COGNITIVE AND LINGUISTIC FUNCTIONS IN PERSONS WITH PARKINSON DISEASE

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CHAPTER I

INTRODUCTION

Cognition and language are interlinked to each other. Jones and Peters (1999) have affirmed language to be an integral component of the cognitive processes. Clark (1998) emphasizes the many ways in which language is used to support human cognition, ranging from shopping lists and post-it notes, to the mental rehearsal of remembered instructions and mnemonics, to the performance of complex arithmetic calculations on pieces of paper.

Learning language involves determining the structure from usage which involves the full scope of cognition like remembering episodes and utterances and the categorization of experiences. Language comprehension is frequently necessary for cognitive skills as the acquisition of new knowledge, as a person attends a lecture, reads a manual or listens to a boss's instruction (Boyle & Strikowsky-Harvey, 1999). In turn the cognitive development in infants and toddlers is strongly related to increased memory and to the ability to acquire symbols in language and gestures and in many other areas (Gopnick & Meltzoff, 1986). The linguistic representations for objects are part of long term lexical memory and must be retrieved and brought to consciousness. Diaz and Berk (1992) found that children tend to verbalize more when the problem solving tasks were more difficult, and that children who verbalized more often were more successful in their problem solving.

Cognition and language undergoes changes throughout the life time. This process begins at birth and continues all through life. Further, it is difficult to separate the

changes in the cognitive process from the changes in the linguistic processes. Research has affirmed that aging may be associated with deterioration in cognitive and linguistic skills (Birren, 1970; Botwinik & Storandt, 1974; Burke & Light, 1981; Schaie & Hertzog, 1983). Research in cognitive aging and related behavioral symptoms of language attrition is becoming an area of growing concern. There are evidences in the literature which state that there is deterioration in sustained and selective attention (Hochandel & Kaplan, 1984), episodic memory (Light, 1991; Nilsson, 2003), attention (Pessoa et al., 2002), executive functions (Crawford et al., 2000), visuo spatial functions (Mesulam, 2000(a) cited by Jones & Peters), problem solving (Denney, Pearce, & Palmer, 1982) and language (Riegel, 1968; Cohen, 1979 & Light, 1990).

Aging individuals may experience a cognitive and linguistic slowing or decline which, are related to their neural substrates, including structural and functional changes in the different areas of the brain (Hedden & Gabrieli, 2004). The decline could also be due to some underlying pathological conditions commonly seen in the geriatric population. Pathological conditions in the elderly occur due to focal neurological deficits at different areas in the CNS and PNS. Consequently, major pathological changes occur in the basal ganglia, thalamus and upper brainstem while, the cerebral cortex is relatively spared due to neurological disorders such as Huntington's disease, progressive supranuclear palsy, Wilson's disease, idiopathic basal ganglia calcification and Parkinson's disease. Parkinson's disease is one of the most common disease condition, seen widely among the elderly.

Parkinson's disease (PD) is a progressive, degenerative, neurological disrder associated with selective loss of dopaminergic neurons in the pars compacta of the

substantia nigra (Uitti & Calne, 1993). The condition arises from nigrostriatal dopaminergic cell degeneration (Obeso, Guridi, & DeLong, 1977), which produces an activity imbalance within dopamine- regulated pathways of the basal ganglia. Due to this pathology, the co-ordinate action of inhibitory and excitatory neural motor commands within the corticobasal circuit gets affected leading to movement related and speech problems.

Epidemiological studies indicate that PD is the second most common neurodegenerative disorder in the developed countries (Wirdefeldt, Adami, Cole, Trichopolos, & Mandel, 2011). The annual incidence of PD is estimated to be 20 per 1,00,000 (Murdoch, 2010). Prevalence rate and average incidence rate among Indian population was found to be 52.85/1,00,000 and 5.71/1,00,000 per year respectively, and average annual PD mortality rate was 2.89/100,000 per year. Anand and Singh (1993) reported that movement disorders form 20% of the neurological patient population, of which, there was an incidence of 16.9% out of the 2,34,021 patients. Nearly 1/3rd of the 493 residents living in elderly homes of Bangalore city had movement disorders and Parkinsonism (24%) was found to be the commonest reason (Ragothaman et al., 2006).

PD can be caused due to many factors such as drugs, encephalitis, toxins, vascular insults, metabolic disorders, head trauma, tumours, gene defects and it can also be idiopathic (Duffy, 2005). Based on the etiology, Fahn and Przedborski (2005) clinically classified Parkinsonism into three types, viz. *idiopathic* PD, *symptomatic PD* and *PD plus syndromes.* The primary cause for PD is unknown, i.e., *idiopathic* type of PD which, also includes sporadic disease and gene mutation cases. PD could also be caused, secondary to antipsychotic (neuroleptic) drugs (neuroleptic parkinsonism), encephalitis

(postencephalitic Parkinsonism), toxins (manganese, carbon monoxide, MPTP, cyanide), vascular insults, brain tumour, and head trauma which then, is broadly called *symptomatic PD*. In case of PD with syndromes (*PD plus syndromes*) parkinsonism symptoms may be caused by a known gene defect and exhibit distinctive pathology. Idiopathic PD is the most predominant type of disorder affecting 80% of the individuals diagnosed with PD (Fahn & Przedborski, 2005).

PD is generally progressive in nature. The course of PD is subdivided into two distinct phases; *presymptomatic* phase (early stage) where in the physiological changes have begun but no overt signs or symptoms are observed and *symptomatic* phase is the middle to later stages where the signs and symptoms are overt and the severity increases from the middle to later stages (Wolters et al., 2000; Del Tredici, Rüb, Vos RAI de., Bohl, & Braak, 2002; Braak et al., 2003). Due to the progressive nature of the disease Hoehn and Yahr in 1967 classified the disability occurring due to PD into V stages using an arbitrary scale, where Stage I indicates no functional impairment and Stage V indicates severe impairment wherein, the patient is confined to bed or wheel chair. Braak et al., (2003) classified the pathology underlying PD into 6 stages which can be divided under the presymptomatic and symptomatic phases mentioned above. The presymptomatic stage includes the 1^{st} and the 2^{nd} neuropathological stage of the PD where the pathology is confined to the medulla oblongata/pontine tegmentum and olfactory bulb/anterior olfactory nucleus. The symptomatic stage includes the 3^{rd} stage to the 6^{th} stage. The 6^{th} stage depicts the most severe stage wherein the patient is confined to the bed or wheel chair. Few patients may also become aphonic.

During the early stage, the most obvious symptoms of PD are movement-related (motor) problems. The most common motor symptoms include rest tremors, bradykinesia (slowness in movement), rigidity (increased tone and resistance to movement), postural instability which, leads to difficulty in standing up from sitting position, dysarthia (hypokinetic variety) and dysphagia. Non motor symptoms such as behavioural, emotional, sensory and sleep related problems may also be present as the disease progresses.

The presence of an associated cognitive impairment in the persons with PD was identified only in the last three decades. When James Parkinson first described Parkinsonism in 1817, he claimed that there were no mental manifestations of the disease. However, it is widely acknowledged that, in PD, even in the absence of global intellectual decline or dementia some individuals will experience subtle deficits in a range of cognitive domains including memory, visuospatial abilities, executive planning, attention and language function (Cooper, Sagar, & Jordan, 1991; Dubois, Boller, Pillon, & Agid, 1991; Levin & Katzen, 1995). Nieoullon in 2002 (as cited in Murdoch, 2010) recognized dopamine as an important neuro-regulator of cognitive functioning. According to her, disruption to the functioning of the striatum and the dopamine connections of the frontal lobes may also be expected to influence cognitive functioning.

Several studies, have been carried out to investigate the cognitive functioning in individuals with PD. Girotti et al. (1988) found that individuals with PD with no dementia exhibited same type of cognitive difficulties such as difficulty in fluency, memory, visuospatial orientation, attention, constructional abilities and verbal abilities as

individuals with PD and dementia. However, the latter group had more severe and widespread cognitive deficits.

Basic et al. (2004) conducted a study which aimed to investigate the drop in the different cognitive tasks in persons with PD. The subjects were tested on fluid intelligence (includes factors like reasoning, problem solving and visual perception), and crystallized Intelligence (defined by the verbal competence, language development, understanding of written text and general knowledge).The results revealed that the clinical group scored significantly lesser than the control group in all the tasks. However, there was significant difference task tapping the only on the testing the fluid attention. Thus they concluded that the PD subjects have greater impairment in fluid intelligence compared to crystallized intelligence.

Verbaan et al. (2007) evaluated the cognitive functioning in patients with using cognition, motor and non-motor domains of the SCales for Outcomes in PArkinson's disease-COGnition (SCOPA-COG). SCOPA-COG included various sub domains like memory, attention, executive functioning and visuospatial skill. It was found that patients with PD scored significantly lower on all cognitive sub domains compared to controls, with large differences in executive functioning and memory.

A longitudinal study, over a period of three years by Muslimović, Post, Speelman, Hann, and Schmand in 2009 aimed to assess the nature, magnitude and frequency of cognitive change thereby to identify the individuals with PD exhibiting cognitive decline. The results showed decreased performance in the newly diagnosed patients mainly on the measure of psychomotor speed and attention and to a lesser extent

on test assessing memory, visuospatial skills and executive functioning. The study concluded that patients with PD within few years of diagnosis, show faster rate of cognitive decline than matched healthy subjects mainly in domains of attention and psychomotor speed. It was found that none of the motor features could predict the cognitive change in patients who were diagnosed newly.

Studies suggest that the language function is impaired in PD along with cognitive functions as several PET studies have demonstrated the activation of the thalamus and basal ganglia during completion of a language task such as picture naming (Price, Moore, Hymphreyas, Frackowiak, & Friston 1996a, cited in Murdoch, 2010) and word repetition (Price, Wise, Warburton, Moore, & Howard, 1996b). There have been reports of poor performance by people with PD on language tasks such as naming, verbal fluency, sentence repetition, and auditory comprehension (Cummings, Darkins, Mendez, Hill, & Benson, 1988; Lewis, Lapointe, Murdoch, & Chenery, 1998; Beatty & Monson, 1998; Blonder, Gur, & Ruben 1989).

Berg, Bjornram, Hartelius, Laakso, and Johnels (2003) assessed higher level language difficulties in subjects with idiopathic PD using a test battery which included repetition of long sentences, recreating sentences, making inferences, comprehension of logico-grammatical sentences, comprehension of ambiguous sentences and metaphors, word definitions, word fluency, naming, sentence analysis and morphological completion. Results showed poorer performance in PD subjects compared to the control group in all the tasks; Significant difference was found mainly in the “Making Inference” and “sentence analysis” tasks.

Some studies, also have tried to investigate the cognitive and linguistic deficits in different stages of the disease. Lieberman et al. (1992) concluded from their study that the moderate group of patients with idiopathic PD, exhibited higher error rates and longer response times than the mild group in the syntax test.

Braak, Ru¨b, and Tredici (2006) administered Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975) on 88 subjects with PD and the point scores were divided into four groups from normal or nonsignificantly impaired cognition to severely impaired cognition. It was observed, that from among the subjects already at stage 3 of PD, about one-third of them showed a pronounced tendency to cognitive decline. The number of such patients increased further to two-thirds at stage 4, exceeded 90% at stage 5 and reached 100% at stage 6.

Need for the study

PD is primarily considered to result in speech disorder. Logemann, Fisher, Boshes, and Blonsky (1978) determined the frequency of deviant speech characteristics in a group of 200 people with PD and found that approximately 90% had a speech deficit attesting to the high prevalence of the hypokinetic variety of dysarthria. In a subsequent study, speech and swallowing problems were observed in nearly 90% of the persons with PD (Ramig, Fox, & Sapir, 2008; Sapir, Ramig, & Fox, 2008).

Although PD was recognized as early as 1817, the presence of certain language and cognitive deficits in the absence of dementia was reported only in the last three decades. There have been studies investigating the language functions in PD (Cummings et al., 1988; Lieberman et al., 1992; Berg, Bjornram, Hartelius, Laakso, & Johnels, 2003

etc.) and there have also been studies focusing on the different cognitive domains viz; attention and concentration, executive functions, memory & visuospatial skills (Bronnick, et al., 2007; Verbaan et al., 2007; Muslimović, Post, Speelman, Hann, and Schmand, 2009 etc.). However, there are limited investigations which study the impact of the disease on both cognitive and linguistic domains. Further, studies are scarce with regard to the cognitive-linguistic functions across the different stage of the disease. Such a study will possibly help us to identify the stage at which the cognitive-linguistic deficits emerge.

The knowledge of the presence of a cognitive-linguistic impairment in PD will help in promoting the assessment of these skills in persons with PD which is usually ignored. Further, it will also help in targeting the cognitive-linguistic skills during the intervention program and contribute to the patient and family education.

In India there is a paucity of data on cognitive-linguistic functions in persons with PD and the results obtained from the western studies cannot be generalized to the Indian context as there are reports which state that there is a difference in the cognitive function across races. A study by Sosa, Albanese, and Prince in 2009 reported that the Chinese participants performed better and Indian participants worse, than those from Latin America in a task which included verbal fluency, word list memory (immediate recall) and recall tests. In another study by Dingman (1996), Caucasians scored significantly better than American Indian college students on verbal-sequential tests, but not on visuospatial tests. Hence there is a need to study the cognitive-linguistic functions in persons with PD specifically in the Indian context. Keeping this in view, the present study was planned.

Aim of the study

The aim of the present study was to investigate the cognitive-linguistic abilities of Kannada speaking persons with idiopathic PD. The specific objectives included the following:

1. To compare the performance of persons with idiopathic PD on a set of cognitive-linguistic tasks with a group of neurotypical individuals.
2. To investigate the cognitive-linguistic abilities of persons with idiopathic PD across the different stages of the disease.

