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## Verb Use in Parkinson's Disease

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Supervisor: JB Orange, *The University of Western Ontario*

A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Health and Rehabilitation Sciences

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VERB USE IN PARKINSON'S DISEASE

(Thesis format: Monograph)

by

Swati S. Nikumb

Graduate Program in Health & Rehabilitation Sciences

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
Master of Science

The School of Graduate and Postdoctoral Studies  
The University of Western Ontario  
London, Ontario, Canada

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## Abstract

Verb-specific impairments in their use and comprehension are well documented in persons with Parkinson's disease (PD). The grammatical and the motor theories have been proposed as possible explanations for verb impairments. The purpose of this study is to describe the use of low-motion and high-motion content verbs in PD in everyday conversation and to determine which theory best supports these findings. In this cross-sectional prospective study, conversation samples were collected and analyzed from participants with PD and their spouses in a mealtime context. Results indicated that total verb use on a proportional basis was not significantly different between persons with PD vs. control participants. Participants with PD produced significantly fewer high-motion verbs compared to low-motion content verbs. However, control participants also produced significantly fewer high-motion verbs compared to low-motion content verbs. The findings do not support the motor theory or the grammatical theory of verb processing in participants with PD.

## Keywords

Parkinson's disease, verb motion, action verbs, discourse, analyses of conversation

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## Chapter 1: Literature Review

### 1.1 PD and Epidemiology

Parkinson's disease (PD) is a neurological disorder characterized by tremors, bradykinesia and rigidity, features that are considered part of the concept termed 'parkinsonism' (Alves, Forsaa, Pedersen, Dreetz Gjerstad, & Larsen, 2008; Kasten, Chade, & Tanner, 2007; Tanner & Goldman, 1996; Theodoros & Ramig, 2011).

Idiopathic PD is the most common form and has an unknown etiology (Kasten et al., 2007; Tanner & Goldman, 1996; Theodoros & Ramig, 2011). The age of onset of PD is between 50 and 70 years but in some cases it has been diagnosed before age 50 (Kasten et al., 2007; Theodoros & Ramig, 2011). Parkinsonism features can develop as a result of brain tumours, head trauma or drug use (Kasten et al., 2007; Tanner & Goldman, 1996; Theodoros & Ramig, 2011) rather than from PD pathology per se. A third type of parkinsonism, known as Parkinson-plus syndrome, develops from a known etiology such as supranuclear palsy or multiple systems atrophy, and has distinct pathologies (Theodoros & Ramig, 2011).

de Lau and Breteler (2006) report that the prevalence of PD is estimated to be 0.3% of the population of industrialized countries. Kasten et al. (2007) reported that incidence rates over a number of epidemiological studies of PD, varied from 4.5 to 19 per 100, 000 persons per year when all ages of PD were considered but dramatically reduced to 11.0 to 13.9 per 100, 000 persons per year when adjusted for age. There is general consensus that PD is more prevalent in men than in women (Alves et al., 2008; Tanner & Goldman, 1996; Kasten et al., 2007) with Tanner and Goldman (1996) reporting twice as many men affected than women. This finding is consistent over all races (Tanner & Goldman, 1996). Finally, prevalence of PD varies across races, with Hispanics and non-Hispanic Caucasians showing the greatest risk for PD followed by Asians and blacks (Tanner & Goldman, 1996; Kasten et al., 2007).

## 1.2 Pathophysiology and Risk Factors of PD

The typical pathophysiology of PD is marked by a substantial decrease in dopamine in the brain. Specifically, the decrease in dopamine is a result of the depletion of dopamine producing (or dopaminergic) neurons in the nigrostriatal dopaminergic pathway (Caballol, Marti, & Tolosa, 2007; Dubois & Pillon, 1997; Peran et al., 2003; Peran et al., 2009). This pathway connects the substantia nigra nuclei with the striatum nuclei in the basal ganglia of the brain. Dopaminergic neuronal death in persons with PD can lead to impairments in motor abilities, cognition, speech and language (Theodoros & Ramig, 2011).

Although the exact cause of PD is unknown, there are several risk factors associated with developing PD. Age, gender and race are reported consistently in the literature as risk factors (Kasten et al., 2007; Tanner & Goldman, 1996; Theodoros & Ramig, 2011). In particular, being a Caucasian male over the age of 50 is a definite risk factor (Kasten et al., 2007) but the risk will vary depending on additional factors such as genetic predisposition and exposure to other risk factors.

Genetic predisposition to PD is defined by investigators as the increased likelihood of developing PD with a family history of the disease (Payami, Larsen, Bernard, & Nutt, 1994). However, twin studies of PD showed that concordance rates are similar between monozygotic and dizygotic twins (Kasten et al., 2007; Tanner & Goldman, 1996) revealing that genetics contribution may not be a key factor. Single gene mutations associated with parkinsonism also have been identified and reported. Some of these mutations include PARK1, PARK2, PARK7, PINK1 and LRRK2 (Kasten et al., 2007). Another genetic factor relating to PD development include variations in apolipoprotein E (APOE) gene expression (Kurz et al., 2009). The recessive allele E4 of the APOE gene has been linked to the diagnosis of PD when present as an E4E4 genotype (Kurz et al., 2009). Other researchers investigated the role of dopamine metabolism genes, mitochondrial metabolism genes and hormones but there is little evidence to support that these genetic factors are associated with the development of PD (Kurz et al., 2009).

Non-genetic risk factors relating to PD development also are reported in the literature. A high intake of milk has been associated with increased risk of developing PD especially in men vs. women (Chen, Zhang, Hernan, Willett, & Ascherio, 2002; Park et al., 2005). Park et al. (2005) reported that this finding is not due to increased intake of calcium. Some investigators suggested that high dietary intake of iron in conjunction with manganese also can increase the risk of developing PD (Powers et al., 2003). A general dietary insufficiency may be a risk factor as reported by Gibberd and Simmonds (1980), who noted prevalence rates of PD to be 512 in 100, 000 in a group of prisoners of war known to have experienced dietary insufficiency. Finally, due to oxidative stress brought on by lipid consumption, a diet rich in animal fats also may increase the risk of developing PD (Kasten et al., 2007).

Environmental exposures to toxins, infections, head trauma and inflammation all are risk factors for developing PD (Kasten et al., 2007; Tanner & Goldman, 1996). Exposure to pesticides such as herbicides, alkylated phosphates and insecticides also are reported by investigators to be risk factors (Firestone et al, 2005). This is especially evident in persons with poor pesticide metabolism (Elbaz et al., 2004). Exposure to some metals, especially in certain occupational settings such as welding, also may increase the chance of developing PD (Gorell, Peterson, Rybicki, & Johnson, 2004; Racette et al., 2005) although this finding is not consistent in the literature. Finally, compounds known as persistent environmental pollutants such as polychlorinated biphenyls are linked with PD development. These pollutants are found in industrialized countries and are often incorporated into fish, marine mammals, meat and dairy products commonly consumed by humans (Kasten et al., 2007).

In the early 1900s an infection known as encephalitis lethargic was thought to result in parkinsonism. This connection, however, was later proved to be false because the neuropathological criteria for developing idiopathic PD was found to be different than the parkinsonism brought on by the infection (Kasten et al., 2007). Since that time, investigators have failed to identify a specific and causal infectious agent (Marttila, Arstila, Nikoskelainen, Halonen, & Rinne, 1977; Wang, Fang, Cheng, Jiang, & Lin, 1993). However, investigators now have reported that the infection may be correlated

with PD. Specifically, increased levels of coronaviruses have been found in persons with PD (Fazzini, Fleming, & Fahn, 1992). In addition, the soil pathogen *Nocardia asteroides* has been found in increased levels in persons with PD (Hubble, Cao, Kjelstrom, Koller, & Beaman, 1995; Kohbata & Beaman, 1991). This pathogen causes a movement disorder in mice but these findings have not been reflected in human studies (Hubble et al., 1995).

Head trauma resulting in brain injury has been linked to PD development in case control studies (Bharucha et al., 1986; Bower et al., 2003). Brain injury is associated with disruptions to the blood-brain barrier which can increase exposure risk to infections and toxins (Kasten et al., 2007). Goldman et al. (2006) found a fourfold increased risk of PD for a twin who experienced brain injury resulting in amnesia or loss of consciousness vs. their non-brain injured sibling.

Finally, there is emerging evidence to suggest that inflammation may be linked to increased risk of PD development (McGeer & McGeer, 2004). Interestingly, non-steroidal anti-inflammatory drugs (NSAIDs) have been shown to have protective properties to PD development (McGeer & McGeer, 2004).

### 1.3 Clinical Features of PD

Parkinson's disease is characterized as a movement disorder with three distinct diagnostic criteria including bradykinesia (i.e., slowness of movement), tremors at rest and rigidity (Baran, Tekean, Gurvit, & Boduroglu, 2009; Caballol et al., 2007; Jankovic, 2008).

Persons with PD present typically with at least 2 of these 3 features in addition to a positive response to levodopa medication. Bradykinesia includes the slowing of movement in activities of daily living such as eating and dressing. Persons with bradykinesia also have trouble gesturing, planning and executing movements, and have loss of facial expression due to muscle weakness (Jankovic, 2008). A second cardinal feature of PD is tremors at rest. This is the most common feature of PD and also the most easily recognized. The hand tremors of persons with PD are often described as pill-rolling. Tremors will disappear during sleep and when persons are engaged in action. However, some individuals report internal shaking tremors as well. This means that the tremor is not outwardly visible. The third feature of rigidity in persons with PD is

associated with resistance in movement. During passive movements such as flexion or extension of limbs, individuals can feel pain and reduced flow in movement (Jankovic, 2008). Another feature of PD is a phenomenon known as cogwheel rigidity. This is observed when an examiner applies force to the arm of a person with PD attempting to flex the arm, while steadying the elbow. What results from this manoeuver is a series of jerking movements resembling a cogwheel-effect instead of normal fluid motion (Ghiglione, Mutani, & Chiò, 2005).

While all three cardinal features are related to movement, persons with PD also experience a range of other emotional and psychological consequences (Jankovic, 2008). Some individuals with PD experience sleep disturbances including daytime somnolence, suffer psychotic disturbances of hallucinations or delusions, and show depression (Merims & Freedman, 2008). In fact, approximately 40 percent of persons with PD have depressive symptoms especially in persons with the akinetic-rigid type of PD (Merims & Freedman, 2008). Other psychological impairments include changes in personality and impulse control disorders such as binge eating and gambling (Merims & Freedman, 2008).

#### 1.4 PD and Cognitive Impairment/ PD and Dementia

It is not uncommon for persons with PD to experience mild cognitive impairment (MCI). MCI is defined as cognitive decline that is not expected for one's age or education level, that does not interfere with daily activity and can be attributed to a well-defined disease pathology (Copeland & Schiess, 2013; Litvan et al., 2012; Petersen et al., 1999). In the past, the lack of a standard definition for MCI has created difficulties for diagnosis. Previous MCI criteria involved a subjective cognitive complaint from the patient that was then verified by a clinician. These criteria placed excessive importance on the clinician's experiences of detecting MCI in persons with PD. This of course created problems of subjectivity as experience can vary from clinician to clinician. Criteria also included neurocognitive testing but cut-off points of cognitive impairment (CI) were either not stated (Litvan et al., 2012) or were too rigid so that they may under- or overestimate MCI in persons with PD (Copeland & Schiess, 2013). Along with lack of standard criteria for MCI, differing epidemiological methods also created difficulties for capturing exact

prevalence and incidence rates of MCI in PD (Copeland & Schiess, 2013; Litvan et al., 2012). Copeland and Schiess (2013) reported incidence rates of MCI in PD ranging from 20 % to 57%. The wide range was attributed to whether the study data were collected in community- vs. hospital-based populations, the type of neurocognitive testing used, the study design, length of follow-up and MCI criteria used (Copeland & Schiess, 2013).

Recently, the Movement Disorders Society Task Force (2012) put forth a diagnostic criteria for MCI specific to PD (PD-MCI) (Litvan et al., 2012). In these criteria the task force outlined the inclusion and exclusion criteria for MCI diagnosis and then described two levels of assessment depending on the comprehensiveness of neuropsychological testing. Using the level one criteria, the clinician can describe CI in PD even if it is impractical to carry out all testing. The clinician can further his/her diagnosis by using level two of the criteria which includes CI subtyping (Litvan et al., 2012). According to the Litvan et al. (2012), the inclusion criteria for diagnosis of MCI in PD now includes: 1) patient- or clinician-reported cognitive decline in the presence of PD, 2) deficits on neuropsychological testing or on a scale of global cognitive abilities and 3) no significant interference of cognitive deficits on patient's functional independence. From this criteria, the Movement Disorder Society Task Force reported that prevalence rates of MCI in PD range from 19% to 38% (Litvan et al., 2012).

Before presenting the cognitive profile of persons with PD-MCI, it is important to outline the difference between MCI and dementia in PD (PDD) and the criteria for diagnosis of PDD. PDD is characterized by a deficit in learning new information (Dubois & Pillon, 1997) and clinically is characterized as slow progressive cognitive decline (Caballol et al., 2007). Dementia is on the continuum of CI and persons with PD-MCI can certainly develop dementia with disease progression (Emre et al., 2007; Litvan et al., 2012). Emre et al. (2007) described the diagnostic criteria for PDD generated by the Movement Disorders Society Task Force. Diagnostic criteria for dementia in PD were not well defined and were adapted from the Diagnostic and Statistical Manual of Mental Disorders IV, which was not specific to PD (Emre et al., 2007). Therefore, some characteristics of PDD may not have been captured during diagnosis including, for example, classifying impairments in activities of daily living as a result of dementia or as a result of motor

disability (Caballol et al., 2007). Today the criteria for PDD include a decline in cognitive ability in more than one cognitive domain within the context of PD that interferes with daily life (Emre et al., 2007). Similarly to PD-MCI, prevalence and incidence rates of PDD were difficult to capture due to the heterogeneous definition of PDD and wide-ranging epidemiological methods (Emre et al., 2007). Past prevalence rates were reported to be between 15 to 20 percent (Dubois & Pillon, 1997). With the criteria proposed by the Movement Disorders Society Task Force, the prevalence of PDD is now thought to be about 30% (Aarsland, Zaccai, & Brayne, 2005; Caballol et al., 2007; Emre et al., 2007).

