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Language contributions to health related quality of life in Amyotrophic Lateral Sclerosis

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LANGUAGE CONTRIBUTIONS TO HEALTH RELATED QUALITY OF LIFE IN AMYOTROPHIC LATERAL SCLEROSIS

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by

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Abstract

Concurrent with the well-documented motor speech production impairments in amyotrophic lateral sclerosis (ALS), individuals with ALS exhibit language problems including confrontation and generative naming difficulties, single word auditory and reading comprehension problems, and decreased self-regulation based on fewer self-corrected utterances, among other language disruptions. Health related quality of life (HRQoL) measures specific to ALS often contain items related to its characteristic speech production problems that are thought to influence overall quality of life. However, the language problems in ALS are rarely if ever considered within the context of HRQoL. The current study aimed to identify the relationship between language problems (i.e., quality of communication) and HRQoL among individuals with ALS. Twenty-eight participants with ALS completed a general HRQoL (i.e., SF-36) and a quality of communication measure (i.e., ASHA QCL). Scores on these measures were compared with standardized language test scores and discourse measures including verbal fluency, the Boston Naming Test (BNT), and discourse measures obtained from a picture description task. Participants also completed a cognitive status and depression screening using the Montreal Cognitive Assessment (MoCA) and the Geriatric Depression Scale (GDS), respectively. The severity of ALS was measured using the ALS Functional Rating Scale. Results indicated that verbal fluency (animals), discourse output, and speech intelligibility are associated with quality of communication. Regression analyses revealed important predictors of quality of communication including the BNT, MoCA, GDS, and speech intelligibility. The only significant predictor for general HRQol (i.e., SF-36) was the GDS. Results suggest that poor performance

on standardized language tests may not be indicative of poor quality of communication, however, findings show that poor efficiency on discourse tasks does affect quality of communication. Results also show that depression in individuals with ALS is associated with poor HRQoL. Overall physical functioning does not significantly contribute to quality of communication or overall HRQoL. An important implication of the findings is that clinicians should focus on optimizing communication in those individuals with ALS who have poor speech intelligibility in order to optimize discourse output, which, in turn, may enhance the quality of communication in individuals with ALS.

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Introduction

ALS Background

Amyotrophic lateral sclerosis (ALS) is a motor neuron disease linked to cell death of lower motor neurons (LMN) of the brainstem and spinal cord, and upper motor neurons (UMN) of the cerebral cortex, leading to progressive paralysis of voluntary muscles and ultimately death. The incidence rate of ALS in Canada is 2/100,000 (ALS Society of Canada, 2008). Peak incidence rates occur between 50 and 70 years of age, with men affected more than women at a ratio of 1.6:1.0 (Eisen & Krieger, 1993; Mitchell & Borasio, 2007). Although ALS most often affects those older than 40 years of age, 10% of cases involve patients younger than 40, and 5% of cases involve persons younger than 30 years of age (Shoesmith & Strong, 2006). ALS is a fatal disease, usually the result of respiratory failure where, following diagnosis, the mean length of survival in ALS ranges from 2.4 to 4.1 years (Boman & Meurman, 1967; Mulder & Howard, 1976). However, twenty percent of individuals with ALS survive longer than five years and 10% survive longer than 10 years (Shoesmith & Strong, 2006). ALS is considered the third most common adult-onset neurodegenerative disease (Strong, Grace, Orange, & Leeper, 1996).

There are different types of ALS. Sporadic ALS is the most common type and accounts for approximately 90% of ALS cases. In sporadic ALS, motor neurons degenerate and die prematurely from unknown causes. Familial ALS occurs in roughly 10% of cases and usually results from an autosomal-dominant pattern of inheritance (Mitchell & Borasio, 2007; Shoesmith & Strong, 2006). This inherited type of ALS typically has a younger age of onset and men are not more likely to develop it

(Mitsumoto, Chad, & Pioro, 1998). Other than fact of inheritance, the two prominent types of ALS are clinically indistinguishable from one another (Mitsomoto et al., 1998).

According to the World Federation of Neurology (1994), individuals diagnosed with ALS must show evidence of upper and lower motor neuron degeneration and demonstrate that the signs have spread within a distinct region of the body. Individuals diagnosed with ALS can first present with symptoms in the limbs, known as limb onset, or in bulbar regions (e.g., speech or swallowing), known as bulbar onset. Shoesmith and Strong (2006) reported that approximately 75% of individuals with sporadic ALS present with limb-onset while approximately 21% present with bulbar onset. Individuals with limb-onset ALS experience weakness in upper and/or lower extremities or truncal muscles while individuals with bulbar-onset ALS initially report weakness and changes in motor speech production and swallowing, known as dysarthria and dysphagia, respectively (Mitsumoto et al., 1998). Bulbar ALS is localized within the corticobulbar area of the brainstem in early stages of ALS and exhibits a faster progression than the limb-onset form (Mitsumoto, 2009). Respiratory onset is an uncommon presenting feature in ALS. However, the presence of impaired respiratory function is a negative prognostic factor (Stambler, Charatan, & Cedarbaum, 1998).

Upper and lower motor neurons degenerate in both types of ALS (Mitsumoto et al., 1998). Degeneration of the upper motor neurons results in muscle stiffness and rigidity, hyperactive reflexes, and decreased ability to control laughing or crying. Pseudobulbar palsy results from degeneration of upper motor neurons in bulbar regions and in descending corticobulbar tracts (Mitsumoto et al., 1998). Pseudobulbar palsy can result in exaggerated snout or jaw reflexes and spasticity of muscles, which cause

slow repetitive movements of the tongue (Brockington, Ince, & Shaw, 2006). Degeneration of the lower motor neurons results in muscle weakness and atrophy, involuntary twitching of muscle fibers (fasciculations), muscle cramps, decrease in muscle tone, weakened reflexes, difficulty swallowing (dysphagia), shortness of breath at rest (dyspnea), and difficulty speaking (dysarthria) (Brockington et al., 2006). Lower motor neuron involvement results in flaccid or paretic bulbar palsy, in which there is wasting of the tongue musculature, a flaccid tone, and fasciculations (Darley, Aronson, & Brown, 1975; Mitsumoto et al., 1998).

Weight loss due to amyotrophy, nutritional deficiencies and dysphagia are common clinical features in ALS. As well, individuals experience head drop, due to weakening of the neck muscles. They also experience dyspnea and orthopnea, due to weakening of the respiratory muscles; and symptoms that result from nocturnal carbon dioxide retention (e.g., morning headache, anorexia, and daytime somnolence) (Mitsumoto et al., 1998).

Speech Production in ALS

Speech production in individuals with ALS can eventually becomes unintelligible as a result of the progressive degeneration of the oral, velopharyngeal, and laryngeal articulators (Bonduelle, 1975). Individuals with ALS exhibit speech difficulties characterized as mixed flaccid-spastic dysarthria as a result of both upper and lower motor neuron degeneration (Darley et al.,1975). Speech production in these individuals is characterized by imprecise consonants, hypernasality, harsh voice quality, slow speaking rate, monopitch, and short phrases. These characteristics manifest slightly differently in each individual and occur at different times throughout disease progression

(Renout, Leeper, Bandur, & Hudson, 1995). The progression of dysarthria leading to anarthria (inability to speak) contributes to communication difficulties in individuals with ALS (Darley, Aronson, & Brown, 1975). In addition to dysarthria, communication in ALS also is affected by problems in cognition and language (Strong et al., 1999).

Cognition in ALS

The neural degeneration associated with ALS was once considered restricted to large motor neurons leaving cognition intact. However, it is now widely accepted that cognitive impairment exists in ALS, wherein it is classified as a multi-systems disorder with a wide range of cognitive problems (Strong et al., 1999). The cognitive profile of individuals with ALS ranges along a continuum from no discernable cognitive deficits to severe dementia meeting diagnostic criteria for frontotemporal dementia (FTD) (Loemen-Hoerth et al., 2003; Neary et al., 1998). Cognitive impairment (CI) in the absence of dementia is now recognized as a robust finding in individuals with ALS (Abe et al., 1997; Abrahams et al., 1997; Bak & Hodges, 1999; Gallassi et al., 1985; Gordon, et al., 2010; Hanagasi et al., 2002; Kilani et al, 2004; Lomen-Hoerth, et al., 2003; Raaphorst, DeVisser, Linssen, DeHaan, & Schmand, 2010; Strong et al.,1999). The prevalence of CI in ALS sample populations is estimated to range from 35.6% to 50% (Massman, Sims, Cooke, Haverkamp, & Appel, 1996; Phukan et al., 2012; Ringholz et al., 2005). In a population based study of 160 individuals with ALS, Phukan et al. (2012) found that 47% of individuals showed no discernable cognitive deficits, 21% exhibited a cognitive impairment including executive dysfunction, 14% possessed a cognitive impairment with no executive dysfunction (i.e., showed language or memory

deficits), 14% demonstrated ALS-FTD, and the remaining 4% displayed coinciding Alzheimer's dementia or were unable to be categorized.