CHAPTER II

REVIEW OF LITERATURE

The term aging or senescence refers to the biological process of growing older (William 1957; Comfort, 1964; Finch, 1990). Aging is said to begin at birth and continues throughout life. Normal aging usually refers to the most common or often encountered functional state of the nervous system in a population of older individuals (Whitehouse, 1986). Partridge and Mangel (1999) defined normal aging as a progressive functional decline or gradual deterioration of the physiological function with age, including a decrease in fecundity. It is associated with molecular, cellular and biochemical changes across the body system. The specific age related anatomic and physiological changes which occur in the nervous system include loss of neurons, which varies substantially between the various regions of the brain (Rossor, 1992), decrease in brain weight (Dekaban & Sadowsky, 1978) and size (Jacoby, Levy, & Dawson, 1980), cell loss-neuroglia (Henderson, Tomlinson, & Gibson, 1980), accumulation of lipofuscin (Katzman & Terry, 1992), increase in neuritic plaques (Selkoe, 1992), enlargement of ventricles (DeCarli, Kaye, Horwitz, & Rapoport, 1990) etc. Changes in the efficiency of transmission of nerve impulses, slow EEG patterns, slower functioning of automatic nervous system, prolonged recovery period required after activation, slow skilled motor movements, altered gross movements related to gait and posture resulting in imbalance (Timiras, 2007), changes in the sleep pattern, decreased visual acuity and presbycusis (Saxon, Etten, & Perkins, 2010) are some of the physiological changes that occur in the individual. Aging is also associated with several changes in the cognitive and linguistic domains.

Cognition and Aging

Cognition can be defined as the processes an organism uses to organize information. This includes acquiring information (perception), selecting (attention), representing (understanding) and retaining information (memory) and using it to guide behavior (reasoning and coordination of motor outputs). Some authors have also included language and visuospatial skills to be part of the cognitive processes (Jones & Peters, 1999).

Perception is a process which involves the recognition and interpretation of stimuli which register on our senses (Rookes & Willson, 2000). *Attention* can be referred to the kind of concentration on a mental task in which you select a certain type of perceptual stimuli for further processing while trying to exclude other interfering stimuli (Shapiro, 1995). Attention can be divided into several components including focus, sustain, select, alternate and divide. Attention plays an important role in discrimination and perception abilities. *Memory* is the process of maintaining information overtime (Matlin, 2005). It covers three important aspects of information processing i.e., encoding, storage and retrieval. *Reasoning* is defined as the activity of reflectively arriving at the judgments through alignment of the progress of our thoughts with certain formal structures to solve problems (Laden, 2012).

Executive function includes a set of related skills that prioritize, regulate and orchestrate an individual's thoughts and behaviors. It is a multidimensional construct which involves volition, planning, purposive action and effective performance (Lezak, 1995; Spreen & Strauss, 1998). These components often involve attention and working memory, cognitive flexibility, decision making, judgment and behavioral regulation.

Visuospatial function is characterized by the ability to produce and recognize figures and to form different relation among spatial locations. Specific visual functions include the ability to recognize familiar faces, the ability to copy or match objects or pictures, and the ability to translate spatial elements from one mode to another. Visuospatial ability can be assessed by various tasks like constructional tasks (assembly of blocks, sticks or puzzles), drawing tasks which involves copying, or matching.

Several researchers have stated that aging may be associated with deterioration in different cognitive skills or processes even in the neurotypical elderly individuals (Birren, 1970; Botwinik & Storandt, 1974; Burke & Light, 1981; Schaie & Hertzog, 1983). Subsequently many other studies have been carried out to investigate the cognitive skills in the elderly individuals. A few of the studies have been described below.

Hochandel and Kaplan (1984) reported that normal aging may result in deterioration in sustained and selective attention. Research has shown that elderly have more difficulty than younger people in allocating attention to the target task. Impaired attention may lead to person's missing information in spoken discourse or in written material, which may have an impact on their responses and cause communication breakdown (Boyle & Strikowsky-Harvey, 1999). Executive functioning was also found to be declining in geriatrics. Many studies have shown that there was a major impairment in the executive functions including volition, planning, purposive action and effective performance in elderly (Lindenberger & Baltes, 1997; Smith & Baltes, 1997; Mungas, Reed, & Kramer, 2003; Carey et al., 2008). Glosser, Gallo, Clark, and Grossman (2002) have documented reading problems associated with visual processing deficits in older adults. Nilsson (2003) conducted a study where he compared the effects of aging on

episodic memory, semantic memory, short term memory and priming. He reported that the episodic memory was primarily impaired in normal aging.

A study conducted by Connelly, Hasher, and Zacks in 1991 aimed to study the ability of younger and older adults to ignore irrelevant information in the context of a task that the required the participants to read connected discourse. 24 younger and 24 older adults participated in the study. The subjects were presented with stories which had to be read aloud and then they were instructed to answer certain questions about the story. These stories did or did not have distracting material in between; when the distracting material was present it appeared in a different font. The task was to read the text attending only to the target. The results indicated that the older adults had more difficulty in ignoring distracting information compared to the younger adults.

Hanninen et al. (1996) conducted a study which aimed to evaluate the prevalence rate of Aging-Associated Cognitive Decline **(**AACD) in elderly people, to evaluate the associations of age, sex and education with prevalence rates and to examine the diagnostic value of a neuropsychological test battery for identifying subjects with AACD. 403 persons between the age ranges of 68-78 years participated in the study. Memory loss was recorded by using a Memory Complaint Questionnaire (MAC). The subjects went through a test battery which included tasks to assess memory, attention, effortful cognitive process, visuoconstructive function and verbal ability. It was found that the prevalence rate for AACD in subjects aged 68-78 years was 26.6%. The prevalence was higher in men (30.1%) than in women (24.4%). The highest rate was found in the group of 71-74 year old subjects and the lowest rate in subjects aged 75-78 years.

A study was conducted by Milham et al. in 2002 to investigate the attentional control i.e., the mechanism by which the brain attempts to limit its processing to that of task relevant information in aging brain from a fMRI study using Stroop Test (sunject had to reas a list of words or identify the color presented with varying instructions and different degrees of distractions) The neural activity of participants between 21-27 and 60-75 years were assessed using an fMRI during their performance in a color-word Stroop test. The tests revealed that there was decreased responsiveness in some of the areas of the brain like the dorsolateral prefrontal and parietal cortices, i.e. the structures which help in attentional control in the older participants.

Language and Aging

Language can be described as a set of arbitrary verbal symbols arranged in a conventional code that evolved as a social tool to communicate ideas and influence the behavior of others (Mc Laughlin, 2006). It is a form of communication that is carried out to convey feelings and thoughts or ideas. Understanding of spoken and written language relies on the ability to correctly process word and phrase meanings, sentence grammar, and discourse. The study of language characteristics of the normal elderly individuals is of particular concern as it has direct implications on clinically aging population.

Several studies have investigated the language functions in the elderly by employing different tasks. The studies in general indicate that there is a slow decline in the linguistic functions. For example, lexical access, confrontation naming and word fluency tasks have been found to decline with an increase in age (Bayles & Kasznaik, 1987). Elderly people were found to have difficulties in understanding complex sentences in grammatical form or sentence structure or both (Davis & Ball, 1989) Kemper (1992)

found that during discourse, older adults produce more ambiguous references and more filled pauses and reformulate their words more than young adults do. Semantic knowledge also appeared to decline with age, although significant differences were not found until relatively late in the span of life (greater than 70 years). Studies have also indicated that older adults make more errors in picture naming task than young adults (Feyereisen, 1997). These dysfluencies indicate that they have word retrieval difficulty while speaking. It was also found that older adults were more likely to omit sounds (MacKay & James, 2004).

Hodgson and Ellis in 1998 aimed to study the naming in the elderly. 26 elderly subjects between the age of 71-86 and 10 young adults between 22-33 years were considered for the study where they had to name 206 line drawing of objects. The results revealed that the younger group named more objects than the elderly group; most of the errors made by the elderly population were semantic, with circumlocutions "don't know" responses.

Another study was conducted in 1986 by Laberge, Edwards, and Knesevich to study the performance of normal elderly on Boston Naming Test (BNT, Confrontation naming). Here 28 elderly males and 30 females of 60-85 years were tested on BNT. The task was to name each object and the scores were compared with the published normative data. It was found that the scores showed a decline as the age increased.

Albert, Heller, and Milberg (1988) studied the changes in naming ability with age. 80 healthy subjects between the age range of 30-80 years were administered BNT (confrontation naming). The study revealed that there was no much change in the

individual's naming ability over a period of time until the person reaches around 70 years of age, during which it was observed, there was a significant decline in performance. It was also observed that semantic and perceptual errors increased with age whereas lexical errors do not.

A study was conducted to obtain normative data for the BNT in the native Dutch speaking Belgian elderly by Marien, Mampaey, Vervaet, Saerens, and Deyn in 1998 for which 200 native Dutch speaking Flemish elderly between 55 to 91 years were considered. After an administration of a series of psychometric tests, BNT was administered. Analysis of the obtained values indicated that the performance was affected by the following order – age, gender and years of education.

Another longitudinal study of confrontation naming in the normal elderly was conducted by Zec, Markwell, Burkett, and Larsen in 2005. The confrontation naming task was done using the BNT. A total of 541 subjects were considered for the study, 238 were followed for 6 years, 81 for a period of 8 years and 43 for 10 years. The authors concluded that the confrontation naming task is usually preserved with aging with subtle decline during 70 and 80 years of age.

Kemper in 1986 studied the imitation of complex syntactic constructions by elderly adults between the age of 70-89 years and young adults between 30- 49 years. The task was to imitate complex sentences which had different clauses. It was found that the younger age groups were able to do the act of imitation despite the length, position or type of clause; whereas the elderly adults were able to imitate the short constructions.

The authors thus concluded that there was an age related decline in syntactic processing ability.

Kynette and Kemper (1986) conducted a cross-sectional study of language performance to assess the relation between aging and the loss of grammatical forms. They studied the spontaneous speech of 4 female and 4 male native English speakers each in 4 age groups: 50–59 yrs, 60–69 yrs, 70–79 yrs, and 80–89 yrs. 16 different measures of syntactic structure, verb tense, form class, lexical use and disfluency were used. They hypothesized that the performance on syntactic structure, tense, and form class measures declined with age, reflecting attention and memory deficits. A 20-min speech sample from each subject was analyzed using the LINGQUEST program of Mordecai, Palin, and Palmer (1985). The results showed that 50–60 yr old subjects used a greater range of complex structures. 70 and 80 yr old subjects made more errors in the use of simple syntactic structures and more errors in tense and matching of subject and verb person. Elderly subjects used fewer forms imposing high memory demands, with constructions requiring fewer interruptions of structure than did the younger subjects. Hence they concluded that age was related to the use of complex grammatical structures.

Shafto, Burke, Stamatakis, Tam, and Tyler (2007) analyzed Tip-of-the-tongue (TOT) experiences or the word-finding failures, where people are temporarily unable to produce a word they are certain they know. They also investigated the neural correlates of this phonological retrieval deficit. TOT frequency increased with normal aging during adulthood and the behavioral evidence suggested that the underlying deficit may be in retrieving the complete phonology of the target word during production. They obtained three dimensional T1-weighted structural magnetic resonance images (MRI) for healthy

participants between 19 and 88 years of age and used voxel-based morphometry to measure the gray matter density throughout the brain. In another session, participants named celebrities cued by pictures and descriptions, indicating when they had a TOT, and also completed Raven's Progressive Matrices (RPM), a task that does not involve phonological production. They found that the number of TOTs increased with age and also with gray matter atrophy in the left insula, an area implicated in phonological production. The errors on the RPM increased with age, but performance did not correlate with gray matter density in the insula. Hence they assumed that there was an association between a region in the neural language system and the rise in age-related word-finding failures and suggested that age-related atrophy in neural regions were important for phonological production and this may contribute to age-related word production failures.

Relationship between Language and Cognition

Language is the major instrument of cognition. Language mediates not only the social relationship systems, but also the control of cognitive processes (metacognition). However, aging paves way for certain cognitive-linguistic changes in an individual. The changes in cognition has its impact on language. Given the inextricable link between cognition and language, it is not surprising that age-related cognitive changes are considered as a causative factor in reduced linguistic processing abilities. There are studies which have shown that as age advances there exists a decline in cognition which would in turn effect the language, i.e., the comprehension and expression. Vander Linden, Hupet, and Feyereisen (1999) attributed the age related difference in language, memory and comprehension to the decreased capacity of working memory due to reduction of speed increasing sensitivity to interference.

Cognition and language are closely interlinked and it is difficult to separate the changes in the cognitive process form the changes in the linguistic processes. Cognitive linguistics describes how language interfaces with cognition and how cognition adapts in the course of language usage, phylogenetically in the evolution of language, ontogenetically in the acquisition of language and moment to moment situated, online language processing and performance (Robinson & Ellis, 2008). Learning language involves determining the structure from usage which involves the full scope of cognition such as remembering episodes and utterances and the categorization of experiences. Language comprehension is frequently necessary for cognitive skills as the acquisition of new knowledge, as a person attends a lecture, reads a manual or listens to a boss's instruction (Boyle & Strikowsky- Harvey, 1999). Cognitive development in infants and toddlers is strongly related to increased memory and to the ability to acquire symbols in language and gestures and in many other areas (Gopnick & Meltzoff, 1986). The linguistic representations for objects are part of long term lexical memory and must be retrieved and brought to consciousness. Object naming requires perception, access to long term memory.

Studies investigating the cognitive-linguistic dynamics in individuals are scarce. However, a few studies have been conducted to study the same. A study was conducted by Vijay Kumar and Prema (2007) on 60 normal healthy adults (30-80 years) to examine the cognitive linguistic flexibility i.e., the ability to shift cognitive set, aptitude, thought or attention in order to perceive, process or respond to situations in different ways (Eslinger & Graten, 1993). This was done across different age groups. Their second aim was to find if there was an overall increase in reaction time for the retrieval of the target

word as age advances. The task was an inter category shifting task where of 5 stimuli one was of a different category and the person had to produce the word which did not belong to the category and this was picked up by the DMDX software. It was found that there was no deterioration which was significant in the cognitive linguistic flexibility as age advanced. It was also found that as the age advanced the time for retrieving the target word also increased.