The cognitive domain profile for PD-MCI is similar to PDD (Litvan et al., 2012). The three main mental faculties affected in persons with PD-MCI and PDD are executive functioning, memory and visuospatial skills (Emre et al., 2007). Executive functioning is the ability to adapt “to new challenging environmental situations that include the processing of relevant information, the generation of new concepts or mental sets, problem-solving and planning abilities” (Dubois & Pillon, 1997, p. 3). Executive function processes require the integrity of the frontal lobes. These regions of the brain are affected by PD resulting in impaired executive functioning. Frontal lobe dysfunction in PD manifests itself in a person’s inability to regulate internally guided behaviour and to sustain cognitive flexibility (Dubois & Pillon, 1997). Executive dysfunction often is measured by tasks such as the Wisconsin Card Sorting Task where participants are required to arrange a set of cards based on rules of categorization and to adapt to cues during the course of testing that change the rules of the categorization (Dubois & Pillon, 1997). Other tests of executive function include those that target set-shifting (i.e., Trail Making and Odd Man Out tests), set-maintenance (i.e., Stroop test) and problem solving (i.e., Tower tasks). Verbal fluency, a test of executive function, is impaired in persons with PDD as demonstrated by the Initiation Perseveration Scale of the Dementia Rating Scale (DRS) (Emre et al., 2007). Furthermore, persons with PDD experience impairments in concept formation as revealed using the “conceptualization subscale” of the DRS compared to controls and non-demented persons with PD (Emre et al., 2007).

The second mental faculty affected by PD is working memory. Working memory refers to a memory system “that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning” (Baddeley, 1992, p. 556). Working memory deficits are evident in persons with PD in the areas of short-term recall, digit ordering and inhibition of interfering stimuli (Dubois & Pillon, 1997). In persons with PD who do not have dementia, memory deficits are seen in retrieval of memory rather than encoding and storage of memory. This is evident when persons with PD but no dementia show improved memory when supplied with retrieval cues (Emre et al., 2007). Persons with PDD, however, do not show enhanced performance when given retrieval cues (Emre et al., 2007).

There is evidence to support visuospatial dysfunction in individuals with PD based on deficits in line orientation tasks (Dubois & Pillon, 1997). However, there also is emerging evidence that visuospatial dysfunctions are the result of central processing deficits rather than core visuospatial function deficits (Dubois & Pillon, 1997). There has been little research conducted on visuospatial abilities in persons with PDD. However, authors of one study that used the Raven’s Progressive Matrices Test, which is comprised of visuospatial/perceptual function tasks found that persons with PDD were impaired (Starkstein et al., 1996). However, some of the tasks on the test involved central processing and therefore the authors of the study state that at least some of the deficits can be attributed to executive dysfunction (Starkstein et al., 1996).

In addition to the cognitive impairments experienced by persons with PD-MCI and PDD, behavioural and neuropsychiatric symptoms also are reported in persons with PDD, often measured by the Neuropsychiatric Inventory (NPI) (Emre et al., 2007). Hallucinations are reported in persons with PD without dementia but are especially prominent in persons with PDD (Aarsland & Kurz, 2010; Emre et al., 2007). In fact, hallucinations in persons with PD but no dementia are almost always a major predictor for the development of dementia (Aarsland & Kurz, 2010; Emre et al., 2007). Visual hallucinations and auditory hallucinations are reported in persons with PDD with visual hallucinations occurring about twice as often as auditory hallucinations (Emre et al., 2007). Delusions also are



common in persons with PD (i.e., prevalence of 17%) but are more prevalent in persons with PDD with rates of 25% to 30% (Emre et al., 2007). Persons with PD and PDD also may experience mood disturbances including depression, anxiety and irritable moods (Emre et al., 2007). Higher prevalence rates of these three mood disturbances are seen in persons with PDD (Emre et al., 2007). Apathy, sleep disorders and eye movement deficits can be experienced by persons with PD and PDD but are not as common as the previously mentioned neuropsychiatric symptoms (Emre et al., 2007).

Risk factors for developing PDD are reported in the literature, with increasing age being the highest risk factor. Some authors report that the age of an individual and not the age of onset of PD is the real risk factor for dementia (Aarsland et al., 2007; Emre et al., 2007), other authors reported that it is a combination of both age and onset age that leads to dementia in persons with PD (Aarsland & Kurz, 2010). Severe parkinsonism also plays a role in the development of dementia especially in conjunction with increasing age because it has additive effects on dementia development (Aarsland & Kurz, 2010; Litvan et al., 2012). Rigidity as part of severe parkinsonism and postural instability and gait disturbance syndrome (PIGD) increase the likelihood of developing dementia (Aarsland & Kurz, 2010; Emre et al., 2007). Several investigators also have reported that MCI at baseline is predictive of dementia development in PD (Aarsland & Kurz, 2010; Emre et al., 2007; Pedersen, Larsen, Tysnes, & Alves, 2013). Finally, authors of one study identified risk factors related to dementia development in PD using neuropsychological tasks (Williams-Gray, Foltynie, Brayne, Robbins, & Barker, 2007). In their longitudinal follow-up of a cohort of persons with PD, the individuals that developed dementia were impaired on tasks of semantic fluency and ability to copy an intersecting pentagons figure (Williams-Gray et al., 2007). They also presented with non-tremor dominant phenotype. The authors cited these three as risk factors for developing dementia in PD (Williams-Gray et al., 2007).

## 1.5 PD and Speech Production

Speech production deficits are hallmarks of Parkinson's disease occurring in about 90 percent of people with PD (Hartelius & Svensson, 1994; Logemann, Fisher, Boshes, & Blonsky, 1978). Hypokinetic dysarthria is the most common form of speech disturbance

in PD (Darley, Aronson, & Brown, 1975; Duffy, 2005). The speech impairments associated with hypokinetic dysarthria are manifest in three main dimensions of speech production including voice, articulation and prosody (Duffy, 2005; Darley et al., 1975). At the level of the larynx, vocal cord weakness causes deficits in phonation. This is evident in reduced loudness, harsh/hoarse or breathy voice quality and even voice tremors (Duffy, 2005; Darley et al, 1975, Theodoros & Ramig, 2011). Articulation of phonemes also is compromised in PD as a result of imprecise and limited range of tongue and mouth movements. Finally, prosody, which refers to the stress, intonation and rhythm of speech (Theodoros & Ramig, 2011), is compromised in PD. This is evident by speech that is monopitch, monoloud, reduced in sound stress, and variable in speech rate. Speech also is produced in short rushes and has inappropriate silences and phoneme repetition (Duffy, 2005; Darley et al., 1975).

The hypokinetic dysarthria in PD results from neurological pathophysiology in the basal ganglia. Basal ganglia which connect to the motor cortex of the brain are responsible for regulating muscle tone and skilled or goal-directed movements such as speaking or writing. Normally, the basal ganglia accomplish this regulation by maintaining an inhibitory effect on the motor cortex. That is, they work to minimize excessive cortical output so that movements can be produced in a discreet and controlled manner. This becomes extremely important for daily activities such as walking, eating and speaking. In PD, dopamine-producing neurons in the basal ganglia diminish and as a result, movement regulation by the basal ganglia becomes impaired.

PD also can cause impairments in respiratory and resonatory dimensions of speech production though this is less common than the previously mentioned laryngeal and articulatory dimensions. Reduced airflow in the lungs of persons with PD can cause impairments in vowel prolongation and syllable repetition tasks. However, the cause of respiratory problems often is a result of smaller rib cages of elderly persons and not a direct result of reduced movement (Duffy, 2005). Finally resonatory deficits in PD can present in speech as hypernasality (Duffy, 2005).

## 1.6 PD and Expressive Communication

Expressive communication including spoken, written and gestural/ facial output is impaired significantly in persons with PD. Persons with PD exhibit difficulties generating and naming certain classes of words such as verbs and adjectives, finding words and making lexical decisions (Strauss Hough, 2004). They also produce fewer grammatical utterances and shorter sentences than control participants (Holtgraves, McNamara, Cappaert, & Durso, 2010). The impact of PD on language can vary based on characteristics such as bilingualism, motor function asymmetry and the presence of CI or dementia, among other influential factors.

### 1.6.1 PD and Spoken Language

Generating the correct words is essential for everyday communication and relies on rich semantic networks. Generative word fluency (i.e., verbal fluency) is a time-limited task of language production where participants produce words that belong to a specific semantic category (e.g., name as many animals in one minute). Verbal fluency tasks are designed to help researchers understand the richness of semantic networks. The semantic memory system and processes are disturbed by PD leading to word generation problems. For example, Strauss Hough (2004) conducted a generative word fluency task in which participants with PD were asked to say as many nouns, verbs and adjectives as they could in each of three separate 60 second tasks. Strauss Hough (2004) hypothesized that persons with idiopathic PD would show greater deficits in verb generation vs. noun or adjective generation because of the frontal lobe dysfunction that occurs in PD. However, she found that persons with PD showed significantly greater deficits producing adjectives vs. verbs or nouns. Strauss Hough (2004) attributed the findings to the semantic network of adjectives being more complex than the semantic networks supporting verbs or nouns and therefore more vulnerable to the effects of PD.

Fine et al. (2011) provided additional evidence to support semantic network vulnerability as a result of PD. They demonstrated the disruptions via reduced verbal fluency for proper noun vs. common nouns. Findings revealed that people in general do not have rich semantic networks for proper nouns such as boys' names vs. common nouns such as

everyday objects. In their verbal fluency task the ability to name proper nouns was reduced more vs. naming common nouns. The authors also showed that the ability to produce proper nouns was more impaired in persons with PD vs. controls. The authors attributed their findings to semantic network vulnerability in persons with PD.

In summary persons with idiopathic PD can present with semantic deficits in the form of generative word fluency impairments (Fine et al., 2011; Strauss Hough, 2004). The reason for these deficits resides in the vulnerability of complex semantic structures to the effects of PD. For persons with PD, reduced ability to generate correct words can impair spoken communication.

A closer investigation of the current literature reveals that semantic network disruption in PD may be the result of an inability to inhibit irrelevant information. Mari-Beffa, Hayes, Machado, and Hindle (2005) demonstrated this idea via a lexical decision task. The authors suggested that unprocessed yet activated information can lead to hyperpriming. Hyperpriming refers to quicker reaction times to concepts that are less closely related semantically. Results from their study supported the idea of hyperpriming because persons with PD react to distractor words leading to faster reaction times. In this way, the inability to inhibit irrelevant words would lead to semantic network disruption as a result of PD which then results in expressive communication impairments such as generative fluency problems and impairments on lexical decision tasks.

Other studies also have supported the hypothesis that a lack of inhibition in persons with PD produces semantic deficits. Copland, Sefe, Ashley, Hudson, and Chenery (2009) furthered conclusions made by Mari-Beffa et al. (2005) using a lexical ambiguity task. In the Copland et al task participants with PD responded to stimuli in a priming paradigm. They were presented with polysemous words (i.e., multiple meanings). For example, words like “bank” which could refer to “money” or “river” were presented. Participants were expected to suppress irrelevant information across several trials. Findings revealed that persons with PD were unable to suppress incongruent meanings. That is, they were not able to reject the meaning of a word if it was not congruent with the meaning in the

subsequent trial. This lends support to the hypothesis that semantic deficit in persons with PD stems from an inability to inhibit unnecessary semantic stimuli.

Additional support for disruptions to inhibitory processes and semantic disruption in PD also comes from studies involving non-priming tasks. Arnott et al. (2010) used a word search task to investigate semantic activation in persons with idiopathic PD. The investigators instructed participants with PD to conduct an open search for a word (i.e., find any word for a breed dog) or a closed search (i.e., find the word “collie”) among a list of words that were either related (i.e., a list of animals) or unrelated (i.e., fruit). Results showed that control participants’ word search performances varied according to the list of words from which they were instructed to choose. For example, response times for finding “any dog” were faster when control participants were asked to choose from a list of unrelated words (i.e., fruits) than they were from a related list of words (i.e., animals). In effect, control participants were able to use lateral inhibition and suppress irrelevant words that were not related to their word search. Contrary to these results, persons with PD showed no change in response times when they searched for the target words in lists of related or lists of unrelated items. That is, they were unable to inhibit irrelevant information.

In summary, research on the effects of PD on semantic networks reveals that a reduced ability to inhibit irrelevant semantic information results in poor word generation, lexical decision and word search tasks. This translates into impairments in persons with PD as it becomes difficult for them to retrieve correct words that, in turn, make it harder to express thoughts in everyday communication.

Murray (2000) described the language profiles of persons with PD at a time where speech deficits were well documented in the scientific literature but language deficits were not as well known or acknowledged. Murray (2000) correlated discourse samples collected via picture story telling tasks with cognitive and motor speech tests. Results showed that persons with idiopathic PD had a lower proportion of grammatical utterances vs. control participants, and that their utterances were not as informative with new or relevant information vs. those produced by controls. Murray concluded that persons with PD

produce less verbal output and what they do say is less complex syntactically than controls. In addition, language capabilities declined as PD severity increased. That is, cognitive abilities played a role in language ability.

Illes, Metter, Hanson, and Iritani (1998) also investigated the quality of spontaneous spoken language by studying how PD affects individuals' abilities to plan sentences and to find words. Illes et al. (1998) elicited language samples through a reading task and an interview that included questions about where participants were born and raised, their travels and their occupations. The language samples were marked for hesitations in speech which, depending on where they occurred in the spoken utterances, were described by the authors as representing word finding difficulties. The authors found that person with idiopathic PD had short sections of uninterrupted spoken language but longer sentences in those short sections. Although longer sentences suggest increased syntactic complexity, the authors found that patterns of divergence from normal language were actually mechanisms for adapting to surroundings.

Taken together, Murray (2000) and Illes et al. (1998) demonstrated that the quantity and quality of spoken language is compromised in persons with PD. The studies revealed that spoken language of persons with PD may not be as content-rich vs. that produced by normal controls. Furthermore, persons with PD may be aware of communication barriers and may use methods to help facilitate communication with others.

Authors of recent studies have addressed other factors that may account for the effects of PD on language capabilities. Zanini, Tavano, and Fabbro (2010) investigated language deficits in bilingual individuals with PD. The rationale of their study was that the two languages would be affected differently and not by general cognitive decline because native languages (L1) are associated with an implicit memory system while secondary languages (L2) involve explicit memory systems. Spoken language samples were collected from bilingual Friulian (L1) (i.e., a dialect of pure Italian) and pure Italian (L2) persons with PD. Results revealed that individuals presented with more impairment in syntax and morphology in L1 vs. L2. This study not only confirms findings by Murray

(2000) that declining cognitive abilities impair language abilities but that the manner in which this occurs can vary according to characteristics of individual.

