Cognitive linguistic abilities across different vocations

Project under AIISH Research Fund (ARF)
(2016-2017)

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Abstract

Project title: Cognitive linguistic abilities across different vocations

Aim and objectives: The present study aimed at investigating the role of different vocations on various cognitive linguistic domains. This study also sought to identify the influence of age, gender and other variables such as duration of occupational experience, level of education, number of languages, SES and substance abuse in cognitive linguistic performances among older adults.

Method: Over 120 participants of both the genders aged between 45-75 years were recruited based on their major lifetime vocation. Participants were categorized into 3 vocations (vocation 1- Doctors, lawyers and professors; vocation 2- School teachers and sports trainers; vocation 3- Manual labourers and security guards) and 3 age groups (45-55 years, 55-65 years and 65-75 years). MMSE and CLAP were administered on these participants and their responses were scored and subjected to statistical analysis.

Results: findings suggested that participants' vocation was strongly associated with their cognitive linguistic performances. Age and gender also revealed some significant changes with interaction effect of vocation. The most significant positive association was observed in the time taken for CLAP domains indicating processing speed as the most sensitive measure. Furthermore, for participants aged over 65 years, effect of retirement with relatively steeper cognitive linguistic decline was noted. Further investigation to determine the influence of other variables also demonstrated significant effect on task performances on CLAP and MMSE.

Conclusions: Results of this study have implications for developing effective preventive interventions or cognitive linguistic training programmes for cognitive linguistic decline and dementia/mild cognitive impairment targeting to prevent or at least delay the onset of clinically significant symptoms. This may also aid in early identification/risk of developing dementia/cognitive impairment and help in the process of escalating the recovery rate like in other neuro-pathological disorders.

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Chapter 1

"If we can control the environment in which rapid cognition takes place, then we can control rapid cognition (Malcolm Gladwell, 2005)"

INTRODUCTION

Cognitive abilities involve a wide range of mental processes such as attention, perception, pattern recognition, memory, organization of knowledge, language, reasoning, problem solving, classification, concept and categorization (Best, 1999). These cognitive abilities are interrelated with one another rather than existing as discrete entities. According to Neisser, (1997) cognitive abilities of an individual are determined by those processes through which information is transformed, elaborated, reduced, stored, recovered and used. However, Chapey (1994) explains that cognitive abilities exist as five mental operations: Recognition/Understanding, Memory, Convergent thinking, Divergent thinking, and Evaluative thinking. On the other hand, Language is considered to be "a tool for thinking" and greater part of all cognitive abilities is mediated by language (Vygotsky, 1986). Thus, researchers argue that language development and cognitive development are interwoven.

There is an intricate relationship between a person's cognitive capacity and linguistic skills which begins to emerge right from infancy. In agreement to this statement, Piaget, (2002) enlightens this relationship by integrating the process and product of cognitive abilities with linguistic abilities at various stages of early development where children develop through different cognitive requirements and linguistic accomplishments. Likewise, Hoskins, (1979) stated that much of language learning is a cognitive process involving problem solving activities such as hypotheses testing and modification based on feedback. Whereas, Bloom & Lahey, (1978) suggest that cognitive abilities constitute the major foundation or underpinning for language. The cognitive abilities such as attention, memory, organization, reasoning, problem solving and meta-cognitive thinking are important for comprehension and production of language. Recently researches are directed towards cognitive communication disorders in which language appears to be deviant along with other cognitive faculties. This ‘‘coupling’’ of linguistic skills and cognitive abilities has been interpreted by some as evidence for the interdependence of linguistic and cognitive development. In most cases, however, strengths and weaknesses in language and cognition are relative rather than absolute and therefore, the process of quantifying impairments becomes straightforward with assessment of "***cognitive linguistic abilities***". The major goal of researchers in the field of Speech Language Pathology is to study how these cognitive abilities are utilized during language behaviour and which cognitive domain when tapped improves the comprehension and production of language.

Evaluating "***cognitive linguistic abilities***" allow us to gain insight of language use when we engage in any language activity, we draw naturally on vast cognitive resources, derive models and frames, set up multiple connections, organize and manage large arrays of information, engage in creative mappings, transferals and elaborations. Hence, various standardised tests are available such as Cognitive Linguistic Assessment Protocol (CLAP) (Kamath & Prema, 2001; Rajasudhakar & Shyamala, 2005), Cognitive Linguistic Quick Test (CLQT) (Helm-Estabrooks, 2001), Cognitive Linguistic Assessment Protocol in Children (CLAP-C) (Anuroopa & Shyamala, 2006), Measures of Cognitive-linguistic abilities (MCLA) (Ellmo, Graser, Krchnavek, Hauck & Calabrese, 1995), Boston Naming test (Goodglass & Kaplan, 1983) etc. that are used to assess ***cognitive linguistic abilities*** in individuals with cognitive communication disorders.

Cognitive linguistic dynamics reflected by “cognitive linguistic abilities” is guided by general cognitive processes that underlie natural linguistic processing. The development of these cognitive linguistic abilities throughout life is influenced by several internal (biological characteristics of the individual) and external factors (environmental factors). There is growing evidence in the literature that the structure of the environment has an important effect on cognitive linguistic development and that cognitive linguistic abilities do not become impervious to environmental influence after adolescence or early adulthood but continue to show "plasticity" throughout the life span (Baltes, 1968; Horn & Donaldson, 1976; Baltes & Schaie, 1976). Research findings support this conclusion by showing that cognitive linguistic flexibility continues to be responsive to environmental experiences even in middle age-career and beyond.

The intrinsic and extrinsic variables that may account for changes in cognitive linguistic abilities of an individual are age, gender, Intelligence Quotient (IQ), genetic and neurobiological factors, educational qualification, occupational characteristics, exposure to multiple languages, socio-economic status, substance abuse, career, lifestyle, hobbies, mental health (anxiety, depression, stress etc.), history/presence of neurological, psychological and sensory issues, physical/loco-motor disabilities, visual/hearing deficits and heath conditions such as renal failure, cardiac problems, diabetes, hypertension etc. The different components of cognitive linguistic abilities tend to follow relatively independent slopes throughout the life span depending on these intrinsic and extrinsic factors (Schaie, 1994). These factors are also responsible in shaping an individual’s ***“cognitive reserve”*** in old age and largely account for the existing individual differences in human performances in cognitive linguistic tasks. Besides, with much interaction of environmental factors (E.g. life experiences, occupational and educational characteristics etc.) and ability of the brain to reorganize its functions; sometimes, humans in later decades of their life span exhibit frequent discrepancy between measured neural correlates and the cognitive abilities. Many neuroimaging studies (fMRI, PET) during the performance of cognitive tasks in healthy older adults reveal that there is reduced activation in brain regions in individuals who perform better than those with poor performance (Haier, Siegel, Tang, Abel & Buchsbaum, 1992; Kosslyn et al., 1996; Larson, Haier, LaCasse, Hazen, 1995; Rypma & D'Esposito, 1999; Rypma, Berger, D'Esposito, 2002; Rypma et al., 2005).

Similarly, studies in neurocognitive aging/disorders have also found a discontinuity between brain pathology and its clinical manifestation. To account for this discrepancy/discontinuity, the concept of ***"Cognitive reserve"*** was proposed. Neurobiological attributes, along with life exposures, such as educational and occupational characteristics, engagement in leisure activities, being socially active have been proposed as elements of ***"cognitive reserve"***, protecting against the risk of developing dementia (Stern et al., 1994; Scarmeas et al., 2001; Valenzuela & Sachdev, 2006), traumatic brain injuries (Fay et al., 2010), Parkinson's disease (Poletti et al., 2011), multiple sclerosis (MS) (Sumowski et al., (2009), HIV-related dementia (Foley et al., 2012) and aids in successful aging (Suchy et al., 2011). Studies on factors such as educational attainment and occupational characteristics, which are believed to be strongly associated with ***"Cognitive reserve"*** have revealed an increased risk of dementia or cognitive impairment and poorer recovery from neuro-pathological diseases/disorders in individuals with low education and less complex occupations. The occupational roles that are regarded as 'complex' demand more mental effort, providing increased mental exercise leading to better intellectual/cognitive capacity in professionals. However, Education or occupational characteristics of an individual can be influenced by his/her early life cognitive ability and social determinants. Therefore, it can be argued that cognitive ability is an early life pre-requisite in attaining a successful education and career and in turn, aids in middle age “plasticity” and “cognitive reserve”. Hence, this relationship can be regarded as reciprocal. Direct causation cannot be concluded from the current researches owing to their limitations with respect to lack of prior cognitive linguistic measures and the use of short-term cognitive linguistic assessments. However, some researches have shown reciprocal effects in the relationship that exists between cognitive linguistic ability and occupational complexity.

1.1. Need for the study

There is dearth of literature evidences in Indian scenario regarding the potential role of lifestyle factors in delaying cognitive linguistic decline or protecting against the risk of dementia. Evidences in western studies also remain inconsistent, and it is still unclear whether or not these factors are directly linked to age related changes in cognitive linguistic functions or not. It is also necessary to understand the individual variability in cognitive linguistic decline demonstrated by older adults and to what extent educational or occupational characteristics affect cognitive linguistic decline. Furthermore owing to limitations in the previous literature, the association between proxy measures (educational attainment, occupational status and lifestyle) and different cognitive linguistic domains is also unclear. Caution must be taken before concluding based on equivocal causal association between occupational status and cognitive linguistic abilities. A life course model of cognitive reserve in aging effects/dementia risk is yet to be evaluated which can aid speech language pathologists to device prevention modules with systematic cognitive linguistic training to delay or prevent the risk of dementia/cognitive impairment.

However, studies documenting effects of occupational complexity do not measure the precise degree of changes and the duration of the impact. Researchers are still uncertain about, how much engagement in stimulating work environment is sufficient enough to impart cognitive reserve and protection against aging effects. Therefore, the present study was planned to investigate the effect of different vocations on cognitive linguistic abilities to address the general notion increased cognitive demands in the occupation facilitates cognitive linguistic abilities throughout life. This study will also shed light on whether co-variables such as age, gender, level of education, exposure to multiple languages, socio-economic status, substance abuse, lifestyle and hobbies contribute in sustaining cognitive linguistic abilities in advanced old age. Thus, it should be feasible to establish the degree of impact of extrinsic/environmental factors or life experiences on cognitive linguistic decline in an individual. Moreover, it would help us gain an insight on preventive cognitive linguistic training for patients with the risk of dementia/cognitive linguistic impairment and also escalate the speed of recovery in other neuro-pathological disorders.

1.2. Objectives of the study

1. To investigate the effect of different vocations on various cognitive linguistic domains

2. To study the extent of age-related changes in cognitive linguistic abilities across different vocations in three age groups (45-55 years, 55-65 years and 65-75 years)

3. To examine age and gender variability in cognitive linguistic abilities across different vocations

4. To explore the influence of other demographic variables in cognitive linguistic performances among older adults.

Chapter 2

REWIEW OF LITERATURE

Healthy aging is a gradual, constant process of multidimensional changes caused by mental waning due to emotional, physical and social burdens. It begins to present during adulthood with general wear and tear at anatomical and functional levels. These natural changes can be characterized as gradual decline in overall biological functions that may or may not result in undesired effects. Healthy aging, in general is accompanied by changes in physical performances and inability to process, recall, and comprehend complex stimuli. Lagishetti & Venkatesh (2011) describe healthy aging as characteristic pattern of age related changes in cognition and behaviour. This pattern of age-related declines in cognitive skills can be termed as ***'cognitive aging'***. The processes that weaken neural health and the individual's environmental exposures influence the rate of cognitive aging. Studies earlier have shown that healthy cognitive aging result in subtle age related decline in complex functional abilities (Anstey & Wood, 2011).

Changes in cognitive linguistic abilities are common problem reported among elderly people. Cognitive linguistic problems that arise due to aging leads to negative impact on an individual's emotion and social well-being. Many studies indicate domain specific age related cognitive linguistic changes and therefore, a linear relationship between age and cognitive linguistic decline cannot be assumed. Although, this age related decline may not be clinically significant, older adults often report difficulties with memory and speed of processing. Literature evidences reveal that cognitive linguistic abilities decline significantly before 50 years of age and more thereafter (Verhaegen & Salthouse, 1997). Elusive changes in cognitive linguistic functions are commonly reported and well established in older adults, even in the absence of significant cognitive impairment or dementia. Even among non-human species, age-related changes in memory and learning capabilities have been observed (Minois & Bourg, 1997; Bunk, 2000). Neural changes occurring in brain are likely responsible for the changes in cognitive linguistic functions associated with neuro-cognitive aging. Research findings confirm that cognitive linguistic decline with age is seen in domains such as memory, speed of processing, reasoning and executive function (Deary et al., 2009; Singh-Manoux et al., 2011). However, there are several variations in the rates of decline documented in each cognitive linguistic domain (Wisdom, Mignogna & Collins, 2012).

Crystallized and fluid intelligence conceptually delineates the changes in cognitive abilities over the lifespan. Skills, abilities, and knowledge that are learnt and made familiar over a period of time are termed as crystallized intelligence. Crystallized knowledge either remains constant or gradually expands through the sixth and seventh decades of life (Salthouse, 2012). Older adults seem to perform better in the tasks/activities demanding crystallized intelligence than younger adults since it is determined by an individual’s life experiences. Conversely, fluid intelligence is demonstrated by those cognitive skills which do not depend on a person’s past learning or experiences. It involves the innate abilities of an individual to process new information. These cognitive skills seem to peak at third decade of one’s life and decline rapidly thereafter (Salthouse, 2012). This distinction between crystallized and fluid intelligence is further supported by some researchers who found verbal abilities (crystallised ability) continuing to be resilient and poor performances in other cognitive linguistic abilities (reasoning, processing speed-fluid abilities) in older adults when compared to younger counterparts (Schwartzman, Gold, Andres, Arbuckle & Chaikelson, 1987); Blum, Jarvik & Clark, 1970).

Processing speed is measured with respect to speed of performance in tasks assessing cognitive linguistic skills and also the speed of motor responses. Several studies report slow performances of healthy older adults consequent to rapid decline in measures of processing speed. This may invariably impact on all cognitive linguistic domains.

The ability to direct ***attention*** on a specific stimulus shows a minor decline in late life (Lezak, Howieson, Bigler & Tranel, 2012). Significant age effect is seen in tasks requiring selective and divided attention (Salthouse, Fristoe, Lineweaver & Coon, 1995; Carlson, Hasher, Zacks & Connelly, 1995). Impaired attention may result in 'communication breakdown' as the individual tends to miss out on information in discourse.

One of the most common complaints reported by older adults is worsening of ***memory***. Explicit memory (conscious recall of facts and events) comprises semantic and episodic memory. Semantic memory includes reserve of information, usage of language, and practical knowledge (For eg. Knowledge of vocabulary and it's meaning). Episodic memory is tapped by personal experiences with respect to time and place. Decline in semantic and episodic memory is reported in older adults in different time frames wherein, episodic memory shows decline sooner and semantic memory deteriorates in late life (Ronnlund, Nyberg, Backman & Nilsson, 2005). On the other hand, procedural memory (implicit memory) seems to remain unaffected throughout the lifespan (Lezak et al., 2012). Older adults also demonstrate poor performances than younger adults in working memory (Salthouse, Mitchell, Skovronek & Babcock, 1989), recall and retrieval of recently learnt information (Haaland, Price & Larue, 2003; Price, Said & Haaland, 2004). However, retention of information in older adults is said to be preserved (Whiting & Smith, 1997).

Executing functioning involves wide range of cognitive skills such as self-monitoring, planning, organization, reasoning, problem solving and mental flexibility

(Lezak et al., 2012). Research evidences show that there is a gradual decline with age in abstraction, concept formation and mental flexibility besides, after the age of 70 years older adults begin to perceive and think in more concrete manner (Lezak et al., 2012). Aging also has negative impact over response inhibition (Wecker, Kramer, Wisniewski, Delis & Kaplan, 2000), inductive reasoning (Singh-Manoux et al., 2012).