The interlink between cognition and language has received significant impetus over the past decade. Consequently, researchers realized the need to study the cognitive and linguistic aspects in the neurologically healthy and disordered population. As a result, many assessment and intervention protocols were developed such as the Cognitive Linguistic Intervention Protocol (Deborah, 1992), Cognitive Linguistic Assessment Protocol (Kamath, 2001), Cognitive Linguistic Quick Test (Helm-Estabrooks, 2001), Cognitive Linguistic Quick Test (Vandana & Shyamala, 2011) etc. to assess and treat the cognitive and linguistic aspects in individuals with brain damage.

Parkinson's Disease

As an individual ages, over a period of time, there would be changes in the structure and the function of different regions in the brain as mentioned earlier. Some of these changes may be associated with the normal aging process and some may be pathological, however the pathological changes may not primarily be age related, because in some individuals these processes can start off early. One of the few disorders which are likely to be seen in individuals and which results in pathological changes are the extra pyramidal syndromes. Here the major pathological changes occur in the basal ganglia, thalamus and upper brainstem while the cerebral cortex is relatively spared. The principal

extrapyramidal syndromes include Huntington's disease, progressive supranuclear palsy, Wilson's disease, idiopathic basal ganglia calcification and Parkinson's disease.

Amongst these the Parkinson's disease (PD) is described as a neurological disorder of middle and later life which has been called 'the most characteristic, or most representative, of the extrapyramidal diseases' (DeJong, 1958). The triad symptoms of muscle rigidity, tremor, and slowness of movement are considered to typify the involvement of the basal ganglia. It is the most common neurodegenerative movement disorder, affecting about 0.5-5% of the population older than age 65, both in European and non-European populations (Chen et al., 2001). The annual incidence of PD is estimated to be 20 per 1,00,000 (Murdoch, 2010). The degree and rate of progression, however, does vary from patient to patient. PD begins most commonly after the age of 40 years and the mean age of onset between 58 and 62 yrs (Murdoch, 2010).

The incidence and prevalence of PD increases with increasing age (Ghosh, Mishra, & Sengupta, 2005). Prevalence among the Indian population shows that the prevalence rate and average annual incidence rate were 52.85/100,000 and 5.71/100,000 per year, respectively. The average annual mortality rate was found to be 2.89/100,000 per year and the relative risk of death was found to be 8.98 as stated in a study by Das et al. (2010). In a hospital-based study, Anand and Singh (1993) reported that movement disorders form 20% of neurological patients out of which there was an incidence of 16.9% for this disease out of the 2, 34,021 patients. Nearly 1/3rd of the 493 residents living in elderly homes of Bangalore city had movement disorders; Parkinsonism (24%) was the commonest (Ragothaman, Murgod, Gururaj, Louis, Subbakrishna, & Muthane, 2006).

Different types of PD have been identified based on the causative agent viz. *Idiopathic* PD, *symptomatic PD* and *PD plus syndromes.* The primary cause for PD is unknown, i.e., *idiopathic* type of PD and it also includes sporadic disease and gene mutation cases which causes symptoms of PD. PD could also be caused secondary to antipsychotic (neuroleptic) drugs (neuroleptic parkinsonism), encephalitis (postencephalitic Parkinsonism), toxins (manganese, carbon monoxide, MPTP, cyanide), vascular insults, brain tumour, and head trauma which then is broadly called *symptomatic PD*. In case of PD with syndromes (*PD plus syndromes*) parkinsonism symptoms may be caused by a known gene defect and have distinctive pathology, which includes progressive supranuclear palsy, multiple system atrophy (pyramid and cerebellar type), dementia syndromes (alzheimers, normal pressure hydrocephalous, frontotemporal dementia), hereditary disorders which includes Wilson disease, Huntington disease, Pantothenate Kinase associated neurodegeneration (Fahn & Przedborski, 2005; Waters, 2005). The idiopathic PD is the most predominant disorder constituting 80% of the individuals with PD (Fahn & Przedborski, 2005). The second most common type of PD is the PD plus syndromes constituting 15% of the individuals with PD.

PD is generaly progressive in nature. The course of the PD is subdivided into two distinct phases; *presymptomatic* phase (early stage) where in the physiological changes have begun but no overt signs or symptoms of the disorder are observed and *symptomatic* phase is the middle to later stages where the signs and symptoms are overt and the severity increases from the middle to later stages (Wolters, Francot, Bergmans, Winogrodzka, Booij, Berendse, & Stoof, 2000; Del Tredici, Rüb, Vos RAI de., Bohl, & Braak, 2002; Braak, Del Tredici, Rüb, Vos RAI de., Jansen Steur, & Braak, 2003). Due

to the progressive nature of the disease Hoehn and Yahr in 1967 conducted a study and classified the disability into V stages using an arbitrary scale.

Stage 1- Unilateral involvement only, usually with minimal or no functional impairment

Stage 2- Bilateral or midline involvement without impairment of balance

Stage3- First sign of impaired righting reflexes; patients are physically capable of leading independent lives and their disability mild to moderate

Stage 4- Fully developed, severely disabling disease; the patient is still able to walk and stand unassisted but is markedly incapacitated

Stage 5- Confinement to bed or wheelchair unless aided.

According to Braak and Braak, 2000, the pathology from the subcortical structure, basal ganglia present during the early stage, gradually extends to the neocortex leading to a gradual progressive decline in all the domains such as cognitive, speech, language, motor, and sensory.

Braak et al. (2003) classified the pathology underlying PD into 6 stages which can be divided under the presymptomatic and symptomatic phases mentioned above. The presymptomatic stage includes the 1^{st} and the 2^{nd} neuropathological stage of the PD where the pathology is confined to the medulla oblongata/pontine tegmentum and olfactory bulb/anterior olfactory nucleus. The symptomatic stage includes the 3^{rd} stage to the 6^{th} stage. In the 3^{rd} and 4^{th} stages the pathology initially extends to the substantia nigra and other nuclear grays, the midbrain and forebrain and then severe pathological changes occur. Most of the individuals at this stage cross the threshold point of the symptomatic phase of illness. Then the pathology extends to the mature neocortex and

the disease manifests in its entire clinical dimension in the 5th and the 6th stages. The 6th stage depicts the most severe stage where the person with PD will be bed ridden and may be aphonic too.

Characteristics of Parkinson's Disease

Due to the progressive nature of the disease, in the early course of the disease, the most obvious symptoms of PD are movement-related. Later, cognitive and behavioral problems may arise; other symptoms may include sensory, sleep and emotional problems. The most obvious motor symptoms of PD can be grossly divided into the following (Bigler & Clement, 1997).

1. Tremors of resting muscles: Rest tremor is the most common and easily recognized symptom of PD. Tremors are unilateral, occur at a frequency between 4 and 6 Hz, and almost always are prominent in the distal part of an extremity. Hand tremors are described as supination–pronation (''pill-rolling'') tremors that spread from one hand to the other. Rest tremor in patients with PD can also involve the lips, chin, jaw and legs but, unlike essential tremor, rarely involves the neck/head or voice.
2. Bradykinesia or hypokinesia: Slow laborious movements are seen. In severe cases there can be akinesia (absence of movement). This decreased movement of all muscles of the body gives the persons with PD a mask like face. Bradykinesia is the hallmark feature of basal ganglia disorders and is the most characteristic clinical feature of PD, although it may also be seen in other disorders, including depression. It encompasses difficulties with planning, initiating and executing movement and with performing sequential and simultaneous tasks. The initial manifestation is

often slowness in performing activities of daily living and slow movement and reaction times.

3. Rigidity: Increased tone and resistance to movement will be present. In case of severe rigidity, tremors may not be seen. Freezing may also be observed. Rigidity is characterized by increased resistance, usually accompanied by the ‘‘cogwheel’’ phenomenon, particularly when associated with an underlying tremor, present throughout the range of passive movement of a limb (flexion, extension or rotation about a joint).
4. Postural instability and disturbed gait: Difficulty standing up from sitting position, small and shuffling steps, forward leaning, absence of hand swinging while walking and festinating gait may be present. Postural instability due to loss of postural reflexes is generally a manifestation of the late stages of PD and usually occurs after the onset of other clinical features.

Consequent to the difficulty in carrying out the movements, the motor movements required for speech production are also affected. The problem could affect the different muscles involved in speech production such as the respiratory muscles, muscles of phonation, resonation and articulation. This would result in several speech deficits such as reduced loudness, monopitch, monoloudness, reduced linguistic stress, breathy, hoarse or harsh voice quality, imprecise consonant and vowel articulation, short rushes of speeches etc.

James Parkinson in 1817 reported sleep disturbance, constipation, dysarthria, dysphonia, dysphagia, sialorrhoea (excessive secretion of saliva or drooling), urinary incontinence and constant sleepiness with slight delirium to be present in person’s with

PD. In addition to these difficulties, swallowing difficulties also could be seen in persons with PD. Factor and Weinere (2008) reported that dysphagia is seen in 40% patients with PD when Levadopa was not effective. Non-motor symptoms are a common and underappreciated feature of PD. These include autonomic dysfunction, cognitive neurobehavioral disorders, and sensory and sleep abnormalities which have been seen in advanced stages of the disease.

Spencer, Sanchez, McAllen, and Weir (2010) carried out a review of the motor, cognitive, sensory perceptual and linguistic deficits that may occur as a result of the loss of dopaminergic neurons, which causes PD. They pointed out the primary triad of symptoms which were tremor, rigidity, and bradykinesia. They also addressed the non-motor symptoms frequently seen in this disorder including cognitive changes, sensory-perceptual deficits, and occasionally linguistic deficits. According to them dysarthria and dysphagia are frequently seen as a result of the motor deficits associated with PD.

Cognitive deficits in PD

The presence an associated cognitive impairment in the persons with PD was identified only in the last three decades. When James Parkinson first described Parkinsonism in 1817 he claimed that there were no mental manifestations of the disease. However, it is widely acknowledged that, in PD, even in the absence of global intellectual decline or dementia some individuals will experience subtle deficits in a range of cognitive domains including memory, visuospatial abilities, executive planning, attention and language function (Cooper, Sagar, & Jordan, 1991; Dubios, Boller, Pillon, & Agid, 1991; Levin & Katzen, 1995). Nieoullon in 2002 (as cited in Murdoch, 2010) recognized dopamine as an important neuro-regulator of cognitive functioning.

According to her, disruption to the functioning of the striatum and the dopamine connections of the frontal lobes may also be expected to influence cognitive functioning.

The cognitive deficits include attention and memory problems, naming problems, impaired discourse comprehension, deficits in executive functioning and impaired visuospatial perception. The Sydney Multicenter Study of PD (2005) found that 84% of patients evaluated had cognitive decline and that 48% met the diagnostic criteria for dementia after 15 years of follow-up.

Several studies have been carried out to assess the cognitive deficits in various domains such as memory, attention, executive function, visuo spatial skills in persons with PD. Some of the recent studies have been described below.

Lees and Smith (1983) conducted a study to examine the putative role of the basal ganglia in cognition by assessing the **c**ognitive deficits in the early stages of PD. The subjects included 30-matched controls (17 males and 13 females) and 30 PD patients (19 males and 11 females). A series of neuropsychological tests were included in the battery. They were Wechsler Adult Intelligence Scale (WAIS, Wechsler, 1958), New Adult Reading Test (Nelson & O'Connell, 1978)**,** Modified Wisconsin Card Sorting Test (Nelson, 1976)**,** Two-choice Recognition Memory Tests for Words and Unknown Faces (Warrington, 1974), Cognitive Estimates (Shallice & Evans, 1978) and Word Fluency Test (Benton, 1978). They found that the patients with PD had significantly greater difficulty in shifting conceptual sets and produced more perseverative errors on both the modified Wisconsin Card Sorting Test and Benton's Word Fluency Test. They also found that the patients and controls did not differ significantly in their performance on the

WAIS and Adult Reading IQ Tests. No difference was found between patients and controls on the cognitive estimates test. The two choice recognition test also failed to reveal the amnestic component. From these findings they inferred that these subtle cognitive difficulties might underlie the mental inflexibility and rigidity of Parkinson's disease and could be attributed to destruction of the ascending dopaminergic mesocorticolimbic pathway.

Lewis, Dove, Robbins, Barker, and Owen (2003) conducted a study to determine the underlying neural correlates of cognitive deficits in early PD. The patients underwent a protocol which included Hoen and Yahr staging, Unified Parkinson's Disease rating (Fahn & Elton, 1987) and a neuropsychological test battery, before undergoing the fMRI. The subjects were then evaluated on a working memory task which was designed to disentangle some of the many cognitive processes. The fMRI results revealed a significant reduction in the intensity of the signal during the working memory task in specific striatal and frontal lobe regions in patients with impairment in cognition compared to the cognitively unimpaired. They concluded that the cognitive deficits in PD are accompanied with neural changes.

Basic et al. (2004) conducted a study which aimed to investigate the drop in the different cognitive tasks in persons with PD. A total of 116 subjects participated in the study. Fifty eight subjects (age range- 42-83 years) with PD (average duration of disease- 6.5 years) constituted the clinical group and 58 subjects comprised of the control group who were matched on age, gender and educational qualification. The subjects were tested on Colored progressive Matrices to measure the fluid intelligence (includes factors like reasoning, problem solving and visual perception), Crichton Vocabulary scale to measure

the crystallized Intelligence (defined by the verbal competence, language development, understanding of written text and general knowledge), which was taken from Raven's Progressive Matrices (RPM) and vocabulary scale (Raven, Raven, & Court, 2001), Digit span forward test to assess the short term memory and attention, Digit span backward test to assess the working memory and attention, and MMSE (Folstein, Folstein, & McHugh, 1975). Metamemory and metacognition were also assessed which included three questions and the higher score indicated greater problems in cognitive processes of participants. The results revealed that the clinical group scored significantly lesser than the control group in all the tasks, but there was significant difference only on the Colored Progressive matrices. Thus they concluded that the PD subjects have greater impairment in fluid intelligence compared to crystallized intelligence.

