all the back values were compared and similarly was done for 'common objects' and 'vehicles' there was no significant difference found for both groups HE and SE. This finding suggests that all the individuals of this study have performed well in the n-back without any significant difference within the group but only between the two groups there was a significant difference. This suggests that in this task as soon as one category is started the brain activity is stable and stays the same for all the four backs and thus there was no fluctuation between the backs under each category for both the groups. Therefore within the elderly individuals with higher education status and secondary education, there was no difference between n-backs for all the semantic categories even though there was a difference in terms of mean reaction time.

Irrespective of the category once the individuals started doing the task be it easy or tough category the mean reaction time was less or high respectively for both HE and SE groups. This explains that the brain neural networking either works fast or slow based on the Sem-back category used to test if it is easy all the back had a lesser reaction time if the category was little tough also the mean value was equally high for all the backs. This explains why there was no significant difference in each category.

Finally, within-group comparison was also studied at n-back levels and semantic category. With reference to n-back levels for the semantic categories of ‘fruit’, ‘common object and ‘vehicles’ there was no significant difference within Group I and Group II. Therefore within the elderly individuals with higher education status and secondary education, there was no difference between n-backs for all the semantic categories even though there was a difference in terms of mean reaction time. This explains that the brain neural networking either works fast or slow based on the Sem-back category used to test if the semantic category (relatively ‘fruit’ and ‘common objects’ were easy) is easy all the back had a lesser reaction time if the semantic category (relatively ‘vehicle’ was tough) was little tough also the mean value was equally high for all the backs. This explains why there was no significant difference in each category.

With reference to semantic categories at the n-back levels, 1-back only showed a significant difference in Group I and Group II. This suggests that only at 1-back level, the semantic category will influence the elderly individuals with higher education and secondary education to perform in an n-back working memory task involving semantic load more effectively. And at 2-back, 3-back and 4-back, the semantic category is not so effective to cause the differences in the semantic load for elderly individuals with higher and secondary education. From the explanation, we can see that the load insensitive task like 1-back has found significant difference which clearly explains the task was easy to be performed for some category but not for others. This part of the discussion is in agreement with the study done by Jansma, Ramsey, Coppola, and Kahn (2000). Less loading tasks or load insensitive tasks usually have fewer effects on cognitive performance. And in the present study, it has been taxing for one or two categories and the other category was load- insensitive.

Further, the semantic category was compared to pairwise within each group. In a group with individuals with higher education, the semantic pair of 'fruit-vehicle', fruit-common object' had a significant difference. Whereas in a group with secondary education, the semantic category 'common object- fruit' only had a significant difference. This suggests, the group with higher education performed well in the category 'vehicles' than in 'fruits'. This explains that more educated elderly people are more concerned and performed well in the 'vehicle' category which is more semantically loaded and requires a good amount of educational knowledge to explore the semantic category called 'vehicle'. For both the groups, the 'common objects' were little more taxing than 'fruits' but still lesser loading than 'vehicles' which were toughest among all.

This finding is in total agreement with the study by Plisatsikas (2018) when the complexity of the task increases the mean reaction time also increased. The study was on 764 individuals with working memory assessment and found that there is a difference between the task load i.e. when doing an n-back task 1- bask task meantime was better than the 2-back task and as the load increased to 2-back the accuracy was also poorer in the elderly individuals. Specifically in this study when accuracy was taken for 1-back the accuracy was better when compared to the 2-back task. Similarly, the present study also showed the mean reaction time of the 1-back being better than 4-back. There are also contradictory findings by Guzman, Mikel, Vicente, and González (2014). In the n-back task, the outcome that was measured was the score and the hit reaction time. The hit reaction time showed acceptable internal consistency, reasonable factorial structure, as well as good criterion validity and statistical dependencies. Between the stimuli, there was no statistical difference found for color, letters, numbers, and words, and also for the load difference 1-back, 2-back, 3-back has had no significant difference between the loads. In the present study, there are significant differences within the categories and also with the n-back with the performance of the healthy elderly individuals with higher education and secondary education.

A person with 18 years of education performed better when compared to people with only 6 to 10 yrs of education in a study by Plisatsikas (2018). In the present study also the participants with minimum 12 to maximum 16 years of education who comprising the group with higher education performed better. The individuals with the education of a minimum of 8 to a maximum of 10 or 11 years who comprised the group with secondary education performed poorer.