Howieson, Holm, Kaye, Oken & Howieson, (1993) stated that visual construction skills (assembling some object with its parts) decline with age however, ***visuospatial abilities*** (the ability to recognize familiar objects, object perception, spatial perception, the ability to perceive an object's physical location in relation to other objects or space) remain intact.

Language is a complex cognitive domain involving several crystallised and fluid cognitive abilities. Overall language ability seems to remain stable across the life span and the minor age-related cognitive linguistic changes may be overlooked in everyday communicative environments. Nevertheless, in spite of trivial changes, cognitive linguistic abilities can aid in drawing a fine line between normal aging and pathological aging. In addition, it may help in understanding the cognitive decline related to language components. Vocabulary seems resistant to cognitive aging and may even improve with age (Park & Reuter-Lorenz, 2009; Salthouse, 2009).

Visual confrontation naming ability remains stable until seventh decade of life, and decline is perceived in subsequent years (Zec, Markwell, Burkett & Larsen, 2005). Whereas, verbal fluency exhibits obvious decline with aging (Salthouse, 2010; Singh-Manoux et al., 2012). This rapid decline in verbal fluency can be attributed to word recall or retrieval difficulties. This is also reflected while speaking and older adults generally complaint of experiencing "*tip of the tongue*" phenomenon. Semantic component is affected in older adults since they are less effective in learning or processing new lexical or semantic information (Thornton & Light, 2006). Although vocabulary remains intact or improves both at word level and sentence level, comprehension difficulties occur due to rapid decline in speed of processing the information and memory retrieval. Syntactic abilities remain unaffected in older adults; however, complex sentences with multiple embedded clauses pose difficulties due to memory and processing decline (Thornton & Light, 2006). Although individual variability is found in discourse processing abilities in healthy older adults, there are some commonly reported age-related declines in both comprehension (Thornton & Light, 2006) and production (Wright, Capilouto, Srinivasan, & Fergadiotis, 2011). Accordingly, assessment in discourse in older adults indicated decline in language fluency (increase in use of fillers and interjections, revisions and repetitions). It also revealed reduced content in terms of both quality and quantity since maintaining global thematic information is affected. Reduced use of cohesive references is observed in narrative discourse.

Promising developments in neuroimaging studies has paved a way to study age-related changes in brain with precision and accuracy. With aging process, the brain undergoes several changes such as loss of myelination, reductions in dendritic branching and neuronal death contributing to decrease in brain volume. Grey matter volume decline is observed in an individual after 20 years of age (Terry & Katzman, 2001). Whereas, Kramer, Fabiani, & Colcombe, 2006 suggest that overall decline in brain volume occurs around the age of 30 years in regions specific to hippocampus and frontal lobe. Reduction in neuronal size and synaptic density was witnessed as contributing factor in brain volume decline (Resnick, Pham, Kraut, Zonderman & Davatzikos, 2003; Terry & Katzman, 2001). Gould, Reeves, Graziano, Gross, (1999) reported reduced ability in remodelling of synaptic connections and replacement of neurons. Studies on older adults reveal that they have increased bilateral activation of prefrontal regions (Cabeza, 2002). Furthermore, minor increase in cellular debris such as amyloid plaques, neurofibrils, libofuscin and decreases in the amount and functions of neurotransmitters also influence age related changes demonstrated in cognitive linguistic functions. Cerebral metabolic measurements have revealed several insights to understand effects of cognitive aging in depth. Coyle & Puttfarcken, (1993) propose the susceptibility of brain to the effects of oxidative stress as a key element to age-related neurodegeneration. Molecular components of the inflammatory response (e.g. C-reactive protein) are also found at lower concentrations in normal aging brain unlike, high concentrations in dementia.

Age related cognitive linguistic decline is also explained by many cognitive aging theories - resource capacity theories, speed of processing theories, and inhibition theories. Resource capacity theories support the notion that decreased brain resources lead to decline in older adults' performance in cognitive linguistic skills. Thus, brain loses its capacity to meet increased demands posed by specific tasks. Many variations of resource capacity theories have been proposed, such as signal degeneration theories, working memory capacity declines and transmission deficit theories. Speed of processing theories suggest slowing of cognitive linguistic processing and therefore, account for performance decline in complex tasks and reaction times. Many researches declare that basic cognitive linguistic functions remain intact; however multiple delays influence the performance in complex tasks. Finally, inhibition theories of cognitive aging indicate that as we age, brain's ability to inhibit certain irrelevant information such as distracting stimuli, competing actions, irrelevant thought processes, degrades allowing these information to interfere with cognitive linguistic processing. Hof & Morrison, (2004), however, contradict the concept of extensive impaired neuronal functions to account for cognitive aging. Other prevalent models of cognitive aging attribute cognitive linguistic decline to impaired neuronal function leading to significant neuronal loss. In other terms, cognitive aging can be understood as net outcome of multiple factors that interrupt the cognitive linguistic functions.

2.1. Cognitive reserve

There is considerable individual variability observed in cognitive aging process as some individuals experience slower rates of cognitive linguistic decline than others (Holland & Rabbitt, 1991). Similar variability is also found between the clinical outcome and the degree of pathology (Nelson, Braak & Markesbery, 2009). A hypothesised explanation for these existing discrepancies is the conceptualization of reserve capacity. Reserve capacity can be defined in terms of both active and passive models. Active models demonstrate brain to actively engage in coping mechanisms for pathology and the degree of damage is sustained against reaching the threshold for clinical manifestation in passive process. Hof & Morrison, (2004) propose that the aging brain is capable of substantial adaptation or reorganization to diminish the effect of aging in cognitive linguistic performances. Brain continues to utilize its neuro-protective (Mattson, Chan & Duan, 2002) and neuro-restorative (Gage, 2000; Limke & Rao, 2002) abilities in old age. Recruitment of other cortical areas (prefrontal, hippocampal, and medial temporal areas) in neural activation, evidently scaffolds cognitive linguistic abilities and reduces the effects of neurological aging. This hypothesised capacity of the brain gives rise to the concept of ***'brain reserve capacity'*** which assists older adults in completing complex cognitive linguistic tasks. This ability to recruit cortical areas may account for variability in performances of older adults and difference between successful aging and *pathological aging*.

Brain reserve also explains the individual susceptibility to brain damage/pathology in older adults as a function of extent of damage and quantitative measure of brain reserve capacity (brain volume, size, synaptic density etc.) of an individual (Satz, Cole, Hardy & Rassovsky, 2011). The brain damage/pathology crosses the threshold of brain reserve capacity and in turn results in apparent functional cognitive linguistic decline. This phenomenon clarifies how a relatively equal extent of brain damage in adults with similar demographics can yield varying clinical manifestations. This notion of brain reserve is usually considered passive because according to the threshold model, once the pathological quantity reaches a threshold with respect to brain quantity, functional impairment is preordained. This threshold model can be practically applied to any brain pathology in older adults.

The recent research facts have been found to reveal associations between head size/circumference and resistance to dementia (Mortimer, Snowdon & Markesbery, 2003). In this regard, researchers have found more nuanced potential quantitative measures of brain reserve such as diffusion tensor imaging (DTI) (Wang et al., 2012; Chao et al., 2013), microstructural anatomical measures such as dendritic spine length, dendritic density, or synaptic proteins (Holtmaat & Svoboda, 2009; Lövdén, Wenger, Mårtensson, Lindenberger & Bäckman, 2013). Although, these measures are practically difficult to obtain in humans except in autopsy studies, histological animal studies are feasible.

In contrast, the model of ***'cognitive reserve'*** is considered as 'active model' in which the threshold for cognitive linguistic decline is not determined only by quantitative brain measures. According to Dekhtyar et al., (2015), protection against the risk of dementia warranted by anatomical variables (brain size, brain volume and synaptic density) is referred as 'brain reserve' and compensatory/adaptation strategies based on innate intelligence and life exposures (lifestyle, educational and occupational characteristics) is termed as ‘cognitive reserve’. It is hypothesised that cognitive linguistic decline becomes apparent only after reserve resources are exhausted at certain threshold. The cognitive reserve model posits that the threshold of functional cognitive linguistic decline can be altered by an individual’s life experiences. Thus, individuals with same brain reserve capacity can have different levels of cognitive reserve and in turn cognitive linguistic decline. Cognitive reserve can be defined as the capacity that creates a delay in time between pathology and clinical manifestation of dementia (Stern, 2002). However, based on recent research observations, Stern (2009) designated cognitive reserve not just to prevention/delay of onset of dementia but also as contributor to healthy aging. Cognitive reserve allows older adults to effectively cope with aging brain.

Cognitive linguistic processes are considered as the base for explaining the variability in older adults, despite their age related changes in brain. These cognitive linguistic processes employed by individuals during tasks, consists of differences that are shaped by life experiences in cognitive efficiency, capacity, or flexibility. Moreover, cognitive reserve model is strongly considered as ‘active’ in two ways – (i) it is based on current neural activity which can justify the existing individual variability in cognitive linguistic performance much more comprehensively than brain reserve, ii) it also advocates that the current neural activity is shaped and moulded by experiences/activities throughout the lifespan. Basically, active model of cognitive reserve focuses on the role played by life exposures, suggesting that higher educational attainment, greater occupational complexity and more participation in leisure activities may provide protection against the effects of brain pathology or atrophy by employing compensatory processes. Therefore, individuals with high cognitive reserve are efficiently able to cope with aging effects.

Salthouse (1991) proposed the idea of "use it or lose it'' which supports the view that, the pattern of everyday routine and experiences may shape the consequent decline of cognitive linguistic processes and skills. Another theory called differential preservation hypothesis states that individuals who exercise their cognitive linguistic functions with several stimulation activities show slow rate of cognitive linguistic decline. Whereas, preserved differentiation suggests similar cognitive gaining trajectories and supports the idea that an individual with better intellectual capacity tends to engage himself in activities with high intellectual demands. For instance, study conducted by Schooler and Mulatu (2001) tested differential preservation hypothesis which evaluated association between cognitive linguistic capacity and leisure activities and found that more engagement in leisure activities in old age has reciprocal effects on cognitive linguistic flexibility.

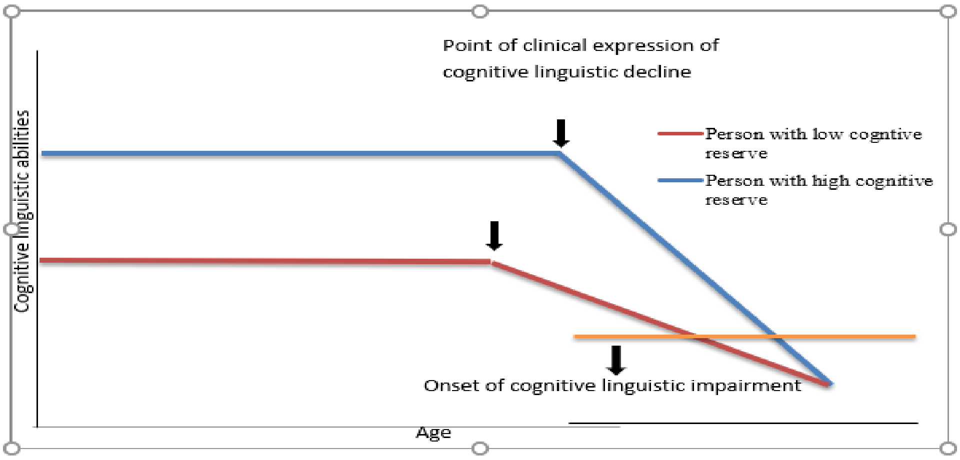

Figure 2.1.: *Representation of how cognitive reserve mediates cognitive linguistic decline*

There is no standard direct measurement for cognitive reserve and in this regard, recent researches have considered proxy measures to estimate cognitive reserve by accounting an individual's occupational complexity, education level, social participation and life style. In a meta-analysis review of studies, Opdebeeck, Martyr & Clare, (2015) considered cognitive reserve in terms of 3 commonly used proxy measures (occupational status, educational level and cognitively stimulating activities) and inspected the association between cognitive linguistic abilities and cognitive reserve. A total of 135 studies indicated that all 3 proxy measure had a positive impact on cognitive linguistic abilities; furthermore, occupational status and cognitively stimulating activities showed large variations across the domains. Therefore, authors conclude that although these proxy measures have basic underlying process that stimulates general cognitive linguistic abilities, they also uniquely contribute to each of the cognitive linguistic component.

Factors such as years of education, literacy level, occupational complexity, measures of crystallised abilities (vocabulary, knowledge etc.), intellectually stimulating leisure activities, socioeconomic status are commonly used to estimate cognitive reserve (Stern, 2002). Besides, another method of estimating cognitive reserve by variance in cognitive linguistic performance was proposed by Reed et al., (2010). Nevertheless, there are critical methodological issues in accounting cognitive reserve through variance in cognitive linguistic performance since it does not explain socio-demographic variables and measures of age related changes in brain. Another theory posits that the accumulation of amyloid protein is an indicator of greater brain reserve and such individuals with greater cognitive reserve are better able to withstand pathologic changes in their brain (Stern, 2002).

Scarmeas & Stern, (2003) explain ***"cognitive reserve"*** as a source of one's innate intelligence or characteristics of life experiences such as educational or occupational accomplishments which takes the form of a set of skills or repertoires that allows a person to cope with cognitive linguistic impairments such as Alzheimer's disease (AD) etc. It is well known fact that a neurological pathology of a given magnitude can have different degree of clinical manifestations and rate of recovery for individuals with similar demographics and researchers point to the concept of 'cognitive reserve' to account for this disjunction between extent of pathology and its outcome. Valenzuela & Sachdev, (2006) reported from a systematic review that there is a significant reduction in dementia incidence in people with high cognitive reserve. Similarly, a longitudinal epidemiologic study over 65 years on 13,000 adults also indicated favourable cognitive linguistic trajectory and lesser risk of cognitive impairment for individuals with high estimate of cognitive reserve (Marioni et al., 2012).

Ahles et al., (2010) evaluated cognitive reserve as a measure of reading score on the Wide Range Achievement Test (WRAT-3) (Wilkinson, 1993) and found higher cognitive reserve protecting against cognitive linguistic decline in women who had undergone chemotherapy treatment for breast cancer. Similarly, Ewers, Insel, Stern & Weiner, (2013) have recognized a connection between higher education and diminished fludeoxyglucose positron emission tomography (FDG-PET) activation in brain, signifying compensatory role of cognitive reserve.

Findings from other epidemiological studies also recognized low educational attainment and low occupational status as significant risk factors for developing dementia or neurological pathology (Zhang et al., 1990; Launer et al., 1999; Cullum et al., 2000). Recent evidences delineates the role of cognitive reserve in monitoring the cognitive linguistic decline and normal aging which is inferred by a number of intrinsic and extrinsic factors (age, gender, Intelligence Quotient (IQ), genetic and neurobiological factors, educational qualification, occupational characteristics, exposure to multiple languages, socio-economic status, substance abuse, career, lifestyle, hobbies, mental health (anxiety, depression, stress etc.), history/presence of neurological, psychological and sensory issues, physical/loco-motor disabilities, visual/hearing deficits and heath conditions such as renal failure, cardiac problems, diabetes, hypertension etc).

Sole Padulles et al., (2009) explored variables of higher cognitive reserve in the context of normal aging. Variables of cognitive reserve documented in this study were verbal IQ, educational and occupational history which was found to be associated with decreased neural activation in right inferior frontal cortex during a working memory task. These research findings support the idea that cognitive reserve employs compensatory strategies to protect against cognitive aging i.e. individuals with higher cognitive reserve are more capable of utilizing alternative/compensatory neural networks in order to maintain the efficiency of cognitive linguistic function in the tasks. Many years of cognitive stimulation associated with occupational complexity (Gaser & Schlaug, 2003), higher education (Coffey, Saxton, Ratcliff, Bryan & Lucke, 1999) and literacy (Carreiras et al., 2009) etc have been found to be indicative of volumetric changes in the brain.