A study was conducted by Braak and Tredici in 2006 with the aim of studying the correlation of cognitive decline and the proposed neuropathological stage (Braak, 2003). For the present study the authors studied 88 patients with PD, the diagnosis was confirmed with the postmortem examination and they were assigned to a mentioned stage between 3-6. MMSE had been administered to the patients no later than 18 months prior to death. The MMSE scores were divided into 4 groups which ranged from non significantly impaired to severely impaired and it was found that each of the subjects could be assigned to one of the three stages of PD. They concluded the study by quoting that the risk of developing dementia in PD becomes greater as the disease progresses in the brain. It was noted that already at stage 3 of PD about one third of them showed a pronounced tendency to cognitive decline, and further it increased to two-thirds at stage 4, it exceeded 90 % at stage 4 and reached 100 % at stage 6.

Caviness et al. in 2007 conducted a study with an objective to set a criterion for cognitive impairment in PD based on the samples available and also to report their properties. A total of 86 persons with PD participated in the study. These subjects were classified into cognitively Normal (PD- CogNL) 62 %, PD - Mild Cognitive Impairment (PD-MCI) – 21 % and PD- dementia (PD-D)- 17 % based on the integration of information available from Unified parkinson's Disease rating score- UPDRS (Fahn & Elton, 1987) to evaluate the motor functioning and MMSE (Folstein, Folstein, & McHugh, 1975) to measure the gross cognitive status. The Global Deterioration scale (Reisberg, Ferris, de Leon, & Crook, 1988), Functional Assessment Staging (Reisberg, 1988), Functional Assessment questionnaire to detect the cognitively based functional impairment and the Geriatic and Hamilton Depression Scale to assess depression (Hamilton, 1960) were administered. The test scores revealed that there was a significant difference among years of PD duration, UPDRS motor scores, MMSE scores and memory functions. In the MCI group it was found that dysfunction in executive function was most common followed by amnestic deficit. Visuospatial skills and attention was not as affected as the other skills. They concluded the study stating there was a stage of impairment in cognition present between PD-CogNL and PD- MCI which had to be investigate.

Bronnick, Emre, Lane, Tekin, and Aarsland (2007) analyzed the cognitive profile of persons with Parkinson disease and dementia (PD-D) with Alzheimer's Disease and compared them with a normal control group. A Neuropsychological tests was performed on 488 patients with PDD and 488 patients with AD using the MMSE and the Alzheimer's Disease Assessment Scale-cognitive subscale- ADAS-cog (Rosen, Mohs, &

Davis, 1984). It was reported that the there was difference in the cognitive profile of patients with PD-D compared to AD. The PDD patients exhibited specific pattern of cognitive impairment compared with AD. The PDD group demonstrated a marked deficit in attention and calculation as compared to the AD group. The prominent attention deficit in PDD may be attributed to the cholinergic pathway s subserving frontal- subcortical circuits.

Stella et al. (2007) conducted a study to identify early cognitive impairment in tasks which requires visuoconstructive and visuospatial skills in patients with mild and moderate idiopathic PD and to verify whether the clock drawing test and MMSE contribute towards the early detection of these impairments. They considered 30 elderly patients with mild or moderate stages of PD. The Schwab and England scale was used to estimate daily life activities along with the clock drawing test and MMSE. The results showed mild but consistently impaired cognitive performance related to tasks requiring visuoconstructive activities and visuospatial organization such as CDT and pentagon reproduction from MMSE. A positive correlation was obtained between difficulty on CDT performance and impaired daily life activities. They concluded that patients in the mild and moderate stage of PD, presented mild cognitive impairment characterized by decay of visuospatial organization and visuoconstructive skills. These impairments were confirmed by means of the clock drawing test, and test can be a predictive tool of early cognitive disturbances in patients with PD without dementia.

Verbaan et al. (2007) evaluated the cognitive functioning in patients with PD and assessed its relation with demographic, disease related and clinical variables in 400 patients with PD using cognition, motor and non-motor domains of the SCales for

Outcomes in PArkinson's disease-COGnition (SCOPA-COG), compared it with 150 matched controls. SCOPA-COG included various sub domains like memory, attention, executive functioning and visuospatial skill. They found that patients with PD scored significantly lower on all cognitive subdomains compared to controls, with the largest differences in executive functioning and memory. The subjects with more severe cognitive impairment demonstratedh significantly more impairment in autonomic, motor, depressive and psychotic domains of the SCOPA-COG. Patients with the postural instability gait difficulty (PIGD) demonstrated more cognitive impairment compared with patients with tremors

A longitudinal study was conducted by Muslimović, Post, Speelman, Hann, and Schmand in 2009, with the aim of assessing the nature, magnitude and frequency of cognitive change to identify the individuals exhibiting cognitive decline and to determine the clinical and demographic variables that can best predict the cognitive decline. Over a period of three years, a total of 205 subjects participated in the study of which 89 were diagnosed at baseline with PD, 52 as established PD and 64 healthy controls. A neuropsychological test battery which included psychomotor speed, attention, language, memory, executive function and visuospatial skills were administered. The results of the study revealed a decrease in the performance over time in newly diagnosed patients mainly on the measure of psychomotor speed and attention and to a lesser extent on test assessing memory, visuospatial skills and executive functioning, thus showing the presence of cognitive decline and dementia in the established PD group. They concluded that within few years of diagnosis, patients with PD show faster rate of cognitive decline than matched healthy subjects mainly in the domains of attention and psychomotor speed.

It was found that none of the features could predict the cognitive change in patients who were diagnosed newly, however the age of onset and axial impairment. i.e., posture and gait, contributed to the decline in patients whose problem was already established.

Rober in 2012 conducted a study to compare the performance PD and normal participants on the Clock drawing test. A total of 24 adults with PD and 40 normal adults participated in the study. The task was to draw a clock including all the numbers, they were asked to set the hands to 10 past 11. The results revealed poorer performance of persons with PD compared to normals. It was noted that there was significant difference for the numbers portion of the clock drawing task and not the face and hand portion.

Linguistic Deficits in PD

It is also highly likely that the language function is impaired in PD along with cognitive functions as several PET studies have demonstrated the activation of the thalamus and basal ganglia during completion of a language task such as picture naming (Price, Moore, Humphreys, Frackowiak, & Friston 1996a, cited in Murdoch, 2010) and word repetition (Price, Wise, Warburton, Moore, & Howard, 1996b). There have been reports of poor performance by people with PD on language tasks such as naming, verbal fluency, sentence repetition, and auditory comprehension (Cummings, Darkins, Mendez, Hill, & Benson, 1988; Lewis, Lapointe, Murdoch, & Chenery, 1988; Beatty & Monson, 1989; Blonder, Gur, & Ruben 1989).

Bayles and Tomoeda (1983) analyzed confrontation naming impairment in dementia using a 20-item confrontation naming task. They considered 33 normal elderly individuals and 61 dementia patients (Alzheimer's disease (N = 29), Huntington's disease

(N = 11), Parkinson's disease (N = 131) and multi-infarct dementia (N = 8)). The subjects were divided into normals, mild and moderate groups based on cluster analysis statistical procedure using a 14 measure language and cognition evaluation. The results revealed that the confrontation naming was not found to be significantly impaired in mildly involved Alzheimer's, Parkinson's, Huntington's or multi-infarct dementia patients. Although moderate HD and PD patients made more naming errors than normals, moderate AD patients were found to have significant impairment. As patients become severely demented, the error rate increased and responses were less logical and less likely to be semantically related to the target.

High-level language difficulties in PD were analyzed in a study conducted by Berg, Bjornram, Hartelius, Laakso, and Johnels (2003). They assessed 26 subjects with idiopathic PD and 26 control subjects with normal cognitive status using a test battery which included repetition of long sentences, recreating sentences, making inferences, comprehension of logico-grammatical sentences, comprehension of ambiguous sentences and comprehension of metaphors, word definitions, word fluency, naming, sentence analysis and morphological completion. The correlation between the MMSE scores and the language scores were also studied. The results showed significant poorer performance by the PD subjects compared to the control subjects in the ability to make inferences and to analyze sentences. There was no significant difference between the PD and the control group in the task of word fluency, comprehension of logico-grammatical sentences and comprehension of ambiguous sentences. MMSE scores were also found to correlate well with the results obtained on the language battery.

Cognitive-Linguistic Deficits in PD

A few studies have also investigated the cognitive-linguistic aspects in persons with PD considering the fact that there is a close relationship between cognition and language and that it is difficult to separate these processes. Girotti et al. (1988) conducted a study to evaluate the frequency of dementia, the clinical characteristics and the pattern of cognitive impairment in Parkinsonians. They considered 147 idiopathic patients with PD (69 females and 78 males) and 51 normal control subjects (21 females and 30 males). The neuropsychological battery included Set Test-a test for fluency (Issac & Kennie, 1973), Short Tale Test from Randt Memory Test (Randt, Brown, & Osborne, 1980), Benton's Visual Orientation Line Test (Benton, Varney, & Hamsher, 1978) - a test for visuo-spatial orientation, and Zazzo's Test (Zazzo, 1969)- a test of attention and visuo motor abilities. In addition, Block Design-to test the constructional abilities, Object Assembly-to test the visual organization, and Vocabulary and Similarities-to test the verbal abilities, which were the subtests of the Wechsler Adult Intelligence Scale (WAIS) were administered. The result showed that 21 patients (14-28%) were judged to be demented. In the PD group, psychotic side effects were similar to those found in the PD-D group even though less severe. Patients with PD were impaired only in Block Designs, Zazzo's Test and Benton's Test in a proportion greater than that expected. On the contrary, PD-D patients scored less in all tests in a proportion greater than that expected. Block Designs proved to be the most sensitive test.

Pillon et al. in 1989 conducted a study to find if the cognitive impairment in PD results from non dopominergic lesions. A total of 120 patients with idiopathic PD participated in the study. Akinesia, tremor, rigidity, gait disorder and dysarthria was

assessed at two time periods, initially, when the treatment was interrupted and later during the levodopa treatment. Neuropsychological assessment was carried out and the assessment included Digit span, similarities and arithmetic test (part of WAIS), Raven 47 Coloured Progressive Matrices (RPM, for visuospatial task), and the Wechsler memory scale to assess the intellectual function and memory. Linguistic function assessments which included object naming, dictation of a sentence and calculation were done. Tests for frontal lobe dysfunction were also carried out which included verbal fluency test and graphic series. Results indicated poor correlation of cognitive impairments with akinesia and rigidity which responded well to the drug (levodopa) treatment and strong correlation between neuropsychological tests and gait disorder and dysarthria which responded little to levodopa treatment. They concluded by stating that the data strongly suggested that the cognitive disturbances in PD are not related to dopamine.

Lieberman et al. (1992) tested forty patients with idiopathic PD without evidence of aphasia to assess speech production, syntax comprehension, and cognitive deficits. They were divided into two groups: 20 patients in stage III within the age range of 56 to 81 years were included in moderate group and the mild group consisted of 20 patients in stage I-II within the age range of 45 to 72 years. The test battery included psychological tests such as The selective reminding test, the Odd man out, the New dot, Digit span-The digits forward and digits backwards, the Verbal fluency test and Syntax test: Rhode Island Test of Sentence Comprehension (Engen & Engen, 1983). The speech sample was elicited using a reading task of a set of 29 isolated words beginning with a stop consonant in the initial position. The results showed that the moderate group had higher error rates and longer response times than the mild group in the syntax test. In the cognition test it

was found that there were significantly more errors in the moderate group compared to the mild group in certain tasks like the odd man out and no significant different between the groups in tasks like new dot, verbal fluency and digit span forward tests.

Grossman, Carvel, Stern, Gollomp, and Hurtig (1992) attempted to evaluate the impairments underlying sentence comprehension difficulties in nondemented patients with PD. The experimental group consisted of 20 patients with idiopathic PD (Stage 1 or 2) who were right-handed, high school-educated, native English speakers in the age range of 48 and 73 years and the control group consisted of 12 age- and education-matched neurologically intact subjects. They carried out three experiments. The experiment 1 included a sentence comprehension task which consisted of 96 target sentences, each of which was followed by a simple question. Subjects were trained to make a two-stage evaluation. The first decision involved judging whether the target sentence was well-formed. If the sentence was judged acceptable, the patients then answered a question about the sentence. The results of this experiment showed that patients with PD significantly compromised in their ability to perform this task. Their difficulties became more prominent as grammatical complexity increased, but they were significantly assisted by semantic constraints that limited possible interpretations of a sentence. Analyses of individual patient profiles revealed heterogeneous performance across the group of PD patients and somewhat inconsistent performance for patients across testing sessions.

The experiment 2 included several neuropsychological tasks including measures of attention which included orientation, digit span, word registration and calculations, and measures of memory which included the tasks such as word recall, long-term memory

and semantic memory. Other measures of language skills included automatic speech, phonemic discrimination, repetition, category fluency naming, confrontation naming, oral semantic comprehension paragraph comprehension and oral expression. Here the only memory or attention task to assess the difficult was recall of three non imageable words at 5 min following presentation. Mild deficits were also seen on category fluency naming, semantic comprehension of grammatically simple sentences, spontaneous oral expression, and spontaneous written expression.