The participants responded better with verbalization, as the task was going on they verbalized and responded. The better responses of the individuals in both the group with verbalization are in accordance with the study conducted by (O'Donnell, Clement, & Brockmole, 2018).

On observation, a final contributing factor could be the social life, the people who had an active life even after having lesser education had a better performance in the working memory task and also if the individuals had poor social or passive lifestyle even if they had a higher education their performance was poor. Their profession and leisure time also affected the Sem-back task, which could be concluded as the possible reasons in the present study, even after having a proper and higher education keeping the brain at rest or giving only passive tasks may lead to poor performance in the task irrespective of education. Especially in elderly individuals, this is mostly correlated with mild cognitive impairment and Alzheimer's whose onset is in the late '50s or '60s after the brain is led to a period of passive working rather than actively working.

Chapter VI

SUMMARY AND CONCLUSION

The present study aimed to investigate the working memory capacity of elderly individuals with higher education in comparison with healthy elderly individuals with secondary education using distinct linguistic processing abilities (semantics) n-back task. The objectives of the study were first, to examine the reaction time and accuracy score of the Sem-back level in healthy elderly individuals with secondary education and age-matched individuals with a higher educational background using the Sem-back task programmed in E-Prime software. Secondly, to study the effect of different educational background on reaction time and accuracy score of Sem-back level of healthy elderly individuals in processing distinct linguistic information (semantic) in the Sem-back task.

Fifty participants were included in the present study, Group I consisting of 25 Healthy Elderly Individuals with Higher Education and Group II consisting of 25 Healthy Elderly Individuals with Secondary Education. All the individuals were age-matched and between the age ranges from 55 to 80 years. All the participants were native Tamil speakers who knew how to read and write in the Tamil language and knowledge of other language were also noted. All the participants had undergone a cognitive screening test using MOCA and passed in it. And were checked for adequate dexterity control which was necessary for performing the n-back task using E-prime software. The hearing, vision, and physical ability were also checked and ruled out before testing.

Psychology Software Tool’s E-Prime software (version 2.0) was used to perform the test. The Sem-back task is a replication of the N-back task using three semantic categories (fruits, common objects, vehicles) linguistic markers with 10 sets of stimuli under each category. All the stimuli were presented using a flat-screen monitor and they were seated 50 cm from the screen. The task began with one set of a trial stimulus with a 1-back task and then followed by the test stimulus.

For the sem-back matching task, items were presented centrally following a fixation cross for the duration of 4000 msec for each sentence, and the participants were asked to match for 1-back, 2-back, 3-back, 4-back. Participants were asked to respond for the match as 1-back or 2-back or 3-back or 4-back using a keypress (Number Key -1) on a standard US keyboard. If there is no match or no N – back found they have to press (Number Key - 2) on a standard US keyboard. Thus, the stimuli were distributed equally across the participants (two groups). Reaction time and accuracy data were recorded in the E-Prime software. The performance was tabulated in terms of the accuracy and the reaction time for the healthy elderly individuals with higher education and secondary education separately and was subjected to statistical analysis.

The mean value of the Sem-back task was obtained by taking the best value out of three trails from the two cache trails and later all the values were considered for mean calculation. Descriptive statistics mean and standard deviation of Sem-back task (1-back, 2-back, 3-back, and 4-back) concerning the reaction time in terms of a millisecond for three different semantic categories (fruits, common objects, and vehicles) markers of linguistic skills were obtained for healthy elderly individuals with higher education and secondary education. It was observed that the mean reaction time (in terms of milliseconds) and the accuracy of the response was better for elderly individuals with higher education when compared to elderly individuals with secondary education.

To study the significant differences between healthy elderly individuals with higher education and secondary education regarding this working memory capacity of Sem-back task the Fisher Exact test and Mann Whitney U test was done. From the former test, there was a significant difference between two groups in the semantic category ‘fruits’ 4-back, ‘common objects’ 3-back, and 4-back and ‘vehicles’ 4-back with reference to the accuracy of the response obtained from the participants. In the later test, there was a significant difference found between the two groups for the mean value (in terms of milliseconds). Under the category ‘fruits’ 3-back, ‘common objects’ 2-back, and 3-back, ‘vehicles’ all the back had a significant difference. Of all the three categories ‘vehicles’ linguistic category had a more significant difference.