Barulli, Rakitin, Lemaire, Yaakov & Stern, (2013) documented higher cognitive reserve with measures such as verbal IQ and years of education in healthy older adults. Results revealed a distinctive observation in older adults unlike young adults that participants with higher cognitive reserve were able to operate better strategies in a computational estimation task. This finding supports the strong impact of cognitive reserve and suggests that strategy selection abilities are not determined by an individual's general cognitive linguistic ability, but it is based on acquired knowledge over the lifespan. Barulli et al., (2013) have stated that cognitive reserve can be used to envisage discrepancies in cognitive linguistic performances in the case of healthy aging. Koenen et al., (2009) suggest that cognitive reserve is essential throughout the lifespan not only for resisting cognitive linguistic decline, but also for psychiatric conditions as well. Thus, cognitive reserve model has broader applicability across the lifespan for all quantitative and qualitative age related alterations witnessed in older adults, in much more better way than any other generalized theories.

2.2. Cognitive linguistic training

Lately, maintaining cognitive health has gained vital importance among middle aged and elderly as the cognitive decline process intrudes general everyday routine (e.g. word recall problems). Recently, researchers, clinicians and entrepreneurs have aimed at testing the brain fitness and devising methods for improvising and maintaining human cognitive linguistic functions to improve the quality of life during old age. Rue, (2010) believes that brain health can be improved through choice of lifestyle. Enhancing cognitive health and well-being may aid in healthy aging and in turn delays or prevents dementia. Cognitive health can be described as traits that individuals possess or acquire later that relates to their skills to perform a cognitive linguistic task and it emphasises on everyday cognitive functioning rather than brain structure or morphology. Interventions or cognitive linguistic training commonly focus on improving general cognitive linguistic abilities. Whereas, there are several discrete but interdependent cognitive linguistic components such as attention, memory, learning, language, visuospatial abilities, perception, reasoning, executive skills, problem solving and knowledge which may require unique training/intervention in each domain.

Moreover, the ‘cognitive linguistic training’ specific to cognitive linguistic process can result in focal changes in the brain areas responsible for it. Nithianantharajah & Hannan, (2009); Lerch et al., (2011) provide evidences for structural alterations in brain via focused cognitive interventions. They suggest cognitively stimulating life exposures can be associated with successful aging. Although cognitive linguistic decline seems unavoidable in elderly, targeted cognitive linguistic training program prove to be effective in moderating the age-related cognitive linguistic decline (Schaie & Willis, 1986). Such programs have been found to be effective especially in cognitive linguistic domains such as inductive reasoning and spatial orientation. Some researchers have shown solid evidences that cognitive linguistic training induce structural changes. Engvig et al., (2010); Engvig et al., (2012) provided intensive memory training and found volume changes in gray matter and white matter integrity in older adults which was further related to improved memory performances.

The Advanced Cognitive Training for Independent and Vital Elderly (“ACTIVE”) study conducted by Ball et al., (2002) examined effects of cognitive training in 2,832 cognitively healthy older adults whose age ranged from 65 to 94 years. Participants were divided into small groups of 10 and 1 hour training per day was provided to each group for duration of 6 weeks. Experimenters observed direct positive effect on the corresponding cognitive linguistic ability. Moreover, more pronounced effects were found in domains such as processing speed, reasoning and memory. Additionally, regular follow ups after training period revealed the impact of training to persist at least for 5 years. ACTIVE study provides strong evidence for specific cognitive linguistic benefits from training and according to the findings of the study, these benefits are said to persist relatively for longer period of time.

A commercial program was marketed by Brain fitness consists of online training of cognitive linguistic exercises which is said to be designed as a tool to enhance ‘brain plasticity’ (Mahncke, Bronstone & Merzenich, 2006). Brain fitness program extended their experimental training on 487 cognitively healthy older adults with mean age of 75 years. This program was focused on procedural learning that involved practicing auditory language processing for 1 hour everyday over a period of 10 weeks. Participants showed improved performances in tasks related to memory and speed of auditory processing when tested at the end of the training program indicating significant impact of brain fitness training in older adults (Smith et al., 2009).

Mahncke et al., (2006); Basak et al., (2008) also found similar cognitive linguistic benefits from training programs and its effect persisting at least for 3 months. Whereas, Green & Bavelier, (2008) speculate that more durable and lasting cognitive linguistic benefits are likely possible only from tasks that are complex and tap many cognitive linguistic processes in parallel and not from simple training regimes with one type of task. Many novel approaches to cognitive linguistic training have been developed by researchers such as collaborative training models, wellness programs, cooperative problem solving, combined cognitive training with physical exercise and volunteering activities such as literacy training for children, which are designed to particularly increase the persistence of benefits of the training program.

Bucher & Siberski, (2009) reported better scores on standard memory measures after a systematic cognitive linguistic training program that included computerized attention and sensory processing activities (paper-pencil tests such as mazes, crossword puzzles, and anagrams). With growing epidemiological findings that intellectually active older adults are likely to retain their cognitive linguistic functions throughout life has provoked interests in public health policies. American Centres for Disease Control and Prevention issued a "National Public Health Road Map to Maintaining Cognitive Health," in 2007, in association with many administrative groups for elderly. This policy health approach emphasised the importance of preserving cognitive linguistic skills rather than preventing disorders related to cognitive linguistic impairment. Currently, there is no standard measurement procedure for estimating cognitive linguistic stimulation in order to know the required amount of stimulation to trigger the reserve component in individuals. These limitations and dearth of valid evidences warrant further researches into studying practical impact of cognitive linguistic training programs in a broader manner.

2.3. Effect of Vocation on Cognitive linguistic abilities

It is hypothesised that complex occupation with demanding environments increase the amount of cognitive reserve. It has been witnessed in many studies that environmental factors such as occupational complexity has huge impact on an individual's cognitive linguistic abilities with improved structural brain reserve, neural efficacy, compensatory pathways or multiple biological pathways. These subtle changes intermediate the relationship between cognitively stimulating activities and cognitive linguistic abilities, through which they have protective effects against the risk of pathologies and lead to successful healthy aging. Many researches have been carried out to establish a relationship between an individual's cognitive linguistic experiences (occupation and education) and age related changes in brain (Cotman & Berchtold, 2002; Lovden, Wenger, Martensson, Lindenberger & Backman, 2013). Some researchers have found strong influence of occupational complexity on cognitive reserve (Andel et al., 2005; Kroger et al., 2008; Karp et al., 2009). Previous studies have assessed occupational characteristics in number of ways – mental work demands (mentally demanding activities performed during work), working hours, job control, organisational justice and occupational complexity with data, things and people. The estimate of occupational complexity with data, things and people has been documented as most valid measure of cognitive reserve and job complexity. In a longitudinal twin study with 4000 male participants, Potter, Plassman, Helms, Foster & Edwards (2006) reported better cognitive linguistic performances among older adults whose occupations had more intellectual demands.

Stern et al., (1995) stated that an individual's cognitive demand placed by occupational complexity is much more important in long term cognitive reserve than educational attainment and evidently delayed the risk of developing dementia independent of age and education. Stern et al., (1995) estimated occupational characteristics of participants through obtaining factor scores for substantive complexity, management requirements, interpersonal demands and physical demands derived using Dictionary of Occupational Titles (U.S. Department of Labour, 1977). The relationship between participants' occupational characteristics and cerebral blood flow was examined. Results revealed that participants whose occupation was characterised with high interpersonal and physical demands had deficits in cerebral blood flow in parietal area compared to other participants who held occupations with low demands. Likewise, a recent research carried out with neuroimaging techniques also concluded that occupational complexity has robust impact on grey matter integrity in the person's brain than the educational characteristics (Suo et al., 2012). Another structural MRI study examined relationship between 3 hypothesized proxies of cognitive reserve – (i) Occupational status, (ii) Educational attainment, and (iii) head size and showed that cognitive reserve is best estimated by a combination of occupational status and educational attainment (Staff, Murray, Deary & Whalley, 2004). Sole Padulles et al., (2009) studied functional neuroimaging in normal older adults with high cognitive reserve which was estimated by proxies such as IQ, educational attainment, occupational status and lifestyle. Authors found larger brain volumes and reduced neural activity during cognitive linguistic processing in the participants which they presumed to be the result of efficient neural network. These findings suggest that individuals with high cognitive reserve have greater control over their cognitive linguistic processing by efficiently utilizing the neural networks to enhance their cognitive linguistic performances in tasks.

Le Carret, Lafont, Mayo, Fabrigoule, (2003) related better cognitive linguistic performances in late life to occupational complexity and acquisition or preservation of abilities such as problem solving and sustained attention. Whereas, Richards & Sacker, (2003) approximated cognitive reserve to crystallized abilities in midlife (verbal memory) and found cognitive linguistic functions to be sensitive to age related changes and revealed occupational complexity along with childhood cognitive ability to be the strongest contributor of cognitive reserve. Schooler, (1984); Schooler, Mulatu, & Oates, (2004) suggest that occupational complexity facilitates cognitive linguistic performance as the individual faces demanding environments to perform complex cognitive linguistic operations on a daily routine.

On the other hand, Bosma et al., (2003) reported inverse relationship between occupational demands and risk of cognitive linguistic impairment. Authors examined whether high complexity occupations protected against cognitive linguistic impairment. Cognitively healthy 630 males and females whose age ranged from 25 to 82 years were required to complete a questionnaire and screening tests. Occupational complexity was coded following the job title scheme of Statistics Netherlands (1985). Further, participants' occupational complexity was coded by job experts on a scale of 1-7 ranging from simple to complex (DGA, 1989). Results suggested that participants who had highly complex occupations were subjected to lesser risk of developing cognitive linguistic impairment. Statistical analyses revealed that only 1.5% of participants with high complex occupations developed cognitive impairment compared to 4% of those with low complexity jobs. Authors also found that this protective effect was independent of their IQ, education, age and gender.

A Swedish Panel study recruited 386 participants who were 77 years old or above. Authors examined the association between participants' complexity of occupation with data, people and things and cognitive linguistic abilities. Age, gender, education and childhood SES were controlled during the analyses in order to examine the role of occupational complexity. The MMSE (Folstein, Folstein & McHugh, 1975) was used to test cognitive linguistic abilities and the subjects who were found to have cognitive impairment were excluded. The MMSE scores obtained were analysed across occupational complexity with data, people and things. Results indicated that occupational complexity with data and people were statistically significant with better MMSE scores. Therefore, Andel, Kareholt, Parker, Thorslund & Gatz (2007) concluded by stating that complexity of primary lifetime occupation are reflected in cognitive linguistic abilities even in old age.

Finkel, Andel, Gatz & Pedersen, (2009) explored the association between occupational complexity and cognitive linguistic decline among 462 older adults in a longitudinal Swedish twin aging study. Additionally, effect of retirement was also examined to gain insight on cognitive aging in old age among working population. Occupational complexity was measured with respect to data (e.g. data manipulations by data analyst), people (e.g. complex interactions with people by counsellor/social worker) and things (precision in working with things by watch repairman) by 1980 Swedish Census and 1970 U.S. Census. The participants were followed up for 7 years and SATSA cognitive test battery (Nesselroade et al., 1988; Pedersen et al., 1992) was used to assess 4 cognitive linguistic domains- verbal abilities (Synonyms, and Analogies), spatial abilities (Block Design, Figure Logic and Card Rotations), memory (Digit Span, Picture and faces naming) and speed of processing (Symbol Digit and Figure Identification). Results revealed that occupational complexity with both data and people had positive association with cognitive linguistic performances of older adults. Variations in trajectories were found for verbal and spatial abilities. Individuals with high complexity occupations with people performed better in verbal abilities until retirement. However after retirement, these participants whose occupation was characterised as highly complex with people, exhibited steeper decline in spatial abilities compared to others.

Marquie et al., (2010) explored association between mental stimulation at work and rate of cognitive linguistic decline. 3237 workers who were aged between 32 and 62 years were followed up for 10 years. Measures of mental stimulation at work were assessed at each follow up. Cognitive linguistic abilities of participants were assessed across episodic verbal memory, processing speed and attention. After controlling age, gender, education, variety of medical, physical and psychosocial illnesses, results obtained indicated that greater mental stimulation at work was associated with higher cognitive linguistic abilities and 10 years follow up showed slower rate of decline in them.

Singh-Manoux et al., (2011) aimed to observe the extent of impact by cognitive reserve on adult cognitive aging trajectories from mid-life to late life. A total of 5,234 males and 2,220 females who were London based office staffs with age range of 35-55 years were recruited to participate in this longitudinal study and participants were subjected to cognitive linguistic assessment in 7 phases. A cognitive test battery consisting of 5 standard tests (Memory, reasoning, vocabulary, and phonemic and semantic fluency) was chosen for the cognitive linguistic assessment. The Alice Heim 4-I (AH4-I) tapped on inductive reasoning, ability to recognise patterns and infer rules with 64 items. Short term verbal memory was assessed with 20-word free recall test. Phonemic and semantic fluency was assessed with verbal fluency tasks of ‘s’ words and ‘animal’ words respectively. Finally, Mill Hill Vocabulary test consisting of 33 stimulus words in multiple choice method, examined vocabulary. A global cognitive score was obtained with the sum of scores of the above tests. Authors used 3 markers of cognitive reserve – Occupational status, height and education to examine across cognitive linguistic functions. All 3 markers were associated with cognitive linguistic decline irrespective of gender. The most significant association was found with occupational status and weakest with height. Thus, authors concluded that cognitive reserve has substantial impact on cognitive linguistic performance through the adult life course.

Correa Ribeiro, Lopes & Lourenço, (2013) documented occupational complexity as influencing factor of cognitive reserve in older adults. Their study examined relationship between lifetime occupational complexity and cognitive linguistic performances of 624 older adults aged 65 and above. Cognitive linguistic performance of these participants was assessed using MMSE and the scores were analysed across 3 domains of occupational complexity - work, people and things. Analyses revealed participants whose occupation is characterised as complex with data, performed better with 1.08 points higher than low complexity group and in occupations with complexity of things also had 0.53 points higher scores than low complexity group. Though, statistically significant differences were not found between these levels of occupational complexity. These results confirmed that the levels of occupational complexity with data and things were significantly associated with global cognitive linguistic scores obtained by older adults, independent of the co-variables such as age, duration of occupation, education and income. Authors speculate that the cognitive stimulation confronted by participants during work (occupation) contributes to higher cognitive reserve and better cognitive linguistic performances.

Smart, Gow & Deary, (2014) explored relations between complexity of main lifetime occupation and cognitive linguistic performance in old age. 1,091 participants (548 males and 543 females) were recruited at a mean age of 69.5 years from the Lothian Birth

Cohort 1936 (LBC1936). Participants' occupational complexity ratings across data, people and things were obtained using DOT (1977) classification. Cognitive linguistic abilities were assessed through Moray House Test (MHT) and Wechsler Adult Intelligence Scale–III. MHT consisted 71 items assessing domains such as following directions, same–opposites, cypher decoding, word classification, practical items, reasoning, proverbs, analogies, arithmetic, spatial items and mixed sentences with a total score of 76. Wechsler Adult Intelligence Scale–III assessed several components such as Letter–Number Sequencing, Logical Memory (immediate and delayed recall), Block Design, Matrix Reasoning, Symbol Search, Digit Symbol, Digit Span Backward, Verbal Paired Associates (immediate and delayed recall) and Spatial Span (forward and backward). Deprivation score and years of education were also recorded. Occupational complexity ratings were analysed across 4 cognitive linguistic domains (IQ at the age of 70 years, general cognitive linguistic ability, memory, and processing speed). Results revealed participants with more complex occupations across data, people and things scored high in all the cognitive linguistic domains. Fine grain analyses revealed 2 observations – (i) participants whose occupation was regarded as complex with data or people had better scores on general cognitive linguistic ability, (ii) secondly, those participants whose occupations were characterized as complex in terms of data tended to have higher scores in processing speed. Therefore, this study supported the differential preservation hypotheses and postulates that higher complexity of occupation facilitates better late-life cognitive linguistic performance.