Experiment 3 aimed to assess the role of memory and attention more directly in sentence processing, an additional set of 80 sentence-probe items similar in form to those used in Experiment 1 were used. Here also the subjects had to make a two-step judgment. To evaluate short-term memory 16 sentences with relative clauses that were well-formed and equivalent in length to the sentences employed in Experiment 1 were used. The results indicated that patients with PD were significantly compromised in their ability to attend to certain critical grammatical features of a sentence. There were no significant correlations between attention and memory performance and the results of the sentence comprehension task. A regression analysis identified specific grammatical, semantic, and attentional mechanisms as significant contributors to PD patients' overall sentence comprehension, accounting for over 97% of the variance in their performance.

In sum, a look into the literature revealed that there have been studies conducted to assess the cognitive processes in person's with PD and also some studies to assess the linguistic aspects. Such studies have revealed poorer performance by the persons with PD on both cognitive and linguistic tasks. Studies have also reported that although persons with PD have a cognition problem, these may not be as severe and widespread as those

found in persons with PD with dementia. In the past years, even though there have been enormous advances in the understanding of the etiology, pathogenesis, and pathology of PD, leading to the development of improved symptomatic therapies and improved quality of life for individuals with PD, much remains to be known, with regard to particularly, the symptoms of PD such as cognitive-linguistic functioning. Studies investigating the cognitive-linguistic abilities in individuals with PD are scarce however, since PD is a progressive neurological disorder, it is also essential to identify the stage in which the deficits emerges. Although some studies have been conducted in the West, the Indian scenario is bleak with hardly any studies focusing on these deficits in persons with PD. Further, speech-language pathologists (SLPs) need to be aware of these aspects in order to better assess and treat patients and educate families of a person with PD. Keeping this in view the present study was conceptualized with the aim of investigating the cognitive-linguistic abilities of Kannada speaking person's with idiopathic PD.

CHAPTER III

METHOD

The present study attempted to study the cognitive-linguistic abilities of Kannada speaking persons with idiopathic PD. The main objective of the study was to compare the performance of persons with idiopathic PD on a set of cognitive-linguistic tasks with a group of neurotypical elderly individuals. The second objective was to investigate the variation in cognitive-linguistic abilities, if any, across the different stages of the disease.

Participants: Nineteen persons (13 males & 6 females) with idiopathic PD with native language Kannada between the age ranges of 60-80 years were considered for the study. This constituted the clinical group. They were further classified into three stages (stage I, II and III) based on Hoehn and Yahr stages and also a checklist to identify PD which incorporated speech, motor and swallowing problems. This checklist has been provided in the Appendix I. Stage I and II were included under the early stage, while stage III was grouped under the middle stage. There were 6, 6 and 7 participants each in the stage I, II and III respectively.

Twenty one age, gender and language matched neurotypical elderly persons constituted the control group. The clinical and the control groups were also matched for the socio-economic status using the NIMH socioeconomic status scale developed by Venkatesan (2011). It is a scale with sections viz occupation, highest education score, annual family income, property and per capita income .The participants selected for the present study had a score of 2 or above for education and 1 and above for occupation and they belonged to SES III & IV status.

Inclusion criteria:

Clinical group

- No history of any other major neurological impairment other than PD.
- Under medication for the treatment of PD.
- No history of alcoholism or drug abuse.
- No deficit in hearing sensitivity for speech or vision (corrected if present).
- Minimum educational qualification upto SSLC.
- Not enrolled into a speech and language program.
- No history of psychological problems like depression, apathy etc. which was ensured by using a 5 point rating scale from Movement Disorder Society - Unified Parkinson's disease rating score (MDS-UPDRS, Goetz et al., 2007).

Control group

- No history of major neurological or psychiatric illness or of alcoholism and drug abuse.
- No deficit in hearing sensitivity for speech or vision (corrected if present).
- No deficit in cognition, communication, speech and language skills which was ensured using an informal assessment.
- A score of 24 and above on Mini Mental Status Examination (MMSE, Folstein, Folstein, & McHugh, 1975).
- Minimum educational qualification upto SSLC.

Test/tools: Adapted and standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT-K, Vandana & Shyamala, 2011) was used to assess the cognitive-

linguistic functions of the participants in the study. This test assesses the cognitive linguistic performance of Kannada speaking individuals within the age range of 20- 80 years on five primary domains of cognition i.e., attention, memory, executive function, language and visuospatial skills. The different tasks and the domains included under The Cognitive Linguistic Quick Test- Kannada (CLQT- K) are provided in Table 1.

Table 1: *Domains included under CLQT-K.*

Sl. No.	**Tasks**	**Cognitive domains**
1.	Personal facts	Memory, language
2.	Symbol cancellation	Attention and visuospatial skills
3.	Confrontation naming	Language skills
4.	Clock drawing	Attention, memory, executive function, language, visuospatial skills
5.	Story retelling	Attention, memory, language, visuospatial skills
6.	Symbol trial	Attention, executive function, visuospatial skills
7.	Generative naming	Memory, executive function, language
8.	Design memory	Memory, visuospatial skills, attention
9.	Mazes	Attention, executive function, visuospatial skills
10.	Design generation	Attention, executive function, visuospatial skills

Procedure:

Phase 1: Selection of participants

The participants were identified through local hospitals and Parkinson's associations in and around Mysore and Bangalore City. The participants were considered based on the clinical diagnosis made by an experienced neurologist. The severity or stage of the disease was assessed by using Hoehn and Yahr staging (1967) and a checklist to identify different stages of PD incorporating the speech, motor and swallowing problems mentioned earlier. Neurotypical individuals were also selected who were matched in terms of age, gender, language and socio-economic status of the clinical group.

Initially a rapport was built by engaging in a casual conversation. This was followed by screening for psychological/psychiatric problems using the rating scale given in MDS-UPDRS (Goetz et al., 2007). The NIMH socio economic scale (Venkatesan, 2009) was then administered to determine the socio-economic status. An informal assessment was done to rule out other significant problems. MMSE (Folstein, Folstein, & McHugh, 1975) was also administered to screen for cognitive impairment. The score on MMSE ranged from 20 to 30 for the clinical group.

Phase 2: Administration of CLQT-K

The cognitive-linguistic abilities were assessed by administering the Cognitive Linguistic Quick Test in Kannada (CLQT- K). The test was administered one hour before the medication was consumed in the clinical group. This was done in order to ensure that the participants were all in the same physiological state. Further it was ensured that they were not in the 'freezing' state. The subjects were seated in a comfortable position and the testing was carried out in a room with less ambient noise and visual distractions. Each

task of CLQT-K was taken one at a time and administered as per the instructions provided in the CLQT- K manual. The details of the tasks are provided below:

1. **Personal facts:** This was tested by asking four questions related to the participants' date and place of birth, current age and complete address.
2. **Symbol cancellation:** The participants were instructed to cross out target symbols within two minutes.
3. **Confrontation naming:** Ten common pictures were presented one at a time for naming. Each picture was presented for 30 seconds.
4. **Clock drawing:** The participants were asked to draw a clock on a page and were instructed to write all the numbers inside the circle and then set the hands of the clock to "ten minutes past 11". Three minutes were given to complete the task.
5. **Story retelling:** The participants were instructed to listen to a story which was read aloud by the examiner and were asked to repeat the story verbatim. Later yes/no questions were asked to probe their auditory comprehension.
6. **Symbol trail:** The task involved drawing a single line to connect a total of 11 circles and triangles in an alternate fashion according to size and shape beginning with the smallest circle.
7. **Generative naming:** The participants were instructed to list out as many names of animals and as many words (no proper nouns) as possible starting with "m" in one minute.
8. **Design memory:** Three target abstract designs were presented one at a time for memorization and the participants were instructed to identify the designs immediately from the arrays of 6.

9. **Mazes:** Two mazes at two levels of difficulty were used. The participants were instructed to trace a continuous line through the maze alleys without entering any dead ends or crossing any line. One minute was given for maze one and two minutes for maze two.
10. **Design generation:** The participants were provided with four dots and four lines and were instructed to construct different designs using those. A maximum time of 3 minutes was given for this activity.

The approximate time of testing ranged from 25-30 minutes depending on the participant's co-operation. However the overall time spent with each participant was approximately 45-60 min. Sufficient breaks were given in case of fatigue. All ethical procedures were followed. A written consent was taken from all the participants before the data collection. Test-retest reliability was established for 10% of the participants selected for the study from each group. They were tested again within a span of one to two weeks.

Phase 3: Scoring and analysis

The response from each participant was scored as per scoring instructions provided in the CLQT-K manual. The details of the scoring procedure have been provided in the Table 2.

Table 2: *Scoring procedure used to rate the performance on each task.*

Task	Scoring	Maximum Score
Personal facts	2 points- Correct response 0 points- Incorrect response	8
Symbol cancellation	Total correctly cancelled - Total incorrectly cancelled	12
Confrontation Naming	1-Correct response 0- Incorrect response	10
Clock drawing	Scoring was based on specific questions which have been mentioned in Appendix II	13
Story Retell	1- Correct story element 0- Incorrect story element	7
Symbol Trails	1- Correct trail 0 - Incorrect trail	10
Generative naming	Correct animals and Correct 'm' words	9
Design Memory	1- Correct design 0 - Incorrect design	6
Mazes	4 points – Maze 1 + 4 points - Maze 2 (Subtract 1 point for each time the line travels half inch in the incorrect direction, but self corrected) 0 points- incorrect path	8
Design generation	1 point for each correct design Total score = Number of correct designs	13

Statistical analysis:

The data thus obtained from each task of CLQT-K from both the groups were totaled and tabulated. This data was analyzed statistically using the SPSS (version 18) software. The data obtained was subjected to different statistical procedures. Reliability coefficient alpha was obtained to determine the test-retest reliability. Descriptive statistics was carried out on the various tasks of CLQT-K to obtain the mean and standard deviation. MANOVA was employed to find the significant difference between the groups and Kruskal Wallis test was employed to find the significant difference across the different stages of PD. The results have been presented and discussed in the next chapter.

CHAPTER IV

RESULTS AND DISCUSSION

The present study aimed to investigate the cognitive-linguistic abilities of Kannada speaking persons with idiopathic PD (clinical group), by comparing them with a matched group of neurotyoical individuals (control group) and also to check for variations in the cognitive-linguistic abilities, if any, across the different stages of the disease. A total of nineteen participants were included in the clinical group and twenty one participants in the control group. The participants in the clinical group were grouped into different stages as stage one, stage two and stage three. The adapted and standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT-K) (Vandana & Shyamala, 2011) was administered on both the clinical and the control group. The responses were scored as per the scoring instruction provided in the CLQT manual. The scores for each task in CLQT-K were totaled for each individual both in the clinical and control group. The data obtained from both the groups was analyzed using the SPSS software version 18. The following statistical procedures were used

- Cronbach's alpha test was obtained for determining the test-retest reliability.
- Descriptive statistics was carried out for the various tasks included under CLQT-K to obtain the mean and standard deviation.
- MANOVA was employed to find the significant difference, if any, between the groups for all overall performance as well as for the performance for each task.
- Non parametric tests- Kruskal Wallis test was employed to find the significant difference, if any, across the different stages of PD on the overall performance in each

task of CLQT-K. Mann-Whitney test was used to find the stage wise significant difference if any existed.

The results obtained for each group for each task has been presented and discussed in this chapter under different sections:

I. Reliability
II. Comparison of both the groups as a whole and on various tasks included under CLQT-K such as personal facts, symbol cancellation, confrontation naming, clock drawing, story retelling, symbol trail, generative naming, design memory, mazes and design generation
III. Comparison of the performance on the clinical group across the different stages of the disease
IV. Relationship between the tasks of CLQT-K and MMSE and CLQT-K and age on onset of the disease in the clinical group.

I. Reliability:

Testing was repeated for 10% of participants from both the control and the clinical group. The test-retest reliability was calculated using the Cronbach's alpha test, which was found to be >0.87. This suggested adequate levels of test-retest reliability for the clinical and control group reliability. The reliability scores for each of the tasks have been given in the Table 3.

Table 3: *Cronbach alpha values for the clinical and control group.*

Tasks [#]	Control group	Clinical group
PF	0.99	0.89
SC	0.96	0.98
CN	0.99	0.95
CD	0.98	0.93
SR	0.99	0.95
ST	0.99	0.97
GN	0.99	0.97
DM	0.99	0.96
MZ	0.87	0.97
DG	0.97	0.98

 # Personal Facts (PF), Symbol cancellation (SC), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), Symbol Trail (ST), Generative Naming (GN), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

II. Comparison of both the groups as a whole and on the various tasks of CLQT-K

The performance of both the groups as a whole on all the ten tasks of CLQT-K and on each task was analyzed. The tasks included Personal Facts (PF), Symbol cancellation (SC), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), Symbol Trail (ST), Generative Naming (GN), Design Memory (DM), Mazes (MZ) and Design Generation (DG).The data was subjected to descriptive statistical methods to obtain the mean and the standard deviation. Table 4 depicts the mean and Standard Deviation (SD) values of different tasks of CLQT-K.

Table *4*. *Mean and Standard Deviation (SD) values of tasks of CLQT-K.*

	Clinical Group		Control Group		F value
Tasks [#]	**Mean**	**SD**	**Mean**	**SD**	
PF	7.84	0.50	7.86	0.36	0.012
SC	8.21	3.16	10.38	1.02	8.92**
CN	9.37	0.77	9.62	0.60	1.37
CD	9.53	2.62	11.38	1.11	8.83**
SR	4.84	1.17	5.76	0.83	8.37**
ST	6.53	3.17	7.57	1.20	1.99
GN	5.16	1.34	5.33	0.66	0.28
DM	3.68	1.73	5.33	0.66	16.42**
MZ	5.79	2.41	6.52	1.12	1.57
DG	5.11	1.86	6.38	1.57	5.57*
Average Mean scores	6.61	1.87	7.61	0.91	2.81*

***$p \leq 0.01$, *$p \leq 0.05$*

 # Personal Facts (PF), Symbol cancellation (SC), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), Symbol Trail (ST), Generative Naming (GN), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

On comparison of the overall mean values on CLQT-K it was seen that the mean value of the clinical group was 6.61 (SD=1.87) which was lesser than mean value of the control group, which was 7.61 (SD=0.91). This indicated poorer performance of the clinical group in comparison to the control group. To check if this difference was statistically significant, the mean values were subjected to MANOVA. The results of

MANOVA revealed a statistically significant difference of [F (1, 29 = 2.81, $p<0.05$)] between the overall values of the two groups. Thus, the results indicated that the clinical group performed significantly poorer than the control group.