When the Friedmann test was done to study the within-group effects for subcategories and the n-backs. In the category fruits, common objects, vehicles considering the reaction time in healthy elderly individuals with higher education and secondary education there was no significant difference within the category. When the same test was carried out between each back of each category, there was a significant difference found for 1 back in both the groups with HE and SE. Of which the Wilcoxon signed-rank test was administered to find the better category which had a more significant difference. There was a significant difference presence for the category in both the HE and SE group were ‘fruits’ and ‘common objects’ and in the HE group, there was a very significant difference in the category between ‘vehicles’ and ‘fruits’.

The semantic category ‘vehicles’ was performed well by the HE and then comes ‘common objects’ then poorly performed was the category ‘fruits’. In the group SE the better-performed category was ‘common objects’ then comes ‘vehicles’ and the poorly performed was the category ‘fruits’. The threshold for the n-back in the HE group was 4 back of response and for the SE group it was 3 back with only 73% of response for 4-back and with 89% of response for 3- back above 80% of response on each back was considered as the threshold of response. Therefore the elderly individuals with higher education have a better response than with secondary education. The threshold for higher educated elderly was 4- back and the threshold for secondary educated is 3 –back.

The contributing features for the poorer performance in elderly individuals with secondary education would be the weaker connections in the brain because of the poor neural connectivity in the brain and lesser education. Reduced physical activity can also be a contributing factor. The other factors could be attributed to the rich lexical knowledge in the higher educated than in secondary educated elderly individuals.

The elderly individuals with secondary education had performed better when taken individually this can be contributed to the active years they had spent even after less education. Keeping oneself active in social life is a major contributing factor to better performance. The overall poor performance by the elderly individuals with secondary education cannot be compared to the poorer cognitive abilities specifically working memory but also to the poor linguistic ability in the individuals with secondary education than the higher education. The processing load might be different for different semantic categories which have contributed to show different n-back levels till 4-back. The individuals with healthy elderly individuals could not easily encode because of the semantically loaded Sem-back task stimuli because of the poorer linguistic network in secondary education. There is a need for further study attempting to find the threshold of n-back through the use of different semantic categories to comment about the cognitive flexibility in elderly individuals with normal aging and pathological aging since the present study was for the paradigm created only till 4-back.

6.1 Implications

This study provided an understanding of the impact of age and education in working memory. The increased reaction time was an indication of depression or poor educational background. Thereby it could be used as an early detector to find the latter effects like MCI or Dementia in elderly individuals with different educational backgrounds. Knowing the effect of normal aging on n- back tasks using E-prime software would lead us to a crystal clear screening approach before the diagnostic approach when there would be a still more delay. At risk of MCI or dementia in elderly individuals with different educational backgrounds could be identified and given proper guidelines for further speech-language and cognitive support.

6.2 Limitations and future directions

Further, the same study can be replicated among elderly individuals with similar educational status and having an active or passive lifestyle, elderly individuals who had education with upgrading professional career life, and static professional career life. The future study should focus on obtaining the n-back threshold since the present study was planned until the 4-back level only. This future studies would give us more understanding of the elderly brain activity with reference to their cognitive abilities. The possible reason for the poorer performance even after better educational status would be interesting to discuss. This software-based task (E-prime Sem back) with proper psychometric properties could be used for the diagnostic and treatment purpose in cognitive-linguistic impairments or memory-related language issues or age-related changes in language usage.