Andel, Silverstein & Kåreholt, (2015) examined whether occupational complexity and cognitively stimulating leisure activities in mid-life predicted the level of cognitive linguistic abilities in old age. 810 participants aged 77 years and above were assessed on their general cognitive linguistic skills through MMSE tool. Demographic variables throughout life were controlled and analyses were carried out across occupational complexity of data, things and people. Results indicated that higher occupational complexity with data and people, and more participation in intellectually stimulating leisure activities was positively related to better cognitive linguistic performances in older adults. Moreover, this positive association on cognitive linguistic performance was independent and interactive effect was not found statistically significant.

Dekhtyar et al., (2015) tested life-course model of cognitive reserve in subjects with dementia. Only 950 (12.5%) individuals were diagnosed with dementia before the age 65 years among 7,574 men and women (age ranging from 14 to 28 years), after longitudinal follow up of 21 years. A global classification of dementia combining Alzheimer disease, vascular dementia and other dementia was considered. 3 markers of cognitive reserve – (i) early life school performance, (ii) education, and (iii) occupational complexity was used to estimate the cognitive reserve measure of participants. Results indicated lower risk of dementia in subjects with higher school grades and with occupational complexity of data. Conclusion was drawn based on the results that higher school grades warrants protection against dementia especially when stimulated through complex occupational environments in adulthood. This is in accordance with active model of cognitive reserve which states that constant intellectually demanding environments in turn paves the way for conservation of optimal cognitive linguistic skills across the lifespan.

From previous studies, it can be reflected that individuals with low intellectual demand may likely face undesirable and negative effects of aging such as more profound functional manifestations and onset of dementia or cognitive impairment. Professionals, whose work demands are complex involving data and people, will likely be able to preserve their cognitive linguistic abilities in old age than those with less intellectually demanding occupations. Nevertheless, retirement seems to have major effect on intellectual benefits leading to sudden fall in their cognitive linguistic performances. The recent empirical evidences presenting positive impact of occupational complexity on cognitive linguistic abilities, when extended to retired workers, show imprecise findings. Schaie, (2005) indicated in his longitudinal study that retirement to have adverse effect on cognitive linguistic performances of over 1000 participants especially those who held complex occupations.

In Indian context, there is a paucity of research evidences in this line and very few studies have attempted to address the association between occupational complexity and cognitive linguistic abilities. Ganguli, Chandra, Gilby & Ratcliff, (1996) studied cognitive linguistic performances among 374 non-demented Hindi speaking males and females ages 55 years and above. A battery of neurophysiological and cognitive tests was administered and analyses revealed no effect of work environment on task performances of the participants. Likewise, Das et al., (2007) investigated prevalence of Mild Cognitive Impairment (MCI) among nondemented and nondepressed older adults. 960 participants were recruited who aged 50 and above and cognitive questionnaire battery was administered on each of them. The performances significantly differed in highly educated participants who also held high occupational status. However, occupational status did not have any effect on cognitive linguistic performances independently.

Whereas, Deepa & Shyamala, (2015) found positive association between occupation and cognitive linguistic performance in elderly. This study attempted to profile cognitive communication abilities in elderly participants whose age ranged from 60 to 80 years. For this purpose, 150 native Kannada speaking individuals were recruited to participate in the study. General demographic questionnaire, Quick Neurological Screening Test (QNST), NIMHANS Mental Health Screening Questionnaire, Addenbrooke's cognitive examination revised (ACE-R) and Cognitive Linguistic Assessment Protocol (CLAP) were administered to estimate cognitive linguistic skills among participants. Occupational status was taken up as one of the independent demographic variables for the analyses. Participants comprised of several occupations – Doctors, Engineers, Home makers, Teachers, Nurses, Farmers and Self-employed. They were grouped into fiver major occupational categories and analysis was carried out across cognitive linguistic scores obtained in each phase. Results revealed that in general the participants who held high complex occupations such as doctors, engineers, teachers and nurses performed relatively better than those who were self-employed, farmers and home makers. The prevalence of MCI was also high in participants with less complex occupations (35.4% of homemakers were diagnosed with MCI). The age related decline in scores were also apparent in all the groups of participants; however, those who held less complex jobs were found to show sharper cognitive linguistic decline compared to other cohorts.

Age factor has always remained a significant moderator in a number of studies in the hypothesised relationship between the cognitive reserve measures (educational attainment, occupational complexity, lifestyle etc.) and cognitive linguistic skills. It is very important to note that age plays a crucial role in these associations and needs to be extensively studied to understand its independent or interactive effect on cognitive linguistic abilities.

2.4. Effect of age on cognitive linguistic abilities

It is a universal phenomenon that every individual experiences decline of cognitive linguistic abilities during adulthood. This pattern of age related cognitive linguistic decline seems similar across different cultural population. Research findings in cognitive aging provide an insight of performances on specific cognitive linguistic domains (Nesselroade & Baltes, 1979). Direct linear relationships cannot be drawn between cognitive linguistic decline and chronological age. It is much more complex than expected, as age effects are presented only in specific domains such as memory, executive function and cognitive processing speed (Salthouse, Atkinson & Berish, 2003). The strong association between age and deteriorating cognitive linguistic functions and has been reported in many studies.

Van Hooren et al., (2007) aimed to investigate whether age had any differential effect on cognitive linguistic abilities. 578 healthy older adults were recruited for the study whose age varied between 64 and 81. Cognitive linguistic variables such as Processing speed, verbal fluency, verbal memory and executive functioning were measured using various tests - The Stroop Color Word Test (SCWT), The Concept Shifting Task (CST), The Letter Digit Substitution Test (LDST), Visual Verbal Learning Test (VVLT) and Verbal Fluency Test. Cognitive linguistic variables were assessed across four age groups of participants (65±1 years, 70±1 years, 75±1 years, and 80±1 years). Results indicated that performances of these 4 age groups were significantly different for various cognitive linguistic domains measured. Moreover, verbal fluency measures showed comparatively lesser effect than other cognitive linguistic measures. The researchers attribute this effect of age to reduced ability to inhibit responses that in turn hinders the memory storage for relevant information. Another explanation provided by authors based on the current observation is “the hypothesis of effortful or controlled processing” nevertheless, older adults seem vulnerable in their resources concerning attention, effortful processing and strategy making.

Dore et al., (2007) examined cognitive linguistic abilities of 945 subjects ranging in age from 20 to 79 years, using 22 different test batteries. Results revealed that cognitive linguistic performance decreases due to old age; however, poor cognitive linguistic performance problems do not always lead to dementia. Similarly, Humes, (2014) examined age related effects in cognitive linguistic processing for 50 young adults (18–30 years), 60 middle-aged adults (40–55 years) and 135 older adults (60–87 years). Performances across the adult life span was analysed for 245 participants and results revealed overall decline in cognitive linguistic domains in middle aged and old age adults. In a Chinese study, Schaie, Nguyen, Willis, Dutta & Yue, (2001) also confirmed that the variable age had a direct linear relationship with most of the measured cognitive linguistic abilities.

Akdag, Telci & Cavlak, (2012) evaluated cognitive linguistic functions in 377 older adults (age range: 65 – 94 years). The Hodkinson Abbreviated Mental Test (HAMT) was utilized to examine short- and long-term memory, attention, and orientation. This test consisted of 10 questions and subjects were scored "1" for each correct response. The total score of less than 8 was considered as the cut off score for the risk of cognitive impairment. Age was found to have profound effect on cognitive linguistic functions of older adults. The current study revealed 51.5% (n=194) of total subjects to have risk of cognitive impairment. They conclude by stating that although age is a strong indicator, other independent variables such as gender, education, substance abuse etc. may have impact on cognitive linguistic functions of elderly individuals.

In Indian context, Kamath & Prema (2001) studied cognitive linguistic performances of 36 normal adults (40-70 years) who were further categorized into 6 age groups. Each age group consisted of 3 males and 3 females. This observed group differences in cognitive linguistic performances of 6 age groups were not statistically significant. In contrast, Rajasudhakar & Shyamala (2005) found younger adults (20-30 years) to perform better than older adults (70-80 years) with respect to both accuracy and processing speed in CLAP.

Lagishetti & Venkatesh, (2011) provided data on cognitive linguistic decline in Telugu speaking participants in the age range of 40-80 years. CLAP-T and ACE-R was administered to estimate the performances across all age groups in domains of attention, memory, problem solving, organization, fluency, language and visuospatial perception. Results indicated that age related effects were observed consistently across all cognitive linguistic domains. On the other hand, Deepa & Shyamala, (2015) considered two age groups – (60-70) years and (70-80) years in their study. Results across all cognitive linguistic tests (ACE-R and CLAP) did not reveal any significant differences between 2 age groups. Moreover, participants of both the age were groups were able to maintain their performances in 2 phases suggesting that statistically significant decline in scores between 2 phases were not observed.

2.5. Effect of gender in cognitive linguistic abilities

Lezak, Howieson, & Loring, (2004) support the view of existing gender variations in cognitive linguistic skills with the evidences of biological differences (brain asymmetry, hemispheric lateralization etc) between males and females. On the other hand, McKelvie, Standing, Jean & Law, (1993) proposed that task demands that engage individuals differentially according to their interests, familiarity and motivation result in differences in cognitive linguistic performances among males and females. In agreement with above statements, Schaie et al., (2001) found significant main effect of gender on cognitive linguistic performances of participants. However, van Hooren et al., (2007) observed better performances in females on verbal memory tasks bot not on overall cognitive linguistic performance. Conversely, Govier & Feldman, (1999) did not find any differences across both spatial and verbal tasks among males and females. In fact, a noticeable similarity was observed in the performances of both male and female participants in a specific occupational category.

In the growing body of Indian literature, studies examining main effect of gender across cognitive linguistic abilities are limited. One such study by Aruna & Kamath (2001), while profiling cognitive linguistic abilities of participants of age ranging from 40 to 70 years, found slight gender differences although it was not statistically significant. In females, a slight decline both in episodic memory and organisational skills was observed unlike in the case of male participants whose performances did not show any cognitive linguistic decline. Similarly, Rajasudhakar & Shyamala (2005) indicated interaction of age and language proficiency on gender i.e. only in young bilinguals and elderly monolinguals, females were observed to perform better than males in memory tasks. However, this observable differences did not show statistical significance at $p<0.05$. Whereas Deepa & Shyamala (2015), observed males to outperform females in CLAP test with better score in almost all domains.

2.6. Effect of educational attainment in cognitive linguistic abilities

Education has always been considered by researchers as one of the major proxy measures of cognitive reserve and higher cognitive linguistic abilities. Mortimer & Graves, (1993) proposed that an individual's educational qualification determines the onset of dementia. Capitani, Barbarotto, & Laicana (1996) posited three patterns of association between education and cognitive linguistic abilities based on studies –

1. Parallelism: The trend of cognitive linguistic decline is similar in different educational groups and there is no interaction

2. Protection: Well educated participants have attenuated cognitive linguistic decline compared to others

3. Confluence: The initial advantage of education to participants is reduced in later life

Higher educational attainment leads to better performances in specific cognitive linguistic domains but does not have an overall impact on cognitive linguistic abilities. Compton. Bachman, Brand & Avet, (2000) supported the advantage provided by educational attainment in cognitive linguistic decline among elderly.

Ardilla, Ostrosky-Solis, Roselli & Gomez (2000) examined effect of educational attainment on cognitive linguistic decline in 806 cognitively healthy individuals ranging in age from 16 to 85 years. A brief neuropsychological test battery (NEUROPSI) was used to administer cognitive linguistic components such as orientation, attention, memory, language, executive functions, visuo-spatial abilities and motor skills. Analysis revealed interaction between age and level of education. It indicated that highly educated participants in middle age performed better than less educated individuals; however, this association was inverse in elderly. Whereas, results obtained in MAAS study by van Hooren et al., (2007) showed that education had significant effect on cognitive linguistic functions. Similar results were found in Indian context by Deepa & Shyamala (2015), wherein cognitive linguistic performances across ACE-R and CLAP was examined and phase I showed significant differences between only two groups with <10 years and 10-12 years of education. While, phase II showed significant differences between all the 4 groups categorised according to years of education (< 10 years, 10-12 years, graduate and post-graduate).

2.7. Effect of lifestyle in cognitive linguistic abilities

The lifestyle-cognition hypothesis posits that an active lifestyle of an individual may prevent age related cognitive linguistic decline and in turn helps in successful healthy aging. This hypothesis is supported by several researches carried out in the past also based on the fact that individuals with greater cognitive linguistic abilities participate more frequently in intellectual activities than those with low cognitive linguistic function. A majority of epidemiologic studies considered and evaluated activities with intellectual demand, social status and healthy routine as lifestyle variable and found reduced rate of cognitive linguistic decline. Scarmeas et al., (2001) observed leisure activities to have cumulative impact on cognitive linguistic decline regardless of the extent of cognitive linguistic stimulation in these activities. Ferreira, Owen, Mohan, Corbett & Ballard (2014) also suggest potential advantages of routine leisure activities in cognitive linguistic decline.

Akdag et al., (2012) suggests mental illnesses, family issues and low socio-economic status (SES) adversely affects the cognitive linguistic functions of an individual. Low SES has always been observed to have a significant association with poorer cognitive linguistic performances or rise the risk of developing cognitive linguistic impairment/dementia (Fratiglioni, Ahlbom, Viitanen, & Winblad, 1993; Stern et al., 1994; Azzimondi, D'Alessandro, Pandolfo & Feruglio, 1998; Kaplan et al., 2001). Hebert et al., (1992) witnessed that smoking increased the risk of dementia; whereas Tyas (1996); Letenneur, Larrieu & Barberger-Gateau (2004) reported contradictory results. Akdag et al., (2012) studied association between substance abuse and cognitive linguistic abilities. Although, it was found that substance abuse had some effect on cognitive linguistic skills of participants, it showed a low odds ratio. Deepa & Shyamala (2015) also found no significant effect of smoking on CLAP and ACE-R scores but they reported minimal changes in relation to alcoholism.

Thus, few researches have specifically addressed some potential evidences to gain insight on hypothetical model of the reserve process. However, due to inconsistent findings and paucity of information, further studies are needed to broaden our understanding about various life experiences and its dynamic role in facilitating cognitive linguistic abilities. Therefore, the present study aims at exploring a potential method to enumerate the impact of different lifetime vocations on cognitive linguistic abilities.

2.8. Aim of the study

The present study aimed at examining cognitive linguistic abilities across different vocations.

Chapter 3

METHOD

The present study aimed at investigating cognitive linguistic abilities among 120 older adults (45 to 75 years) across different vocations.

3.1. Objectives of the study

1. To investigate the effect of different vocations on various cognitive linguistic domains

2. To study the extent of age-related changes in cognitive linguistic abilities across different vocations in three age groups (45-55 years, 55-65 years and 65-75 years)

3. To examine age and gender variability in cognitive linguistic abilities across different vocations

4. To explore the influence of other demographic variables in cognitive linguistic performances among older adults.

3.2. Participants

Three groups of participants categorised based on their nature of occupation were recruited to participate in this study who were primarily Doctors, Professors and Lawyers in group 1, School teachers and sports trainers in group 2, and security guards and manual labourers in group 3. Each group with 40 participants consisted both working and retired individuals of both genders, aged between 45 to 75 years. They were further subdivided into 3 age groups for analyses purpose (45-55 years, 55-65 years and 65-75 years). A total of 120 participants who met inclusion/exclusion criteria were recruited from many sources such as schools, colleges, residential areas, hospitals, nursing homes, construction sites and factories etc. in Mysore, Karnataka.