The typical profile of CI in ALS includes disruptions to attention systems and processes, executive dysfunction, problems with multiple memory systems, and impaired visuospatial skills. Deficits also manifest as declines in verbal and non-verbal fluency, working memory, cognitive flexibility, sustained attention, recognition memory for words and faces, visual perception, reasoning, word generation, word fluency, and executive functions such as planning, organizing, and self-monitoring (Abe et al., 1997; Abrahams et al., 2000; Elamin et al., 2011; Portet, Cadilhac, Touchon, & Camu, 2001; Strong et al., 1996; Strong et al., 1999, Talbot et al., 1995). Portet et al. (2001) found that ALS disease severity was more pronounced when cognitive impairment was present. Cognitive impairments in ALS are associated with shorter survival times (Elamin et al., 2011; Gordon et al., 2010).

Whereas in some individuals with ALS cognitive dysfunction is undoubtedly due to the degenerative process associated with the disease, others exhibit cognitive dysfunction that is related to respiratory compromise. Cognitive status in persons with ALS has been correlated with reduced vital capacity. Kim et al. (2007) found that participants with a reduced vital capacity performed significantly poorer in memory retention, retrieval efficacy, and spoken verbal fluency than those participants with a normal vital capacity. Individuals with ALS showed improved cognition as a result of using non-invasive positive pressure ventilation over six weeks (Newsom-Davis, Lyall, & Leigh, 2001). The cognitive status is likely due to neuronal loss, gliosis, or sponginess in the hippocampus and parahippocampal regions that are vulnerable to hypoxia (Kato,

Oda, & Hayashi, 1994). Respiratory insufficiency can be identified using values of vital capacity, nasal inspiratory pressure, oxygen saturation, diaphragmatic amplitude, or blood gas levels (Hardiman, 2011). Low carbon dioxide-blood gas levels measured non-invasively in arterialized venous blood using a transcutaneous earlobe monitor are considered the "gold standard" of respiratory insufficiency (Hardiman, 2011).

In addition to respiratory compromises affecting cognition in ALS, there is a large body of evidence showing that depression affects cognition. For example, Lichetenburg, Ross, Millis, and Manning (1995) found a modest relationship between scores of 220 older adults on the Geriatric Depression Scale (GDS) and two measures of cognition; the Dementia Rating Scale (DRS) and the Logical Memory Test. The GDS scores were a consistently significant predictor of the DRS and Logical Memory scores. The authors concluded that depression is an independent predictor of cognition. Depression also can frequently be associated with executive deficits, which in turn, can influence participants' performances in high-level language processing or verbal fluency tasks, which are largely dependent on executive functions (Starkstein, Bolduc, Mayberg, Preziosi, & Robinson, 1990). Prevalence rates for depression in individuals with ALS range from 0% to 44%, but studies using the structured interview according to DSM-IV criteria for depression find highly consistent rates of 9 to 11% (Kurt, Nijboer, Matuz, & Kubler, 2007). More recently, McElhiney, Rabkin, Gordon, Goetz, and Mitsumoto (2012) found that, in a sample of 223 individuals with ALS, only 7% (16/223) had major or minor depression and that the depression was not associated with ALS severity. It is prudent to take into account the presence of depressive symptoms when evaluating language abilities in individuals with ALS.

A diagnosis of dementia requires multiple cognitive deficits of gradual onset and continual decline, which include both memory and any one or more of the following: language problems, movement programming problems, agnosia, or disturbance in executive functioning (DSM –IV TR, 2000). These impairments must cause significant impairment in social or occupational functioning and must represent significant decline from previous functioning. In addition, deficits cannot be caused by other central nervous system (CNS) conditions, systemic conditions known to cause dementia, substance abuse, delirium, or any other primary psychiatric disorder (DSM IV-TR, 2000).

Frontotemporal-type dementia (FTD) is the most common type of dementia in ALS (Bak & Hodges, 1999). FTD is defined as a behavioural syndrome marked by profound alternations in personality and social conduct, inertia and loss of volition or social disinhibition, with a relative preservation of memory (Neary et al., 1990). The term FTD is restricted to the overall clinical spectrum of frontotemporal dementia including behavioural variant FTD (bvFTD), and three variants of primary progressive aphasia (PPA). The term frontotemporal lobar degeneration (FTLD) is restricted to the neuropathological correlate of FTD (Strong, 2008).

Symptoms of FTD include disinhibition, impulsivity, changes in sleep and eating patterns, decreased attention, decreased executive functioning and planning, apathy, and poverty of speech production and spoken language progressing to mutism (Neary et al., 1990). ALS-frontotemporal dementia (ALS-FTD) is estimated to occur in three percent of sporadic cases and 15% of the familial type (Bak & Hodges, 1999; Loemen-

Hoerth et al., 2003). ALS-FTD is a negative prognostic indicator including shortened disease duration with more severe symptom presentation (Elamin et al., 2011).

Any variant of FTD can be associated with ALS, however, the behavioural variant FTD (bvFTD) and nonfluent variant primary progressive aphasia (nfvPPA) are most commonly associated with ALS, because they are localized to the frontal lobes of the cortex near the motor strip. Individuals with ALS can display signs and symptoms of each variant of PPA that occur within the clinical syndrome of FTD; nfvPPA, semantic variant PPA (svPPA), or logopenic variant PPA (lvPPA). nfvPPA is sometimes the first clinical diagnosis in those who develop ALS-FTD (Bak, O'Donovan, Xuereb, Boniface, & Hodges, 2001; Lomen-Hoerth et al., 2003; Strong, 2008). Although language deficits are common in ALS, it is debatable whether these deficits are strictly language impairments or part of an underlying cognitive impairment (South, Findlater, Strong, & Orange, 2012).

Language in ALS

Individuals with ALS exhibit language impairments in the absence of CI or FTD. The language performances of individuals with ALS have been studied in combination with other neuropsychological batteries as part of general cognitive testing in ALS (Cobble, 1998). Language deficits of individuals with ALS without CI or FTD most commonly include word retrieval problems (Abrahams et al., 2004; Abrahams, Leigh, & Goldstein, 2005; Mantovan et al., 2003; Racowicz & Hodges, 1998; South, Findlater, Strong, & Orange, 2011; Strong et al., 1999). Naming deficits occur in both category verbal fluency tasks (e.g., naming animals) and letter verbal fluency tasks (e.g., naming words that begin with the letter "F") (Abrahams et al., 2000; Hanagasi et al., 2002;

Strong et al., 1999) along with problems in confrontation naming (Abrahams et al., 2004; Hanagasi et al., 2002; Mantovan et al., 2003; Ringholz et al., 2005; Strong et al., 1999). Reduced single-word vocabulary comprehension (Strong et al., 1999), impaired auditory comprehension (Mantovan et al., 2003), and verbal and semantic paraphasias on confrontation and noun naming tasks (Cooper et al., 2008; Strong et al., 1999) also are overall common features of the language profile of individuals with ALS. Abrahams et al. (2005) found impairments in both spoken and written verbal fluency tasks in ALS participants without dementia. However, the verbal fluency did not change over time. This suggests that verbal fluency impairments in ALS may result from higher order cognitive dysfunction, indicating deficits in attention systems or central executive component of working memory (Abrahams et al., 2004). It is important to note that among normal individuals, it is not until they are generally over the age of 75 that they experience word retrieval problems and difficulties on confrontation and generative naming tasks associated with aging (Goodglass, 1980; Nicholas, Barth, Obler, Au, & Albert, 1997). Executive functioning (i.e., planning, organizing, and reasoning) and episodic memory also are affected by aging. Typically, recall of information is affected more than the ability to recognize previously seen or heard information (Nyberg et al., 2003).

Individuals with ALS without CI or without FTD demonstrate decreased self-regulation with fewer self-corrected utterances during discourse (South et al., 2011; Strong et al., 1999). Narasimha (2009) also showed that individuals with ALS without CI or without FTD produce more simplified verb structures, as well as more parenthetical remarks, suggesting possible word retrieval or language deficits. Using

the same discourse measures, South et al. (2011) showed differences in word finding indices of word retrieval in individuals with ALS compared to controls. Reduced discourse efficiency in the South et al. (2011) study was hypothesized to be due to presence of revisions and reformulations (i.e., "*[He is] [she is climbing] she was reaching for a cookie*,") or to the presence of "empty words" which do not enhance the content (*e. g. "The [thing] it is somewhat a [you know thing]"). W*ord retrieval problems may underscore the reduced discourse efficiency seen at all time points in the study. Strong et al. (1999) also tested communication during discourse in ALS using a topic-directed interview (TDI) protocol, based on Ripich and Terrell (1988), at two times periods over six months. Results indicated that individuals with ALS produced significantly fewer self-corrected utterances than did controls at the six-month period.

Two longitudinal studies addressed the progression of language impairment without dementia throughout the course of ALS (Abrahams et al., 2005; Strong et al., 1996). In both studies, participants were tested at baseline and again six months later. Strong and colleagues (1996) did not find any significant differences in the language performances of their participants over time. Abrahams and colleagues (2005), however, found evidence of significantly slower word retrieval times for the participants with ALS on the Computerised Sentence Completion test at the six-month follow up period.