Finally, spoken language of persons with PD can be impacted by asymmetric motor deficits. Holtgraves et al. (2010) correlated motor symptoms of persons with idiopathic PD with spontaneous language samples collected via interviews. Spontaneous discourse requires higher-level language abilities such as knowledge of pragmatics and the use of extensive cognitive resources. These resources are associated with the right hemisphere vs. the left hemisphere of the brain (Holtgraves et al., 2010). Therefore, it would stand to reason that persons with PD with greater left-side motor severity, and therefore right-brain impairments, would experience more language impairments in spoken language than individuals with severe right-side motor symptoms. Results of the study showed exactly this relationship. Persons with left-side motor severity used fewer verbs and spoke shorter sentences.

Taken together, findings from Zanini et al. (2010) and Holtgraves et al. (2010) demonstrate that persons with PD not only experience impairments in spoken language but that these deficits can be impacted by factors such as bilingualism and motor asymmetry. These findings are significant in that impairments can manifest uniquely in persons with PD.

Overall, spoken communication is impacted in persons with PD as a result of a combination of word-finding deficits and short, content-poor and ungrammatical utterances. Furthermore these language impairments can be influenced by external factors such as bilingualism and motor asymmetry making spoken communication difficult for persons with PD.

### 1.6.2 PD and Written Language

Writing, like other activities which require precise coordination and execution, relies on high-level motor activity that engages the supplementary motor area, premotor area, motor cortex and basal ganglia of the brain (Gangadhar, Joseph, & Chakravarthy, 2008). As a result of dopamine depletion, motor deficits impact writing ability in persons with

PD. Micrographia which is characterized as progressive reduction in amplitude of writing is a common clinical feature of PD (Wagle Shukla et al., 2012). The characteristic profile of writing in persons with PD was described by McLennan, Nakano, Tyler, and Schwab (1972). The authors showed that persons with PD were unable to sustain normal-sized writing for more than a few letters at a time and that writing became progressively slanted from left to right as participants reached the end of a message. Some participants with PD were able to increase the size of their letters temporarily when guidelines were provided but this was not possible for persons with fully-developed micrographia. Factors contributing to poor writing also were described by the authors. McLennan et al. (1972) noted that mood played a role in writing ability. Participants with PD performed poorly when they were stressed or were experiencing anxiety. In addition, time pressure, fatigue and poor concentration were major factors in handwriting quality in persons with PD. Finally the authors noted that levodopa, a drug used to manage PD, helped to improve writing by reducing tremor and rigidity impairments in some participants. As a result, the authors stated that tremor and rigidity had no relationship to writing ability in persons with PD and that the cause of micrographia likely stemmed from poor motor regulation. Wagle Shukla et al. (2012) investigated further motor regulation in micrographia by examining the relationship of micrographia in PD with bradykinesia (characterized by slowness in movement) and hypophonia (characterized by reduction in volume of speech). The authors found a strong correlation between these two features of PD and micrographia suggesting that there is an overlapping pathophysiology between micrographia, bradykinesia and hypophonia (Wagle Shukla et al., 2012). From these studies it is clear that a combination of motor pathophysiology and cognitive factors such as anxiety and stress play a role in written communication in persons with PD.

### 1.6.3 PD and Facial/ Gestural Language

Displaying emotion through facial expression is essential for successful communication. Hypomimia, which refers to a reduction of spontaneous facial movements and emotional expression, is evident in persons with PD making it difficult for them to convey emotional content (Bologna et al., 2012; Kegl & Poizner, 1998; McNamara & Durso, 2003). Hypomimia occurs bilaterally usually and can affect both the upper and lower



regions of the face. The hypomimia manifests as reduced spontaneous blinking and reduced smiling or opening and closing of the mouth (Bologna et al., 2012). While facial communication deficits would be problematic for almost any individual, the magnitude of its importance and loss of it is clearly evident in persons with PD who also are deaf. Kegl and Poizner (1998) described both facial and gestural communication deficits among three deaf persons with PD who conversed using American Sign Language (ASL). The authors reported that masklike expressions caused grammatical difficulties since the majority of syntactic information in ASL is expressed using the face. Gestural communication which requires the use of handshapes, movement and orientation also were compromised. Participants in the study accommodated the bradykinesia by using gestures that were minimally distinguishable from each other. For example, participants would not open or close fingers fully during gestures or failed to make contact with the area of the body required to complete a sign. This meant that communication through ASL was impaired and it was left to the conversational partner to distinguish what was being communicated by the signer with PD. Another aspect of gestural communication that was lost as a consequence of PD was visual contact. In ASL, visual contact is crucial for turn-taking in conversation. The impact of PD on attention caused participants failure in shifting attention to accommodate other speakers and thus visual focus needed for successful turn-taking was compromised (Kegl & Poizner, 1998). In summary, it is clear that consequences of PD in the form of bradykinesia and impaired attention, seriously impairs facial and gestural communication.

## 1.7 PD and Receptive Language

Receptive communication encompasses attending to and understanding language including, reading, listening and pragmatic comprehension. Reading comprehension in persons with PD is compromised especially at the sentence level. Much of the literature on reading comprehension has verified that persons with PD show deficits in understanding sentences (Grossman, 1999; Hochstadt, Nakano, Lieberman, & Friedman, 2006). However, the issue of whether or not deficits are due to limited cognitive resources or to a core linguistic deficit is not entirely clear. In the following sections

studies that address grammar/linguistic profiles and cognitive influences on sentence comprehension in PD will be reviewed.

McNamara, Krueger, O'Quin, Clark, and Durso (1996) sought to pinpoint linguistic comprehension deficits in persons with PD by comparing participants' grammaticality judgments with comprehension impairments observed among those with Broca's aphasia. The rationale behind this comparison was that if persons with PD had deficits understanding grammar that were related to the frontal lobe pathophysiology of PD then the deficits should be similar to those seen in individuals with Broca's aphasia. Participants with PD and Broca's aphasia were read aloud sentences from four categories: grammatical declarative (i.e., A man brought a package to Samuel last Tuesday), ungrammatical declarative (i.e., A man bought a package to Samuel last Tuesday), a grammatical question (i.e., What was brought to Samuel?) and an ungrammatical question (i.e., What was bought to Samuel?). As illustrated, "brought" was replaced by "bought" to create the ungrammatical sentences. The participants were required to indicate whether the sentence was or was not grammatically correct. Results revealed that persons with PD showed no difference in their judgements among sentence categories but did judge correctly the grammaticality of the sentences nearly 75% of the time. That is, persons with PD showed overall sentence comprehension deficits but since there were no differences in judgements among the types of sentences, there was no reason to suspect that persons with PD had linguistic deficits.

Terzi, Papapetropoulos, and Kouvelas (2005) added evidence to support the non-linguistic nature of sentence comprehension deficits in persons with PD. In Greek, passive sentences are generated by applying a grammatical rule. Therefore, it was expected that if persons with PD indeed do have grammatical deficits in sentence comprehension, then participants who spoke and understood Greek would not be able to apply the grammatical rule to form passive sentences. Results revealed that in a fill-in-the-blank task, Greek speaking participants with PD performed better than expected on applying grammatical rules for passive sentence formation. In conjunction with the findings of McNamara et al. (1996), results showed that sentence comprehension problems in PD are not the result of linguistic deficits.

Grossman (1999) provides a possible explanation for the non-linguistic sentence comprehension deficits in PD. He examined the roles of short-term memory and attentional resources on sentence comprehension in PD. Firstly, Grossman (1999) hypothesized that the use of short-term memory or working memory is required to rehearse and to hold sentences while grammatical features of the sentence can be processed. He found that there was an insignificant correlation between short-term memory skills and sentence comprehension. However, it is important to note here that subsequent studies supported set-switching impairments and reduced working memory as contributing factors to sentence comprehension deficits in PD (Hochstadt et al., 2006).

Secondly, using stepwise linear regression analysis Grossman (1999) concluded that a combination of variables explained 97.74% of the variance in sentence comprehension in PD. Grossman (1999) noted that sentences with center-embedded phrases, grammatical factors in subordinate phrase structures and participants' attentional ability to detect missing grammatical morphemes contributed to poor sentence comprehension. Grossman (1999) also used dual tasks to investigate further the role of cognitive resources in sentence comprehension. He concluded that participants with PD were able to appreciate grammatically simple sentences when not participating in a dual task. However, when additional cognitive demands were added, attentional resources in person with PD were exhausted which contributed to poor sentence comprehension.

In summary, sentence comprehension tasks have provided insight into why persons with PD show deficits in comprehension. Findings show that problems in sentence comprehension among persons with PD do not result from a core grammatical deficit resulting from PD but instead stem from fewer cognitive resources.

## 1.8 Pragmatics in PD

Pragmatics refers to the use of language based on social norms and contextual influences. The use of language in daily communication requires individuals to be knowledgeable about what is appropriate in varying contexts. For example, how an individual speaks to peers is different from how he/she speaks to authoritative figures. Likewise, communicative norms in one culture may be inappropriate in another. Pragmatic

awareness then becomes an essential tool for successful communication. Deficits in pragmatics among individuals with PD are well documented in the literature.

A preliminary pragmatic profile of persons with PD was published by McNamara and Durso (2003). The purpose of their study was two-fold. The first purpose was to investigate which pragmatic communication abilities were impaired in persons with PD. They examined the relationship of these deficits to frontal lobe dysfunction and studied whether persons with PD were aware of their impairments in pragmatics. Results confirmed that persons with PD had pragmatic deficits in the areas of conversational appropriateness including topic initiation, topic maintenance, turn-taking and pausing at appropriate points in conversation. The authors also found that persons with PD have problems with prosodics, and gestural or facial communication. The authors provided evidence to support the relationship that pragmatic impairments are correlated with frontal lobe dysfunction though they could not attribute the findings to cognitive decline. The second purpose was to investigate the ratings by spouses and persons with PD of the pragmatic abilities of persons with PD. The ratings indicated that persons with PD overestimated their communication ability. That is, persons with PD estimated their conversation appropriateness and ability to understand speech acts as better than they actually were, at least according to the ratings provided by their relatives. This means that they not only have pragmatic difficulties but that their self-awareness of impairments also can be compromised. As a consequence, daily communication may be less successful among persons with PD.

Holtgraves and McNamara (2010) investigated further speech act theory in relation to persons with PD. Speech act theory refers to concepts that help explain the intention behind an utterance, the act of making the utterance and the outcome or the effect of stating the utterance (Searle, 1968). For example, the intention behind the utterance “I guarantee that I’ll have it finished tomorrow” is a promise (Holtgraves & McNamara, 2010, p. 389). In everyday conversation people use phrases that are not as direct or explicit as “I promise” and instead use utterances that imply their intentions. The ability to decipher the meaning or intention behind utterances is essential for successful communication. The authors investigated the ability of persons with PD to recognize the

intention in speech acts. Results indicated that persons with PD were indeed impaired on recognizing intention in utterances. Furthermore, removing time constraints on the task did not influence their performance. That is, persons with PD experienced difficulties understanding elements of speech acts even when they were given sufficient time to respond. Again, the lack of pragmatic ability in speech act recognition can impact how persons with PD interact with others in daily conversation.

Holtgraves and McNamara (2010) also investigated politeness use and comprehension among persons with PD. The authors asked participants with PD to imagine themselves making a request of another individual. Participants also were asked to rate how powerful the other person was and how large of a request it was. The requests were coded in terms of the Politeness Theory by Brown and Levinson (1987). Results showed that persons with PD were indeed impaired in pragmatic communication abilities. They were unable to vary their level of politeness based on the power of the person they were requesting from or the size of their request.

In summary the literature shows that receptive communication and pragmatics are impaired in persons with PD. Persons with PD experience reading comprehension deficits as a result of cognitive impairments. They also can show impairments in the appropriate use of language. These findings translate into impaired and inappropriate communication skills in persons with PD.

## 1.9 PD and Verb Use

Of relevance to the present study is research conducted on verb production in individuals with PD. Findings from published studies revealed unanimously that there is a verb production deficit compared to other classes of words such as nouns in persons with PD (Bertella et al., 2002; Cotelli et al., 2007; Crescentini et al., 2008; McDowd et al., 2011; Signorini & Volpato, 2006; Woods et al., 2005). However, what is unclear is the cause of these verb deficits. Investigators have attributed verb deficits in persons with PD to a grammatical theory while authors from more recent studies have attributed their findings to a motor theory.

## 1.10 Grammatical Theory

Researchers who support a grammatical theory that explains verb disruption in persons with PD suggest that verbs are accessed in the brain as a lexical category and that they rely on intact frontal lobe functioning (Bertella et al., 2002; Cotelli et al., 2007; Crescentini et al., 2008; McDowd et al., 2011; Piatt et al., 1999; Woods et al., 2005). Authors of published studies have used action fluency, action naming and verb generation tasks to investigate verb production in persons with PD. What follows is an overview of the research conducted on verb production in PD in support of the grammatical theory.

Action fluency tasks, which have been used to examine verb use, require participants to respond verbally to a statement such as “Can you give me an example of things people do.” (Piatt et al., 1999, p. 1501). Other similar tasks require participants to generate as many action verbs (i.e., run, jump, etc.) as they can in one minute (Signorini & Volpato, 2006). A third type of action fluency task requires participants to generate actions that can be performed with a specific object. For example, McDowd et al. (2011) asked participants to generate “Things you can do to an egg” (p. 215). Regardless of the verbal fluency method used to generate action verbs, several studies conducted on participants with PD without CI showed significant impairments in persons with PD vs. participants with Alzheimer’s disease (AD) or healthy older adults (McDowd et al., 2011). With the exception of McDowd et al. (2011), action fluency deficits in persons with PD were attributed to executive function deficits (Piatt et al., 1999; Signorini & Volpato, 2006). Such perspectives support the grammatical theory of verb processing.

In addition to the studies mentioned above, it is important to note the findings of Woods et al. (2005) who examined action fluency in persons with HIV-1 infection and found action naming deficits. Their finding provides further evidence for the grammatical theory given that HIV-1 infection is known to result in damage to the frontal-basal ganglia circuit.

Verb generation tasks also have been used to study verb production in persons with PD. Peran et al. (2003) investigated verb and noun generation in participants with idiopathic

PD and in healthy controls. In this method of verb elicitation, participants were presented aurally with either a noun or a verb and were asked to respond verbally with a semantically similar noun or verb. In some test conditions participants were asked to switch between grammatical categories. For example, participants were given a noun and were required to generate a semantically similar verb. Consistent with the literature, Peran et al. (2003) and colleagues found deficits in verb generation among participants with PD across all test conditions. The authors interpreted their findings within the context of the grammatical theory. The ability to shift grammatical categories is thought to be under frontal lobe control and thus findings of significant impairment in participants with PD added robust evidence to the grammatical theory. That is, the authors concluded that verbs are accessed in the brain as a lexical category and deficits were the result of failing frontal lobe functioning.