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APPENDIX A

The 28-items of the scaled version of the GENERAL HEALTH QUESTIONNAIRE (Goldberg and Hillier 1979)

HAVE YOU RECENTLY:

1. Been feeling perfectly well and in good health?
2. Been feeling in need of a good tonic?
3. Been feeling run down and out of sorts?
4. Felt that you are ill?
5. Been getting any pains in your head?
6. Been getting a feeling of tightness or pressure in your head?
7. Been having hot or cold spells?
8. Lost much sleep over worry?
9. Had difficulty in staying asleep once you are off?
10. Felt constantly under strain?
11. Been getting edgy and bad-tempered?
12. Been getting scared or panicky for no good reason?
13. Found everything getting on top of you?
14. Been feeling nervous and strung-up all the time?
15. Been managing to keep yourself busy and occupied?
16. Been taking longer over the things you do?
17. felt on the whole you were doing things well?
18. Been satisfied with the way you've carried out your task?
19. Felt that you are playing a useful part in things?
20. Felt capable of making decisions about things?
21. Been able to enjoy your normal day-to-day activities?
22. Been thinking of yourself as a worthless person?
23. Felt that life is entirely hopeless?
24. Felt that life isn't worth living?
25. Thought of the possibility that you might make away with yourself?
26. Found at times you couldn't do anything because your nerves were too bad?
27. Found yourself wishing you were dead and away from it all?
28. Found that the idea of taking your own life kept coming into your mind?

APPENDIX B

NIMH Socio-Economic Status Scale, Revised Version

(Venkateshan, 2011)

A.	**Pooled Monthly Income**		**Score**
	1.	Rs. 5000 or below	1
	2.	Rs. 5001 – Rs. 10000	2
	3.	Rs. 10001 – Rs. 15000	3
	4.	Rs. 15001 – Rs. 20000	4
	5.	Rs. 20001 & above	5
B.	**Highest Education**		**Score**
	1.	Illiterate	1
	2.	Primary/Secondary School	2
	3.	Matriculation	3
	4.	Graduation	4
	5.	Post Graduation & Above	5
C.	**Occupation**		**Score**
	1.	Unskilled labor/Unemployed/Daily Wager	1
	2.	Semi-skilled Worker/Class IV Service	2
	3.	Skilled/Technical/Class III Service	3
	4.	Professional/Class II Service/Blue Collared Jobs	4
	5.	Specialized/Class I Services/White Collared Jobs	5
D.	**Family Properties (Immovable & Movable)**		**Score**
	1.	Nil or Below Rs. 50000	1
	2.	Between Rs. 50000 to Rs. 1.5 Lakhs	2
	3.	Between Rs. 1.5 Lakhs to Rs. 2.5 Lakhs	3
	4.	Between Rs. 2.5 lakhs to Rs. 5.0 Lakhs	4
	5.	Above Rs. 5.0 Lakhs	5
	Total		

Note: Circle the appropriate score and enter sum into the cell against 'Grand Total'; Interpretative Norms for Obtaining Overall SES: 0-4 is SES I; 5-8 is SES II; 9-12 is SES III; 13-16 is SES IV; 17-20 is SES V.

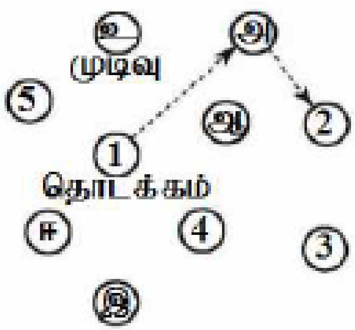
APPENDIX C

மொன்றியல் அறிவாற்றல் மதிப்பீடு (MOCA)
Tamil Version

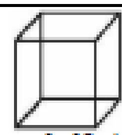
பெயர்:
கல்வி:
பால்:

பிறந்த திகதி:
திகதி:

காட்சி அமைப்பு / நிறைவேற்று செயலாண்மை



[ ]



கனசதுரத்தை பிரதிசெய்தல்

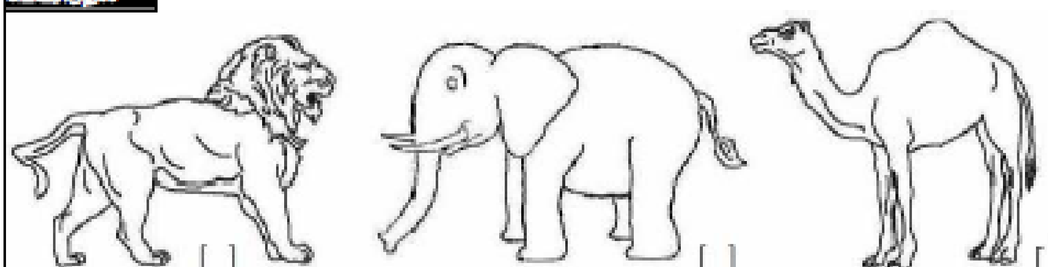
[ ]