Even though the control group scored better on all the tasks of CLQT-K when compared to the clinical group, their performance on these tasks were also reduced since they obtained relatively lower scores on these tests. This can be attributed to the aging factor. Several researchers have stated that aging may be associated with deterioration in different cognitive skills or processes (Birren, 1970; Botwinik & Storandt, 1974; Burke & Light, 1981; Schaie & Hertzog, 1983). Hochandel and Kaplan (1984) reported that normal aging may result in deterioration in sustained and selective attention. Glosser, Gallo, Clark, and Grossman (2002) have documented reading problems associated with visual processing deficits in older adults. Nilsson (2003) reported that the episodic memory was primarily impaired in normal elderly. There are also studies which have shown that there is a decline in linguistic abilities due to aging. It was found that the confrontation naming and word fluency tasks declined with increase in age (Bayles & Kasznaik, 1987). Cognitive-linguistic abilities also decline by age as reported by various authors. Vander Linden, Hupet, and Feyereisen (1999) attributed the age related difference in language, memory and comprehension to the decreased capacity of working memory due to reduction of speed increasing sensitivity to interference. Vijay Kumar and Prema (2007) also found that as the age advanced the time for retrieving the target word also increased. Thus the results of the present study are in consensus with the above mentioned studies.

Since there was an overall difference in the performance between the two groups it was important to compare the performance of the two groups in each of the task.

a. Comparison of the clinical and control groups in the task of personal facts

The clinical group obtained a mean of 7.84 (SD=0.50) and the control group obtained a mean value of 7.86 (SD=0.36) in the task of personal facts (Table 4). This indicated that although the clinical group performed poorer compared to the control group, there was only a minimal difference in the performance of both the groups. The mean values were subjected to MANOVA to determine, significant difference, if any, between the two groups. The results of MANOVA showed no statistical significance [F= (1, 38) = 0.012, p>0.05)] between the clinical and the control group on the task of personal facts. The comparison of the clinical and control group has been graphically represented in Figure 1.

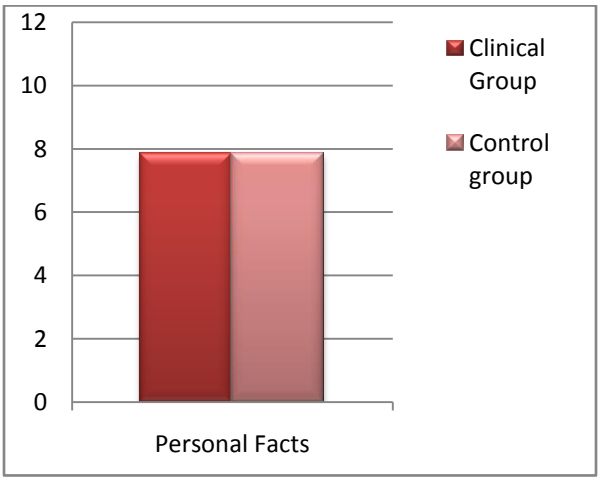

Figure 1: Performance of clinical and control group on the task of Personal Facts.

The task of personal facts involved the participant to answer certain questions regarding his age, date of birth, place of birth and current address for which the cognitive

skills such as memory and language are essential. It was observed during the testing process that both the clinical and the control group performed in a similar manner for this task.

b. Comparison of clinical and control group on the task of symbol cancellation

The clinical group obtained a mean value of 8.21 (SD=3.16) when compared to the control group which obtained a mean value of 10.38 (SD=1.02) in the task of symbol cancellation (Table 4). The mean scores indicated poorer performance by the control group. To determine if there was a statistical significance between the two groups, MANOVA was carried out and the results showed a statistically significant difference [$F(1, 38 = 8.92, p < 0.05]$ between the clinical and the control group on this task. The comparison of the clinical and control group has been graphically represented in Figure 2.

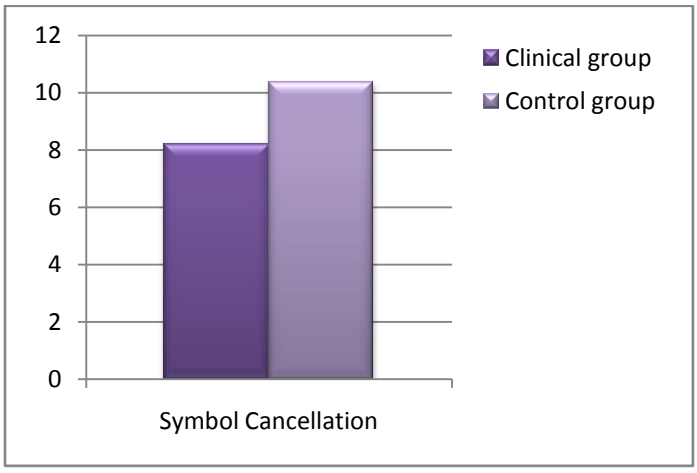

Figure 2: Performance of clinical and control group on the task of symbol cancellation.

In this task participants had to cross out target symbols within a time duration of two minutes. This task involves the process of attention and visuospatial skills. During the testing period it was observed that the clinical group cancelled the visually similar symbol along with the target symbol and also they took more time to do the activity compared to the control group

c. Comparison of clinical and control group on the task of confrontation naming

The clinical group obtained a mean of 9.37 (SD=0.77) and the control group obtained a mean value of 9.62 (SD=0.60) in the task of confrontation naming (Table 4). This indicated that although the clinical group performed poorer compared to the control group, there was only a minimum difference in the performance of both the groups. The mean values were subjected to MANOVA, to determine significant difference, if any, between the two groups. The results of MANOVA revealed no statistically significant difference [F (1, 38=1.34, p>0.05] between the clinical and the control group on this task. The comparison of the clinical and control group has been graphically represented in Figure 3.

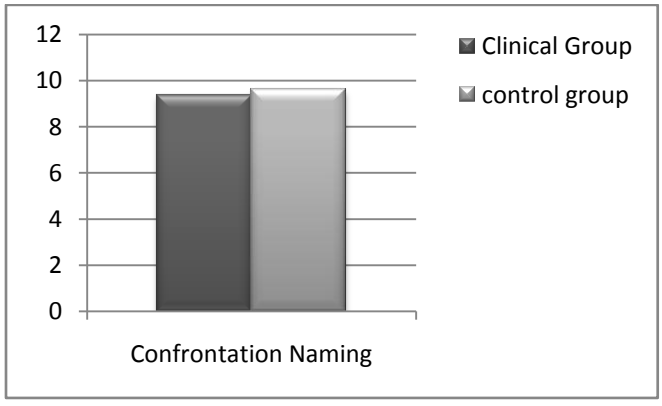

Figure3: Performance of clinical and control group on the task of confrontation naming.

Here the task involved was naming ten common pictures; this is primarily a language task. It was observed that there was within category paraphasia (e.g. pig for cow) in the clinical group.

d. Comparison of clinical and control group on the task of clock drawing

The clinical group obtained a mean value of 9.53 (SD=2.62) when compared to the control group which obtained a mean value of 11.38 (SD=1.11) on the task of clock drawing (Table 4). The mean values indicated that the performance of the clinical group was poorer compared to the control group. To determine if there was a statistical significance between the two groups, MANOVA was carried out and the results showed statistically significant difference [F (1, 38 = 8.82, p <0.05] between the clinical and the control group on the task. The performance of the clinical and control group on this task has been graphically represented in Figure 4.

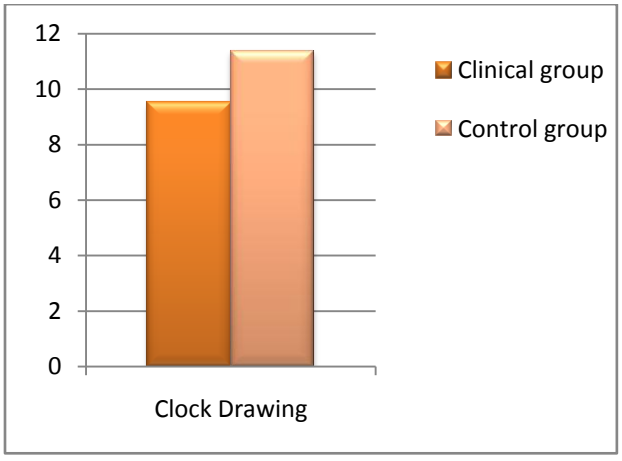

Figure 4: Performance of clinical and control group on the task of clock drawing.

This task involved drawing a clock on a page and put all the numbers inside the circle and then set the hands to "ten minutes past 11". Three minutes was given to

complete the task. To draw a clock involves the process of attention, memory, language, executive function and visuospatial skills. In the clinical group, the errors noted were with respect to the placement of numbers which were not against the rim of the circle. Similar results were observed by Rober in 2012 who noted that there was significant difference for the numbers portion of the clock drawing task and not the face and hand portion. Though the clinical and the control group completed the test within three minutes, the clinical group took more time compared to the control group. This may be attributed to bradykinesia.

e. Comparison of clinical and control group on the task of story retelling

The clinical group obtained a mean of 4.84 (SD=1.17) when compared to the control group, the mean value of which was 5.76 (SD=0.83) on the task of story retelling (Table 4). To determine if there was a statistical significance between the two groups, MANOVA was carried out and the results revealed statistically significant difference [F (1, 38 = 8.37, p <0.05] between the clinical and the control group on this task. The performance of the clinical and control group on this task has been graphically represented in Figure 5.

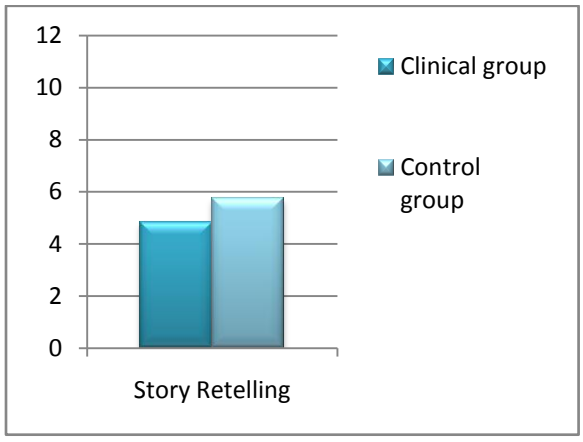

Figure 5: Performance of clinical and control group on the task of story retelling.

The task was to listen to a story which was read aloud by the examiner and the participant was instructed to repeat the story verbatim. Later yes/no questions were asked to probe auditory comprehension. This involved the processes of attention, memory language and visuospatial skill. In the story retell task, it was observed that the name of main character was replaced or not mentioned by the participants of the clinical group

f. Comparison of clinical and control group on the task of symbol trail

The clinical group obtained a mean of 6.53 (SD=3.17) and the control group obtained a mean value of 7.57 (SD=1.207) on the task of symbol trail (Table 4).On comparison of the mean values, it was seen that although the clinical group performed poorer to the control group, there was only a minimum difference in the performance of both the groups. The mean values were subjected to MANOVA to determine, significant difference, if any, between the two groups. The results of MANOVA revealed no statistical significance [F (1, 38 = 1.98, p >0.05] between the clinical and the control group on the task of symbol trail. The comparison of the clinical and control group based on the mean values has been graphically represented in Figure 6.

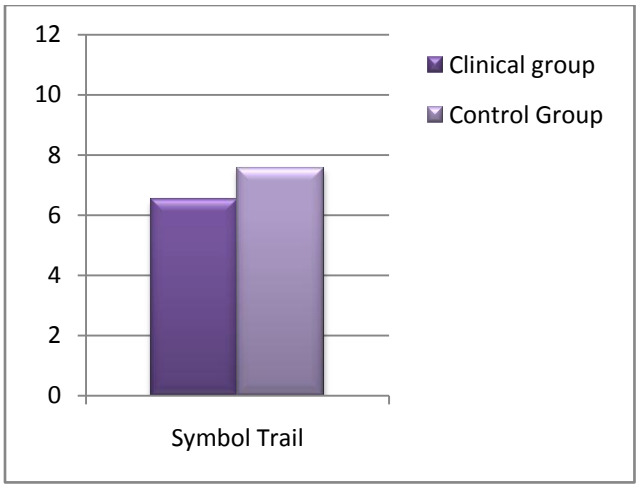

Figure 6: Performance of clinical and control group on the task of symbol trail.

The task involved drawing a single line to connect a total of 11 circles and triangles in an alternate fashion according to size and shape beginning with the smallest circle. The processes involved are attention, executive functioning and visuospatial skills. It was observed that both the clinical and the control group made mistakes in judging the size of the shape; however the participants in the control group were able to self correct, but not the clinical group. The clinical group also had difficulty in drawing straight lines and took more time to join the circles and triangles

g. Comparison of clinical and control group on the task of generative naming

The clinical group obtained a mean of 5.16 (SD=1.34) when compared to the control group which obtained a mean value of 5.33 (SD=0.66) on the task of generative naming (Table 4). This indicated that there was only a minimum difference in the performance of both the groups, where in the clinical group performed poorer compared to the control group. The mean values were subjected to MANOVA to determine, significant difference, if any, between the two groups. The results showed no statistical

significance F (1, 38 = 0.29, p >0.05] between the clinical and the control group on the task of generative naming. The performance of the clinical and control group on this task has been graphically represented in Figure 7.