Action naming tasks are similar to action fluency tasks in that they both require participants to generate action verbs. However, in action naming tasks participants must name the action as illustrated in picture stimuli. Cotelli et al. (2007) conducted an action naming task in which persons with PD without CI and healthy older adult controls were asked to name depicted actions (i.e., verbs) and depicted objects (i.e., nouns). They found that the participants with PD were more impaired than control participants in their accuracy of naming both actions and objects. Furthermore, within group analysis showed that participants with PD were more impaired in naming actions vs. objects. These results are consistent with the literature showing that action verb processing is impaired in persons with PD. Again, Cotelli et al. (2007) concluded that their findings support the grammatical theory where deficits occurred as a result of frontal lobe dysfunction.

In summary, the results of several published studies conducted on action fluency, verb generation and action naming in persons with PD show that verb production in persons with PD without CI is impaired. The impairment is explained best in these studies by the grammatical theory of verb processing where verbs are accessed as a lexical category. This interpretation is supported further by the action verb deficits seen in persons with frontal lobe pathophysiology including PD and those with HIV-1 infection.

## 1.11 Motor Theory

The motor theory of verb processing posits that neural activity in the premotor and primary motor areas of the brain contribute to action verb production (Hauk, Johnsrude, & Pulvermüller, 2004; Herrera et al., 2012; Kemmerer, Castillo, Talavage, Patterson, & Wiley, 2008; Rodríguez-Ferreiro, Menéndez, Ribacoba, & Cuetos, 2009). Supporters of the motor theory propose that there is a link between language and movement. Authors of recent studies who provided evidence in support of the motor theory for verb production conducted studies among groups of individuals with and without neurological disorders including AD, amyotrophic lateral sclerosis (ALS), progressive supranuclear palsy (PSP), and corticobasal degeneration (CBD). The following is an overview of research conducted on verb production in PD, with findings interpreted in context of the motor theory.

Rodríguez-Ferreiro et al. (2009) compared action naming in participants with PD without dementia, persons with probable AD and healthy older adults. The study included an action naming task that was similar to the task used by Cotelli et al. (2007) but with two important differences. Firstly, the investigators used coloured picture stimuli to ensure that representations were more salient to participants and would not interfere with visuospatial deficits that are known to be present in persons with PD (Cotelli et al., 2007). Secondly, by comparing performances of participants with PD vs. those with AD, the authors were able to compare action naming performances between persons who have frontal lobe dysfunction (i.e., PD) vs. persons who have generalized degradation of anterior and posterior Perisylvian regions (i.e., semantic knowledge and AD). The rationale was that if action naming deficits result from frontal lobe pathophysiology, then persons with PD and AD should have similar action naming deficits. However, if significant differences in action naming emerge between the two groups, processes other than frontal lobe functioning such as motor processes, may be contributing to participants' ability to access action verbs. Results of the study revealed significant deficits in action naming in persons with PD vs. persons with AD and therefore provided evidence to support the motor theory.



Other investigators sought to explore in depth previous findings by testing persons with PD in their “ON” and “OFF” levodopa medication cycles. Levodopa is a medication commonly used to treat motor symptoms of persons with PD. In the “ON” state a person with PD would be optimally medicated with levodopa and would not be medicated or would be sub-optimally medicated in the “OFF” state. Therefore, authors predicted that if motor areas of the brain were involved in action verb related tasks, then using fMRI, there should be increased overlapping patterns of brain activity in motor areas of brain and areas related to action verb processing when persons were in “ON” state vs. in “OFF” state. Peran et al. (2013) tested this hypothesis using a “GenA” task where participants had to say action verbs after viewing a depicted object and using a “MoSA” task where participants were required to imagine an action related to a depicted object. Participants with PD showed activation in premotor and motor areas of the brain under both conditions when in the “ON” state. The authors interpreted these findings as evidence that motor areas are involved in action verb processing. Herrera, Cuetos, and Ribacoba (2012) also made use of the “ON”/ “OFF” levodopa paradigm in persons with PD and tested the involvement of the motor areas of the brain in verbal fluency tasks. These investigators tested letter fluency, action fluency and semantic fluency. They found that persons with PD, when in an “OFF” state, had a deficit in generating action verbs. These findings were interpreted as evidence that lack of dopamine in the motor areas of the brain contributed to poor performance on action fluency. Taken together, authors of studies that used an “ON”/ “OFF” levodopa paradigm in persons with PD provided deeper evidence in support of the motor theory of verb processing.

Investigators in the field of neuroscience and experimental psychology have used a paradigm known as the action-sentence compatibility (ACE) paradigm to assess motor and language systems in PD. The ACE requires participants to listen to sentences that describe actions typically performed with an open-hand such as clapping or performed with a closed-hand such as hammering. Participants respond to the sentences by pushing a button but with their hand in a pre-assigned configuration (either open or closed). A longer reaction time to incompatible vs. compatible conditions is expected for control participants. Ibanez et al. (2013) reported that after using the ACE paradigm in persons with PD in the “ON” state, participants with PD did not demonstrate differences in

reaction times between compatible vs. incompatible situations even when they were optimally medicated. That is, persons did not demonstrate the ACE effect. Since the ACE was abolished in persons with PD, the authors concluded that there must be ongoing motor and language coupling. The authors also performed a second experiment using intracranial cortical recordings and concluded that sentence processing affects motor processes and vice versa. Cardona et al. (2014) took these results one-step further by comparing the ACE paradigm among persons with PD, persons with acute transverse myelitis (ATM) and persons with neuromyelitis optica (NMO). Persons with PD have preserved peripheral and musculoskeletal systems but impaired brain motor systems. On the other hand, persons with ATM and NMO are known to have impairments with peripheral and musculoskeletal systems but preserved brain motor systems. Performance on the ACE was impaired only for persons with PD. Therefore, the authors attributed the results to an impaired brain motor system and thus provided evidence in support of the motor theory.

Finally, Fernandino et al. (2013a) argued that several studies claiming a link between the motor areas of the brain and action verb processing actually compared verbs with other word classes such as nouns (i.e., Peran et al., 2003) and that verbs could be semantically and structurally more complex than other word classes. For this reason the authors compared action verbs with non-action verbs, that they termed “abstract verbs”, in persons with PD. The authors found that persons with PD were more impaired vs. controls in processing action verbs and confirmed that the motor system is involved with verb processing at both a shallow automatic level when recognizing verbs and at a deeper controlled level when making semantic judgments about the words. The same research team investigated action verbs in different contexts (literal, idiomatic and metaphoric sentences) and concluded that not only does the motor system of the brain play a causal role in action verb processing but that these results exist when processing figurative language (Fernanindo et al., 2013b).

In summary, there is growing evidence to suggest that the motor system including the premotor and motor areas of the brain play roles in action verb processing. Investigators who examined action verb processing in persons with PD without CI have used a number

of methods including levodopa treatment models and ACE paradigms to investigate the role of the motor system in action verb processes. Several investigators revealed that these results can be extended to deeper level language processes (Fernandino et al., 2013a) or figurative language (Fernandino et al. 2013b). In any case, the motor system seems to play a role in action verb processing in PD and this same evidence can also be found in normal healthy adults.

Hauk et al. (2004) were the first to reveal using fMRI data that there is a statistically significant relationship between action verb processing and neural activity in the premotor and motor cortices of normal healthy adults. The investigators used face-, arm- and leg-related action verbs such as “lick”, “pick” and “kick” in a passive reading task. fMRI scans of the normal healthy participants were taken as they completed the reading task. The results indicated that action words relating to the arm and leg activated neural activity in the somatotopic area of the motor cortex that represent arm and leg movements, respectively. Interestingly, a strong significant connection was found for arm-related action verbs and leg-related action verbs but not for face-related action verbs. Words like “pick” (carried out by the arm) and words like “kick” (carried out by the legs) showed activation in the respective areas of the motor cortex while face words such as “chew” and “bite” did not show the same activation pattern. To understand the results further, the investigators asked new individuals to rate the relatedness of the action verbs to the subcategory of which they were a part (i.e., arm, leg and face). Words like “chew” and “bite” were found to be less related to the face since they involved a wider range of movements requiring the jaw or tongue. The authors interpreted this information as compelling evidence to support the motor theory of verb processing.

Kemmerer et al. (2008) also used fMRI data to investigate action verb representation in the motor cortex. The purpose of the study was to test predictions of “The Stimulation Framework” which proposes that semantic knowledge of words is rooted in sensorimotor systems and that these systems are activated when words are conceptualized. To test these predictions, a collection of action verbs that were categorized as running verbs (i.e., run), speaking verbs (i.e., shout), cutting verbs (i.e., slice), hitting verbs (i.e., jab) and change of state verbs (i.e., shatter) were used in a semantically similar judgment task.

fMRI scans of the participants were collected while participants pressed buttons to indicate on a screen which of two possible verbs was most semantically related to a third stimulus verb. fMRI scans of running, cutting, and hitting verbs revealed that the action component of the words mapped onto the primary motor and/or premotor cortex. The authors also noted task differences between their study and previous studies as a plausible explanation for why they did not see mapping of speaking verbs.

Taken together, initial fMRI studies by Hauk et al. (2004) and Kemmerer et al. (2008) revealed that some action verb processing in normal healthy individuals require input from the motor cortices of the brain. Regardless of the type of task used, these studies provided evidence in support of the motor theory.

Not surprisingly, action verb deficits are present in persons with movement disorders other than PD. Results from studies conducted on action verb processing in individuals with ALS, PSP and CBD show that verb processing deficits may be linked to motor deficits in these diseases. Bak and Hodges (2004) described action verb use in individual cases of persons with ALS, a neurological disease that affects parts of the nervous system needed for motor execution. The authors used the Kissing and Dancing Test (KDT) to examine verb comprehension. The KDT requires participants to choose a picture from a selection of two that is semantically similar to a stimulus picture. The KDT is identical to the Pyramids and Palmtrees Test (PPT) except that it is comprised of pictures of actions vs. pictures of objects. Results of the study indicated that persons with ALS were significantly impaired on the KDT compared to the PPT. In fact, as the disease worsened in one participant, his score on the KDT was close to chance whereas his score on the PPT remained relatively the same compared to his previous scores. The fact that action verb use worsened with disease progression in this participant suggests a link between action representation and motor control. Thus, results from this study support the motor theory of verb processing.

Finally, researchers investigated action verb use in persons with PSP and CBD.

Progressive supranuclear palsy is a hereditary neurodegenerative movement disorder that causes atrophy of the midbrain, pons and striatum (Cotelli et al., 2006). Corticobasal

degeneration also is a movement disorder characterized by atrophy of the premotor cortex and superior parietal lobes (Cotelli et al., 2006). Cotelli et al. (2006) revealed that persons with PSP and CBD have significant impairments in action naming vs. object naming. In their study, only participants with CBD were impaired in naming action verbs that included features of manipulation (i.e., verbs such as “squeeze”). This is robust evidence to support the motor theory given that atrophy of the premotor cortex in persons with CBD causes deficits in naming verbs that require acting. However, Bak et al. (2006) found verb deficits in a sample of participants with PSP. They reported evidence of a connection between movement and language function and proposed that genetic factors may underlie both movement control and verb processing. This link between movement control and verb processing can be interpreted as evidence in support of the motor theory as well.

Herrera, Rodriguez-Ferreiro, and Cuetos (2012) conducted a unique study exploring motor control contributions to action naming in persons with PD without CI. What was unique about this study was that the authors explored the connection of verb production and movement by varying the degree of motion in motion-content verbs. In this study, participants were asked to name the action verb in coloured drawings. Some of these drawings were categorized as depicting high-motion content words while others were categorized as depicting low-motion content words. For example, the verb “to dig” has a high degree of movement associated with it and was therefore categorized as a high-motion content verb compared to the verb “to sleep” which was categorized as a low-motion content verb. As expected, results of this study revealed that persons with PD without CI were more impaired in verb naming than healthy older adult controls. In addition, persons with PD without CI were more impaired in naming high-motion content verbs compared to low-motion content verbs. These findings provided robust evidence in support of the motor theory. Their rationale was that if action verb use is solely a function of frontal lobe functioning, persons with PD without CI would not have shown significant impairments in naming when the motion-content of the verb stimuli was varied. Shortly after this study Herrera and Cuetos (2012) furthered their findings by examining low-motion and high-motion content verbs under the “ON”/ “OFF” levodopa paradigm. Not surprisingly, persons with PD had poor results on action verb naming than controls. In

addition, those in the “OFF” state performed worse on high-motion verb naming. These results added robust evidence in support of the motor theory.

In summary, results from several studies conducted on action verb use in PD provide evidence of frontal lobe dysfunction and support the grammatical theory of verb impairment. Results from other studies including research conducted on action verb use between persons with and without movement disorder, showed that the premotor/primary motor cortices of the brain contribute to verb processing. Therefore these studies support the motor theory of verb processing. The present study will investigate action verb use in PD in discourse and interpret the findings in support of one of these two theories of verb processing.

## 1.12 Analyses of Conversation

The analyses of conversation has been widely used in past research to study various features of conversational discourse in adults with a wide range of neurological conditions including aphasia, traumatic brain injury, dementia and other progressive degenerative disorders. The analyses of conversation enables researchers to set operationally defined variables a priori and then analyze conversation samples using those set parameters. For example, Garcia and Joannette (1997), Orange, Lubinski and Higginbotham (1996), and Perkins, Whitworth and Lesser (1998) analyzed conversations in their study protocols of individuals with Alzheimer’s disease. In these studies authors elicited conversational discourse samples, sometimes in participants’ homes, to obtain a collection of natural discourse. Analyses of these samples were then carried out in accordance to previously set operational definitions of study interests. For example, Garcia and Joannette (1997) defined topic shifting behaviours prior to collecting samples and then used those criteria to analyze patterns of topic shifting behaviours in their conversational discourse samples. A similar method was used by Orange et al. (1996) and Perkins et al. (1998) for investigating trouble source repair and turning-taking, repair and topic management, respectively.