Structural and functional brain imaging changes correlate strongly with cognitive and language impairments in individuals with ALS (Abrahams et al., 2004; Bak & Hodges, 2004; Kew et al., 1993). Cognitive and language impairments may be secondary to neuronal loss in the cortex throughout disease progression. Using PET

imaging, Abrahams et al. (1997) reported that individuals with ALS who exhibited deficits in verbal fluency demonstrated cortical and subcortical dysfunction. These deficits affected the frontal lobes with extension into the insular cortex and thalamic nuclei. Abrahams et al. (2004) studied letter fluency, category fluency, and picture confrontation naming in 28 ALS participants and 18 controls in conjunction with fMRI. The letter fluency task was associated with reduced activation in extensive regions of the left prefrontal cortex, left temporal lobe, left parietal lobe, and right anterior cingulate gyrus. Increased activation was found in the right inferior frontal gyrus, right middle temporal gyrus, and left superior frontal gyrus. During the confrontation-naming task, there was impaired activation in the left prefrontal cortex, right inferior frontal gyrus, right cingulated gyrus, left temporal lobes, bilateral parietal lobes, and occipital lobes. Although language deficits in ALS are evident, it is unclear whether these deficits are part of an underlying cognitive impairment or strictly linguistic in nature (South et al., 2011). Recent evidence suggests that executive dysfunction impairments do not underscore the language problems in ALS (Taylor et al., 2012). Language impairments in individuals with ALS without CI or without dementia may be an under recognized feature of ALS and can progress over time.

Individuals with ALS-FTD display various language impairments (Hayley & Ramer, 2000). These include impaired comprehension for both complex sentences and single word semantic processing tasks, as well as reading and writing difficulties (Caselli, et al., 1993; Cobble, 1998; Hayley & Ramer, 2000; Rakowicz & Hodges, 1998). ALS-FTD affects word retrieval, language comprehension, and spelling (Bak & Hodges, 1997, 2004; Neary et al., 1990; Rakowicz & Hodges, 1998). Individuals with ALS-FTD

ranged from normal, to mildly impaired to echolalic on tests of verbal repetition (Cavelleri & DeRenzi, 1994; Neary, et al., 1990). Impairments also are prominent for nouns and verbs on both naming and comprehension tasks, with increased difficulty for verbs (Bak & Hodges, 1997, 2004; Hillis, Oh, & Ken, 2004). Bak and Hodges (2004) reported that language deficits might be an early and prominent feature of individuals with ALS-FTD.

Quality of Life (QoL) in ALS

The World Health Organization (1994) defines QoL as, "the individual's perception of their [sic] position in life in the context of culture and value systems in which they [sic] live and in relation to their [sic] goals, expectations, standards and concerns" (p. 1). "QoL is a broad ranging concept affected in a complex way by the persons' physical health, psychological state, level of independence, social relationships and their relationship to salient features in their environment" (WHO, p.1). QoL is determined by considering heath-related factors (physical, functional, emotional, and mental-wellbeing) and non-health-related factors (jobs, family friends, spirituality, and other life circumstances) (Burns, Graham, Rose, & Simmons, 2012).

Physical status has been shown to be less relevant in determining overall QoL in ALS, wherein QoL remains stable while physical function declines (Chio et al., 2004; Lulé, Häcker, Ludolph, Birbaumer, & Kübler, 2008; Nygren & Askmark, 2006; Robbins, Simmons, Bremer, Robbins, Walsh, & Fisher, 2001). Tramonti, Bongioanni, Di Bernardo, Davitti, and Rossi (2012) found that participants' self-perceived quality of life, measured by the Schedule for the Evaluation of Individual Quality of Life Direct Weighting Scale (SEIQoL-DW), was not correlated with any scores of physical

functioning or depression, confirming previous findings emphasizing how the subjective perception of life satisfaction is not necessarily related to physical functioning and even to HRQoL. The Amyotrophic Lateral Sclerosis Functional Rating Scale (ALS-FRS), a measure of disease severity, score is not a predictor of QoL. However, depression severity is correlated with lower QoL scores in those with ALS (Krampe et al., 2008). The QoL of 26 individuals with ALS, as assessed by participants' responses to the McMaster QoL (Sterkenburg, King, & Woodward, 1996) scale every four to seven months did not change significantly over a 24-month follow up period (Nygren & Askmark, 2006). Using the same QoL scale, Roach, Averill, Segerstrom, and Kasarski (2009) found that the effect of time did not affect the QoL of individuals with ALS. However, the total QoL, and in particular QoL related to physical symptoms of individuals with ALS, declined over time for their caregivers. Lule et al. (2008) did not find any correlation between physical disability in ALS and either depression or self-perceived QoL (SEIQoL-DW). The severity of depression in this study was inversely related to educational status, and QoL of these individuals with ALS was comparable to healthy controls. Individuals with ALS experienced a satisfactory QoL without depressive manifestations even if they were severely physically impaired, including those who were in the terminal phases of the disease.

Goldstein, Atkins, and Leigh (2002) found that global self-ratings of individuals with ALS, measured by the SEIQoL-DW (O'Boyle, 1994), were correlated positively with scores on a self-report measure of cognitive functioning called the Short Inventory of Mental Lapses (SIML). In this instance, greater self-rated cognitive impairment was related to poorer perceptions of QoL. The authors noted, however, that with more

cognitive impairment, the use of the SEIQoL-DW might be invalidated. since its completion requires the participant to have insight, to think about abstract concepts, to make judgments, and to use visual analogue scales. The investigators also found that there is no correlation between SEIQoL-DW scores and any of the measures of physical or functional status as measured by the ALS Severity Score (ALSSS) or the Sickness Impact Profile (SIP). Anxiety or depression scores were not significantly correlated with SEIQoL-DW scores, indicating that mood did not influence self-perceived QoL scores. The researchers concluded that cognitive functioning also should be considered when evaluating QoL in ALS.

The presence of neurobehavioural symptoms associated with ALS-FTD correlates significantly with lower caregivers' QoL, higher caregiver depression, and higher caregiver burden, which can have profound impacts on caregivers' emotional status (Chio, et al., 2010). A low level of QoL in participants with ALS is thought to be due to pre-existing individual differences, whereas age and disease progression are likely to affect QoL among ALS caregivers (Roach et al., 2009). Grehl, Rupp, Budde, Tegenthoff, and Fangerau (2011) found that self-ratings of QoL by individuals with ALS vs. their relatives perceived ratings of QoL for their relative with ALS are not statistically different using the Munish Quality of Life Dimensions List (MLDL) (von Steinbüchel, Bullinger, & Kirchberger, 1999).

More research has been completed in HRQoL and other neurodegenerative diseases. In a study of individuals with Parkinson's disease (PD), Schrag, Jahanshahi and Quinn (2000) found that the spheres of daily living that deteriorated with advancing disease are associated predominately with mobility, self-care, activities of daily living,

physical and social functioning on generic measures of QoL such as the SF-36 (Ware & Sherbourne, 1992) and the EuroQoL (The EuroQoL Group, 1990). However, when participants with PD completed a disease-specific QoL measure, the PDQ-39 (Jenkinson & Fitzpatrick, 2007), cognition, communication, and bodily discomfort lower QoL scores significantly. Ross and Wertz (2003) found that individuals with chronic aphasia could be distinguished from persons who do not exhibit aphasia based on different facets of QoL. These facets include level of independence, social relationships, and environment. Ross and Wertz (2003) suggested that, to enhance QoL in individuals with language impairments such as those with chronic aphasia, therapy should focus on situation-specific communication and societal participation. Although individuals with PD and aphasia do not exhibit the same communication difficulties as individuals with ALS, some of the features of these diseases are similar to features in ALS.

Health Related Quality of Life (HRQoL) in ALS

HRQoL is defined as, "the value assigned to the duration of life as modified by social opportunities, perceptions, functional states and impairments that are influenced by disease, injury, treatment, or policy and should include some assessment of general wellbeing and satisfactions with treatment, outcome, and health status with future prospects" (O'Boyle & Waldron, 1997, p. 3). HRQoL is a more narrow term than QoL, although the terms have been used interchangeably, on occasion, in the literature. HRQoL often is viewed from more of a medical perspective, and so it often does not include factors such as family, support systems, religiosity, or income, unless these domains are directly affected by the health status of the individual. HRQoL differs from

QoL in that it addresses issues that are related to the presence of disease or to the treatment of disease (Burns et al., 2012). The devastating physical and emotional effects of ALS have detrimental impacts on the HRQoL of those with ALS as well as on the HRQoL of caregivers, family, and friends.

It has become increasingly important to use HRQoL measures to assess the improvement of health care services and to incorporate patient based outcomes to provide patient-centered baseline for assessment and treatment of various health conditions (Mitsumoto & Del Bene, 2000). For example, scores on the ALS-specific HRQoL scale (SIP/ALS-19), which are primarily based on physical function, decline in parallel with scores on the ALS-Functional Rating Scale (ALS-FRS), a disease severity measure (Robbins et al., 2001). Tramonti, et al. (2012) also found an overlap in the domain of physical functioning when comparing scores on the physical functioning subscale of the SF-36 and the ALSFRS-R. Kiebert et al. (2001) asked individuals with ALS who were at different stages of the disease to complete a visual analogue scale of their own health rating and to complete a ALS-specific health status measure (ALSAQ-40) (Jenkinson, Brennan, Fitzpatrick, Bromberg, & Swash, 1999) to measure HRQoL. They found that HRQoL decreases systematically with disease severity. Olsson Oazanne, Strang, and Persson (2011) compared the scores from individuals with ALS and their next of kin on the Short-Form 36 (SF-36) a general HRQoL measure vs. the scores from a subset of a general Swedish population. A strong correlation was found in both the mental component summary in SF-36 and in scores related to anxiety between the groups of participants and their next of kin. There were no significant correlations for the physical component summary scores or the depression scores

between the groups of participants and their next of kin. Findings showed that the HRQoL socres are not related to the physical function of the participants with ALS. Both individuals with ALS and their next of kin exhibited some poorer ratings on the SF-36 and on measures of anxiety and of depression than did those from the general Swedish population. Gender or age did not affect the estimates in any of the scales. Chio et al. (2004) concluded that HRQoL measures may not be adequate to assess overall QoL in ALS because QoL in ALS depends on psychological, supportive, and spiritual factors. Interestingly, although HRQoL in individuals with ALS declines over time, self-rated global QoL, does not appear to do so (Burns et al., 2012).