Table 3.1.: *Number of participants across different vocations and age groups*

Participants	Group 1 (Doctors, professors and lawyers)	Group 2 (School teachers and sports trainers)	Group 3 (Security guards and manual labourers)
45-55 years	14	14	14
55-65 years	13	13	13
65-75 years	13	13	13

3.3. Selection criteria

The following criteria were considered for the selection of 3 groups of participants across different vocations:

3.3.1. Inclusion criteria

a. Participants with Kannada as their native language

b. Participants having minimum of 10 years' experience in their first occupation i.e. whereby the individuals had no change in career and have done same or similar jobs in different organisations

c. Participants should be able to read and write at least at elementary level

d. The individual should be physically fit during the assessment procedures in the study

3.3.2. Exclusion criteria

a. Participants with complaint or history of motor, neurological and psychological issues

b. Presence of any cognitive impairment/dementia or deficits in speech, language, hearing and communication and minor mental illnesses (Depression, anxiety etc.) in the participants were ruled out through screening procedures

c. Participants with uncorrected visual deficits

3.4. Materials

1. *General Health Questionnaire (Goldberg & Williams, 1988)* comprises 12 questions relating to one's mental health conditions. GHQ 12 was administered on participants to rule out minor mental illnesses such as depression, anxiety etc.

2. *Mini Mental Status Examination (Folstein, Folstein & McHugh, 1975)* is generally utilised to screen cognitive impairment. This tool evaluates various cognitive domains such as orientation, memory, language, visual construction, attention and concentration. Total scores in MMSE range from 0 to 30 and participants who scored 25 and above were only taken up for the study to rule out the presence of mild to severe cognitive impairment. Participants' scores were included for further statistical analyses

3. *Cognitive-Linguistic Assessment Protocol (Kamath & Prema, 2001; Rajasudhakar & Shyamala, 2005)* is a comprehensive cognitive test battery which represents four cognitive domains: I attention, perception & discrimination (60), II memory (60), III problem solving (60) and IV organization (60). Domain I include cancellation tasks, sound count, discrimination and backward naming of months. Memory tasks assess episodic memory (orientation and recent memory), working memory (digit forward and digit backward) and semantic memory (naming tasks, word fluency,

sentence repetition and commands). Problem solving is measured by tasks such as sentence disambiguation, sentence formulation, predicting causes and outcome, reasoning and sequential analysis. Finally, organization skills are tapped by categorization, analogies and sequencing tasks. The maximum score with sum of all 4 domains ranged up to 240 and Scoring involved analysing both accuracy and time (only certain tasks were timed).

3.5. Procedure

Permission through official correspondence was sought from concerned authorities in all the sources (schools, colleges, hospitals, nursing homes, construction sites and factories) before conducting data collection. Besides, these institutions/organisations also provided residential addresses and contact numbers of their retired employees for the process of data collection in elderly group (65-75 years). Pilot study was performed on 12 participants in the age range of 45 to 65 years who belonged to two groups of occupations, based on which some modifications were done for further data extraction and analyses procedure.

All the participants were examined individually and brief instructions were provided to them regarding the purpose of the study. They were also informed about, what cognitive tests will be carried out and its time span (~90 minutes). Informed consent was obtained from each participant and confidentiality was maintained on the information collected. Furthermore, during the assessment participants were instructed extensively about the tasks and an overview of their performance was detailed to them in a sensitive manner.

The data was extracted from the participants in a systematic manner following a protocol:

1. Detailed demographic data
2. Administration of NIMH Socio Economic Status Scale (Venkatesan, 2009)

3. Screening for minor mental illnesses through General Health Questionnaire-12 (GHQ-12) (Goldberg & Williams, 1988)
4. Administration of Mini Mental State Examination (MMSE) to rule out presence of cognitive impairment (Folstein, Folstein & McHugh, 1975)
5. Administration of Cognitive Linguistic Assessment Protocol (Kamath & Prema, 2001; Rajasudhakar & Shyamala, 2005)
6. Scoring and analyses of responses in CLAP

Participant variables (demographic data) such as highest level of education, mother tongue, bilingual/multilingual, number of languages known, substance abuse, occupation, retirement age, hobbies, and significant health conditions such as diabetes, hypertension, stroke/head injuries, cardiac issues, renal failure, and corrected vision/hearing were profiled through self-report from each participant.

Highest level of education was recorded with number of years of formal schooling (full time), based on which participants were rated on 5-point scale from *1 (≥20 years of formal school or college) to 5 (≤10 years of formal schooling).*

Number of languages known by a participant was considered as an independent variable and participants were grouped into ***bilingual*** (≤2 languages) and ***multilingual*** (>2 languages) for analysis purpose.

Socioeconomic Status of each participant was determined by administering NIMH Socio Economic Status Scale (Venkatesan, 2009). Information regarding participants' occupation, highest education, family income, property and per capita income was noted and graded upon 5-point scale. Each participant was assigned to Socio Economic status ranging from V to I according to their total score. For analysis purpose, participants with SES of V and

IV were categorised as group with ***high SES*** and participants with SES of III, II were considered as group with ***low SES.***

After obtaining demographic data from each participant, they were subjected to tests such as GHQ-12 (Goldberg & Williams, 1988) and MMSE (Folstein, Folstein & McHugh, 1975) to rule out the presence of minor mental illnesses (Anxiety, Depression etc.) and mild to severe cognitive impairment/dementia respectively.

3.5.1. Dictionary of Occupational Titles (DOT)

Participants' major lifetime *occupation* was considered and the duration of work experience till date/retirement was obtained. In order to understand ***occupational complexity***, these occupations of three groups of participants were matched to occupational titles listed in **Dictionary of Occupational Titles (DOT)** revised fourth edition (1977) by the US Dept. of labour. The DOT classifies occupations based on complexity with data, people and things, in 9 digit codes, wherein lowest scores (0/1) reflect more complex jobs and highest scores (9) reflect least complex jobs. Thus, group 1 and group 2 vocations (Doctors, Lawyers, Professors, School teachers and sports trainers) were matched to the title- ***Professional, Technical and Managerial Occupations,*** which represented **0/1** as complexity score. Group 3 participants consisted of labourers in construction sites who were matched to the title- ***Structural Work Occupations,*** with **8** as complexity score. Likewise, securities and garment factory workers (group 3 participants) were also matched to the title- ***Benchwork Occupations,*** which reflected **7** as its complexity score.

Table 3.2.: *Participants categorized according to Dictionary of Occupational titles (DOT) revised fourth edition (1977) by the US Dept. of labour*

S.No.	Participants	Occupational title (DOT,1977)	Complexity score
1	Group 1 (Doctors, Lawyers, Professors)	Professional, Technical and Managerial Occupations	0 or 1
2	Group 2 (School teachers and sports trainers**)**		0 or 1
3	Group 3 (Security guards, manual labourers- workers in garment factory and construction site)	Structural Work Occupations and Benchwork occupations	7 and 8

3.5.2. Cognitive-Linguistic Assessment Protocol (Kamath & Prema, 2001; Rajasudhakar & Shyamala, 2005)

CLAP (Kamath & Prema, 2001; Rajasudhakar & Shyamala, 2005) was administered on 120 participants who met inclusion and exclusion criteria and their responses (accuracy and time span) were recorded on the score sheet (appendix). Recorded accuracy scores and time taken of each task was added to obtain total scores for the domains I Attention, Discrimination and Perception, II Memory, III Problem solving and IV Organisation. Table 2 gives us a preview of CLAP administration with domains, sub domains, tasks embedded in it and scoring.

Table 3.3.: *Administration procedure of CLAP*

Domains	**subtest**	**Task**	**Score**	**Instructions**
I Attention, Discrimination and Perception	Visual	Letter cancellation	10*	Participants are instructed to identify the letter ‘l’ and letter ‘k’ beside ‘i’ and the word ‘kḷtale’
		Contingent letter cancellation	10*	
		Word cancellation	10*	

	Auditory	sound count	10	Instructions are given to participants to carefully listen and count the no. of occurrences of the sound ‘ba’ while the administrator reads them. Participants were asked to recognize whether the letter & word pair is similar or dissimilar and they are asked to name months backward in correct order.
		Letter pair discrimination	5	
		Word pair discrimination	5	
		Month backward naming	10*	
II Memory	Episodic memory	Orientation and recent memory questions	10	Participants are required to answer orientation and recent memory questions.
	Working memory	Digit forward	5	Participants are asked to repeat the number sequence in same order and reverse order.
		Digit backward	5	
	Semantic memory	Coordinate naming	5*	This subtest consists of naming tasks wherein participants are required to list things used in writing and list as many as words possible beginning with letters p,a,s,i and t. they are also asked to give category names of a group and perform other tasks such as repeating sentences and carrying out given commands.
		Superordinate naming	5	
		Word naming fluency	5*	
		Generative naming	5	
		Sentence repetition	10	
		Commands	10	
III Problem solving	Sentence disambiguation		10	Participants are engaged in tasks such as finding 2 interpretations for one sentence, form a correct sentence with jumbled words, explain one similarity and a difference between given 2 objects, answer ‘why’ questions, elaborate a task given in more than 4 steps, predict various outcomes and causes of given situations.
	Sentence formulation		5*	
	Predicting outcome		10	
	Compare and contrast		10	
	Predicting cause		10	
	Reasoning		5	
	Sequential analysis		10	
IV Organization	Categorization		10*	Participants are required to find the *‘odd one out’* from the given objects, find a related word according to the analogy given and sequence the short stories by marking the sentences in the proper order.
	Analogies		10	
	Sequencing events		40*	

*Time taken was recorded for these tasks

Statistical analysis

Both qualitative and quantitative data obtained were analysed with respect to age and gender. The total scores and total time span of domains I, II, III and IV were subjected to statistical analysis using SPSS software version 20. The Descriptive measures, Shapiro Wilk normality test, Kruskal Wallis test and Mann-Whitney U test were performed to check level of significance across vocations, age groups and between genders.

Chapter 4

RESULTS AND DISCUSSION

The present study examined cognitive linguistic abilities among 120 participants who were aged between 45 and 75 years. These participants were grouped according to their type of vocation (group 1- *doctors, lawyers and professors*; group 2- *school teachers and sports trainers*; group 3- *security guards, manual labourers from construction site and garment factory*) and age (45-55 years, 55-65 years and 65-75 years) to study the extent of cognitive linguistic decline in several domains. Participants' major lifetime vocations grouped under three categories was coded for occupational complexity with work, things and people based on **Dictionary of Occupational Titles (DOT)** revised fourth edition (1977) by the US Dept. of labour. Detailed demographic data and screening procedures for mild cognitive impairment and minor mental illnesses were carried out. Demographic variables obtained from participants are outlined below in the table 4.1.

Table 4.1.: *Demographic variables as reported by participants*

Variables	N (%)	Mean	SD
Gender			
Females	59 (49.2%)		
Males	61 (50.8%)		
Level of education			
1- (≥ 20 years, PhD/MD)	37 (30.8%)		
2- (17-18 years, PG)	30 (25%)		
3- (15-16 years, Graduate)	13 (10.8%)		
4- (12 years, PU)	12 (10%)		
5- (≤ 10 years, SSLC)	28 (23.3%)		
Languages known			
Bilingual (2 languages)	46 (38.3%)		
Multilingual (proficiency in >2 languages)	74 (61.7%)		
Participants who reported **substance abuse**	17 (14.2%)		
Participants who reported **diabetes**	22 (18.3%)		
Participants who reported **hypertension**	27 (22.5%)		

Socio-economic status (SES)			
SES I	81 (67.5%)		
SES II — High SES			
SES III	39 (32.5%)		
SES IV — Low SES			
Major hobbies reported by participants			
Watching TV	103 (85.8%)		
Reading (newspaper, books, novels)	51 (42.5%)		
Sports and fitness (walking, yoga, cycling etc)	43 (35.8%)		
Shopping	49 (40.8%)		
Traveling	26 (21.6%)		
Music/singing/art/dance	17 (14.1%)		
Mobile/social media	53 (44.1%)		
Participants' duration of experience in their lifetime vocation		32.87	6.91

MMSE and CLAP was administered on participants and responses were analysed to obtain total score of MMSE test and domain wise scores (both accuracy and time taken) of CLAP. This data was subjected to statistical analysis using SPSS (version 20) and descriptive statistics (Mean and Standard deviation) were obtained. Shapiro Wilk's test of normality showed that data did not follow a normal distribution ($p<0.05$). Therefore, non-parametric statistical analysis using Mann Whitney U test and Kruskal Wallis test was performed to check the level of significance of different vocational groups, age and gender in CLAP and MMSE scores. Other demographic variables (SES, level of education, duration of vocational experience and no. of languages known) were also taken in consideration for analysis across CLAP and MMSE performance scores. The statistic results and interpreted findings for each analysis will be discussed under the following headings:

1. Comparison between age groups
2. Comparison between gender
3. Comparison between vocations
4. Other variables

Table 4.2.: *Means and standard deviation (SD) of scores obtained in MMSE and CLAP across different vocational groups, age groups and both genders*

Scores		Gender	Mean (SD)								
			Vocation 1			Vocation 2			Vocation 3		
			Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
MMSE		Females	29.43 (1.13)	28.83 (1.16)	29.33 (0.81)	29.43 (0.78)	28.83 (0.4)	29.00 (0.89)	27.71 (0.95)	27.29 (0.95)	26.86 (0.9)
		Males	28.71 (1.38)	29.43 (0.78)	29.00 (1.01)	28.57 (1.13)	28.71 (0.95)	28.29 (0.75)	27.14 (0.69)	26.83 (0.98)	26.00 (0.89)
CLAP	I total score	Females	59.14 (0.69)	59.00 (1.09)	59.17 (0.75)	58.86 (1.21)	59.33 (0.81)	58.5 (1.51)	58.86 (0.69)	58.14 (0.69)	57.71 (0.48)
		Males	58.43 (1.27)	59.00 (1.00)	59.43 (0.78)	57.71 (1.7)	58.00 (1.29)	57.43 (0.78)	59.00 (0.57)	57.83 (1.47)	57.00 (0.89)
	I time taken	Females	0.72 (0.1)	0.69 (0.07)	0.77 (0.1)	0.75 (0.1)	0.69 (0.07)	0.72 (0.15)	1.07 (0.08)	1.37 (0.11)	1.38 (0.17)
		Males	0.65 (0.05)	0.8 (0.09)	0.8 (0.06)	0.68 (0.11)	0.86 (0.1)	0.88 (0.06)	1.15 (0.07)	1.25 (0.24)	1.5 (1.14)
	II total score	Females	57.00 (0.57)	56.5 (0.83)	56.5 (1.37)	55.71 (0.95)	55.67 (1.21)	55.5 (1.04)	55.00 (1.15)	54.86 (0.69)	54.29 (1.11)
		Males	56.43 (0.97)	56.86 (0.69)	56.43 (0.78)	55.14 (1.06)	55.29 (0.95)	55.14 (1.06)	54.29 (1.38)	53.33 (1.5)	53.5 (1.37)
	II time taken	Females	1.57 (0.27)	1.95 (0.82)	1.93 (0.6)	1.74 (0.51)	1.3 (0.17)	2.05 (0.79)	3.33 (0.31)	3.52 (0.35)	3.87 (0.49)
		Males	1.89 (0.56)	1.99 (0.65)	2.07 (0.43)	1.53 (0.53)	2.28 (0.66)	2.13 (0.68)	3.57 (0.32)	3.43 (0.69)	3.69 (0.73)
	III total score	Females	57.71 (1.25)	57.00 (1.89)	57.17 (2.04)	56.57 (2.14)	55.5 (1.87)	57.00 (2.0)	52.86 (1.46)	53.29 (1.49)	53.71 (1.11)
		Males	56.57 (1.13)	56.14 (1.06)	56.71 (1.7)	56.57 (1.51)	56.14 (0.9)	56.43 (1.61)	53.00 (1.00)	52.5 (1.37)	52.00 (1.26)
	III time taken	Females	0.91 (0.29)	1.22 (0.5)	1.53 (0.39)	1.41 (0.55)	0.97 (0.36)	0.95 (0.35)	2.08 (0.56)	2.11 (0.26)	2.63 (0.61)
		Males	1.2 (0.36)	1.39 (0.16)	1.39 (0.32)	1.00 (0.67)	1.25 (0.31)	1.47 (0.5)	2.18 (1.53)	1.61 (0.32)	2.89 (0.32)
	IV total score	Females	48.14 (4.63)	47.67 (2.87)	49.5 (2.66)	45.57 (3.82)	46.5 (3.78)	46.33 (3.32)	43.00 (1.82)	43.57 (2.07)	42.86 (1.95)
		Males	48.71 (3.2)	48.29 (4.11)	47.43 (3.04)	40.86 (6.28)	40.43 (6.34)	45.57 (3.3)	40.43 (2.07)	41.00 (3.34)	40.67 (3.07)
	IV time taken	Females	5.48 (2.17)	6.65 (2.19)	6.36 (1.77)	7.54 (1.87)	6.4 (1.48)	5.53 (1.44)	6.73 (1.51)	8.46 (1.48)	9.54 (1.68)
		Males	6.10 (1.28)	8.04 (2.36)	6.57 (1.76)	5.42 (2.75)	6.15 (1.87)	7.49 (1.24)	8.11 (0.99)	8.99 (1.78)	10.95 (1.49)

Note: I total score, I time taken, II total score, II time taken, III total score, III time taken, IV total score, IV time taken, signifies total score and total time taken of each CLAP domain – I Attention, discrimination and perception, II Memory, III Problem solving and IV organisation respectively; group 1 – 45 to 55 years, group 2 – 55 to 65 years and group 3 – 65 to 75 years.