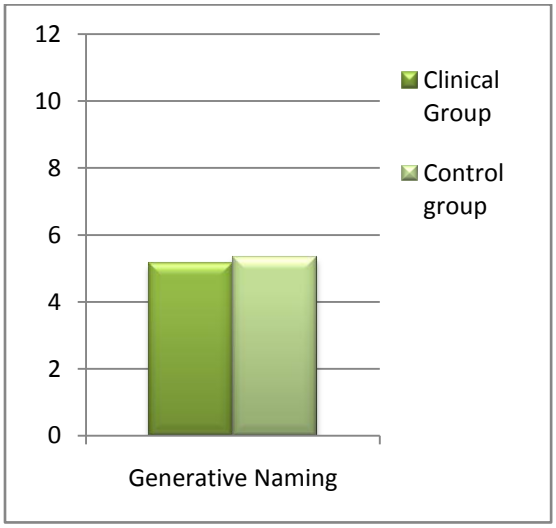

Figure 7: Performance of clinical and control group on the task of generative naming.

The task was to list out as many names of animals and as many words (no proper nouns) as possible starting with "m" in one minute for each task. The processes involved were memory, executive functioning and language. It was observed that both the control group and the clinical group, named birds when asked to name animals and repetitions were present in the task of naming items starting with 'm'. In the clinical group category shifting was observed (Eg: dog, cat… apple). It in the task which involved naming items starting from 'm', they included proper nouns even after constant prompts.

h. Comparison of clinical and control group on the task of design memory

The clinical group obtained a mean of 3.68 (SD= 1.73) when compared to the control group which obtained a mean value of 5.33 (SD= 0.66) on the task of design memory (Table 4). This indicated that although the clinical group performed poorer than

the control group, there was only a minimum difference in the performance of both the groups. The mean values were subjected to MANOVA to determine significant difference, if any, between the two groups. The results revealed statistical significance [F (1, 38 = 16.42, p <0.05] between the clinical and the control group. The performance of the clinical and control group on this task has been graphically represented in Figure 8.

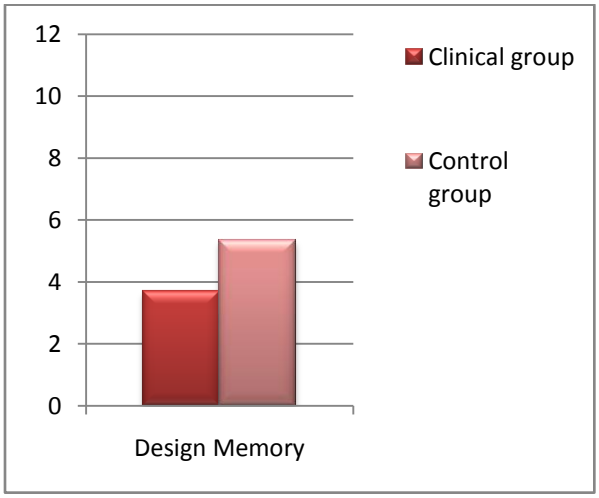

Figure 8: Performance of clinical and control group on the task of design memory.

Three target abstract designs were presented one at a time for memorization and participants were instructed to identify the designs immediately from the arrays of six. This involves the tasks of memory, visuospatial skill and attention. There was no notable difference in the performance between the clinical group and control group.

i. Comparison of clinical and control group on the task of mazes

The clinical group obtained a mean of 5.79 (SD=2.14) when compared to the control group which obtained a mean value of 6.52 (SD=1.12) on the task of mazes (Table 4). This indicated that although the clinical group performed poorer than the control group, there was only a minimum difference in the performance of both the

groups. The mean values were subjected to MANOVA to determine, significant difference, if any, between the two groups. The results of MANOVA revealed no statistically significant difference [F (1, 38 = 1.57, p > 0.05] between the clinical and the control group on this task. The comparison of the clinical and control group has been graphically represented in Figure 9.

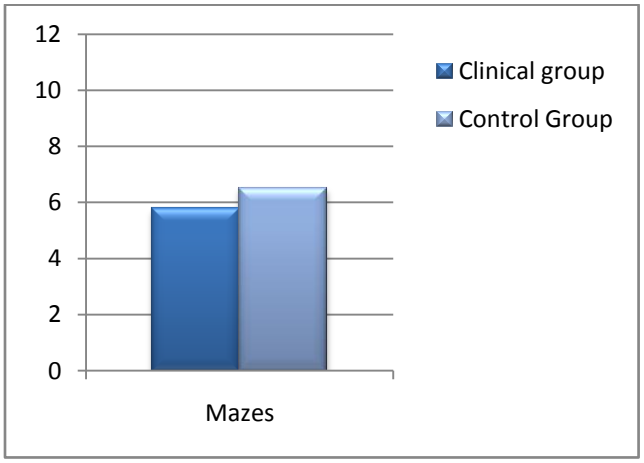

Figure 9: Performance of clinical and control group on the task of mazes.

The task was to trace a continuous line through the maze alleys without entering any dead ends or crossing any line. One minute was given for maze one and two minutes for maze two. It involved the processes of attention, visuospatial skills and executive functioning. During the testing it was observed that the clinical and control group performed similarly. It was also noted that the clinical group took more time to complete the activity.

j. Comparison of clinical and control group on the task of design generation

The clinical group obtained a mean of 5.11 (SD=1.86) when compared to the control group which obtained a mean value of 6.38 (SD=1.52) on the task of design generation (Table 4). The clinical group performed poorer compared to the control group.

To determine if there was a statistical significance between the two groups, MANOVA was carried out and the results showed statistical significance [F (1, 38 = 5.57, p <0.05] between the clinical and the control group on the task of design generation. The comparison of the clinical and control group has been graphically represented in Figure 10.

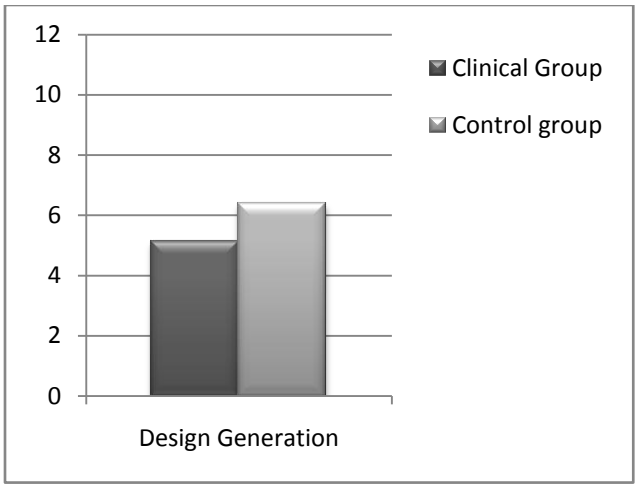

Figure 10: Performance of clinical and control group on the task of design generation.

The task was to use the four dots and four lines and to construct different designs using those. A maximum time of three minutes was given for this activity. It was observed that the clinical group used more than four lines to generate each design and repeated the designs. The clinical group required more time for the task which involved motor activity as compared to the control group ,this may be attributed to the slowness in movement i.e., bradykinesia.

To summarize there was a significant difference between the two groups in the tasks pertaining to symbol cancellation, clock drawing, story retell, design memory and design generation. The symbol cancellation task involved attention and visuospatial

skills; clock drawing involved attention, memory, executive function, language and visuospatial skills; story retelling involved attention, memory, language, visuospatial skills; design memory involved memory, visuospatial skills and attention and finally the design generation task involved attention, executive function, visuospatial skills. Thus the results from the present study indicated impairment in all the five cognitive processes in the clinical group compared to the control group. The results of the present study are in consonance with the study by Basic et al. (2004) and Verbaan et al. (2007). The results of their study revealed poorer performance on tasks which evaluated memory, attention, executive functioning and visuospatial skill. The study by Rober in 2012 also found poorer performance of PD compared to normals on the task of clock drawing. Further they reported that persons with PD performed significantly poorer on the numbers portion of the clock drawing task compared to the face and hand portion. The results of a study conducted by Bayles and Tomoeda (1983) revealed moderate PD as having more naming errors compared to normals. Berg, Bjornram, Hartelius, Laakso, and Johnels (2003) also found poor performance on naming task compared to the normal group. A study by Gorriti et al. in 1988 also revealed poor performance of the PD group on tasks assessing visuospatial skills, attention and visual construct compared to the normal group.

III. Comparison of performance of the clinical group across the different stages of the disease.

a. Comparison of the overall performance and the performance on each task across the different stages: The clinical group comprised of participants who were in the different stages of the disease; 6 were in stage I, 6 in stage II, 7 in stage III. The mean

and the standard deviation values were computed for the participants in each stage for each of the tasks included under CLQT-K. The mean values of the participants of the clinical group in stage I, II & III have been depicted in the Table 5.

Table 5. *Performance of the clinical group across the different stages on the various tasks included under CLQT-K.*

Tasks[#]	**Stage 1**		**Stage 2**		**Stage 3**		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Chi square**
PF	8.00	0.000	8.00	0.000	7.57	0.787	3.72
SC	10.83	1.329	7.33	1.366	6.71	4.071	7.83*
CN	10.00	0.000	9.33	0.816	8.86	0.690	8.26*
CD	11.33	1.862	9.67	1.211	7.86	3.132	5.32
SR	5.17	0.983	4.83	0.753	4.57	1.618	0.83
ST	7.00	1.549	8.33	1.033	4.57	4.392	2.89
GN	5.67	0.816	5.67	1.211	4.29	1.496	4.14
DM	4.50	1.761	3.67	1.633	3.00	1.732	2.83
MZ	8.00	0.000	6.00	1.549	3.71	2.360	11.99*
DG	6.50	0.548	5.00	1.265	4.00	2.309	6.19*
Total average mean	7.7	0.88	6.78	1.08	5.51	2.25	5.40

*$p<0.05$

 # Personal Facts (PF), Symbol cancellation (SC), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), Symbol Trail (ST), Generative Naming (GN), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

The overall mean values obtained on the different tasks of CLQT- K by participants of stage I was 7.7 (SD=0.88), stage II was 6.78 (SD=1.08) and stage III was 5.14 (SD=2.25), thus indicating that the performance of stage I was better compared to stage II who performed better compared to stage III. This indicated that as the stage of the disease advanced, the performance on cognitive tasks decreased, leading to deterioration in the overall scores. When the mean value of each task was compared across the three stages, it was seen that the participants in stage III showed the poorest performance in comparison to stage I and stage II. On some tasks such as personal facts and generative naming, the participants of stage I and stage II performed at par.

To check if the difference present across the different stages of PD was statistically significant, a non Parametric test, Kruskal-Wallis was carried out. The results indicated a significant difference among the following tasks: confrontation naming χ^2 (2, 19) = 8.26, p= 0.02, symbol cancellation $\chi 2$ (2, 19) = 7.8, p= 0.02, mazes χ^2 (2, 19) = 11.99 p= 0.00 and design generation χ^2 (2, 19) = 6.19, p= 0.04.

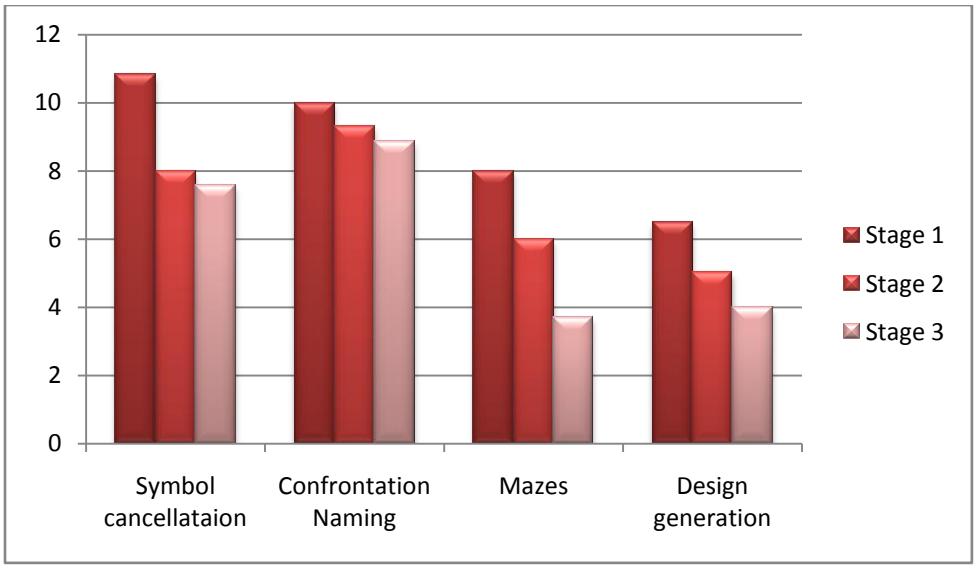

Figure 11: Performance of participants between stage I, stage II and Stage III on the tasks of symbol cancellation, confrontation naming, mazes and design generation.

Even though the persons with PD performed poorer as the stage progressed in most of the tasks, significant difference was obtained only for symbol cancellation task for which the cognitive processes involved were attention and visuospatial skills, confrontation naming for which language was involved, mazes for which there was an involvement of attention, executive function and visuospatial skills and design generation task for which the processes involved were attention, executive function and visuospatial skills. At stage I, the participants obtained full score on the task of confrontation naming which is a language task, from stage II onwards the mean scores for the confrontation naming task decreased, thus indicating a significant decrease in the language ability with advancement of the disease. For the tasks of symbol cancellation, mazes and design generation there was decrease in the mean scores from stage I itself which indicated poorer performance in the cognitive processes namely attention, visuospatial skills and executive function from stage one itself.

b. **Stage wise comparison of participants of clinical group:** The performance of the participants of the clinical group between stage I, stage II and stage III was compared using Mann-Whitney *U* test to identify the exact stage between which there was significant difference on the task.