QoL and HRQoL are difficult concepts to measure, especially among individuals with ALS. Some of the QoL and HRQoL measures are disease specific while others are generic and not disease specific in nature. A disease-specific vs. a general measure of the quality of life, and vice-versa, will be appropriate depending on the purpose and the objectives of the study (Burns et al., 2012).

Statement of the Problem

Health care providers can underestimate the QoL and HRQoL of individuals with chronic diseases and often can make assumptions about the importance of strength and physical ability (Olsson et al., 2010). Many of the scales used to evaluate QoL and HRQoL in ALS are generic in nature and items therein often are not specific to the disease per se (Bromberg & Forshew, 2001). Moreover, there are few disease specific QoL and HRQoL measures for persons with ALS and none that contain items that address communication problems; problems that are now well recognized in published studies on the cognitive and language impairments in ALS (Paul et al., 2004).

The determinants of HRQoL in ALS are unclear. The relationship between HRQoL and communication impairments in ALS needs to be explored, where current evidence shows that psychological and social issues in ALS affect HRQoL more severely than do physical symptoms alone. The communication of individuals with ALS is impaired in both the severity of their dysarthria and their language and cognitive-communication deficits. The impact of language deficits on quality of communication in those with ALS remains to be explored. It is expected that individuals with ALS who exhibit language or cognitive impairments will display lower HRQoL than individuals with ALS who are not affected by any language or cognitive deficits.

Objectives

The objective of this study is to determine whether language and speech intelligibility impairments in individuals with ALS are associated with poor self-perceived quality of communication and overall HRQoL.

Research Questions

The following research questions are posed for this study. They are:

RQ 1 Language and Quality of Life Measures

What is the association between language scores on the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983), verbal fluency (i.e., animals), and measures of language output from the Cookie Theft description task (Boston Diagnostic Aphasia Examination – BDAE – 3rd edition) (Goodglass, Kaplan, & Baressi, 2001) and:

a) Self-Rated Quality of Communication (ASHA QCL measure) (Paul et al., 2004)?

b) Self-Rated Health Related Quality of Life (SF-36 measure) (Ware & Sherbourne, 1992)?

RQ 2 Speech Intelligibility and Quality of Life Measures

What is the correlation between perceived speech intelligibility ratings and:

a) Self-Rated Quality of Communication (ASHA QCL measure) (Paul et al., 2004)?

b) Self-Rated Health Related Quality of Life (SF-36 measure) (Ware & Sherbourne, 1992)?

RQ 3 Speech Intelligibility and Language Measures

What is the correlation between perceived speech intelligibility ratings and language scores on the BNT, verbal fluency (animals), and measures of language output from the Cookie Theft description task?

RQ 4 Predictors

What are the relative contributions of the BNT, MoCA, GDS, speech intelligibility, and the ALSFRS-R to:

a) Self-Rated Quality of Communication (ASHA QCL) (Paul et al., 2004)?

b) Self-Rated Health Related Quality of Life (SF-36) (Ware & Sherbourne, 1992)?

Method

Participants

Twenty-eight participants with a diagnosis of probable or definite ALS defined by the El Escorial diagnostic criteria (1995) for ALS were recruited as a convenience sample from the London Health Sciences Centre (LHSC) Motor Neuron Disease Clinic at University Hospital in London, Ontario led by neurologist Dr. Christen Shoesmith (CS). All participants were between 38 to 74 years of age with a mean of 59.25 years (+/- 9.62 SD), and spoke and understood English as their first language. All 28 participants self-reported normal and functional vision and hearing. Participants were excluded if they had a history of other neurologic or psychiatric conditions that affect cognition and language performance (e.g., major hemispheric stroke, traumatic brain injury, learning disability, epilepsy, alcohol dependence syndrome, severe mental illness, use of high-dose psychoactive medication, or evidence of FTD according to Neary et al. (1998) criteria and Strong et al. (2009) criteria. Participants were not excluded based on cognitive or depression screening, and instead cognition and depression scores were factored into the analyses. It was thought that not enough participants in the MND clinic would be eligible to participate in this study if such strict exclusion criteria were used. Participants also were excluded if they exhibited a PCO_2 level greater than 50 mmHg within three months of participation, as determined by chart review. Table 1 displays the demographic characteristics of the participants with ALS. No controls were used in this study.

Table 1

Demographics of participants with ALS (N=28)

Characteristics and Tests	Mean	SD	Range
Age (yrs)	59.3	9.61	43-74
Education (yrs)	14.2	2.7	7-19
Handedness (27 R: 1 L)			
Gender (17 Men: 11 Women)			
MoCA (max 30)	24.6	3.4	16-30
GDS (max 30)	7.8	4.8	2-22
ALSFRS-R (max 48)	30.9	9.7	14-45
Speech subtest (max 4)	2.7	1.0	1-4

Note. MoCA = Montreal Cognitive Assessment, GDS = Geriatric Depression Scale, ALSFRS-R = ALS-Functional Rating Scale Revised

Procedure

This study of individuals with ALS was a cross-sectional in design. All testing was video and audio digitally recorded using a Canon™ VIXIA HFM500 video camera and a Rode™ Videomic Pro Compact Shotgun Microphone. Data were collected in one session lasting approximately 1.5 hours. Data were collected in the research room of the Motor Neuron Diseases unit on the seventh floor at the LHSC-UH site (n=15) or in participants' homes (n=13). Data were collected by the author (KMF) and her research supervisor (JBO) (n=19) or by the author herself (n=9). Written consent was obtained from each participant. This study was authorized by the Office of Research Ethics at Western University (HSREB code #102807). A Data Transfer Agreement with Lawson Health Research Institute was also granted for this study (See Appendix A for the Letter of Information, Letter of Consent, HSREB authorization form, Lawson Health Institute Approval, and Data Transfer Agreement).

ALS participants first completed the Cookie Theft picture description task from the Boston Diagnostic Aphasia Examination – 3rd Edition (Goodglass, Kaplan & Baressi,

2001) to obtain a language sample suitable to calculate measures of correct content units and measures of content efficiency. The purpose of collecting these measures was to obtain a sample that was representative of each participant's spontaneous discourse output given the same picture to describe.

Productivity measures for the language samples included total words, total utterances, and mean length of utterance (MLU). Words were defined according to the criteria described by Nicholas and Brookshire (1993), including intelligible words within context but which are not required to be accurate, relevant, or informative relative to the topic being discussed. For example, filler words such as, "you know", "I mean" or interjections such as "oh, wow, golly, gosh, and gee" were counted. Words or partial words that were intelligible in context such as, "The **moth** mother," for example, were not counted. Non-filler words, such as, "um, er, uh, hmm, and mmm," were not counted. Utterances were defined as a group of words expressing a complete thought separated from other utterances based on content shifts, intonation changes, and/or pauses (Shewan, 1988). Mean length of utterance was defined as described in Retherford (1993).

Discourse measures of content including Correct Information Units (CIUs) were defined using the definition of Nicholas and Brookshire (1993). CIUs were defined as those words that were intelligible in context, accurate to picture/topic content, and relevant to picture/topic content. The number of different novel concepts used to describe the picture was determined using content units (CUs), based on the method reported by Yorkston and Beukelman (1980). CUs reflect participants' abilities to deduce information from the Cookie Theft picture. A second content efficiency measure

was calculated by dividing the number of CU by the total number of words to generate the measure of words per CU. None of the 28 participants were anarthric, as each participant was able to complete the task verbally.

After the discourse sample was obtained, the content was transcribed orthographically and segmented into utterances by the author (KMF) and a trained but naïve assistant (undergraduate student) who did not know the purpose of the study. Reliability scores for words for intra- (all samples) and inter-transcriber agreement studies (5 transcripts = 17.8% of transcripts for the naïve transcriber) were calculated using Cronbach's alpha and were (α = .999) and (α = .997), respectively. Reliability scores for utterance segmentation for intra- (all samples) and inter-transcriber agreement studies (5 transcripts = 17.8% of transcripts for the naïve transcriber) were calculated using Cronbach's alpha and were (α = .997) and (α = .995), respectively. Reliability scores for correct information units for intra- (all samples) and inter-transcriber agreement studies (5 transcripts = 17.8% of transcripts for the naïve transcriber) were calculated using Cronbach's alpha and were (α = .998) and (α = .898), respectively. Reliability scores for Content Units for intra- (all samples) and inter-transcriber agreement studies (5 transcripts = 17.8% of transcripts for the naïve transcriber) were calculated using Cronbach's alpha and were (α = .997) and (α = .982), respectively.