4.1. Comparison between age groups within each vocation and gender

The mean and standard deviation values of cognitive linguistic measures (MMSE and CLAP scores) across each vocation, age groups and both genders are presented in table 4.2.

The mean and standard deviation (SD) values of MMSE and CLAP total scores did not show any major noticeable differences across 3 age groups (45-55 years, 55-65 years and 65-75 years). However, time taken scores in most of the CLAP domains exhibited slight differences especially between age groups 1 and 3. Kruskal Wallis test was run to examine the significant main effect of age on MMSE and CLAP scores and results indicated no significant differences across age groups. Further, interaction effect of vocation and gender was considered and the statistical analysis was done using Kruskal Wallis test. Comparison between these 3 age groups was carried out within each vocation and gender across CLAP and MMSE scores and the results obtained are presented in table 4.3.

Table 4.3.: *χ2 and significance values of MMSE and CLAP scores compared between age groups within each vocation and gender*

Scores		Vocation 1				Vocation 2				Vocation 3			
		Females		Males		Females		Males		Females		Males	
		χ2	Sig.	χ2	Sig.	χ2	Sig.	χ2	Sig.	χ2	Sig.	χ2	Sig.
MMSE		1.56	0.45	1.17	0.55	2.49	0.28	0.86	0.64	2.86	0.23	4.56	0.1
CLAP	I total score	0.00	0.99	2.74	0.25	1.08	0.58	0.68	0.71	8.13	0.01*	8.29	0.01*
	I time taken	1.35	0.5	10.87	0.00**	0.46	0.79	9.22	0.01*	11.29	0.00**	10.55	0.00**
	II total score	2.27	0.32	1.2	0.54	0.1	0.94	0.21	0.89	1.88	0.38	1.73	0.42
	II time taken	0.69	0.7	1.17	0.55	4.62	0.09	5.7	0.06	5.21	0.07	1.16	0.55
	III total score	0.37	0.82	2.09	0.35	1.64	0.44	0.42	0.8	1.48	0.47	1.88	0.39
	III time taken	6.92	0.03*	4.29	0.11	3.87	0.14	5.32	0.07	4.8	0.09	11.58	0.00**
	IV total score	1.56	0.45	0.75	0.68	0.72	0.69	2.38	0.3	0.74	0.68	0.2	0.9
	IV time taken	1.73	0.42	3.78	0.15	5.22	0.07	5.38	0.06	8.97	0.01*	8.06	0.01*

*****$p<0.05$, **$p<0.01$

Table 4.3 indicates significant main effect of age groups at $p<0.05$* and $p<0.01$** and Post hoc Mann Whitney test was utilised to perform pair wise analysis among 3 age groups.

4.1.1. Vocation 1

The results indicated significant main effect of age groups in time taken of domain III (Memory) among females of vocation 1 was between age group 1 & 3 (|Z|=2.44, $p=0.01$). Similarly, males belonging to vocation 1 also exhibited significant differences between age groups 1 & 2 (|Z|=2.63, $p=0.00$); 1 & 3 (|Z|=3.00, $p=0.00$) in time taken of domain I (Attention, discrimination and perception).

4.2.1. Vocation 2

Significant differences between age groups were not observed in females of vocation 2 across both MMSE and CLAP scores. However, male participants showed significant effect of age group difference between groups 1 & 2 (|Z|=2.56, $p=0.01$); 1 & 3 (|Z|=2.62, $p=0.00$) in time taken of domain I.

4.2.3. Vocation 3

In domain I, both female and male participants of vocation 3 showed significant age group difference between group 1 & 3 in total score (|Z|=2.69, $p=0.00$; |Z|=2.96, $p=0.00$). Whereas in time taken, males were found to have significant age group differences between groups 1 & 3 (|Z|=3.00, $p=0.00$); 2 & 3 (|Z|=2.00, $p=0.04$) and similar significant effect of age groups in females were found between groups 1 & 2 (|Z|=2.87, $p=0.00$); 1 & 3 (|Z|=2.88, $p=0.00$). In domain III, only male participants displayed significant main effect of age groups in time taken between groups 1 & 2 (|Z|=2.17, $p=0.03$); 1 & 3 (|Z|=2.15, $p=0.03$); 2 & 3 (|Z|=2.89, $p=0.00$). However, in domain IV, females and males showed significant age differences between groups 1 & 2 (|Z|=2.1, $p=0.03$); 1 & 3 (|Z|=2.61, $p=0.00$) and groups 1 & 3 (|Z|=2.71, $p=0.00$) respectively.

Parallel pattern of cognitive linguistic decline was not observed across 3 vocations. From the above findings it can be inferred that vocation 1 consisting of manual labourers and security guards were more vulnerable to aging effects than other 2 groups of participants. The trend of decrease in cognitive linguistic scores with increase in age was evident in vocation 3 participants consisting of manual labourers and security guards. According to ***Dictionary of Occupational Titles (U.S. Department of Labour, 1977)*** applied in the present study, it was noted that vocation 3 participants belonged to lesser complexity occupations with the score of 7 and 8. Thus, it can be speculated based on the current results that vocation 3 participants were at disadvantage as only higher complex occupations induce preservation of cognitive linguistic functions until a threshold of age. Therefore, cognitive linguistic decline was more pronounced in vocation 3 -manual labourers and security guards when compared to doctors, lawyers, professors, school teachers and sports trainers (vocation 1 and 2). The present study is in agreement with findings from other recent experiment indicating that exposure to complex occupational demands, protect against cognitive linguistic decline (Bosma et al., 2003; Finkel et al., 2009; Marquie et al., 2010). Interestingly, in the present study, comparison between age groups in general without considering interaction effect of vocation and gender did not show any significant effect of aging on CLAP and MMSE scores. Similar results were witnessed by Deepa & Shyamala (2015) suggesting that age factor alone does not have influence cognitive linguistic abilities. This provides evidence for cognitive reserve hypothesis wherein factors such as vocation, lifestyle and education have major impact on cognitive linguistic decline.

Moreover, these aging effects were observed only in time taken scores of CLAP domains indicating that ***processing speed*** was affected in all the cases. In the present study time taken scores of CLAP is considered as a measure of processing speed in each domain. The current findings indicating the change in processing speed with age was predicted by the preserved differential hypothesis which suggests that an individual with better intellectual capacity tends to engage himself in activities with high intellectual demands. In many recent studies, processing speed has been found to be enormously susceptible to age related changes (Salthouse et al., 1995; Carlson et al., 1995; Salthouse et al., 2003; Salthouse, 2010). In addition to above findings, it was also noted that both males and females of vocation 3 showed cognitive linguistic decline in domain I (attention, discrimination and perception) of CLAP which was also evident in studies done by Salthouse et al., (1995); Carlson et al., (1995); Lezak et al., (2012).

4.2. Comparison between gender within each vocation and age group

The mean and standard deviation values (table 4.2) obtained across both genders illustrate slight variations wherein females seem to perform better than males in CLAP but not in MMSE across all vocations and age groups.

Table 4.4.: *|Z| and significance values of MMSE and CLAP scores compared between males and females within each age group in vocation 1*

Scores		Vocation 1					
		Group 1		Group 2		Group 3	
		|Z|	Sig.	|Z|	Sig.	|Z|	Sig.
MMSE		1.06	0.28	0.99	0.32	0.62	0.53
CLAP	I total score	1.17	0.24	0.07	0.94	0.69	0.48
	I time taken	1.4	0.15	1.93	0.05	0.93	0.35
	II total score	1.31	0.18	0.65	0.51	0.37	0.7
	II time taken	0.76	0.44	0.14	0.88	0.85	0.39
	III total score	1.59	0.11	0.65	0.51	0.44	0.65
	III time taken	1.16	0.24	1.0	0.31	0.79	0.42
	IV total score	0.12	0.89	0.64	0.51	1.32	0.18
	IV time taken	1.15	0.25	1.0	0.31	0.42	0.66

*****$p<0.05$, **$p<0.01$

To check the significance of these differences observed between males and females, Mann Whitney U test was done. Results obtained suggested no significant differences between genders in overall analysis and therefore interaction effect of age groups and vocation was taken into consideration. Mann Whitney U test was again performed to compare between males and females within each vocation and age group across MMSE and CLAP scores. The table 4.4 presents the results of comparison between genders within each age group in vocation 1 and it indicates no statistical significant differences at *p<0.05*.

Table 4.5.: *|Z| and significance values of MMSE and CLAP scores compared between males and females within each age group in vocation 2*

Scores		**Vocation 2**					
		Group 1		**Group 2**		**Group 3**	
		|Z|	**Sig.**	**|Z|**	**Sig.**	**|Z|**	**Sig.**
MMSE		1.48	0.13	0.08	0.93	1.36	0.17
CLAP	I total score	1.38	0.16	1.96	0.04*	1.58	0.11
	I time taken	1.4	0.15	1.93	0.05	2.14	0.03*
	II total score	1.1	0.27	0.59	0.55	0.67	0.5
	II time taken	0.31	0.74	2.71	0.00**	0.28	0.77
	III total score	0.13	0.89	0.65	0.51	0.51	0.6
	III time taken	1.73	0.08	1.86	0.06	2.14	0.03*
	IV total score	1.22	0.22	1.72	0.08	0.72	0.47
	IV time taken	1.72	0.08	0.57	0.56	2.14	0.03*

*****$p<0.05$, **$p<0.01$

Table 4.5 represents the results obtained in Mann Whitney U test indicating significant differences between males and females in each age group in vocation 2. Age group 1 did not show any significant gender differences. Whereas, age group 2 demonstrated significant gender differences in total score of domain I (|Z|=1.96, *p=0.04*) and time taken of domain II (|Z|=2.71, *p=0.00*). Likewise, in age group 3, the time taken scores of domain I (|Z|=2.14, *p=0.03*), domain III (|Z|=2.14, *p=0.03*) and domain IV (|Z|=2.14, *p=0.03*) revealed significant main effect of gender.

Table 4.6.: *|Z| and significance values of MMSE and CLAP scores compared between males and females within each age group in vocation 3*

Scores	**Vocation 3**		
	Group 1	**Group 2**	**Group 3**

		|Z|	Sig.	|Z|	Sig.	|Z|	Sig.
MMSE		1.36	0.17	0.85	0.39	1.49	0.13
CLAP	I total score	0.45	0.65	0.59	0.55	1.58	0.11
	I time taken	1.92	0.05	0.78	0.43	0.93	0.35
	II total score	1.06	0.28	1.97	0.04*	1.06	0.28
	II time taken	1.53	0.12	0.28	0.77	0.21	0.83
	III total score	0.27	0.78	0.74	0.45	2.14	0.03*
	III time taken	0.58	0.56	2.58	0.01*	0.88	0.37
	IV total score	2.12	0.03*	1.51	0.12	1.3	0.19
	IV time taken	2.1	0.03*	0.93	0.35	1.71	0.08

*****$p<0.05$, **$p<0.01$

Table 4.6 reports the results of Mann Whitney U test performed to check significant differences between genders within each age group in vocation 3. Group 1 revealed that both the total score (|Z|=2.12, $p=0.03$) and time taken (|Z|=2.1, $p=0.03$) of domain IV in CLAP have significant effect of gender. Participants in group 2 also displayed significant gender differences in total score of domain II (|Z|=1.97, $p=0.04$) and time taken of domain III (|Z|=2.58, $p=0.01$). On the other hand, group 3 participants had significant main effect of gender only in total score of domain III (|Z|=2.14, $p=0.03$).

The overall gender comparison of cognitive linguistic abilities indicated no significant differences which is in consensus with Govier & Feldman, (1999); Kamath & Prema, (2001). Whereas, the study done by Rajasudhakar & Shyamala (2005) supports the findings in the present study as it indicated interaction effect of age and other confounding variables on gender. The current findings suggest that comparison carried out between genders within each age group and vocation had varying effects across age groups and vocations. Participants who belonged to vocation 2 (school teachers and sports trainers) and vocation 3 (manual labourers and security guards) were observed to exhibit gender variability unlike vocation 1 participants. It may be assumed that participants of vocation 1 who were doctors, lawyers and professors can effectively employ their high cognitive reserve capacity gained with higher complex occupational experiences and were able to maintain their cognitive linguistic performance across all 3 age groups and both genders. On the other hand, participants in vocation 2 displayed gender differences only in time taken scores of CLAP i.e. processing speed. It may be speculated that processing speed is the most sensitive measure to predict age and gender differences which is in agreement with many other recent investigations where they found processing to be highly susceptible to even minor changes in the participants. Vocation 3 participants exhibited gender differences in the domains characterised by memory, problem solving and organisation.

Moreover, it was noted that in all the cases of gender variability only females outperformed males suggesting that the existing biological differences as well as the distinct way of experiencing and coping with the external cognitive linguistic demands in each gender are the underlying causes of significant gender differences shown in cognitive linguistic abilities. These findings are in parallel with the results of van Hooren et al., (2007) who reported females to perform better in all tasks related to memory, verbal fluency and language but not in overall cognitive abilities. On the contrary, Deepa & Shyamala investigated gender variability in CLAP and ACE-R and found males to perform better than females.

4.3. Comparison between vocations with each age group and gender

The mean and standard deviation (SD) values (table 4.2) indicated major observable differences in CLAP scores between vocation 1 and vocation 3. A decreasing trend of CLAP scores was noticed from vocation 1-vocation 2-vocation 3. Therefore, the differences exhibited between vocation 1 and 3 seemed significant. To check the statistical significance of these variations, Kruskal Wallis test was performed to compare between 3 vocation groups (vocation 1, vocation 2 and vocation 3) within each age group and gender. To precisely examine statistical significance between each vocation, pair wise comparisons (i.e. vocation 1 and 2; vocation 2 and 3; vocation 1 and 3) were carried out using Post hoc Mann Whitney U test in MMSE and CLAP scores.