மணிக்கூடு வரைதல் (பதினொரு மணி பத்து நிமிடம்) (3 புள்ளிகள்)

[ ] உருவரை [ ] இலக்கம் [ ] கைகள்

__/5

பெயரிடுதல்



[ ] [ ] [ ]

__/3

நினைவு

[illegible]

	முகம்	பட்டு	கோவில்	மல்லிகை	சிவப்பு	
1வது தேர்வு						புள்ளிகள் இல்லை
2வது தேர்வு						

கவனம்

பட்டியலிடப்பட்டுள்ள எண்களை வாசித்தல் (1எண்/செக) — [illegible] [ ] 2 1 8 5 4

[illegible] [ ] 7 4 2

__/2

[illegible] ≥2 [illegible]

[ ] க ம எ உ ந ம எ எ த ம ட ம எ க எ ம ன ல எ எ எ த எ ந ப க எ எ ம

__/1

தொடர் 7 கழித்தல். 100 இருந்து ஆரம்பிக்கவும். [ ]93 [ ]86 [ ]79 [ ]72 [ ]65

4 அல்லது 5 சரியான கழித்தல்:3 புள்ளிகள், 2 அல்லது 3 சரியான கழித்தல்: 2 புள்ளிகள், 1 சரியான கழித்தல்:1 புள்ளி, 0 சரி:0 புள்ளி

__/3

மொழி

ஒப்புவித்தல் [illegible] [ ]

[illegible] [ ]

__/2

[illegible] / ஒரு நிமிடத்தில் [illegible] "க" [illegible] [ ] ___ (N≥11 சொற்கள்)

__/1

கருத்துப்பொருள்

[illegible] = பழம்

[ ] தொடர்வண்டி - மிதிவண்டி [ ] கைக்கடிகாரம் - அளவுகோல்

__/2

காலந்தாழ்ந்திய நினைவு கூர்தல்

		முகம்	பட்டு	கோவில்	மல்லிகை	சிவப்பு	
[illegible]		[ ]	[ ]	[ ]	[ ]	[ ]	[illegible] புள்ளிகள்
கட்டாயமற்றது	வகை நினைவுச் சொல்						
	பல்தேர்வு நினைவுச் சொல்						

__/5

ஆள்குறிப்பிடுதல் [ ] திகதி [ ] மாதம் [ ] ஆண்டு [ ] கிழமை [ ] இடம் [ ] நகரம் __/6

இயல்பான நிலை ≥ 26/30

மொத்தம் __/30

[illegible] 1 புள்ளியினை சேர்க்கவும்.

APPENDIX D

CONSENT FORM

All India Institute of Speech and Hearing, Naimisham Campus,
Manasagangothri, Mysore – 570006.

Dissertation on

Working Memory Assessment in Healthy Elderly Individuals with Different Educational Background Using Distinct [Semback] Linguistic Processing Ability

Information to the participants

I, Ms. Jasper Priences. V studying II Msc SLP at AIISH doing a dissertation project titled – ‘’Working Memory Assessment in Healthy Elderly Individuals with Different Educational Background Using Distinct [Semback] Linguistic Processing Ability’’ with the Principal Investigator Dr. Hema N., Assistant Professor, Dept. of Speech-Language Sciences, AIISH, Mysore – 6. The present study aims to assess the working memory capacity and its effect on healthy elderly individuals with different educational backgrounds using the Semback task programmed in E-Prime software. I need to collect data from 60 individuals in the age range of 60 to 90. Information will be collected through a task in E - Prime software. I assure you that this data will be kept confidential. There is no influence or pressure of any kind by us or the investigating institute to your participation and the research procedure is different from routine medical or therapeutic care activities. There is no risk involved to the participants but your cooperation in the study will go a long way in helping us in understanding working memory in elderly individuals and it will thus assist in the assessment and treatment of these individuals.

Informed Consent

I have been informed about the aims, objectives, and the procedure of the study. I understand that I have a right to refuse participation as a participant or withdraw my consent at any time.

I, ____, the undersigned, give my consent to be participant of this investigation/study/program.

Signature of participant — Signature of the investigator

(Name and Address) — Date

____