Participants with ALS also completed standardized language tests including a 30-item short-version of Boston Naming Test (BNT) (Kaplan et al.,1983). The BNT is a 60-item test in which participants are shown black-line drawings of nouns and are asked to name those nouns. The purpose of using the BNT in this study was to assess

participants' abilities on confrontation noun naming, which can be impaired in ALS. Participants also completed seven measures of verbal fluency, including four categories of living items (i.e., animals, breeds of birds, breed of dogs, and water creatures) and three categories of non-living items (i.e., methods of transportation, musical instruments, and tools). These categories are based on an adapted version of the Hodges, Salmon, and Butters (1992) category fluency task conducted with individuals with Alzheimer's disease. All participants with ALS were asked to generate verbally as many items as they could in one minute for each of the seven categories. One participant was allowed to respond in written form due to severe motor speech impairment. An additional 30 seconds was provided to the participant for the first category (animals). In the first 60-second period of the animals category she produced a normal number of exemplars and did not write any additional exemplars in the extra 30 seconds that were provided. Given her performance on this category, it was decided that she did not need additional time to complete the written task. She was allowed 60 seconds for each remaining category. The purpose of the verbal fluency task was to assess participant's ability in generative noun naming when given a category, which has been shown to be impaired in most individuals with ALS.

Participants with ALS then completed the Geriatric Depression Screening Scale (GDS), a 30-item, self-rated depression scale specifically designed for identifying and rating depression in older adults (Yesavage & Brink, 1983). The GDS is reliable and valid in rating depression among adults with and without dementia (Stiles & McGarrahan, 1998). The GDS questions are answered using "Yes" or "No" responses. The binomial response option enables those who are ill or who suffer a mild or

moderate cognitive impairment to complete the measure with relative ease. The scale is used commonly as a routine part of a comprehensive geriatric assessment (Koenig, Meador, Cohen, & Blazer, 1988). One point is assigned to each answer that indicates depression and the cumulative score is rated on a scoring grid. The grid sets a range of 0 to 9 as "normal", 10 to 19 as "mildly depressed", and 20 to 30 as "severely depressed" (Lesher & Berryhill, 1994). One participant scored 22/30 on the GDS, indicating severe depression. The participant's attending neurologist (CS) was notified about the score on this measure. All other 27 participants had scores on the GDS that indicated they did not suffer from severe depression. The purpose of using the GDS in our study was to screen for individuals in the study who may be affected by depression, which could affect their scores on other tests of cognition and language, such as the MoCA and SF-36.

Participants with ALS then completed the MoCA (Nasreddine et al., 2005). The MoCA is a screening instrument designed to detect mild cognitive dysfunction. The MoCA has well established and robust validity and reliability psychometric properties (Nasreddine et al., 2005). The MoCA contains tasks designed to assess attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. It takes approximately 10 minutes to administer the MoCA. The maximum possible score is 30 points; a score of 26 or above is considered normal (Nasreddine et al., 2005). Adjustments in administration and scoring were made in accordance with published criteria for participants with clinically significant motor impairments (Nasreddine et al., 2005). One point was added to the total score if the participants' education was less than or equal to 12 years, as is

standard in MoCA testing (Nasreddine et al., 2005). There were ten participants who were unable to write due to physical limitations. These individuals, completed the trail-making task of the MoCA verbally. These same individuals who were unable to write, were unable to complete the cube drawing and clock drawing subtests of the MoCA. These individuals could only obtain a maximum score of 26. All of the MoCA scores for each of the 28 participants were converted into percentage scores to account for the differences in total possible items correct (26 or 30). The MoCA was administered in this study to identify those participants who might possess mild cognitive impairment.

Participants with ALS also completed a general health related quality of life (HRQoL) measure called the Short Form 36 (SF-36) (Ware & Sherbourne, 1992), and the American Speech and Hearing Society's Quality of Communication Scale (ASHA QCL) (Paul et al., 2004). The SF-36 is a self-administered general measure of HRQoL, which focuses on physical and mental aspects. It consists of 36 items in eight health domains; (1) limitations in physical activities because of health problems, (2) limitations in social activities because of physical or emotional problems, (3) limitations in usual role activities because of physical health problems, (4) bodily pain, (5) general mental health (psychological distress and well-being), (6) limitations in usual role functioning because of emotional problems, (7) vitality (energy and fatigue), and (8) general health problems (Ware & Sherbourne, 1992). Participants record responses using a Likert method of summated ratings. The SF-36 takes approximately 10 to 15 minutes to complete. Scores are translated to a scale from 0 to 100, where higher scores represent a higher (i.e., better) HRQoL. The SF-36 was chosen as a generic HRQoL measure because of its robust use with the ALS population, and its overall strong reliability and

validity psychometric properties in the general population and in several different disease groups (e.g., stroke, multiple sclerosis, and cancer). Scores on the SF-36 are normalized such that a score of 50 becomes the average score and the norm. This norm-based score enables comparison across more than 17,000 studies in the last 20 years (Calsyn et al., 2004). The SF-36 displays good internal consistency (>0.80 in all dimensions except social functioning, 0.68) (Gandek et al., 2004; McCallum, 1995; McHorney, Ware, Lu, & Sherbourne, 1994; Stevenson, 1996; Ware, Kosinski, & Keller, 1994). It possesses adequate test-retest reliability (>0.70 in all studies) (Bowling, 1995; Hopman et al., 2004; Kagee, 2001; Sanson-Fisher & Perkins, 1998; Ware et al., 1994). Inter-rater reliability has not been measured because it is a self-administered tool. The SF-36 also is a very valid instrument. Studies showed that it possesses adequate discriminatory power (Kagee, 2001; Komaroff et al., 1996), good correlation with other measures (0.19-0.69 across domains) (Beaton, Hogg-Johnson & Bombardiner, 1997; Calsyn et al., 2004; Essink-Bot, Krabbe, Bonel, & Aaronson, 1997; Prieto, Alonson, Ferrer, & Anto, 1997), good construct validity (>0.70) (Jenkinson, 1999; Ware et al., 1995, 1998), and good criterion validity (>0.70) (Elliott, Renier, & Palcher, 2003; Kagee, 2001; Jenkinson, Wright & Coulter, 1994). The SF-36 also is sensitive to change, (Jenkinson, Lawerence, McWhinnie, & Gordon, 1995; Jenkinson et al., 1997; Sharples, Todd, Caine, & Tait, 2000), is translated into many languages and its content can be administered cross-culturally (Perneger, Lepledge & Etter, 1999; Wagner et al., 1998). The SF-36 has been used in previous studies designed to examine determinants of HRQoL in individuals with ALS (Neudert, Wasner, & Borasio, 2004; Olsson Orzanne et al., 2011; Swash, 1998). However, with only a few questions in the SF-36 that address

communication and social interaction, the American Speech and Hearing Association's Quality of Communication Life Scale (ASHA QCL) was completed by participants in this study to provide greater detail about the factors of communication and language impairments that load onto overall QoL in individuals with ALS. The ASHA QCL possesses adequate reliability and validity across a population of 85 individuals with the following conditions: aphasia due to left or right-hemispheric stroke, cognitive communication disorder due to traumatic brain injury, and dysarthria due to an acquired progressive neurological disease such as Parkinson's disease, Multiple Sclerosis, and ALS (Paul et al., 2004). Although the ASHA QCL has not been widely cited in the literature, it was chosen for this study because of its communication context. The purpose of using the ASHA QCL was to access participant's self-rated quality of communication.

Lastly, ALS disease severity was measured using the ALS-Functional Rating Scale- Revised (ALSFRS-R) (Cedarbaum et al., 1999). The ALSFRS-R is a validated rating instrument for monitoring the progression of disability in patients with ALS. The original ALSFRS had a disproportionate weighting toward limb and to bulbar onset vs. respiratory dysfunction. It is now validated as a revised version of the ALSFRS-R, which incorporates additional assessments of dyspnea, orthopnea, and the need for ventilator support. The Revised ALSFRS (ALSFRS-R) retains similar psychometric properties of the original scale and shows strong internal consistency and construct validity. ALSFRS-R scores correlate significantly with quality of life as measured by the Sickness Impact Profile, indicating that the quality of function is a strong determinant of quality of life in ALS (Cedarbaum et al., 1999). The purpose of using the ALSFRS-R

was to assess participant's disease severity, which can widely vary from individual to individual within the ALS population. Disease severity could affect scores on other measures of HRQoL such as the SF-36.