Table 4.7.: *χ2 and significance values of MMSE and CLAP scores compared between vocations within each age group and gender*

Scores		Group 1				Group 2				Group 3			
		Females		Males		Females		Males		Females		Males	
		χ2	Sig.	χ2	Sig.	χ2	Sig.	χ2	Sig.	χ2	Sig.	χ2	Sig.
MMSE		9.4	0.00**	6.53	0.03*	8.74	0.01*	11.39	0.00**	11.63	0.00**	12.76	0.00**
CLAP	I total score	0.45	0.79	2.44	0.29	5.74	0.05	2.96	0.22	6.94	0.03*	12.46	0.00**
	I time taken	13.61	0.00**	13.54	0.00**	12.64	0.00**	8.53	0.01*	13	0.00**	13.96	0.00**
	II total score	10.39	0.00**	8.41	0.01*	6.94	0.03*	13.37	0.00**	8.76	0.01*	11.04	0.00**
	II time taken	13.51	0.00**	13.56	0.00**	12.53	0.00**	9.34	0.00**	12.64	0.00**	9.6	0.00**
	III total score	12.1	0.00**	13.14	0.00**	8.89	0.01*	11.98	0.00**	10.01	0.00**	11.6	0.00**
	III time taken	12.72	0.00**	9.55	0.00**	11.99	0.00**	4.18	0.12	12.19	0.00**	12.34	0.00**
	IV total score	4.44	0.1	10.64	0.00**	6.1	0.04*	7.3	0.02*	11.12	0.00**	9.33	0.00**
	IV time taken	3.76	0.15	8.66	0.01*	5.64	0.06	5.46	0.06	11.45	0.00**	12.09	0.00**

*****$p<0.05$, **$p<0.01$

Table 4.7 represents the results obtained by Kruskal Wallis test indicating significant effect of vocation within each age group and gender across MMSE and CLAP scores.

4.3.1. Group 1

Females of age group 1 showed statistically significant effect of vocation in MMSE scores between vocations 1 & 3 (|Z|=2.45, *p=0.01*); 2 & 3 (|Z|=2.72, *p=0.00*). Similarly in CLAP measures, females of this group demonstrated significant differences between- vocations 1 & 3 (|Z|=3.13, *p=0.00*); 2 & 3 (|Z|=3.13, *p=0.00*) in time taken of domain I, vocations 1 & 2 (|Z|=2.35, *p=0.01*); 1 & 3 (|Z|=3.04, *p=0.00*) in total score of domain II, vocations 1 & 3 (|Z|=3.13, *p=0.00*); 2 & 3 (|Z|=3.13, *p=0.00*) in time taken of domain II, vocations 1 & 3 (|Z|=3.16, *p=0.00*); 2 & 3 (|Z|=2.66, *p=0.00*) in total score of domain III and vocations 1 & 2 (|Z|=2.24, *p=0.02*); 1 & 3 (|Z|=3.13, *p=0.00*); 2 & 3 (|Z|=2.05, *p=0.04*) in time taken of domain III.

On the other hand, males belonging to age group 1 displayed significant main effect of vocation on MMSE scores between vocations 1 & 3 (|Z|=2.08, *p=0.03*); 2 & 3 (|Z|=2.34, *p=0.01*) and on CLAP scores between- vocations 1 & 3 (|Z|=3.13, *p=0.00*); 2 & 3 (|Z|=3.13, *p=0.00*) in time taken of domain I, vocations 1 & 2 (|Z|=2.03, *p=0.04*); 1 & 3 (|Z|=2.68, *p=0.00*) in total score of domain II, vocations 1 & 3 (|Z|=3.00, *p=0.00*); 2 & 3 (|Z|=3.13, *p=0.00*) in time taken of domain II, vocations 1 & 3 (|Z|=3.17, *p=0.00*); 2 & 3 (|Z|=3.01, *p=0.00*) in total score of domain III, vocations 1 & 3 (|Z|=2.89, *p=0.00*); 2 & 3 (|Z|=2.36, *p=0.01*) in time taken of domain III, vocations 1 & 2 (|Z|=2.49, *p=0.01*); 1 & 3 (|Z|=3.07, *p=0.00*) in total score of domain IV and vocations 1 & 3 (|Z|=2.36, *p=0.01*); 2 & 3 (|Z|=2.23, *p=0.02*) in time taken of domain IV.

4.3.2. Group 2

Significant main effect of vocation was found in females of age group 2 in MMSE scores between vocations 1 & 3 (|Z|=2.14, *p=0.03*); 2 & 3 (|Z|=2.88, *p=0.00*). Likewise, in CLAP scores, females showed significant difference between vocations 1 & 3 (|Z|=3.00, *p=0.00*); 2 & 3 (|Z|=3.00, *p=0.00*) in time taken of domain I, vocations 1 & 3 (|Z|=2.61, *p=0.00*) in total score of domain II, vocations 1 & 3 (|Z|=2.79, *p=0.00*); 2 & 3 (|Z|=3.00, *p=0.00*) in time taken of domain II, vocations 1 & 3 (|Z|=2.69, *p=0.00*); 2 & 3 (|Z|=2.06, *p=0.03*) in total score of domain III, vocations 1 & 3 (|Z|=2.79, *p=0.00*); 2 & 3 (|Z|=3.00, *p=0.00*) in time taken of domain III and vocation 1 & 3 (|Z|=2.22, *p=0.02*) in total score of domain IV.

Whereas, males belonging to age group 2 exhibited significant difference between vocations 1 & 3 (|Z|=2.93, *p=0.00*); 2 & 3 (|Z|=2.56, *p=0.01*) in MMSE scores. Furthermore, significant differences were also found in CLAP scores between vocations 1 & 3 (|Z|=2.57, *p=0.01*); 2 & 3 (|Z|=2.28, *p=0.02*) in time taken of domain I, vocations 1 & 2 (|Z|=2.76, *p=0.00*); 1 & 3 (|Z|=2.92, *p=0.00*); 2 & 3 (|Z|=2.22, *p=0.02*) in total score of domain II, vocations 1 & 3 (|Z|=2.64, *p=0.00*); 2 & 3 (|Z|=2.57, *p=0.01*) in time taken of domain II, vocations 1 & 3 (|Z|=2.91, *p=0.00*); 2 & 3 (|Z|=3.03, *p=0.00*) in total score of domain III and vocations 1 & 2 (|Z|=2.17, *p=0.02*); 1 & 3 (|Z|=2.44, *p=0.01*) in total score of domain IV.

4.3.3. Group 3

In age group 3 both males and females exhibited statistical significance at $p<0.01$ in all the domains of CLAP scores and MMSE scores between vocations 1 & 3 (|Z|=2.91, *p=0.00;* |Z|=2.8, *p=0.00;* |Z|=3.00, *p=0.00;* |Z|=2.81, *p=0.00;* |Z|=3.00, *p=0.00;* |Z|=2.59, *p=0.00;* |Z|=2.30, *p=0.02;* |Z|=2.94, *p=0.00;* |Z|=2.57, *p=0.01;* |Z|=2.92, *p=0.00;* |Z|=2.92, *p=0.00;* |Z|=3.00, *p=0.00;* |Z|=2.92, *p=0.00;* |Z|=2.71, *p=0.00;* |Z|=2.87, *p=0.00;* |Z|=3.00, *p=0.00;* |Z|=3.00, *p=0.00;* |Z|=2.66, *p=0.00;* |Z|=2.85, *p=0.00*) and 2 & 3 (|Z|=2.78, *p=0.00;* |Z|=3.00, *p=0.00;* |Z|=3.00, *p=0.00;* |Z|=2.76, *p=0.00;* |Z|=2.87, *p=0.00;* |Z|=2.15, *p=0.03;* |Z|=3.00, *p=0.00*). The significant difference between vocations 1 & 2 was also exhibited among males only in domain I and II (|Z|=2.98, *p=0.00;* |Z|=1.98, *p=0.04;* |Z|=2.12, *p=0.03*).

This study witnessed profound impact of vocation on both MMSE and CLAP in almost all domains. Many studies have found results parallel to the present study and support the cognitive reserve hypothesis (Le Carret et al., 2003; Andel et al., 2007; Finkel et al., 2009; Smart et al., 2014). On the other hand, Ravaglia et al., (2002); Fritsch et al., (2007); Murray et al., (2011) revealed contradictory findings indicating no association between vocation and cognitive linguistic performance or dementia in late life. Participants in the age range of 65-75 years exhibited significant differences between vocations in all the CLAP domains and MMSE scores. Whereas, in other age groups significant impact was found only in MMSE scores and CLAP domains related to memory and problem solving. Other domains tapping on attention, discrimination, perception and organisation skills did not display any significant main effect of vocation as a factor. The strong impact of vocation on participants in elderly group of 65-75 years can be attributed the effect of retirement. Although complexity of occupation plays a role in preservation of cognitive linguistic abilities, it may not be able to protect an individual against detrimental effect of retirement from a complex vocation. Several studies have noted that participants experience sudden drop in cognitive linguistic abilities or faster cognitive linguistic decline after retirement (Finkel et al., 2009; Marquie et al., 2010; Finkel et al., 2014). It can be hypothesised that the disuse of stimulating cognitive linguistic skills at work may contribute to greater loss especially for those who had higher complex vocations. This supports the concept proposed by Salthouse (1991) as “use it or lose it” suggesting that only continued stimulation at work gives rise to cognitive reserve and preservation of cognitive linguistic abilities.

In addition to the above results, it was also found that major significant differences existed only between vocations 1 and 3 and vocations 2 and 3. According to Dictionary of Occupational titles (DOT) revised fourth edition (1977) by the US Dept. of labour, vocations 1 and 2 fall into same category of occupational complexity (***Professional, Technical and Managerial Occupations***) based on their score of 0/1. Thus, it can be anticipated that vocations 1 and 2 belonging to same occupational complexity might exhibit similar cognitive linguistic abilities since they experience similar occupational demands with work, people and things. Therefore, it can be presumed that participants who are doctors, lawyers, professors, school teachers and sports trainers belong to higher complex occupation and participants who are manual labourers and security guards are characterised with lesser complex occupations.

4.4. Other variables

4.4.1. Duration of major lifetime occupational experience

Table 4.8.: *Correlation coefficient and significance values obtained between duration of occupational experience and MMSE and CLAP scores*

		Duration of occupational experience	
		r_s	Sig.
	Duration	1.00	.
	MMSE	0.23	0.01 *
CLAP	**I total score**	0.22	0.06 *
	I time taken	0.34	0.00 **
	II total score	0.15	0.08
	II time taken	0.29	0.00 **
	III total score	0.14	0.12
	III time taken	0.29	0.00 **
	IV total score	0.01	0.84
	IV time taken	0.30	0.00 **

**p<0.05, **p<0.01*

Spearman’s correlation was run to determine the relationship between duration of occupational experience and MMSE and CLAP scores. Table 4.8 reports that positive correlation exists between duration of occupational experience and MMSE at significance level of $p=0.01$. Similarly, time taken scores of all CLAP domains were significantly correlated with duration of occupational experience at $p<0.01$. In agreement to previous findings it can be stated that occupational status is strongly associated with better cognitive linguistic abilities. Some studies have noted retirement age /duration of occupation experience to be a predictor for cognitive linguistic performances (Kroger et al., 2008; Finkel et al., 2009). As expected, the present study found duration of occupational experience to have major significant effect on MMSE scores and processing speed in CLAP. Similar findings were revealed by Kroger et al., (2008) wherein occupational status was found to have stronger impact on cognitive linguistic decline in individuals who were reported to have experience of more than 23 years in their primary occupation.

4.4.2. Level of education

The present study categorised participants based on their years of formal schooling/college into five groups- pHD/MD - (≥20 years), PG - (17 to 19 years), Graduate – (14 to 16 years), PU – (11 to 13 years) and SSLC - (≤10 years).

Table 4.9.: *Means and standard deviation (SD) of scores obtained in CLAP and MMSE across different levels of education*

Scores	Mean (SD)				
	Level of education				
	pHD/MD	PG	Graduate	PU	<SSLC
MMSE	29.11 (1.07)	28.87 (0.81)	28.77 (1.01)	27.00 (0.73)	27.00 (1.08)
I total score	58.92 (1.09)	58.43 (1.22)	58.38 (1.5)	58.50 (1.00)	57.96 (1.03)
I total time	0.74 (0.1)	0.76 (0.13)	0.76 (0.1)	1.22 (0.2)	1.31 (0.19)
II total score	56.62 (0.82)	55.63 (1.06)	55.15 (1.06)	53.75 (1.21)	54.46 (1.29)
II total time	1.88 (0.53)	1.85 (0.65)	1.89 (0.73)	3.37 (0.48)	3.66 (0.49)
III total score	56.84 (1.38)	56.77 (1.81)	55.69 (1.43)	52.50 (1.16)	53.11 (1.37)
III total time	1.30 (0.33)	1.13 (0.5)	1.24 (0.55)	2.19 (0.64)	2.27 (0.57)
IV total score	48.38 (3.24)	44.70 (5.29)	43.38 (4.77)	41.08 (2.71)	42.36 (2.48)
IV total time	6.73 (1.95)	5.89 (1.8)	7.20 (2.08)	8.78 (2.13)	8.72 (1.84)

Table 4.9 shows the mean and standard deviation (SD) values of MMSE and CLAP scores obtained by participants who were categorised based on their years of formal schooling/college. Mean values of groups with higher years of formal schooling were observed to be better when compared to groups with lesser years of formal schooling. This trend was observed invariably in all cognitive linguistic scores (both MMSE and CLAP domain scores). In order to check the statistical significance of this observed variations, Kruskal Wallis test was run to compare between five groups. The results are illustrated in table 4.10 wherein it can be observed that all 4 CLAP domain scores and MMSE scores exhibit significant differences at $p<0.01$ except domain I total score which is significant at $p<0.05$. Consequently, post hoc Mann Whitney test was run to determine pair wise comparisons.

Table 4.10.: *|Z| and significance values of MMSE and CLAP scores compared between groups categorised based on years of education*

Scores		Level of education	
		χ2	Sig.
MMSE		56.36	0.00**
CLAP	I total score	11.61	0.02*
	I time taken	77.24	0.00**
	II total score	57.40	0.00**
	II time taken	73.65	0.00**
	III total score	71.37	0.00**
	III time taken	59.02	0.00**
	IV total score	45.13	0.00**
	IV time taken	30.00	0.00**

$*p<0.05$, $**p<0.01$

According to Mann Whitney U test, pair wise comparison between pHD/MD and PG revealed that only total scores of domain II (|Z|=3.75, $p=0.00$) and domain IV (|Z|=3.16, $p=0.00$) had significant differences. Similarly total scores of domain II (|Z|=3.87, $p=0.00$) and domain IV (|Z|=3.57, $p=0.00$) demonstrated significant main effect of level of education between pHD/MD and graduate. Pair wise comparison between pHD/MD and PU, pHD and SSLC, PG and PU, PG and SSLC revealed significant differences on all CLAP domains and MMSE scores at $p<0.01$. When groups graduate and PU, graduate and SSLC were subjected to pair wise analysis, it was found that except domain I and domain IV, all other CLAP domains and MMSE scores showed significant differences at $p<0.01$. On the other hand, comparison between PG and graduate, PU and SSLC did not show any significant effect at the level of $p<0.01$ in both MMSE and CLAP scores.

From above findings we can infer that level of education has major impact on CLAP and MMSE scores. In the present study 5 groups were subjected to pairwise analysis. As anticipated, pairwise analysis revealed that consecutive groups (PG vs. graduate, graduate vs. PU and PU vs. SSLC did) did not show any statistical difference. Whereas, pHD/MD group performed significantly better than PG group in memory and organisation skills. Similar findings were reported by Deepa & Shyamala (2015) wherein they found significant differences between all 4 groups of participants in phase II. In general, participants with higher level of education were at an advantage of performing better in MMSE and CLAP in relative to participants belonging to lower level of education. The present study confirms the findings of stern et al., (1995); Capitani et al., (1996); Compton et al., (2000); Ardilla et al., (2000) and van Hooren et al., (2007). It may be assumed that along with occupational status, educational attainment is also a major predictor of higher cognitive linguistic abilities. In turn, it can be speculated that education does have a strong role in cognitive reserve and may also be a pre-requisite for attaining high occupational status defined with high complexity with data, people and things.