### 1.13 Statement of the Problem

Much of what is known about action verb use in persons with PD has been acquired through studies that include tasks of action fluency, verb generation or action naming with picture stimuli under experimental conditions. The methodology used in these studies restricts participants' response sets. For example, in action fluency and verb generation tasks participants produce verbal responses of items that belong to a particular category (i.e., action fluency) or are in response to another word stimulus (i.e., verb generation based on noun form of word; responding "kick" for "ball"). Picture stimuli used in action naming tasks require participants to give a targeted, single item response that matches the picture stimuli (i.e., responding "run" to a picture of someone running). Although results from these studies have revealed impairments in action verb use among persons with PD, what remains unknown is whether these findings are reflective of how persons with PD use action verbs in everyday communication. What still needs to be determined is whether persons with PD produce many verbs in conversational discourse. Moreover, we need to determine what types of verbs (i.e., low-motion vs. high-motion) are produced in conversational discourse by persons with PD and whether findings of verb type use can be explained best by the grammatical theory or the motor theory of verb production in PD. Moreover, we need to know how the results of experimental elicitation of actions verbs and the resulting profiles (i.e., relative uses of low vs. high) compares and contrasts with low vs. high verb use in everyday communication (i.e., conversation).

To date, authors of studies who provided findings that support the motor theory of verb processing have only provided evidence for a relationship between motor control and action verb use. They have not investigated the extent to which motor issues are involved in action verb use. That is, with the exception of Herrera et al. (2012) and Herrera and Cuetos (2012), previous studies supporting the motor theory have not examined movement as a variable in action verb processing within a discourse production paradigm.

## 1.14 Objective

The objective of the present study is to describe action verb use in persons with PD in a discourse paradigm (i.e., everyday communication as in mealtime conversations). The intention of this study is to add evidence to support either the grammatical theory or the motor theory of verb use in PD within a discourse framework. Although there is growing evidence to suggest that movement and motor activities play a role in action verb access, the motor theory should explain findings regardless of the type of task used. Thus, conversations were used as an elicitation task to provide evidence to support one of the two theories. The study used methodology similar to that of Herrera et al. (2012) in which movements depicted by the verb (i.e., low-motion vs. high-motion) were the primary outcome variable. The procedure used in the current study created an environment where participants with PD were able to converse freely and were free to use both low- and high-motion verbs. Such a procedure provided a context in which to examine how low- and high-motion verbs are used in the conversational genre of discourse. Findings of this study are intended to provide new perspectives on how to interpret verb use relative to theories used to explain connections, if any between movement/motion and language changes in PD.

## 1.15 Research Questions

The following three research questions were addressed in this study:

1. Do persons with idiopathic PD use fewer verbs compared to control participants in daily conversation?
2. Do persons with idiopathic PD use fewer high-motion verbs compared to low-motion verbs in daily conversation?
3. Do findings provide support to the motor theory of verb processing in PD?

## 1.16 Hypothesis and Rationale

1. It is hypothesized that persons with PD will produce fewer verbs compared to control participants. According to the pilot study (see below), persons with AD produced fewer verbs than controls in a 40-minute conversation sample. Even



though AD is not the same as PD there is no reason to suspect that persons with PD would not reveal the same results.

2. It is hypothesized that persons with PD will produce fewer high-motion content verbs than low-motion content verbs in mealtime conversations. Fernandino et al. (2013a) showed that persons with PD were impaired in using action verbs during semantic similarity judgment tasks that require a deep level of language processing. Furthermore, Fernandino et al. (2013b) showed that action verb impairments can be found in different language contexts such as figurative language. Herrera et al. (2012) showed that persons with PD exhibit more impairments naming high-motion vs. low-motion content verbs. Since conversation requires a deep level of language processing, the results of Herrera et al. (2012) will be revealed in natural conversation. Moreover, the results of the present study will support the motor theory of verb processing.

## Chapter 2: Method

### 2.1 Participants

A group of 10 participants who met the clinical diagnosis criteria for idiopathic PD as outlined by the UK Parkinson's Disease Society Brain Bank (Petrova et al., 2012) were recruited for the study. Participants were recruited from the London Health Sciences Centre Movement Disorders Clinic at Western University headed by Dr. Mandar Jog. Participants with PD and cognitive impairment (P-MCI) and PD and dementia (PDD) were excluded on the basis of their scores on the Mattis Dementia Rating Scale- II (DRS-II). A cut-off point of <123 was used to differentiate PDD from PD (Llebaria et al., 2008). The sample size of N=10 was determined using the software G-Power (Faul, Erdfelder, Buchner, & Lang, 2009; Faul, Erdfelder, Lang, & Buchner, 2007) based on data from Herrera et al. (2012) on the use of high-motion content verbs (M= 14.06, SD= 4.89) and low-motion content verbs (M=18.51, SD= 4.57) by persons with PD. Using the Herrera et al. (2012) data and a one-tailed test parameter, the calculated effect size was 0.8 with an alpha of 0.05 and actual power of 0.53 with a critical t-value of 1.734.

Spouses of participants with PD served as the conversational partner to participants with PD to promote natural and spontaneous discourse. Spouses also were recruited and selected so that they were, a) familiar with each other's verbal and nonverbal signals and idiosyncratic cues and b) could adjust to conversation styles (Orange, VanGennep, Miller, & Johnson, 1998).

All participants were between 55 to 80 years of age, native English speakers, were right-handed (with the exception of one spousal participant) and had a minimum Grade 8 level of education. All participants did not exhibit other medical (e.g., stroke), neurological (e.g., tumour, brain injury) or psychiatric conditions (e.g., depression), other than PD for the participants with PD, that could interfere with their language or cognition. Self-report hearing and vision screening were performed for each participant prior to inclusion into the study to ensure that any deficits could not compromise conversation samples.

Demographics of participants with PD and spousal controls are listed in Table 1 and Table 2, respectively. Consent to participate was obtained from participants with PD and their spouse in accordance with procedures approved by the Human Ethics Review Board - Health Sciences at Western University (see Appendix A).

Table 1  
Demographic Information of Participants with PD

Characteristics	Participants with PD									
	1	2	3	4	5	6	7	8	9	10
Sex	M	M	M	M	M	M	M	M	F	M
Age <sup>a</sup>	80	71	71	54	55	75	67	71	77	68
Education <sup>a</sup>	17	19	15	13	12	19	17	17	14	14
UPDRS-III (Total max score=108)	15	24	35	42	29	19	31	28	31	33
H & Y	1.5	2	3	3	2.5	2	3	2.5	2.5	2.5
DRS-2 (Total max score=144)	140	141	137	128	140	140	142	142	139	142
Married <sup>a</sup>	25	44	32	30	32	48	42	44	56	46

*Note.* <sup>a</sup> Reported in years; UPDRS- Unified Parkinson Disease Rating Scale; H & Y- Hohen and Yahr stage; DRS-2- Dementia Rating Scale-2; E= English; R= Right.

Table 2  
Demographic Information of Spousal Controls

Characteristics	Spousal Controls									
	1	2	3	4	5	6	7	8	9	10
Sex	F	F	F	F	F	F	F	F	M	F
Age <sup>a</sup>	81	67	66	53	56	74	63	67	79	64
Education <sup>a</sup>	12	16	20	16	12	17	12	10	10	10
DRS-2 (Total max score = 144)	-	144	144	141	144	141	140	141	-	139
Married <sup>a</sup>	25	44	32	30	32	48	42	44	56	46

*Note.* <sup>a</sup> Reported in years; DRS-2- Dementia Rating Scale-2; E= English; R= Right; L= Left.

## 2.2 Procedure

Conversational mealtime data were obtained in participants' homes; a location where participants were likely to engage in spontaneous conversation. Rutters, Stephenson and Dewey (1981) reported that when participants are placed in conversational settings without visual and/or physical cues, conversations are depersonalized and unspontaneous. The authors noted that placing persons in cueless situations increases psychological distance which affect the content, style and outcomes of conversations (Rutters et al., 1981).

In the present study, participants conversed with their spouses and reported being comfortable conversing. Mealtimes have been used by researchers as an excellent medium to achieve this goal (Goodwin, 2003). The act of sharing a meal gives participants value and feelings of unity within a group (Seymour, 1983). This creates an opportunity for participants to foster emotional connections as they participate in meal sharing and consumption (Seymour, 1983; Keller et al., 2010). Keller et al. (2010) described the meaning of mealtimes for participants with dementia. Mealtimes provided participants with a chance to strengthen relationships and to give and to gain support because they were in an environment where they were face-to-face. This then would be a way of reducing cluelessness, as noted by Rutters et al. (1981). Mealtimes also gave participants a chance to be psychologically involved. This meant that participants with dementia and their spouse were able to communicate, reaffirm their roles in the dyad and to show care and love towards each other. Finally, the authors noted that regularity of meal timings created an opportunity for positive connection that could be lost in other areas of life. Thus, mealtimes are social experiences that enable participants to converse comfortably and freely. Since sharing in meals is a daily routine, conversations recorded in this setting would be spontaneous and reflective of daily conversation.

Another reason mealtimes function as an appropriate setting for conversational data collection is that food becomes the reason or source of conversation. Apart from strengthening emotional connections, food has been shown to be the topic of conversation. The acts of offering, receiving, praising and assessing food are all reasons to engage in spontaneous conversation (Mondada, 2009). This would be more useful for

obtaining samples that reflect spontaneous daily conversation than asking participants to converse without any context or to converse on specified topics unrelated to their interests.

Finally, researchers demonstrated that conversation productions over mealtime settings increased communication in various populations. Altus, Engelman, Kimberly and Mathews (2002) reported that communication doubled when participants with dementia were served meals in a family-style setting and dropped back to baseline levels when participants ate alone. VanBiervliet, Spangler and Marshall (1981) found that “retarded” (VanBiervliet et al., 1981, p. 295) youth who were served meals with other youth increased communication and that most utterances concerned food and eating. Sandman, Norberg and Adolfsson (1988) found the same finding for participants with dementia. For these reasons, the present study made use of mealtime settings to generate appropriate conversation samples that are reflective of daily communication.

Conversations were digitally video recorded in participants’ homes on a single day, using a Canon Vixia HFM500 digital video camera and a RØDE VideoMic Pro Compact Shotgun microphone in a location where participants normally dined (e.g., kitchen, dining room, etc.). Lapel or head mounted microphones with separate transducers for each participant were not available for use in this study. The video camera and microphone were placed in such a way as to be unobtrusive to minimize distraction and to promote natural conversation. Mealtime conversations were recorded after language data were collected. Participants and spousal controls read letters of information (see Appendix B and C) and signed a consent form (see Appendix D). Demographic information also was collected using the Participant Intake Form (see Appendix E). This study was part of a larger study on the discourse of persons with PD (Roberts, 2014) however this study only reports on the verb performance in conversations and not on the other language and discourse outcomes. Medications for persons with PD were taken according to participants’ normal routine such that medications were likely be at maximum therapeutic effect when data were collected during the meal.

Participants were not assigned preselected topics for their conversations. If topics were assigned then the task would not be normal, representative conversation. Participants were asked to converse as they normally would during mealtimes. The examiner (SN) was not present during the mealtime video recording. The examiner (SN) provided the following instructions before leaving the participants' home prior to the start of the meal, "I would like the two of you to carry on with your meal and to communicate as you normally do during your meals. You may talk about anything you like; anything you normally talk about during meals. I will return in 35 to 40 minutes". When the examiner (SN) returned in the allotted 35 to 40 minutes, she stopped the video and audio recordings and turned off the video camera. Participants then were asked if their conversations during mealtime were reflective of their typical mealtime talk.

The conversational data used for analyses began when researchers departed from participants' homes. The end of the meal and conversation was marked either when researchers returned to the home or when the participants finished eating and left the table.

### 2.2.1 Orthographic Transcripts and Ratings of Motion

The examiner (SN) transcribed orthographically all verbs and associated words required for correct contextual interpretation of the verb produced by each participant with PD and each spousal control during their mealtime conversation. The operational definition of a verb used in this study is outlined in Appendix F. Only unambiguous words on the digital audio record were transcribed for this study. For example, when participants temporarily moved off-camera verbs from utterances produced off-camera were transcribed and used for analyses only if they were unambiguous. Utterances produced when speaking or interacting with researchers were not transcribed. The occurrence of each verb was time stamped on the electronic and hardcopy transcription that was anonymized for participants and spousal controls. Talking time was calculated for each person in each dyad according to the definition outlined in Appendix F.

All transcribed verbs produced were included in a database. The database then was converted electronically into an online rating form for five independent raters to rate the

amount of motion associated with the verb (i.e., no motion or low to high-motion indicated by placing an adjustable electronic slider along a 10 cm visual analogue scale). Verbs were randomized within and across each of the five rating forms. Five native English-speaking raters (i.e., graduate students in speech-language pathology) rated the verbs as either no motion, low-motion or high-motion content verbs, based on written instructions and examples (see Appendix G).

A visual analogue scale was used to quantify the amount of motion associated with the verbs based on feedback from members of the Advisory Committee on a previously conducted pilot study (outlined below). Verbs were considered low-motion if the rating was below or at one standard deviation on the scale (i.e., below or at 15.9 mm). Verbs were considered high-motion if the rating was above or at one standard deviation on the scale (i.e., above or at 84.1 mm).

A “majority rules” threshold was used to classify verbs as low-motion or high-motion across the five independent raters. For example, if across five independent ratings of the same verb, three raters rated the verb as low-motion, one rater rated the verb as high-motion and the last rater rated the verb as neither low-motion nor high-motion (i.e., the rating was between 15.9 mm and 84.1 mm on the scale), then the verb was assigned an overall classification of low-motion. This was more appropriate than averaging numerical values because it prevented outliers from skewing the ratings. For example if for a single verb, the values across five raters were four ratings of 100 mm and one rating of 0 mm, then the averaged value would be 80 mm. This verb would be classified as neither low-motion nor high-motion. By using the “majority rules” test, the verb would be classified as high-motion, which provides a truer classification of the motion in the verb. Interestingly, there are no published normative data on low- or high-motion verb use among normal adults.

### 2.2.2 Pilot Study

A pilot study was conducted to support the validity of the procedure and data analyses proposed for the current study. The pilot study consisted of analyses of verb production in video recorded and orthographically transcribed mealtime conversations from 12

participants with AD and a spouse and 12 normal control participants and a spouse (Orange et al., 1998). Of the 12 participants with AD, 6 individuals had mild Alzheimer's disease and 6 individuals had moderate Alzheimer's disease. All verbs (as defined in the operational definition in Appendix F) and the frequency of occurrence were identified in the written transcripts by the author (SN). Conversation time also was recorded. The verb stem for each unique verb was examined and coded. Seven native English-speaking individuals naïve to the purpose of the study rated the verbs as having either low-motion content or high-motion content, based on provided instructions (see Appendix H).