Speech intelligibility is defined as, "the match between the intention of the speaker and the response of the listener to the speech passaged through the transmission system" (Kent, 1992, pp. 13). Speech intelligibility was rated by a group of 15 adult, naïve independent listeners for all participants with ALS. There are several ways to quantify speech intelligibility using naïve listeners. The first procedure involves using a word identification task in which the listener writes down every word that the speaker says. The second procedure involves the use of a scaling protocol in which the listener makes judgments about the talker's intelligibility using a technique such as an equal appearing interval scale or direct magnitude estimation (Kent, 1992). Scaling procedures are an appropriate alternative to a more time-consuming, expensive, or cumbersome procedures, such as direct magnitude estimation and direct transcription. (Metz, Schiavetti, & Sitler, 1980). A visual analogue scale (VAS) was used to measure speech intelligibility. The VAS scale consisted of a 10 cm line with anchors of "Completely Intelligible" and "Completely Unintelligible" (See Appendix B). The n=15 naïve raters of participants' speech samples were blinded to the objectives of the study and to the nature of the participants' diagnosis. They were, however, given the picture of the Cookie Theft description task before listening to the speech samples. All naïve listeners were between the ages of 18 and 57 years, with no self-reported hearing problems. Five listeners were graduate students in the School of Occupational Therapy at Western University. Ten listeners were friends and relatives of KF. All of the

listerners were naïve to the nature and purpose of the study. They listened to the speech samples in a quiet environment with a sound pressure level of 70 decibels HL to ensure the samples were presented at a reasonable loudness level. The samples were audio samples only and did not portray any visual description of the participants. The samples were given in three randomized orders. Six participant samples were duplicated to access intra-rater reliability in judging speech intelligibility. This protocol was used successfully by Cooper et al., (2008) in her study of verbal naming among individuals with ALS. The inter-rater reliability score was strong for speech intelligibility across listeners (r = .850) using an interclass correlation coefficient. The intra-rater reliability score also was strong (average r = .988) across all 15 raters using an interclass correlation coefficient. The purpose of accessing speech intelligibility in this study was to measure severity of dysarthria and to ensure any deficits found on category fluency tasks are attributable to language or cognitive-communication declines rather than to motor speech difficulties as a result of a possible mixed flaccid-spastic dysarthria.

Data Analyses

Measures of central tendency were calculated including the mean, standard deviation, and range for all measures of language, speech intelligibility, cognition, depression, and quality of life. These values were calculated in order to compare scores to normative data and to describe overall trends in the data.

Research question 1 addressed the association between language (BNT, verbal fluency (animals), total words, total utterances, MLU, CIU, CU, and Words/CU) and quality of communication (ASHA QCL), and the association between language (BNT,

verbal fluency (animals), total words, total utterances, MLU, CIU, CU, and Words/CU) and HRQoL (SF-36). Pearson's correlations were calculated between each measure of language and the ASHA QCL and SF-36. In statistics, the Pearson product-moment correlation coefficient is a measure of the linear correlation (dependence) between two variables, giving a value between +1 and −1 inclusive. It is widely used in the social, cognitive, linguistic and neurosciences as a measure of the strength of linear dependence between two variables. Given the normal distribution of the data in this study, Pearson's correlations were chosen as the appropriate measure to analyze the relationship between the variables in the study. The alpha level was set at $p < 0.05$ for all analyses. However, a multiple comparisons correction was then applied to the significance level using a Bonferroni correction. The Bonferroni correction was applied to each research question individually, as part of a "family wise correction error" in which each research questions was considered a "family comparison." The adjusted significance level for research question one was $p < 0.003$, to account for the sixteen correlations calculated in research question 1. If the p values were less than 0.05 but did not meet the level of significance after the Bonferroni correction, they were considered to be approaching significance.

Research question 2 addressed the association between speech intelligibility and quality of communication, and the association between speech intelligibility and HRQoL. A Pearson's correlation was calculated between speech intelligibility and the ASHA QCL, and between speech intelligibility and the SF-36. As described above, the alpha level was set at $p < 0.05$ and a multiple comparisons correction was then applied to the significance level using a Bonferroni correction. The Bonferroni correction was applied

to the significance level for research question two separately, as part of a "family wise correction error" in which each research question was considered a "family comparison." The adjusted significance level for research question 2 was $p < 0.025$.

Research question 3 addressed the association between speech intelligibility and each of the language measures (BNT, verbal fluency for animals, total words, total utterances, MLU, CIUs, CUs, and Words/CU). Pearson's correlations were calculated between speech intelligibility and each of the language measures scores. As noted above, the alpha level was set at $p < 0.05$ and a multiple comparisons correction was applied to the significance level using a Bonferroni correction. The Bonferroni correction was applied to each research question individually, as part of a "family wise correction error", in which each research question was considered a "family comparison." The adjusted significance level for research question three was $p < 0.006$, to account for the eight correlations made in research question 3.

Research question 4 addressed the relative contributions of the BNT, MoCA, GDS, speech intelligibility, and the ALSFRS-R to quality of communication (ASHA QCL) and to HRQoL (SF-36). A hierarchical direct-entry regression analyses was performed. In hierarchical multiple regression, the predictor variables are entered in stages. In the first stage, the predictor variables that we want to control for are entered into the regression. In the second stage, the predictor variables whose relationship we want to examine after the control variables are entered. A statistical test of the change in R^2 from the first stage is used to evaluate the importance of the variables entered in the second stage. The alpha level was set at $p < 0.05$. The first stage of the model involved the BNT and the MoCA. The second stage added the GDS. The third stage of

the model added speech intelligibility. In the last and fourth stage of the model, the ALSFRS-R was added. After each model was computed, significance levels were reported to show to relative contributions and predictive power that each variable had when determining the criterion variable (ASHA QCL or SF-36). Once all the variables were entered into each of the regression models, a regression equation for each criterion variable (ASHA QCL and SF-36) was calculated. Zero-order, partial, and part correlations among all of the measures were reported. Zero-order correlations are the direct correlations (Pearson's correlations). A partial correlation coefficient is another way of expressing the unique relationship between the criterion variable (ASHA QCL or SF-36) and a predictor variable (BNT, MoCA, GDS, speech intelligibility, and ALSFRS-R). Partial correlations represent the correlation between the criterion variable and a predictor variable after common variance with other predictors has been removed from both the criterion variable and the predictor variable of interest. That is, after removing variance that the criterion variable and the predictor variable have in common with other predictors, the partial expresses the correlation between the residualized predictor and the residualized criterion variables. A part correlation coefficient represents the correlation between the criterion variable (ASHA QCL or SF-36) and a predictor variable (BNT, MoCA, GDS, speech intelligibility, and ALSFRS-R) that has been residualized with respect to all other predictor variables in the equation. After removing variance that the predictor variable (BNT, MoCA, GDS, speech intelligibility, and ALSFRS-R) has in common with other predictor variables (ASHA QCL or SF-36), the partial expresses the correlation between the residualized predictor variable and the unaltered criterion variable. The square of the partial can be interpreted as the proportion of the criterion

variable (ASHA QCL or SF-36) variance associated uniquely with the predictor variable (BNT, MoCA, GDS, speech intelligibility, and ALSFRS-R).

The purpose of these regression analyses was to analyze which predictor variables added significant predictive power to the regression equation when predicting each criterion variable (ASHA QCL or SF-36). This means that the regression analysis was used to determine which scores on measures of language, cognition, depression, speech intelligibility, or disease severity are able to predict scores of quality of communication and HRQoL.

Results

The overall generalized results from the language measures, ASHA QCL measure and SF-36 measure are reported at the beginning of this section. Each research question is then addressed individually thereafter.

The mean, standard deviation and range for each language measure and quality of communication life are presented in Table 2. The mean, standard deviation and range of the SF-36 measure and each of its eight domains are presented in Table 3.

Table 2

Language Measures and ASHA Quality of Communication Score (N=28)

Language and HRQoL Scores	Mean	SD	Range
BNT (max 30)	25.25	3.63	15-30
Verbal Fluency	95	19.88	65-142
Animals	18.50	3.76	12-25
Birds	12.85	3.00	9-20
Water creatures	12.71	4.47	5-24
Dogs	11.03	3.33	5-17
Transportation	14.07	3.99	9-24
Musical instruments	13.39	3.92	8-23
Tools	12.42	4.34	5-21
Cookie Theft description			
Total words	84.57	44.37	17-186
Total utterances	11.39	4.96	5-28
MLU	7.35	2.32	3.4-13.22
Correct Information Units	56.18	28.07	23-123
Content Units	10.17	3.23	2-17
Words/Content Unit	8.83	4.62	3.5-15.54
ASHA QCL (max 85)	63.46	9.69	39-80

Note. HRQoL = Health related quality of life, BNT = Boston Naming Test, MLU = Mean Length of Utterance, ASHA QCL = American Speech and Hearing Association's Quality of Communication Life Scale

Participants' mean scores on the 30-item Boston Naming test were below normal values. Normative data for the mean scores on the short form BNT for Caucasians aged 55 to 64 is 29.2 +/- 1.1 SD (Jefferson et al., 2007). Nine participants' scores on the BNT were between -1.5 to -2.5 SD below normals, and 14 participants were greater than -2.5 SD below normals. Participants' average verbal fluency scores for the category of animals also were below normal values. Normative data for Canadians for the mean number of animals in the verbal fluency task for individuals 16 to 59 years of age with an education level of 13 to 21 years is 21.9 +/- 5.4 SD (Tombaugh, Kozak, & Rees, 1999). Three individuals fell greater than -1.5 SD below the normal mean score of individuals similar to the average education of our participants. Rakowicz and

Hodges (1998) reported mean scores for verbal fluency for all seven categories for ten participants with motor neuron disease but no aphasia or dementia (100.1 +/- 25.25 SD). Participants in our study performed somewhat more poorly on all categories of verbal fluency (95 +/- 19.88 SD) when compared to scores reported by Rakowicz and Hodges (1998).