There was a significant difference between the participants of stage I and stage II for the tasks: symbol cancellation (/z /= 2.84, p=0.00), mazes (/z /=3.15, p=0.00) and design generation (/z/= 2.01 p= 0.0) but no significant difference was present for confrontation naming task. However when stage II and III were compared, even though there was reduction of the mean scores, there was no significant difference between the participants with respect to symbol cancellation, confrontation naming, mazes and design generation. When stage I and stage III were compared there was a significant difference between all the four tasks i.e., symbol cancellation (/z/ = 2.04, p = 0.04), confrontation naming (/z/ = 2.85, p = 0.00), mazes (/z/ = 2.82, p = 0.01) and design generation (/z/=2.211, p=0.027). Thus we can conclude that the cognitive processes such as attention, visuospatial skills and executive functions were significantly impaired from stage I of the disease itself and language was impaired from stage II of the disease onwards.

The results of the present study that the severity of the cognitive-linguistic deficits increases as the stage advances are in consensus with the study conducted by several researchers. Braak and Tredici (2006) found that the cognitive decline becomes more evident in the stage III of the disease. The results of a study by Owen et al. (1995) also revealed that the participants with PD in stage one showed better performance on the tasks of planning and spatial memory when compared to the other stages. The study by

Lieberman et al. (1992) showed that the moderate group of persons with PD had higher error rates in speech production, syntax comprehension, and cognition based tasks and longer response times than the mild group. Bayles and Tomoeda (1983) found that the confrontation naming was significantly impaired in the moderately involved Parkinson's patients than the mild group. Also the cognitive decline was significant in the moderate group compared to the mild group. Stella et al. (2007) found mild but consistently impaired cognitive performance related to tasks requiring visuoconstructive activities and visuospatial organization in persons with Parkinson's disease across the different stages.

IV. Relationship between the task of CLQT-K vs. MMSE and CLQT- K vs. onset of PD.

A Spearman's rank order correlation was run to determine the relationship between the tasks of CLQT-K and the MMSE scores. There was a strong positive correlation between the tasks of story retelling (ρ =0.51, n=19, p= 0.03), symbol trail (ρ =0.61, n=19, p=0.01), and generative naming (ρ=0.49, n=19, p=0.04) and the MMSE scores indicating that as the MMSE scores increased, the CLQT-K scores also increased.

Berg, Bjornram, Hartelius, Laakso, and Johnels (2003) found that the MMSE scores correlated well with the results obtained on the language battery for persons with PD. These results were in consensus with the present study, as in the present study also it was found that apart from attention, memory, visuospatial skills and executive functioning, the language domain also correlated with the MMSE results.

In addition, statistical analysis was carried out to determine the relationship between the tasks of CLQT-K and the age of onset of PD. There was a negative correlation (ρ = -0.5, n=19, p= 0.03) between the clock drawing test and the onset of the

disorder indicating that as the age of onset increased, the clock drawing scores decreased. Thus it can be stated that the clock drawing test is sensitive task to assess the cognitive decline. This result is in agreement with the results by Stella et al. (2007) who also stated that the clock drawing test can be a predictive tool of early cognitive disturbances in patients with PD without dementia.

Thus to summarize, the clinical group in general performed poorer to the control group on all the ten tasks of CLQT-K, however, there was a significant difference between the groups on symbol cancellation, clock drawing, story retelling, design memory, and design generation. These tasks tested the domains of cognition namely attention, visuospatial skills memory, language and executive function. Hence it can be concluded that these cognitive domains are affected in persons with PD. When clinical group was compared across the stages, it was found that there was a decline in cognitive processes of attention, visuospatial skills, executive function and language. The processes of attention, visuospatial skills and executive function was found to be significantly affected from stage I of the disease, while the linguistic skills was found to be affected from stage II of the disease.

CHAPTER V

SUMMARY AND CONCLUSIONS

Parkinson's disease (PD) is a progressive, degenerative, neurological disorder associated with selective loss of dopaminergic neurons in the pars compacta of the substantia nigra (Uitti & Calne, 1993). Due to pathology, the co-ordinate action of inhibitory and excitatory neural motor commands within the corticobasal circuit gets affected leading to movement related and speech problems. The most obvious symptoms of PD are motor related which includes rest tremors, bradykinesia, rigidity, postural instability, dysarthia and dysphagia. Non motor symptoms such as behavioural, emotional, sensory and sleep related problems may also be present as the disease progresses.

The presence of an associated cognitive impairment in the persons with PD was identified only in the last three decades. Even in the absence of global intellectual decline or dementia some individuals experience subtle deficits in a range of cognitive domains including memory, visuospatial abilities, executive planning, attention and language function (Levin & Katzen, 1995). There have also been studies investigating the language functions in PD. Such studies revealed that the linguistic functioning with regard to making inferences, naming, analyzing sentences etc. are affected. However, there are limited investigations which study the impact of the disease on cognitive-linguistic domains. Further, studies are also scarce with regard to the cognitive-linguistic functions across the different stage of the disease. In India there is a paucity of data on cognitive-linguistic functions in persons with PD and the results obtained from the western studies cannot be generalized to the Indian context. Hence, there is a need to study the cognitive-

linguistic functions in persons with PD specifically in the Indian context. Keeping this in view, the present study was planned.

The present study aimed to investigate the cognitive-linguistic abilities of Kannada speaking persons with idiopathic PD. The specific objective was to compare the performance of persons with idiopathic PD on a set of cognitive-linguistic tasks with a group of neurotypical individuals and also to investigate the cognitive-linguistic abilities of persons with idiopathic PD across the different stages of the disease.

The clinical group consisted of nineteen persons (13 males & 6 females) with idiopathic PD with native language Kannada between the age range of 60-80 years. The clinical group was recruited based on specific inclusion criteria. Further the clinical group were divided into three stages - stage I, stage II and stage III based on Hoehn and Yahr stages and a checklist which was formulated to identify the stage of PD, this checklist which incorporated speech, motor and swallowing problems. Stage I and II were included under the early stage, while stage III was grouped under the middle stage. There were 6 participants in stage I, 6 in stage II and 7 in stage III.Twenty one age, gender and language matched neurotypical elderly persons constituted the control group. The clinical and the control groups were also matched using the socio-economic status; all participants belong to the SES III and SES IV status.

Adapted and standardized version of the Cognitive and Linguistic Quick Test Kannada (Vandana & Shyamala, 2011) was used to assess the cognitive-linguistic abilities in all the participants. CLQT- K assesses five cognitive processes i.e. attention, memory, executive function, visuospatial skills and language through ten different tasks

incorporating the different cognitive processes. The clinical group underwent a series of screening procedures after which CLQT- K was administered. CLQT-K was administered one hour before the consumption of medication in order to ensure that all the participants in the clinical group were in the same physiological state. After the scoring of each task the data was subjected to different statistical analysis using SPSS version 18 software. The mean and standard deviation was computed. The mean values were subjected to different statistical procedures such as MANOVA, Kruskal Wallis and Mann Whitney *U* test.

The results revealed that there was a difference between persons with PD and the neurotypical adults across all the tasks of CLQT-K. The mean scores of the persons with PD were poorer than the mean of the neurotypical group. A significant difference across five tasks i.e., symbol cancellation, clock drawing, story retelling, design memory and design generation was seen, implying that the there was decline in the cognitive processes of attention, memory, executive function, visuospatial function and language.

There was a gradual fall in the mean scores across stages in all the tasks, this difference, across the three stages of PD implies that, as the stage of the disease advanced the cognitive processes declined. A significant difference was observed between, the stages for four of the ten tasks - symbol cancellation, confrontation naming, mazes and design generation which tap on the processes of attention, executive function, visuospatial skills and language. Stage wise comparison revealed significant difference between stage I and stage II for the tasks of symbol cancellation, mazes and design generation and no significant difference was found for any of the tasks between stage II and stage III. However, between stage I and stage III there was a significant difference

between symbol cancellation, confrontation naming, mazes and design generation. The results, imply that language is affected significantly from stage II, whereas, executive functioning, visuospatial skills and attention are affected significantly from stage I.

Hence, it can be concluded that PD has an effect on the cognitive-linguistic functioning of an individual right from the early stages itself and as the stage of PD progresses, there is a decline in the cognitive-linguistic functions.

Implications

The results of the present study provide an insight into the cognitive linguistic functioning of persons with PD. The results throw light on the possible inclusion of the cognitive-linguistic protocols, along with the traditional assessment tools to assess persons with PD in the early stages of the disease. It emphasizes the importance of including cognitive linguistic aspects along with the speech aspects during the development of treatment plans for persons with PD even in the early stages. The knowledge of the cognitive and linguistic aspects of PD will also help in counseling the family members and or the persons with PD.

Future directions

The present study is a preliminary attempt towards understanding the cognitive linguistic functions in persons with PD. More systematic and in depth studies can be taken up in other Indian languages to elaborate our knowledge on the cognitive-linguistic functions of persons with PD in the Indian scenario. Larger sample across different stages can be considered and studied. Further studies can be done on different types of PD other than idiopathic PD to understand the nature of cognitive-linguistic deficits.

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APPENDIX I

Checklist to identify the stage of idiopathic PD based on speech, swallowing and motor symptoms

Stage 1

- Sporadic or intermittent or fleeting tremors.
- One finger or one hand intermittent shaking **
- Small movements of fingers are awkward in daily routine.
- Sense of stiffness (frozen shoulders)
- Slowing in movements (Bradykinesia)**
- Change in handwriting noticed
- Little stoop or one side leaning**
- No balancing problems
- Reduction of spontaneous facial expressiveness (masked or poker face)**
- Minimal or no monotone, less inflection.
- Minimal Hypophonia (reduced loudness) **

Stage 2

- Tremors present bilaterally**
- Increased sense of stiffness
- Increased bradykinesia
- Mild stoop postured **
- Affected posture and gait**
- Depression or anxiety
- Mild monotone and less inflection in the voice
- Hypophonia (reduced loudness) – asked to repeat what you say.**
- Dysfluencies (present /absent) (if present, mention its types)

Stage 3

- Tremor more persistent and increased in amplitude
- Tremors more conspicuous to others**
- Sense of stiffness while getting up from chair or sitting on a chair or while wearing dress.
- Slower in their daily routine**
- Very difficult to fasten the buttons, need occasional assistance from others

- A stooped posture, and leaning forward while standing and walking**
- Tilt of one shoulder being held higher than the other while walking or standing
- Early impairment of equilibrium**
- Lessening of further facial expressiveness (distinctly less expressive in conversation)
- Constipation, excessive sweating (at nights)**
- Restlessness
- Depression
- Fragment sleep at nights**
- Slower chewing and swallowing (harder to go down)**
- Occasional coughing and choking during swallowing food or water
- More reduction in voice, more reduced inflection of voice (have impact on communication)**
- Dysfluencies (present /absent) (if present, mention its types)
- Festinating speech (present/absent) (If present, mild/moderate/severe)**
- Occasional unintelligibility present**

** Indicates those salient features, the presence of which confirms the stage of disease in a person with PD. These features also help tp differentiate one stage from another

(Hermanowicz, 2007; Varanese, Bimbaua, Rossi, &Di Rocco, 2010)

APPENDIX II

Scoring for clock drawing Test

1. **How many numbers are present? Are they legible in context**?

   3= Numbers 1-12 are present with no perseverated or extra numbers.
   2= Atleast one of the following is present
   - Only 6 to 11 correct numbers present
   - One or more numbers higher than the number 12 is present in addition to 6 to 12 correct numbers.
   - 6 to 12 correct numbers are present, with one or more numbers perseverated.

   1= only 1 to 5 correct numbers perseverated.

   0= No correct numbers presented.

2. **Does the clock show 12 and only 12 of something?**
   1= the clock is divided by 12 of something (e.g.: numbers, hands, dots)
   0= One of the following is present
   - The clock is divided by less than 12 of something
   - The clock is divided by more than 12 of something (perseveratin, extra numbers)

3. **Are the numbers oriented correctly for reading vs. rotated?**
   1= 0 to 2 numbers are rotated
   0= 3 or more numbers are rotated

4. **Are the numbers spaced correctly?**
   1= the numbers 12, 3, 6 and 9 are in the correct places, and the other numbers are reasonably well spaced.
   0= numbers are poorly spaced

5. **Are the numbers inside the circle arranged in a circular pattern?**

   1=Numbers are arranged in a circular pattern inside the circle .One or two numbers may stay from a circular pattern , but no numbers or less than half of any number is placed outside the circle.

   0=At least one of the following is present

   - No circle arrangement of numbers is evident.

- Three or more numbers stay from a circular pattern.
- At least of one or more numbers is placed outside the circle.
- One or more numbers is placed outside the circle.

6. Are the numbers presented clockwise?

1=All numbers are written clockwise around the clock.

0=At least one of the following is present

- Numbers are counter clockwise.
- Numbers are in a random arrangement.
- Numbers in columns.

7. How many hands are there?

1=Two hands are present.

0=At least one of the following is present.

- No hands are present.
- More than two hands are present.

8. What lengths are the hands?

1=A distinguishable long hand and short hand are present.

0=At least one of the following is present.

- Equal size hands are present.
- Only one hand is present.
- More than two hands are present.(No penalty for a " seconds " hand)

9. Where do the hands originate?

1=Hands (or a single hand if only one hand is present)emanate from the centre of the circle , or within ½ inch from the centre of the circle .Hands(if more than a single hand) touch , or come within ½ inch of the touching at the point of origin.

0=At least one of the following is present.

- Hands originate more than ½ inch at the point of origin.
- Hands are separated by more than ½ inch at the point of origin.
- No hands are present.

10. Where do the hands point?

1=One hand is pointing to 11 and the hand is pointing to,2 ,or one two-directional hand is pointing to 11 and 2.

0=At least one of the following is present.

- One or more hands is not pointing to to 11 and 2.
- No hands are present.
- More than two hands are present. (No penalty for a "seconds " hand.)

11. Do the hands tell the correct time?

1= The short hand points to 11 and the long hand points to 2.

0=At least one of the following is present.

- One or more hands does not point to the correct number.
- Equal size hands are present.
- No hands are present.
- Only one hand is present.

If More than two hands are present. (No penalty for a second's hand.)