Average conversation times for each of the three diagnostic groups (mild AD, moderate AD and controls) are outlined in Table 3. All groups held conversations for about the same length of time. The average number of verbs produced by the AD and control participants are outlined in Table 3. Participants with mild and moderate AD produced fewer (184.3 = mild AD, 79.0 = moderate AD) verbs than controls dyads who produced the most verbs on average (301.7). The average numbers of low-motion content verbs vs. high-motion content verbs also are outlined in Table 3. The participants with mild AD produced on average 49.2 high-motion verbs, those with moderate AD produced on average 18.7 high-motion verbs and control participants produced on average 75.1 high-motion verbs.

Based on these pilot study data, it was clear that a relatively high number of verbs can be generated by persons with AD in a single 40-minute conversation. Furthermore, it was clear that these conversation parameters elicited both low-motion and high-motion content verbs. Even though AD is different from PD, there is no reason to suggest that the same number of verb and the same proportion of low-motion to high-motion content verbs could not be found in mealtime conversations of persons with PD.



Table 3

## Verb Analyses in Alzheimer's Disease Mealtime Conversation Data

Parameter	Alzheimer's Disease		Control (n=12)
	Mild (n=6)	Moderate (n=6)	
Conversation Time			
M (SD) <sup>a</sup>	29.3 (7.4)	29.3 (8.8)	29.0 (7.1)
Range <sup>a</sup>	23.2-39.3	12.5-36.7	19.6-41.2
Utterances			
M (SD)	156.8 (90.4)	104.2 (39.9)	181.4 (114.2)
Range	86-328	61-161	58-444
Verbs <sup>b</sup>			
M (SD)	184.3(128.5)	79.0 (42.8)	301.7 (258.4)
Range	89-427	30-137	66-891
High-Motion			
M (SD)	49.2 (42.3)	18.7 (15.0)	75.1 (63.3)
Range	15-129	1-42	15-217
Low-Motion			
M (SD)	81.5 (47.8)	39.2 (19.2)	133.2 (111.1)
Range	42-169	20-67	39-369

Note. <sup>a</sup>Reported in minutes; <sup>b</sup>Frequency counts; M= means; SD= standard deviation.

## 2.3 Statistical Data Analysis and Alpha Level

Quantitative analyses of the data were conducted using an independent sample t-test for research question one and a paired sample t-test for research question two. An independent sample t-test was chosen for research question one because the number of verbs produced by the two groups (i.e., persons with PD and spousal controls) were independent of each other. A paired sample t-test was chosen for research question two because low-motion and high-motion verbs were produced by the same group of persons with PD. An analysis was conducted for research question three which compared the proportions of low-motion verbs to high-motion verbs in control participants. A paired sample t-test was conducted to support or to refute findings from research question two. ANOVAs could not be conducted due to the small sample size.

In order to equate verb production across all participants, raw verb scores (i.e., total verbs, total low-motion verbs and total high-motion verbs) were converted to proportional scores. To obtain proportional scores, raw verb scores were divided by the talking time for each participant. Talking time is defined in Appendix F. Total utterances also could have been used in lieu of talking time but only verbs were transcribed.

An alpha level of 0.05 was set for all tests of significance. This alpha level was appropriate as it is the most typically used alpha level for exploratory research.

## Chapter 3: Results

The primary focus of this study was to describe verb use in persons with Parkinson's disease using a discourse paradigm. The author (SN) investigated the total number of verbs produced by persons with PD compared to control participants as well as the type of verbs (i.e., low-motion vs. high-motion) used by persons with PD within this context. Summary scores including the average number of total verbs, low-motion content verbs and high-motion content verbs are outlined in Table 4.

Table 4

## Verb Analyses in Parkinson's Disease Mealtimes Conversation Data

Parameter	Parkinson's Disease (n=10)	Control (n=10)
Talking Time		
M (SD) <sup>a</sup>	11.93 (6.45)	13.78 (6.59)
Range <sup>a</sup>	2.61-22.62	3.53-23.58
Verbs <sup>b</sup>		
M (SD)	231.9 (120.45)	303.9 (170.89)
Range	35-388	65-676
High-Motion		
M (SD)	0.6 (0.97)	0.4 (0.70)
Range	0-3	0-2
Low-Motion		
M (SD)	66.7 (34.66)	85.4 (55.91)
Range	13-121	17-219

*Note.* <sup>a</sup>Reported in minutes; <sup>b</sup>Frequency counts; M= means; SD= standard deviation.

### 3.1 Agreement Studies

An undergraduate student, trained in verb transcription, independently re-transcribed verbs from three randomly selected dyads (i.e., 30% of the total sample). The transcripts were compared verb-to-verb to those transcribed by the examiner (SN). Agreement scores were calculated. The mean inter-rater agreement for persons with PD was 78.2% and 91% for spousal controls. After resolving discrepancies to consensus on the agreement transcripts, the inter-rater agreement for persons with PD was 98.5% and 99% for spousal controls. In addition, the examiner (SN) re-transcribed the verbs from two randomly selected dyads (i.e., 20% of the total sample) and intra-rater agreement scores were calculated using verb-to-verb comparisons. The mean intra-rater scores were 96% for persons with PD and 98% for spousal controls.

### 3.2 Descriptions of Conversation Contexts

In all cases mealtime conversations were recorded in participants' homes where they normally dined. Three dyads had the television on when they participated in conversation with their spouses. In one additional case, the participants' adult son was in the room when the dyad engaged in conversation. While every attempt was made to control for the environment, it is important to note that in these cases, having the television on or having another person in the room who was not part of the task, could have influenced the conversation of the participants in terms of the number of verbs and types of verbs used by the participants.

### 3.3 Research Question 1

Research question one addressed whether the participants with PD used fewer verbs compared to control participants. It was hypothesized that persons with PD would produce fewer verbs compared to control participants on a proportional basis in a discourse context.

A proportional score was calculated for each participant with PD and for each control participant based on the total number of verbs they produced divided by their individual talking time. Proportional scores were calculated in order to equate verb production

across all participants in terms of the different talking times among the PD dyads. An independent sample t-test was used to answer this research question.

The analysis revealed PD participants produced an average of 19.3 verbs/minute with a standard deviation of 3.9 verbs/minute. Spousal control participants produced an average of 21.9 verbs/minute with a standard deviation of 4.9 verbs/minute. A Levene's Test for Equality of Variances was conducted as an indirect measure of normality of these data.

The test revealed that the variances of the two independent groups were not significantly different ( $p= 0.627$ ) meaning that they did not violate assumptions of normality.

Independent sample t-tests indicated that persons with PD did not produce, on proportion, significantly fewer total verbs/minute than control participants ( $t(18) = -1.304, p= 0.209$ ).

### 3.4 Research Question 2

Research question two addressed whether the participants with PD used fewer high-motion verbs compared to low-motion verbs. It was hypothesized that persons with PD would produce fewer high-motion verbs than low-motion verbs on a proportional basis in a discourse context.

A proportional score was calculated for each participant with PD based on the total number of low-motion and high-motion verbs they produced divided by each person's individual talking time. Proportional scores were calculated in order to equate verb production in terms of the different talking times among the participants with PD. A paired sample t-test was used to answer this research question.

The analysis revealed that persons with PD produced on average 0.1 high-motion verb/minute with a standard deviation of 0.1 high-motion verb/minute. The PD group produced on average 5.6 low-motion verbs/minute with a standard deviation of 1.0 low-motion verbs/minute. The paired sample t-test indicated that persons with PD produced significantly fewer high-motion verbs vs. low-motion verbs ( $t(9) = 18.04, p= 0.000$ ).

### 3.5 Research Question 3

Research question three addressed whether findings from the study provide evidence in support of the motor theory of verb processing in persons with PD. Findings from research questions one and two do not support either the grammatical theory or the motor theory of verb processing in the participants with PD.

The proportion of total verbs produced by persons with PD was not significantly different from the proportion of total verbs produced by control participants which does not support the grammatical theory. Analyses of control participants showed that they produced on average 0.3 high-motion verbs/minute with a standard deviation of 0.05 high-motion verbs/minute. They produced on average 5.9 low-motion verbs/minute with a standard deviation of 1.6 low-motion verbs/minute. The paired sample t-test indicated that control participants produced significantly fewer high-motion verbs compared to low-motion verbs ( $t(9) = 11.66, p = 0.000$ ). These findings contradict the findings of research question two. Taken together, the findings from the present study do not support the motor theory of verb processing among the participants with PD.

## Chapter 4: Discussion

The purpose of this study was to investigate verb use in persons with PD vs. spousal controls using a discourse paradigm and to determine whether the findings for the study aligned with what is reported in the literature on experimental findings of action verb use among persons with PD. Moreover, the study was designed to obtain evidence that could support the motor theory of verb production among persons with PD. The following is a discussion of the significance and implications of the findings of the study and how they do not support the grammatical theory or the motor theory of verb processing among the participants with PD.

### 4.1 Research Question 1

It has been reported unanimously in the literature that persons with PD have difficulty producing verbs compared to control participants (Bertella et al., 2002; Cotelli et al., 2007; Crescentini et al., 2008; McDowd et al., 2011; Signorini & Volpato, 2006; Woods et al., 2005). However, it is unclear what the reasons are behind these verb deficits. Two

theories have been proposed as explanations for the deficits: the grammatical theory and the motor theory. The grammatical theory proposes that verbs are accessed in the brain as a lexical category that rely on intact frontal lobe functioning (Cotelli et al., 2007; Piatt et al., 1999). The motor theory suggests that neural activity in the premotor and primary motor areas of the brain contribute to action verb production. (Hauk et al., 2004; Herrera et al., 2012; Kemmerer et al., 2008; Rodríguez-Ferreiro et al., 2009)

Findings from this study revealed that the proportion of total verb production in persons with PD does not differ significantly from that produced by control participants. Interestingly, there is no evidence in the published literature that quantifies the total number of verbs spoken by persons with PD and control participants or quantifies these values within a discourse context. Therefore, the results of this study represent the first attempt to quantify total verbs spoken by participants with PD on a proportional basis within a discourse framework. This novel finding is significant because it challenges the theoretical concept that verbs are accessed as a lexical category, which is what is posited by the grammatical theory. The grammatical theory implies that all verbs are processed in the same manner and that there are no differences among how sub-classes of verbs such as action verbs or abstract verbs might be processed. The findings from this study show that since there was no difference in the proportion of total verb production in PD vs. control participants, verbs cannot be viewed as being accessed as a lexical category and that studying sub-classes of verbs matter. That is, if verbs were accessed in the brain as a lexical category, we would expect to find that the proportion of total verb production in PD would be significantly different from total verb production in controls. Moreover, one would expect that other sub-classes of verbs would be processed differently (i.e., regular vs. irregular past tense verbs).

Although much of the research on verb use in PD has been conducted comparing verb classes to other classes of words such as nouns (Peran et al., 2003; Cotelli et al., 2007) there is some published literature comparing sub-classes of verbs within PD. For example, Fernandino et al. (2013a) demonstrated that persons with PD performed worse on action verbs (i.e., “to reach”) vs. abstract verbs (i.e., “to improve”). Nguyen (2013) compared upper-limb related action verbs (i.e., “to draw” and “to grab”) to lower-limb

related action verbs (“to kick” and “to run”) in persons with PD with either upper-limb or lower-limb impairments. Nguyen (2013) found that persons with PD with greater upper-limb impairments had difficulties processing upper-limb related verbs. Taken together, both of these studies reveal that within PD, sub-classes of verbs whether they are abstract verbs or are action verbs relating to specific parts of the body, are processed differently in the brain.

Different processing systems have been shown to govern different sub-classes of verbs outside of PD. For example, Tyler et al. (2002) conducted a priming study where they tested persons with nonfluent aphasia with damage to the left inferior frontal gyrus and persons with herpes simplex encephalitis (HSE) with damage to the inferior temporal cortex. They found that persons with nonfluent aphasia had priming for irregular verbs but not regular verbs and that the persons with HSE had impaired performance on irregular verbs (Tyler et al., 2002). The authors concluded that two separate systems were associated with regular and irregular verbs (Tyler et al., 2002).

These findings fall in line with the conclusions from the present study that verbs cannot be lumped together and accessed as a lexical category and that sub-classes of verbs are processed in different ways in the brain. The theoretical implications of the current findings are that the idea that verbs are accessed as a lexical category does not hold. Moreover, future studies should consider how sub-classes of verbs are processed so subtle differences in verb processing are not lost by lumping all verbs together as one lexical category.

Further investigation is required to replicate these findings in different discourse contexts. For example, quantifying total verb production in persons with PD and controls in procedural discourse tasks or a narrative discourse tasks can serve to replicate and to support or refute this novel finding.

## 4.2 Research Question 2

Authors of recently published studies provided much of the evidence to support the motor theory of verb processing in persons with PD. Their evidence suggests that neural activity



in the premotor and primary motor areas of the brain contribute to action verb production. (Hauk et al., 2004; Herrera et al., 2012; Kemmerer et al., 2008; Rodríguez-Ferreiro et al., 2009). All of these cited studies, with the exception of Herrera et al. (2012) and Herrera and Cuetos (2012), showed a link between the motor areas of the brain and action verb use. What was unique about Herrera et al. (2012) and the subsequent article by Herrera and Cuetos (2012) was that these authors treated motion in action verbs as a variable and tested the extent to which motion played a role in verb production in PD vs. controls. The present study aimed to examine motion-content verbs in PD in a discourse context in an attempt to find evidence to support the motor theory of verb processing.

Findings from the current study revealed that the proportion of high-motion content verbs produced by persons with PD in a discourse paradigm were significantly lower than the proportion of low-motion content verbs produced by the same group. Interestingly there is no evidence in the literature of authors examining motion-content verbs in PD outside of an experimental setting or in a discourse framework. Therefore, this is the first study to quantify motion-content in verbs in PD within a natural discourse setting.

Little research has been conducted on the topic of motion-content in verbs in PD. Only two other published studies have examined motion-content verbs in PD. The first study by Herrera et al. (2012) found that persons with PD performed significantly worse on naming high-motion verbs compared to low-motion verbs. The second study by Herrera and Cuetos (2012) studied motion-content verbs in persons with PD who were in the “ON” or “OFF” phase of their levodopa medication. These authors also found that persons with PD performed worse on action verb naming compared to controls and those who were in the “OFF” phase did even worse than controls on naming high-motion content verbs. Findings from the present research question fall in line with these two papers that found a difference in motion-content verbs in persons with PD.