Table 3

Healthy Related Quality of Life Scores on the SF-36 for ALS Participants (N=28)

HRQoL Scores	Mean	SD	Range
SF-36 Total Average Score	43.06	15.37	15-60.69
Physical functioning	16.25	39.59	0-85
Role limitations due to physical health problems	32.14	39.59	0-100
Role limitations due to emotional problems	67.86	35.70	0-100
Energy/fatigue	43.03	22.70	0-75
Emotional well-being	78.14	14.58	28-92
Social functioning	62.41	30.21	0-100
Pain	63.84	29.61	0-100
General health	42.5	19.41	5-80

Note. HRQoL = Health related quality of life

Scores on the SF-36 are calibrated such that a score of 50 becomes the average score and the norm. The overall mean score on the SF-36 for the n=28 participants in the study was below normal (see Table 3). The most notably low average score was in the subdomain of physical functioning where as the highest average score was in the domain of emotional well-being, which was well above 50. Mean subdomain scores that fell below 50 include the domains of physical functioning, role limitations due to physical functioning, energy/fatigue, and general health. Mean subdomain scores that were above 50 include the domains of role limitations due to emotional problems,

emotional well-being, social functioning, and pain. There was a high level of dispersion among the scores on the SF-36 and each of its subdomains. Scores on four subdomains ranged from the lowest possible value of zero to the highest possible score of 100.

Research Question 1

Research question 1 addressed the association between the language measures and the quality of life measures. The association was examined to determine if an impairment of language performance in ALS affects the quality of communication or HRQoL among individuals with ALS. Pearson's correlation coefficients were computed between each language measure (i.e., BNT, verbal fluency for animals, total words, total utterances, MLU, CIU, CU, and Words/CU) and the ASHA QCL and SF-36 scores. The correlation coefficients and their p values are show in Table 4. A moderate positive correlation was found between the ASHA QCL and language measures of verbal fluency (animals), total utterances, and words per content unit ($p < 0.10$), which approached the set significance level of $p < 0.05$. There were no significant correlations between any of the language measures and the SF-36. A Bonferroni correction was applied to the significance level for each correlation that addressed research question 1 to account for the multiple comparisons. None of the language measures were significantly correlated after the correction was applied (i.e., $p < 0.003$).

Table 4

Pearson's Correlations Between Language and Quality of Life Measures (N=28)

Language Measure	ASHA QCL	p value	SF-36	p value
BNT	-.198	.311	.119	.545
Verbal Fluency	.480*	.010	.063	.749
Total Words	.230	.240	-.171	.385
Total Utterances	.354*	.064	-.062	.754
MLU	-.030	.880	-.246	.207
CIU	.122	.535	-.185	.347
CU	.007	.971	-.186	.344
Words/CU	.346*	.071	.152	.440

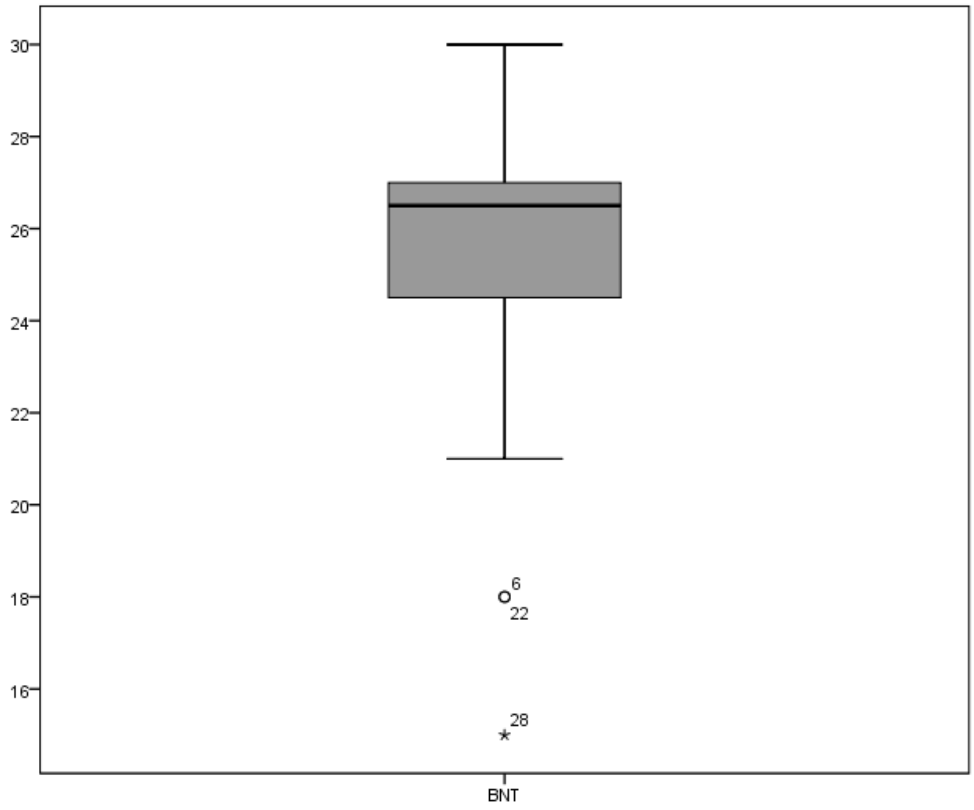
Note. *Correlation is significant at the 0.10 level (2-tailed).
**Correlation is significant at the 0.05 level (2-tailed).
***Correlation is significant after Bonferroni correction.
BNT = Boston Naming Test, MLU = Mean Length of Utterance,
CIUs = Correct Information Units, CUs = Content Units

Box plots were displayed using IBM Statistics SPSS Version 19 to determine if there were any outliers in the language and HRQoL data. The box plots show the first quartile (bottom of box) and third quartile (top of box) (i.e., the 25th and 75th percentiles). The plots also display the median (the horizontal line in the box), the range (excluding outliers and extreme scores), the "whiskers" or lines that extend from the box show the range, and the outliers (a circle represents each outlier and the number next to the outlier is the participant number). An outlier is defined as a score that is between 1.5 and 3 box lengths away from the upper or lower edge of the box (the box represents the middle 50 percent of the scores). An extreme score (represented by an asterisk) is defined as a score that is greater than 3 box lengths away from the upper or lower edge of the box. Figure 1 shows that participants 6 and 22 were outliers and participant 28 was an extreme value on the BNT data. When these three participants' BNT scores were excluded from analyses, the correlations between the BNT and the ASHA QCL (r

= -.243; p= .242) and between the BNT and the SF-36 remained not statistically significant (r = .190; p = .363).

Figure 1

Box Plots of the BNT Showing Outliers

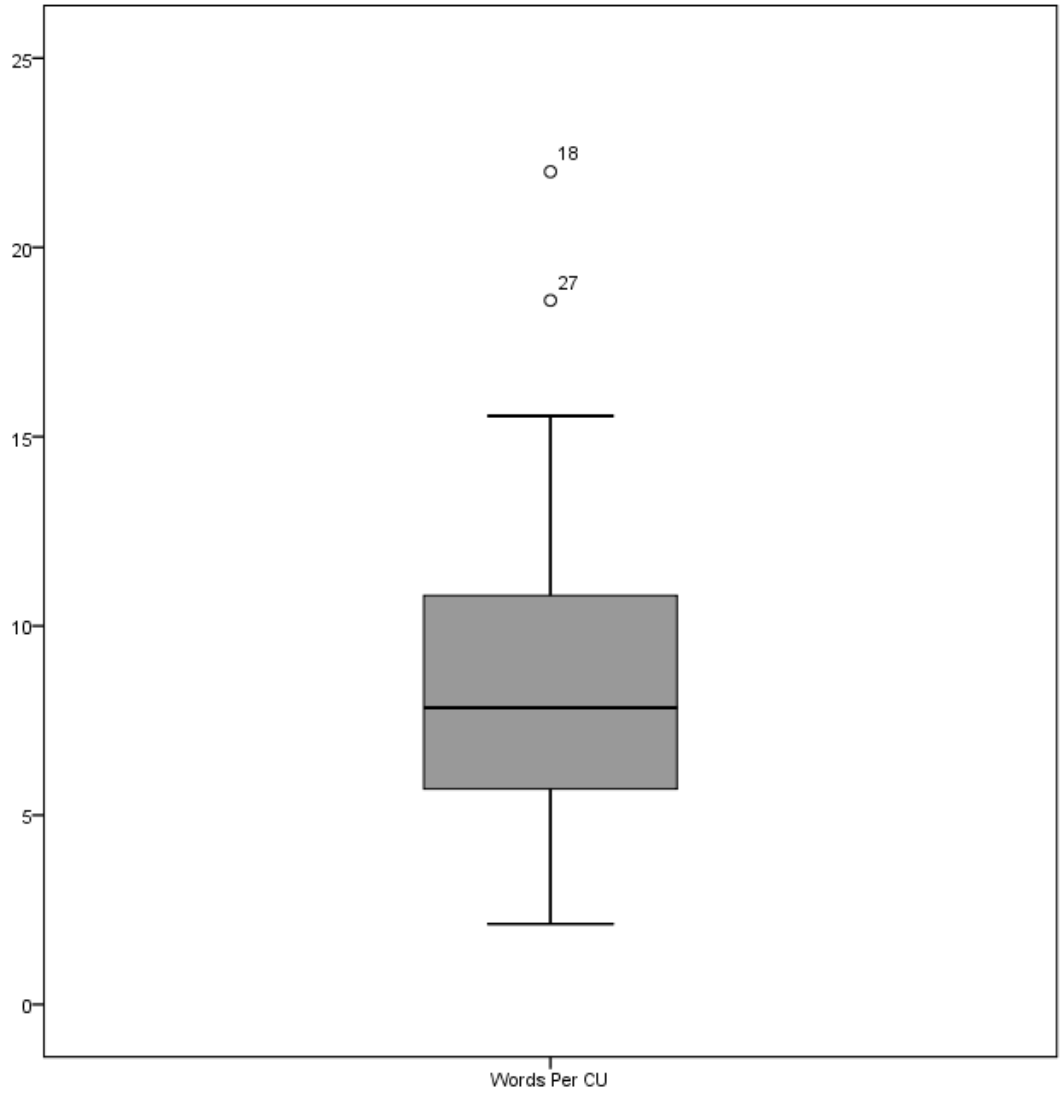


Participants 18 and 27 were the two outliers for Words/CU as shown in Figure 2. When these cases were excluded from analyses, the correlation between Words/CU and the ASHA QCL was r = 0.271 (p= .181). The correlation between Words/CU and the SF-36 with the outliers excluded was r = -0.107 (p= 0.601), remaining not

statistically significant. All of the variables for the language data were plotted using box plots and no other measures had any outliers or extreme scores.