4.4.3. Number of languages known

Table 4.11.: *Means and standard deviation (SD) of scores obtained in CLAP and MMSE across groups categorised based on their proficiency in languages (bilingual and multilingual)*

	Scores	Mean (SD)	
		Bilingual ≤2 lang	**Multilingual >2 lang**
MMSE		27.74 (1.32)	28.66 (1.24)
CLAP	**I total score**	58.26 (1.1)	58.61 (1.22)
	I time taken	1.1 (0.28)	0.83 (0.24)
	II total score	54.83 (1.19)	55.8 (1.46)
	II time taken	3.08 (0.9)	2.04 (0.81)
	III total score	54.26 (2.02)	56.09 (2.2)
	III time taken	1.90 (0.74)	1.36 (0.57)
	IV total score	43.33 (3.88)	45.69 (4.8)
	IV time taken	8.13 (1.95)	6.68 (2.18)

Table 4.11 illustrates the mean and standard deviation (SD) values of groups categorised based on their proficiency in languages. Based on the mean and standard deviation (SD) values, participants belonging to multilingual group seemed to have better CLAP and MMSE scores than bilingual group.

Table 4.12.: *|Z| and significance values of MMSE and CLAP scores compared between bilingual and multilingual*

Scores		No. of languages known	
		|Z|	Sig.
MMSE		3.62	0.00**
CLAP	**I total score**	1.84	0.04*
	I time taken	5.19	0.00**
	II total score	4.01	0.00**
	II time taken	5.42	0.00**
	III total score	4.37	0.00**
	III time taken	4.20	0.00**
	IV total score	3.16	0.00**
	IV time taken	3.59	0.00**

******$p<0.05$*, **$p<0.01$*

Thus, Mann Whitney U test was performed to compare between bilingual and multilingual group and results are depicted in table 4.12. Both MMSE and CLAP scores demonstrated significant differences between bilingual and multilingual group at $p<0.01$ except for domain I total score which exhibited significant variation at $p<0.05$. It is apparent from the present study that multilingual participants were at advantage of better cognitive linguistic abilities than bilinguals. It is reported Bialystok, Craik, Klein and Viswanathan (2004) that multilingual group have better cognitive control and perform better in problem solving and organisation skills than bilinguals or monolinguals. Hakuta & Diaz (1985); Deepa & Shyamala (2015) also report similar findings where multilingual group performed consistently better than bilingual and monolingual groups on cognitive linguistic tasks.

4.4.4. Socioeconomic status

Table 4.13.: *Means and standard deviation (SD) of scores obtained in CLAP and MMSE across high SES group and low SES group*

Scores		Mean (SD)	
		High SES	Low SES
MMSE		28.95 (0.97)	26.97 (0.98)
CLAP	I total score	58.65 (1.21)	58.1 (1.04)
	I time taken	0.76 (0.12)	1.28 (0.2)
	II total score	55.98 (1.16)	54.28 (1.29)
	II time taken	1.9 (0.64)	3.56 (0.5)
	III total score	56.57 (1.67)	52.95 (1.33)
	III time taken	1.24 (0.45)	2.25 (0.6)
	IV total score	46.12 (4.79)	42.00 (2.61)
	IV time taken	6.53 (1.98)	8.7 (1.92)

Table 4.13 represents the mean and standard deviation (SD) values obtained for CLAP and MMSE scores across high SES group and low SES group. On observation, high SES group seemed to have performed better both in MMSE and CLAP than low SES group. To check the statistical significance of this apparent effect of SES, Mann Whitney U test was carried out to compare between high SES and low SES groups across CLAP and MMSE scores.

Table 4.14.: *|Z| and significance values of MMSE and CLAP scores compared between high SES and low SES*

Scores		SES	
		|Z|	Sig.
MMSE		7.4	0.00 **
CLAP	I total score	2.65	0.00 **
	I time taken	8.6	0.00 **
	II total score	5.89	0.00 **
	II time taken	8.35	0.00 **
	III total score	8.02	0.00 **
	III time taken	7.48	0.00 **
	IV total score	5.3	0.00 **
	IV time taken	4.91	0.00 **

**p<0.05, **p<0.01*

Mann Whitney U results are presented in table 4.14. Comparison between high SES and low SES revealed significant differences at $p<0.01$ across all CLAP domains and MMSE scores. Participants who belonged to high SES performed significantly better than the group categorised as low SES. In parallel to the present study findings, Fratiglioni et al., (1993); Stern et al., (1994); Azzimondi, et al., (1998); Kaplan et al., (2001); Akdag et al., (2012) also found low SES to be associated with poorer cognitive linguistic performances.

4.4.5. Substance abuse

Table 4.15.: *Means and standard deviation (SD) of CLAP and MMSE scores obtained by participants with or without substance abuse*

Scores		Mean (SD)	
		With substance abuse	**Without substance abuse**
MMSE		27.06 (1.14)	28.51 (1.26)
CLAP	**I total score**	57.94 (1.34)	58.56 (1.14)
	I time taken	1.18 (0.34)	0.89 (0.26)
	II total score	54.00 (1.87)	55.66 (1.21)
	II time taken	3.36 (0.83)	2.29 (0.92)
	III total score	53.12 (1.99)	55.77 (2.14)
	III time taken	1.95 (0.77)	1.51 (0.66)
	IV total score	41.47 (4.21)	45.33 (4.47)
	IV time taken	8.55 (2.03)	7.02 (2.17)

Table 4.15 presents mean and standard deviation (SD) values of CLAP and MMSE scores obtained by participants grouped into 2 categories based on substance abuse (smoking/alcohol) reports in demographic data. Interestingly, participants with substance abuse were observed to have lesser mean scores (MMSE and CLAP) than participants who do not smoke or consume alcohol. Mann Whitney U test was carried out to determine the significant main effect of substance abuse on participant's cognitive linguistic performance.

Table 4.16.: *|Z| and significance values of MMSE and CLAP scores compared between groups with and without substance abuse*

Scores		Substance abuse	
		|Z|	Sig.
MMSE		4.06	0.00 **
CLAP	I total score	1.67	0.09
	I time taken	3.21	0.00 **
	II total score	3.49	0.00 **
	II time taken	4.09	0.00 **
	III total score	4.18	0.00 **
	III time taken	2.41	0.00 **
	IV total score	3.30	0.00 **
	IV time taken	2.67	0.00 **

******p<0.05*, *****p<0.01*

Results of Mann Whitney U test is presented in table 4.16. Comparison between 2 groups with and without substance abuse depicted significant differences across all CLAP domains and MMSE scores at $p<0.01$ except total score of domain I in CLAP. Therefore, it may be assumed that substance abuse had detrimental impact on cognitive linguistic tasks such as memory, orientation, recall, problem solving, organisation and visuo-spatial construction etc. However, the CLAP domain which assesses attention, discrimination and perception was resilient to the effect of substance abuse. Hebert et al., (1992); Akdag et al., (2012) reported similar findings that substance abuse increased the risk of rapid cognitive linguistic decline. On the contrary, Tyas (1996); Letenneur (2004) reported no effect of smoking on cognitive linguistic abilities. Deepa & Shyamala (2015) also found no significant effect of smoking on CLAP and ACE-R scores but they reported minimal changes in relation to alcoholism.

In summary, the present study has revealed that vocation and its degree of complexity plays a stronger role in determining one's cognitive linguistic abilities and its extent and degree of change in old age. Both CLAP and MMSE scores have been found to exhibit significant main effect of vocation and this effect has been observed to be more pronounced in higher age group (65-75 years) of retired individuals. This effect of retirement was also noted by Finket et al., (2009); Marquie et al., (2010); Finkel et al., (2014). Based on the present study results along with literature it can be inferred that higher occupational complexity was related to better cognitive linguistic performances, however there was no evidences stating occupational complexity protected against cognitive linguistic decline after retirement in any form. Although continuing impact of cognitive linguistic training has been witnessed in some researches, there are no evidences of the positive impact of primary lifetime occupation on an individual's cognitive linguistic abilities after retirement. On the contrary, several studies which have similar findings to the present study, reported that cognitive linguistic performances seem to have a sudden fall and steeper decline after retirement.

Besides, it was also observed in this study that vocation 1 and 2 participants (doctors, lawyers, professors, school teachers and sports trainers) who belonged to same occupational complexity based on their score according to DOT (1977) performed similarly across all CLAP domains and MMSE test. Significant differences were noted only between vocation 1 and 3 and vocation 2 and 3 but not between vocation 1 and 2. Therefore, this study supports the notion of occupational complexity as the results indicated that only vocation 3 participants who were manual labourers and security guards differed significantly from vocation 1 and 2 participants (doctors, lawyers and professors; school teachers and sports trainers respectively). Furthermore, an interesting observation showed that the domain of processing speed was the most sensitive measure as indicated by the current study findings.

In addition to above findings, it was clear that age and gender had major interaction effect and other variables such as duration of occupational experience, educational attainment, number of languages known, SES and substance abuse also revealed significant effect on CLAP and MMSE scores. Thus, this study supports the notion that along with occupational status as major determinant, few other factors such as age, gender, educational attainment, number of languages known, socio-economic status, lifestyle can facilitate or impede an individual's cognitive linguistic functions.

Chapter 5

SUMMARY AND CONCLUSION

An individual's cognitive linguistic processes are said to be dynamic and modifiable throughout the life course. The potential factors which can facilitate cognitive linguistic abilities have often been researched in order to improve cognitive reserve and in turn delay the cognitive linguistic decline or prevent the onset of dementia/cognitive impairment. Though, there is high heterogeneity in the recognised factors which can modify an individual's cognitive linguistic abilities, these factors have imperative consequences for the age related changes in brain. There are several researches investigating the potential role of these factors with the aim of designing and implementing new methods of interventions to improve preservation of cognitive linguistic functions in late life.

The current study aimed at examining the potential impact of vocation on various cognitive linguistic abilities. 120 participants of both the genders with age range of 45-75 years were recruited based on their major lifetime vocation categorized into 3 vocations. Participants in each vocation were further divided into 3 groups (45-55 years, 55-65 years and 65-75 years) according to their reported age. MMSE and CLAP were administered on these participants who met both inclusion and exclusion criteria. The participants' responses obtained were analysed and scored accordingly. Statistical analysis was run to determine the significant main effect of vocation, age, gender and other variables (duration of occupational experience, level of education, number of languages known, socio-economic status and substance abuse) across MMSE and CLAP scores.

The findings of the present investigation revealed, vocation as one of the potential factors in shaping cognitive linguistic abilities in older adults. It was clear from statistical findings that type of occupation, occupational complexity, duration of occupational experience and retirement had major influence on cognitive linguistic performances throughout the course of life. Processing speed was found to be the major sensitive measure in CLAP that effectively quantified the degree of cognitive linguistic decline in older adults. Moreover, the comparison across age and gender also revealed some significant changes with interaction effect of vocation. Other demographic variables such as duration of occupational experience, level of education, number of languages known, SES and substance abuse also demonstrated significant effect on task performances in CLAP and MMSE indicating its confounding nature. Outcome of the present study favours the notion of cognitive reserve and differential preservation hypothesis and delineates that continued engagement in stimulating activities at work have a protective effect against rapid cognitive linguistic decline or dementia in late life.

The present findings add to the growing body of research suggesting that cognitively stimulating and healthy lifestyle with complex work environment are often related to better cognitive linguistic abilities in elderly. This impact of vocation can be attributable to work environments in which practice and reinforcement of cognitive linguistic functions are often encountered. This facilitation and preservation of cognitive linguistic abilities induced by vocation provides us insight of dynamic nature of cognitive reserve. From the intervention point of view, employing these influential factors such as vocation, education, cognitively stimulatory lifestyle can pave way for effective treatment methods in preventing or delaying cognitive linguistic decline or onset of dementia in older adults.

5.1. Implications and future directions

SLPs have a role in the maintenance and enhancement of cognitive linguistic skills among older adults as they relate to communication that are well within the scientific and clinical purview of the field of speech language pathology. The present study has shed light on possibilities of preventive interventions for dementia/cognitive impairment at pre-clinical stages to prevent or at least delay the onset of clinically significant symptoms. Future preventive interventions should aim at developing occupationally derived cognitive stimulation and identification of more protective factors in order to improve the cognitive linguistic training. Lastly, from an intervention standpoint, efforts aimed at public awareness on cognitive linguistic decline and cognitive linguistic training modules should be encouraged which may help individuals to achieve successful healthy aging. In addition, preventive cognitive linguistic training for individuals would also help us broaden our understanding on the process of escalating the recovery rate in other neuro-pathological disorders. Future investigations should focus on the development of diagnostic tools capable of early detection of subtle cognitive linguistic decline which may provide the key to effective management of patients with dementia or cognitive impairment.

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Appendix: A

General information

Name: Age/sex:

Mother tongue: Bilingual/multilingual: yes/no

Highest educational qualification: Languages known:

Occupation: Medium of instruction:

Specify the duration you have been working in this present occupation?

Smoking/alcohol abuse:

Please tick the boxes if you have history/complaint of the below mentioned illnesses;

Diabetes ☐

Hypertension ☐

Stroke or head injuries ☐

Seizure disorder ☐ (if any neurological/other issues, please specify)

Cardiac issues ☐

Renal failure ☐

Visual impairment: ☐

Hearing impairment: ☐

Psychological illness ☐

Other physical disabilities: ☐ (if yes, mention in detail)

Socio economic status:

GHQ12 score:

MMSE score:

CLAP score: I Attention, discrimination and perception -

II Memory -

III Problem solving -

IV Organization –

Hobbies:

Appendix: B

General Health Questionnaire-12 (GHQ-12; Goldberg & Williams, 1988)

Annex IV

Method for Calculating Scores Obtained in the GHQ

1. In the survey, respondents were asked to answer a General Health Questionnaire (GHQ) that comprised 12 questions relating to one's mental health conditions as given below.

In the past four weeks, have you encountered any of the following situations? Show card and read out items (a) – (l) one by one (Probe the degree)		Answers and corresponding code numbers			
		Often	Sometimes	Seldom	Never
(a)	Feeling that you had not made good use of time	1	2	3	4
(b)	Feeling that you were not decisive	1	2	3	4
(c)	Feeling that you had suffered from pressure	1	2	3	4
(d)	Feeling that you could not overcome your own difficulties	1	2	3	4
(e)	Feeling unhappy or distressed	1	2	3	4
(f)	Able to lead a happy life	1	2	3	4
(g)	Able to face your own difficulties	1	2	3	4
(h)	Sleepless because of worrying something	1	2	3	4
(i)	Having lost self-confidence	1	2	3	4
(j)	Able to concentrate on doing anything	1	2	3	4
(k)	Feeling that you were a useful person	1	2	3	4
(l)	Feeling happy in general	1	2	3	4

2. The scores obtained in the GHQ were calculated by the following method –

<u>Step 1</u> Firstly, the answer codes for questions (a), (b), (c), (d), (e), (h) and (i) were re-coded in reverse term (i.e. 1 to 4; 2 to 3; 3 to 2; and 4 to 1).

<u>Step 2</u> One's total score in the GHQ was then obtained by summing up all the scores in the 12 questions from (a) to (l) and deducting the sum by 11.

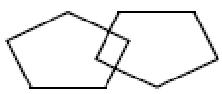
Appendix: C

Mini Mental Status Examination (MMSE; Folstein, Folstein & McHugh, 1975)

Mini-Mental State Examination (MMSE)

Patient's Name: ______________________________ Date: __________

Instructions: Score one point for each correct response within each question or activity.

Maximum Score	Patient's Score	Questions
5		"What is the year? Season? Date? Day? Month?"
5		"Where are we now? State? County? Town/city? Hospital? Floor?"
3		The examiner names three unrelated objects clearly and slowly, then the instructor asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible.
5		"I would like you to count backward from 100 by sevens." (93, 86, 79, 72, 65, …) Alternative: "Spell WORLD backwards." (D-L-R-O-W)
3		"Earlier I told you the names of three things. Can you tell me what those were?"
2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them.
1		"Repeat the phrase: 'No ifs, ands, or buts.'"
3		"Take the paper in your right hand, fold it in half, and put it on the floor." (The examiner gives the patient a piece of blank paper.)
1		"Please read this and do what it says." (Written instruction is "Close your eyes.")
1		"Make up and write a sentence about anything." (This sentence must contain a noun and a verb.)
1		"Please copy this picture." (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All 10 angles must be present and two must intersect.) 
30		TOTAL