The theoretical implications of these findings are that the current motor theory of verb processing, which simply suggests a link between premotor/ motor areas of the brain and language, needs to be re-examined to account for the variability of motion in verbs. Recall that it is the decreased dopaminergic input in premotor/ motor areas of the brain as

a result of PD that can impact language use in particular verbs (Herrera et al., 2012). Since significant differences were found in low-motion and high-motion verbs use, it could be that some motor areas that receive decreased dopamine input affect only high-motion verb processing while other areas only affect low-motion verb processing. Further research needs to be done to investigate motion-content words in various analyses contexts. For example, neuro-imaging studies that examine which parts of the brain are active when processing low-motion vs. high-motion verbs need to be conducted. Knowing about which areas of the brain correspond to either low-motion verbs or high-motion verbs may help to carry the motor theory of verb processing further.

Moreover, since the findings were found in persons with PD in daily conversation it may have clinical implications. For example, clinicians may need to modify conversations with persons with PD so that high-motion verbs are used more frequently which would help improve high-motion verb use in person with PD. High-motion verbs could be combined in low-technology language boards or high-technology computer generated voice systems so that persons with PD have access to a variety of words that they may not otherwise use. Again, since this study is only the third of its kind to examine motion as a variable in verbs and how high-motion verbs are used by persons with PD, further research is needed to investigate how motion-content in verbs is displayed in natural settings. For example, next steps may include replicating these findings using other forms of discourse such as in narrative or procedural discourse.

### 4.3 Research Question 3

Two theories have been proposed as explanations for the verb deficits found in persons with PD. The first is the grammatical theory which posits that the verbs are accessed as a lexical category and frontal lobe functioning in the brain is required for verb processing (Bertella et al., 2002; Cotelli et al., 2007; Crescentini et al., 2008; McDowd et al., 2011; Signorini & Volpato, 2006; Woods et al., 2005). Findings from research question one that total verb production in persons with PD does not differ significantly from control participants suggest that not all verbs can be accessed as a lexical category. If verbs were accessed as a lexical category in the brain, the findings from research question one would have revealed that the proportion of total verbs produced by persons with PD would be

significantly lower vs. the proportion of total verbs produced by control participants. Furthermore, the findings from research question two that persons with PD produced a significantly lower proportion of high-motion verbs vs. low-motion verbs support the idea that verbs cannot be accessed as a lexical category. Taken together, these two findings suggest that the grammatical theory is not a suitable theory to account for the verb deficits found in persons with PD.

The second theory is the motor theory of verb processing which suggest that premotor/motor area of the brains are linked to action verb use (Hauk et al., 2004; Herrera et al., 2012; Kemmerer et al., 2008; Rodríguez-Ferreiro et al., 2009). The findings from this study showed that the participants with PD produced significantly fewer high-motion verbs compared to low-motion verbs. This finding aligns with the only two other published studies on motion-content in persons with PD (i.e., Herrera et al., 2012 and Herrera & Cuetos, 2012). However, analyses showed that control participants also produced significantly fewer high-motion verbs vs. low-motion verbs on a proportional basis in a discourse setting. The foundation of the motor theory stems from the idea that premotor/ motor areas of the brain have decreased dopaminergic input that affects the ability of persons with PD to produce high-motion verbs. This conceptualization means that control participants should not show a significant difference in their production of low-motion vs. high-motion verbs since they do not suffer from PD.

There are currently no normative data available on the proportions of low-motion and high-motion content verbs produced in a discourse setting by persons with or without PD. Therefore, it could be that the findings from these studies reflect normal variation between control participants and persons with PD. That is, it could be quite typical in a mealtime context that both persons with PD and control participants use significantly fewer high-motion verbs vs. low-motion verbs. Since control participants and the participants with PD produced similar proportions of high- and low-motion verbs, the findings from the present study do not support the motor theory of verb processing in the participants with PD. Further research is needed to determine whether different discourse settings influence the use of motion-content verbs among persons with PD and control participants. Research on the influence of different discourse genres on verb motion used

will improve our knowledge of motion-content verb use in persons with PD and controls. Moreover, data on verb motion use among normal adults need to be gathered to develop norms for motion-content verbs.

#### 4.4 Strengths

This study has a number of strengths. Firstly, this is the first study to use discourse-based methods vs. experimental conditions or pre-selected stimuli to examine the use of motion-content verbs in persons with PD. Unlike the previous studies conducted under experimental settings, verbs and verb phrases were extracted from the conversation samples of participants with PD and their spousal controls and were presented to raters in the exact form in which they were produced. Such a methodological feature enabled the investigator (SN) to investigate verb-motion as manifested in everyday conversation. Secondly, a visual analogue scale (VAS) was used rather than a binomial choice scale with only low-motion and high-motion options. The VAS ensured a more precise level of measurement than a nominal level of measurement (Salkind, 2011). Thirdly, the cut-off points selected for classifying verbs as low-motion vs. high-motion were set at one standard deviation (SD) above and below the mean. The 1 SD threshold, often used as a clinical threshold to separate normal from abnormal, provided a reasonable benchmark to analyze performances. Finally, graduate students in speech-language pathology were selected as raters in order to create a more cohesive group with similar educational backgrounds. In addition, they were familiar with the concepts of motion and verb-motion, thereby facilitating the training and optimizing the validity of their ratings.

#### 4.5 Limitations

This study does possess limitations. Firstly, the sample size was small but does compare somewhat favorably with the sample sizes used in other experimental studies on verb production among participant with PD. The smaller sample size does make it difficult to generalize findings. As a result of the small sample size, the study was underpowered making it difficult to detect significant differences in the sample groups. Secondly, the present study used analyses of conversation where an operational definition for verbs was set apriori. While this method is appropriate, transcribing only the verbs from the sample

meant that much of the context surrounding the verbs was lost. As described in Griffiths, Barnes, Britten, and Wilkinson (2011), true conversation analysis not only involves transcription but also takes into account features such as prosody, overlapping talk and any silences in the conversation. Non-verbal features of talk such as gestures and gazes or other body movements also are included in the transcriptions. Transcripts of this study did not include any of these features of talk. This was a limitation because the investigator (SN) could not present the precise context surrounding each verb to each rater, leading to some variation in ratings depending on how raters interpreted the verbs.

Thirdly, the present study used conversation samples between spouses and persons with PD as a way of encouraging talk that was reflective of daily conversation. The limitation of this method, however, is that since the two people in a dyad can and do influence what each other says, it may compromise how much or what was said by each person. It could also be that one partner in the dyad purposely said more or less depending on how they wanted to be viewed or how they wanted their partner to be viewed on the video recording. Moreover, spousal dyads meant that the spouses may have already adjusted her or his talk to suit the needs of their spouse with PD. Fourthly, the investigator (SN) tried to ensure that videos were recorded with the best possible audio and lighting. However, since videos were recorded in a place where participants normally dined, it was not always possible to adjust for poor audio quality and dim lighting. The investigator asked participants to turn off or to turn down radios and televisions prior to the mealtime data collection. Poor audio and lighting compromised obtaining and transcribing a very small proportion of verbs from the conversations since it was not always possible to confirm what participants said by repeated listening or watching the video. Post analyses of the data showed that less than approximately 136 verbs were missed due to poor audio quality. The value is compared to the 1262 total verbs produced by the dyads. Finally, microphones were placed in the dining area at a distance that was the least obtrusive. As a result, when participants left the dining area and spoke off-camera, some communication could have been lost and therefore left untranscribed.

## 4.6 Future Directions

While the findings from the present study provide a starting point to investigating the use of a variety of verb motions in everyday conversation, there are many ways to improve the current study. Firstly, in order to ensure that raters are able to interpret and to rate correctly the motion in the verbs, it would be crucial to use a conversation analyses approach when transcribing the conversations. Transcripts should consist of the entire conversation including features of talk such as prosody and overlapping talk as well as non-verbal features. This would minimize the variation in verb interpretation among the raters and would give a better indication of true low-motion vs. high-motion verbs since appropriate contexts would be provided. Another way of providing context to raters would be to have raters view the videos while they rate the verbs. Secondly, conversations between dyads should be obtained from two unrelated individuals. This way, participants would not have any reason to control how much or what they say based on how they want themselves or their partners to be viewed on the video recording. Conversation samples obtained from two unrelated persons could minimize the personal influences of the participants on each other, though it may not be reflective of the most typical daily conversation. The conversation samples also could be collected from a dyad of two people with PD and a separate dyad of two control participants. This way there is no influence of any group on the other. Thirdly, a more sophisticated microphone could be used for data collection. Using a microphone that can be worn on a participant's clothing or is closer to his/her mouth, could help reduce background noise and pick up a better audio signal.

Apart from addressing the limitations of the current study, many steps can be taken to go beyond the current findings. Firstly, it would be interesting to obtain video recordings of participants over many mealtimes. Recordings could be obtained every time a dyad has a meal (i.e. breakfast, lunch and dinner) since they may talk about different topics at each meal. Secondly, the data collection could be collected over a number of weeks or months so that it becomes a longitudinal prospective study vs. a cross-sectional prospective study. Thirdly, although the current study used mealtime conversations to provide context that is reflective of daily conversation, it may be interesting to investigate data that comes

from conversations that occur in other settings such as talking on the telephone. Fourthly, the current study focused on samples that were reflective of daily conversation but it may be interesting to analyze verb use in PD from samples obtained using other form of discourse such as narrative or procedural discourse samples.

Data analyses also can be done differently. Firstly, it would be interesting to correlate the UPDRS-III score of the participants with the motion verbs used by persons with PD. This type of analyses might reveal how verb use varies with disease severity and symptoms. Secondly, it would be interesting to see how subtypes of Parkinson's disease (i.e. akinetic-rigid vs. tremor-dominant) influence verb motion use (i.e. low-motion vs. high-motion). For example, it may be the case that persons with the akinetic-rigid subtype of PD use fewer high-motion verbs. Thirdly, future studies could investigate how levodopa equivalence dosages influence verb motion use. Dopamine generally improves cognitive/motor function (Herrera & Cueto, 2012) and so investigating levodopa equivalence dosages could inform us on how dopamine impacts the frequency of high-motion vs. low-motion verb use in daily conversation in persons with PD. Next, it would be important to measure the conversational and general communicative styles of persons with PD using relevant disease specific scales. For example if a participant is an expressive talker, she/he may talk differently than someone who is not as expressive in conversation. Fifthly it would be a good idea to investigate correlations between topic and verb use because it may be the case that the content of topics (e.g., sports vs. a topic that involves sedentary motion) could influence verb-motion use. Sixthly, future studies should control for the environment surrounding the conversations. For example, it might be a good idea to ask participants to turn off televisions or radios as they could influence verb motion use or could distract participants during the conversations. Seventhly, it would be good to investigate the hobbies/interests of participants to find out if their hobbies influence what types of verbs they use. For example, would a person who currently engages in sports or engaged in sports in the past, impact the types of verbs they use in their present conversations. Moreover, it would be interesting to assess raters as well to investigate if their personal hobbies/interests have any impact on how they rate the verbs. Ninthly, on the present study, all verb structures including copulas and verb phrases were rated. This

was done because there is currently no evidence of how copula linking verbs might influence the rating of a verb phrase. It may be a good idea to present just the verb stems in future studies to determine if this yields different results. Finally it would be very interesting to analyze conversation samples from persons with PD who are known to be “ON” or “OFF” levodopa medication. In the present study it was not known how much medication was in participants’ systems. Herrera and Cuetos (2012) reported that some dopamine receptors are associated with cognitive functions while others are associated with motor functions. Since dopamine generally improves cognitive function, future studies could test the effect of varying dopamine levels on the use of motion-content verbs in daily conversation.



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## Appendix A: Ethics Approval Notice

### LAWSON FINAL APPROVAL NOTICE

LAWSON APPROVAL NUMBER: R-13-531

PROJECT TITLE: Verb Use in Parkinson's Disease

PRINCIPAL INVESTIGATOR: Dr. Joseph Orange

LAWSON APPROVAL DATE: December 19, 2013

Health Sciences REB#: 103717

Please be advised that the above project was reviewed by the Clinical Research Impact Committee and Lawson Administration and the project:

Was Approved

Please inform the appropriate nursing units, laboratories, etc. before starting this protocol. The Lawson Approval Number must be used when communicating with these areas.

Dr. David Hill

V.P. Research

Lawson Health Research Institute

All future correspondence concerning this study should include the Lawson Approval Number and should be directed to Sherry Paiva, Research Administration Officer, Lawson Approval,

Lawson Health Research Institute, 750 Baseline Road, East, Suite 300.

cc: Administration

## Appendix B: Letter of Information for Persons with PD

**Project Title:** Verb Use in Parkinson's Disease

**Principal Investigator:**

JB Orange, PhD, Western University, School of Communication Sciences and Disorders

**Research Support Staff:**

Dr. Mandar Jog, MD Movement Disorders Neurologist, London Health Sciences Centre

Angela Roberts-South MA, Speech-Language Pathologist National Parkinson Foundation Centre of Excellence London Health Sciences Centre, PhD student, Western University Health and Rehabilitation Sciences Program.

Swati Nikumb- Masters Candidate, Health and Rehabilitation Sciences, Speech and Language Science Field, Western University

### **Letter of Information Individuals with Parkinson Disease**

#### **1. Invitation to Participate**

You are being invited to participate in a research study that explores how individuals with Parkinson disease communicate in every day conversation. You are being asked to participate in this study because you have been diagnosed with Parkinson disease and you do not presently have a diagnosis of dementia.

#### **2. Purpose of the Letter**

The purpose of this letter is to provide you with information required for you to make an informed decision regarding participation in this research. Please take the time to read this letter carefully. Please feel free to ask any questions if any part of the explanation of this study is unclear.

#### **3. Purpose of this Study**

The purpose of this study is to develop a better understanding of the effects of Parkinson's disease on language use in daily conversation. Specifically we are investigating the effects of Parkinson's disease on the use of verbs with varying motion content. We seek to understand the underlying linguistic processes that are linked with verb deficits in PD by providing evidence to support one of two proposed theories of verb processing.

#### **4. Inclusion Criteria**

Individuals who meet the following criteria are eligible to participate in this study:

- Diagnosed with idiopathic Parkinson disease (e.g., not the result of confirmed genetic cause)
- Completed a minimum of Grade 8 level of education
- Are a native English speaker
- Do not have dementia based on the results of a test designed to identify the potential presence of dementia, the Mattis Dementia Rating Scale-2
- Age 55 to 80 years
- Have no history of brain injury or brain disease (e.g., stroke) other than Parkinson disease
- Have no history of brain surgery
- Have no history of Schizophrenia or clinically diagnosed depression
- Are not currently taking medications that affect thinking or memory.

#### **5. Exclusion Criteria**

Individuals who do not meet all of the criteria listed above are not eligible to participate in the study.

#### **6. Study Procedures**

If you agree to participate, you will be asked to be videotaped in your home while you engage in conversation with your spouse during your regular lunch timing. We will set up a video camera in the home where you normally dine and will leave it there until data collection is complete. The researcher will not be present during the video recording session. It is anticipated that the entire task will take about 1 hour (including camera set up and instruction delivery), over 1 session. There will be a total of 28 participants in this study, 14 individuals with Parkinson's disease and 14 individuals without Parkinson's disease.

#### **7. Possible Risks and Harms**

There is a possible risk for stress or anxiety for some individuals given the use of audio and video recording. Audio and video recording equipment will be placed as unobtrusively as possible to minimize the potential for increased stress and anxiety associated with this component of the protocol.

If results from the screening test of your focus, memory, and problem solving suggest you might have possible cognitive problems, we encourage you to see your attending physicians, including Dr. Mandar Jog, for follow-up and possible detailed testing.

## **8. Possible Benefits**

You may not benefit directly from participating in this study. However, information from this study may provide benefits to society as a whole including a deeper understanding of the effects of Parkinson's disease on language use. Results of this study are intended to provide society with a better understanding of how movement deficits in persons with Parkinson's disease impacts their ability to use certain verbs in daily conversation. This is important as it can inform future communication therapies.

## **9. Compensation**

You will not be compensated for your participation in this research.

## **10. Voluntary Participation**

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your care.

## **11. Confidentiality**

All data collected will remain confidential and accessible only to the investigators of this study. All data collected will remain anonymous.

The hardcopy paper research records of your data will be stored in the following manner: locked in a cabinet in a locked, secured office. Electronic research records will be stored in the following manner: firewall protected on the Western University network drive accessible only from a password protected computer located in the Aging and Communication Laboratory (Room 2208) in Elborn College at Western University. Audio and video recordings will be reviewed only by members of the research team and they will be destroyed after 10 years in accordance with our professional college regulations for data management. If the results are published, your name and video images will not be used. If you choose to withdraw from this study, your data will be removed and destroyed from our database.

Representatives of The Western University Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research.

## **12. Publication**

If the results of the study are published your name and video images will not be used. The results of this study may be presented at research conferences or community meetings. Further the results of this study may be published in the form of research articles and the Masters thesis of Ms. Swati Nikumb.

*This letter is yours to keep for future reference.*

## Appendix C: Letter of Information for Spousal Controls

**Project Title:** Verb Use in Parkinson's Disease

**Principal Investigator:**

JB Orange, PhD, Western University, School of Communication Sciences and Disorders

**Research Support Staff:**

Dr. Mandar Jog, MD Movement Disorders Neurologist, London Health Sciences Centre

Angela Roberts-South MA, Speech-Language Pathologist National Parkinson Foundation Centre of Excellence London Health Sciences Centre, PhD student, Western University Health and Rehabilitation Sciences Program.

Swati Nikumb- Masters Candidate, Health and Rehabilitation Sciences, Speech and Language Science Field, Western University

### **Letter of Information Individuals without Parkinson Disease**

#### **1. Invitation to Participate**

You are being invited to participate in a research study that compares how individuals with or without Parkinson disease communicate in functional (i.e., every day) tasks. You are being asked to participate in this study as part of the latter control group.

#### **2. Purpose of the Letter**

The purpose of this letter is to provide you with information required for you to make an informed decision regarding participation in this research. Please take the time to read this letter carefully. Please feel free to ask any questions if any part of the explanation of this study is unclear.

#### **3. Purpose of this Study**

The purpose of this study is to develop a better understanding of the effects of Parkinson's disease on language use in daily conversation. Specifically we are investigating the effects of Parkinson's disease on the use of verbs with varying motion content. We seek to understand the underlying linguistic processes that are linked with verb deficits in PD by providing evidence to support one of two proposed theories of verb processing.



#### **4. Inclusion Criteria**

Individuals who meet the following criteria are eligible to participate in this study:

- Completed a minimum of Grade 8 level of education
- Are a native English speaker
- Do not have dementia based on the results of a test designed to identify the potential presence of dementia, the Mattis Dementia Rating Scale-2
- Age 55 to 80 years
- Have no history of brain injury or brain disease (e.g., stroke)
- Have no history of brain surgery
- Have no history of schizophrenia or clinical diagnosed depression
- Are not currently taking medications that affect thinking or memory.

#### **5. Exclusion Criteria**

Individuals who do not meet all of the criteria listed above are not eligible to participate in the study.

#### **6. Study Procedures**

If you agree to participate, you will be asked to be videotaped in your home while you engage in conversation with your spouse during your regular lunch timing. We will set up a video camera in the home where you normally dine and will leave it there until data collection is complete. The researcher will not be present during the video recording session. It is anticipated that the entire task will take about 1 hour (including camera set up and instruction delivery), over 1 session. There will be a total of 28 participants in this study, 14 individuals with Parkinson's disease and 14 individuals without Parkinson's disease.

#### **7. Possible Risks and Harms**

There is a possible risk for stress or anxiety for some individuals given the use of audio and video recording. Audio and video recording equipment will be placed as unobtrusively as possible to minimize the potential for increased stress and anxiety associated with this component of the protocol.

If results from the screening test of your focus, memory, and problem solving suggest you might have possible cognitive problems, we encourage you to see your attending physician for follow-up and possible detailed testing.

## **8. Possible Benefits**

You may not benefit directly from participating in this study. However, information from this study may provide benefits to society as a whole including a deeper understanding of the effects of Parkinson's disease on language use. Results of this study are intended to provide society with a better understanding of how movement deficits in persons with Parkinson's disease impacts their ability to use certain verbs in daily conversation. This is important as it can inform future communication therapies.

## **9. Compensation**

You will not be compensated for your participation in this research.

## **10. Voluntary Participation**

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your care.

## **11. Confidentiality**

All data collected will remain confidential and accessible only to the investigators of this study. All data collected will remain anonymous.

The hardcopy paper research records of your data will be stored in the following manner: locked in a cabinet in a locked, secured office. Electronic research records will be stored in the following manner: firewall protected on the Western University network drive accessible only from a password protected computer located in the Aging and Communication Laboratory (Room 2208) in Elborn College at Western University. Audio and video recordings will be reviewed only by members of the research team and they will be destroyed after 10 years in accordance with our professional college regulations for data management. If the results are published, your name and video images will not be used. If you choose to withdraw from this study, your data will be removed and destroyed from our database.

Representatives of The Western University Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research.

## **12. Publication**

If the results of the study are published your name and video images will not be used. The results of this study may be presented at research conferences or community meetings. Further the results of this study may be published in the form of research articles and the Masters thesis of Ms. Swati Nikumb.

*This letter is yours to keep for future reference.*

## Appendix D: Consent Form

### Consent Form

**Project Title:** Verb Use in Parkinson's Disease

**Study Investigator's Name:**

JB Orange, PhD, Western University, School of Communication Sciences and Disorders

**Research Support Staff:**

Dr. Mandar Jog, MD Movement Disorders Neurologist, London Health Sciences Centre

Angela Roberts-South MA, Speech-Language Pathologist National Parkinson Foundation Centre of Excellence London Health Sciences Centre, PhD student, Western University Health and Rehabilitation Sciences Program.

Swati Nikumb- Masters Candidate, Health and Rehabilitation Sciences, Speech and Language Science Field, Western University

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

Participant's Name (please print): \_\_\_\_\_

Participant's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Person Obtaining Informed Consent (please print): \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

## Appendix E: Participant Intake Form

### Verb Use in Parkinson's Disease

**Principal Investigator:**

JB Orange, PhD, Western University, School of Communication Sciences and Disorders

**Research Support Staff:**

Dr. Mandar Jog, MD Movement Disorders Neurologist, London Health Sciences Centre

Angela Roberts-South MA, Speech-Language Pathologist National Parkinson Foundation  
Centre of Excellence London Health Sciences Centre, PhD student, Western University  
Health and Rehabilitation Sciences Program

Swati Nikumb- Masters Candidate, Health and Rehabilitation Sciences, Speech and  
Language Science Field, Western University

#### Participant Intake Form

Participant Code #: \_\_\_\_\_

Education (yrs): \_\_\_\_\_

Gender:            F                                  M  
                          \_\_\_\_\_                                  \_\_\_\_\_

Native language: \_\_\_\_\_

Handedness: \_\_\_\_\_

Yrs Married: \_\_\_\_\_

From Participant/Patient File (Dr. Jog's Clinic)

UPDRS Score: \_\_\_\_\_

Y & H score: \_\_\_\_\_

DMS-2 Score: \_\_\_\_\_

## Appendix F: Operational Definitions

The operational definition of a verb used in this study has been adapted from the following definitions:

“A verb is the use of a word or phrases to express action or assertion with respect to a subject, a complement or both. The verb is the central element of the sentence, the core or axis around which all the other sentence elements revolve” (Aiken, 1933, p. 47)

“A verb is a word which signifies action or being. A neutral verb is one that simply implies existence or certain state” (Smith, 1846, p. 64)

Modal and auxiliary verbs were also included in the operational definition of a verb. The following definitions were used to include modal and auxiliary verbs:

“Auxiliaries or Auxiliary verbs are a very small group of verbs that only occur in verb phrases. Like determiners, they will occur at the start of the phrase before the lexical verbs” (Ballard, 2007, p. 43)

Primary auxiliaries: have, be, do (Ballard, 2007, p. 43)

Modal auxiliaries: can, could, shall, should, will, would, may, might, must (Ballard, 2007, p. 43)

### **Talking time**

“Talking time is calculated by recording each participant’s talking time minus his/her within utterances pauses of greater than 5 seconds. Filled pauses, including the production of non-words, sighs, groans, and laughs are included in the talking time. However, sighs, groans and laughs at the beginning or the end of a participant’s turn are not included in the talking time.” (Rzepczyk, 2001)

## Appendix G: Verb Rating Instructions

### Verb Motion Study

Swati Nikumb, BSc and J.B. Orange, PhD

June 2014

#### Background Information

Thank you for agreeing to participate in our study. Please print a hard copy of these instructions or maintain an e-copy for easy access while you complete the on-line ratings of verbs.

Verbs are perceived to have motion/movement associated with them. It is possible to rate the amount of perceived motion/movement in verbs. For example, verbs such as “run” and “jump“ are perceived to have high-motion content. They can be rated as high-motion verbs. Conversely, verbs such as “like”, “sit” and “sleep” are perceived to have low-motion content. They can be rated as low-motion verbs.

#### Examples

High-motion content verbs (adapted from Weber & Colonius, 1983 and Herrera et al., 2012):

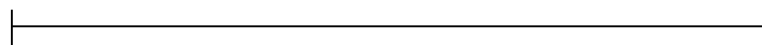
hunt, swim, travel, jump, run, sprint

Low-motion content verbs (adapted from Weber & Colonius, 1983 and Herrera et al., 2012):

sit, sleep, like, sneak, hobble, stroll, trot

### INSTRUCTIONS

- Using the link provided and the examples outlined above as guides, please indicate the amount of perceived motion (low to high) in each verb, by moving the slider-marker along the line next to each verb. Please note that by “motion/movement” we are referring to any physical motion/movement in the verbs



**Low**

**High**

2. If you think there is NO motion in a verb, indicate this by clicking on the “N/A” checkbox. This will disengage the slider-marker. You will not be able to move the marker once you indicate “N/A”.
3. If you DO think there is motion in the verb, you **MUST** move the slider-marker in order for the verb to be considered “evaluated”.
4. Please rate all verbs listed on the rating form. Once you have completed the rating form, submit your responses by clicking on the “Submit” button at the bottom of the page.
5. **Please note that you can only submit the rating form once and will not have a chance to return to the rating form to change any answers after you have submitted your responses.** Therefore, please ensure that you rate each verb in the list and that you respond as accurately as possible.
6. **Please note:** Answers CANNOT be saved for any of the verbs listed on the rating form. If you cannot complete the rating form in one sitting (expected to take approximately 1 to 2 hours), leave the browser window and rating form open (i.e., do not exit out of the browser window). When you return to the rating form, you will be able to continue from where you left off so long as you have not exited the browser.
7. There is no correct answer. It is your perception of the motion/movement that counts.
8. Thank you for your participation in this study.



## Appendix H: Pilot Study Verb Rating Instructions

### Verb Motion/Movement Study in Parkinson's Disease

Swati Nikumb, BSc and J.B. Orange, PhD

November 2012

### Verb Motion/Movement Rating Instructions

Verbs are perceived to have motion/movement associated with them. It is possible to rate the amount of perceived motion/movement in verbs. For example, verbs such as “run” and “jump” are perceived to have high-motion content. They can be rated as high-motion verbs.

Conversely, verbs such as “like”, “sit” and “sleep” are perceived to have low-motion content. They can be rated as low-motion verbs.

Using the examples outlined below as guides, please indicate whether each verb listed on the **Motion Content Rating Form** is a:

- a) High-motion content verb – Please mark with an uppercase **H**
- Or
- b) Low-motion content verb – Please mark with an uppercase **L**

### Examples

High-motion content verbs (adapted from Weber & Colonius, 1983 and Herrera et al., 2012):

**hunt, swim, travel, jump, run, sprint**

Low-motion content verbs (adapted from Weber & Colonius, 1983 and Herrera et al., 2012):

**sit, sleep, like, sneak, hobble, stroll, trot**

Using the **Motion Content Rating Form**, please use an uppercase **H** for what you perceive to be a high-motion verb. Please use an uppercase **L** for what you perceive to be a low-motion verb. Place your rating in the **Rating** cell corresponding to the verb. This is a binomial choice. Moreover, there is no correct answer. It is your perception of the motion/movement that counts.

## Curriculum Vitae

**Name:** Swati Nikumb

**Post-secondary Education and Degrees:** Western University  
London, Ontario, Canada  
2006-2010 B.Sc. Physiology & Psychology (Double Major)

Western University  
London, Ontario, Canada  
2011-2014 M.Sc. Speech and Language Sciences

**Honours and Awards:** Western Graduate Research Scholarship  
2011-2013

**Related Work Experience** Teaching Assistant  
Western University  
2011-2013

Research Assistant  
The Redpath Centre  
2014