Figure 2

Box Plot for Words per Content Unit Showing Outliers



Research Question 2

Research question 2 addressed the correlation between speech intelligibility and the quality of life measures. The correlation was calculated to determine if speech intelligibility is associated with quality of communication and HRQoL. Table 5 shows the Pearson's correlation coefficients and their associated p values. Mean speech intelligibility scores ranged from 5.25 to 95.33. There were no outliers when speech intelligibility scores were plotted using box plots.

There was a moderately positive significant correlation between speech intelligibility and the ASHA QCL (see Table 5 below). That is, as speech intelligibility declined scores on the ASHA QCL declined. There was no significant correlation between speech intelligibility and the SF-36. When the p value for research question 2 was adjusted using a Bonferroni correction, the correlation between speech intelligibility and the ASHA QCL was still significant at the corrected p value (i.e., $p < 0.025$).

Table 5

Pearson's Correlations Between Speech Intelligibility Measures and Quality of Life Measures (N=28)

Quality of Communication	Speech Intelligibility	p value	SF-36	p value
ASHA QCL	.522***	.004	-.138	.483

Note. *Correlation is significant at the 0.10 level (2-tailed).
**Correlation is significant at the 0.05 level (2-tailed).
***Correlation is significant after Bonferroni correction.
ASHA QCL = American Speech and Hearing Association's Quality of Communication Life Scale

Research Question 3

Research question 3 addressed the association between language performance and speech intelligibility. Table 6 shows the Pearson's correlation coefficient between each language measure and the speech intelligibility score, and their associated p values. There were positive significant correlations between verbal fluency (animals), total words, and total utterances with speech intelligibility. Only the category of animals was used for the verbal fluency measure to minimize multiple comparisons. Also, there are only normative data available for the verbal fluency category of animals. There was a strong positive significant correlation between speech intelligibility and words per CU. That is, as speech intelligibility improved there was an increase in the number of words per content unit. A Bonferroni correction was applied to the significance level to account for multiple comparisons. When the Bonferroni correction was applied, none of the correlations reached significance (i.e., $p < 0.006$). However, the correlation between speech intelligibility and words/CU approached significance.

Table 6

Pearson's Correlations Between Language and Speech Intelligibility Measures (N=28)

Language Measure	Speech Intelligibility	p value
BNT	-.138	.485
Verbal Fluency	.354*	.065
Total Words	.355*	.064
Total Utterances	.353*	.065
MLU	.102	.605
CIU	.244	.212
CU	-.159	.420
Words/CU	.486**	.009

Note. *Correlation is significant at the 0.10 level (2-tailed).
**Correlation is significant at the 0.05 level (2-tailed).
***Correlation is significant after Bonferroni correction.
BNT = Boston Naming Test, MLU = Mean Length of Utterance,
CIU = Correct Information Units, CU = Content Units

Research Question 4

Regression Analyses

Hierarchical direct-entry regression analyses were run by calculating a series of prediction equations to evaluate the relative contributions of cognitive or language impairments, depression, speech intelligibility, and physical function scores to ASHA QCL scores as a dependent variable. The first stage of the model involved the BNT and the MoCA, yielding a non-significant prediction equation, $F(2,24)= .3659$, $p = .527$. The second stage of the model added depression (score on the GDS). Adding the depression score yielded a statistically significant effect for the predictive power of the combination of variables ($F(1, 23)= 7.720$, $p = 0.011$). Speech intelligibility scores then were added to the analyses yielding a statistically significant effect ($F(1,22)= 8.168$, $p = .009$). Finally, physical function (i.e., ALSFRS-R) was added to the analyses. The ALS-FRS values did not increase in the predictive power ($F(1, 21) = .716$, $p = .407$) beyond

that which was found when speech intelligibility was added to the equation The final analysis was statistically significant, $F(5, 21) = 4.191$, $p = .008$. Overall, the equation can be written as:

$\hat{y}$= -.130 (MoCA) + .050 (BNT) -1.007(GDS) + .172 (Speech Intelligibility) - .147 (ALSFRS)+ 74.883. The zero order, partial, and part correlations between each consecutive variable and the ASHA QCL are reported in Table 7.

Table 7

Zero-Order, Partial, and Part Correlations for MoCA, BNT, GDS, Speech Intelligibility, ALSFRS-R and the ASHA QCL

Variable	Zero-order	Partial	Part
MoCA	-.201	-.180	-.129
BNT	-.183	.024	.017
GDS	-.494	-.567	-.486
Speech Intelligibility	.490	.537	.451
ALS-FRS	.191	-.182	-.131

Note. MoCA = Montreal Cognitive Assessment, BNT = Boston Naming Test, GDS = Geriatric Depression Scale, ALSFRS-R = ALS- Functional Rating Scale Revised

The relative contributions of cognitive or language impairments, depression, speech intelligibility, and physical function to HRQoL were evaluated using a hierarchical direct-entry regression analysis. In this evaluation, a series of prediction equations were calculated with SF-36 as a dependent variable. The first stage of the model included the BNT and the MOCA and resulted in a non-significant prediction equation, $F(2,24)= .358$, $p = .703$. The second stage of the model added depression (scores on the GDS) which produced a statistically significant increase in the predictive power of the equation, $F(1, 23)= 21.001$, $p < .001$. Speech intelligibility then was added

to the prediction equation, yielding no statistically significant change, $F(1,22)= .698$, $p = .412$. Finally, physical function (ALSFRS-R) was added, which did not produce an incremental prediction beyond what was found when depression was added to the equation, $F(1, 21) = .236$, $p = .632$. This final equation was statistically significant, $F(5, 21) = 4.433$, $p = .007$, and can be written as: $\hat{y}= .036$ (MoCA) + .908 (BNT) -2.234 (GDS) -.090 (Speech Intelligibility) + .135 (ALSFRS-R) + 34.327. The zero order, partial, and part correlations between each consecutive variable and the SF-36 are reported in Table 8.

Table 8

Zero-order, Partial, and Part Correlations for MoCA, BNT, GDS, Speech Intelligibility, ALSFRS-R and the SF-36

Variable	Zero-order	Partial	Part
MoCA	.162	.032	.022
BNT	.116	.279	.203
GDS	-.655	-.690	-.665
Speech Intelligibility	-.132	-.203	-.145
ALSFRS-R	.082	.105	.074

Note. MoCA = Montreal Cognitive Assessment, BNT = Boston Naming Test, GDS = Geriatric Depression Scale, ALSFRS-R = ALS-Functional Rating Scale Revised

Table 9 contains a summary of the significant research findings for the study.

Table 9.

Summary of Significant Findings

Research Question	Significant Relationship
RQ1a. Language measures and ASHA QCL	Verbal Fluency* (r = .480) Total Utterances* (r = .354) Words/CU* (r = .346)
RQ1b. Language measures and SF-36	NS
RQ2a. Speech Intelligibility and ASHA QCL	r = .522***
RQ2b. Speech Intelligibility and SF-36	NS
RQ3. Language measures and Speech Intelligibility	Verbal Fluency* (r = .354) Total Words* (r = .355) Total Utterances* (r = .353) Words/CU** (r = .486)
RQ4a. Predictors of ASHA QCL	GDS**, Speech Intelligibility**
RQ4b. Predictors of SF-36	GDS**

Note. *. Correlation is significant at the 0.10 level (2-tailed).
**. Correlation is significant at the 0.05 level (2-tailed).
***. Correlation is significant after Bonferroni correction.
NS= not significant
CU = Content Units

Discussion

In this section, the meaning and importance of the overall findings are discussed first. These interpretations then are followed by a discussion of the significance and importance of the results for each research question. The section concludes with a discussion of the strengths and limitations of the study and possible future directions.

Consistent with previous published literature (Abrahams et al., 2004; Abrahams, Leigh, & Goldstein, 2005; Mantovan et al., 2003; Racowicz & Hodges, 1998; South et al., 2011; Strong et al., 1999). the participants with ALS in this study exhibited word retrieval problems on the confrontation-naming task (BNT) as well as on the category fluency tasks (verbal fluency) Overall mean scores on the BNT were significantly below

normative data. Although there are no normative data for six of the seven categories of verbal fluency used in this study, normative data for the category of animals suggests that a very small portion of the participants were slightly below normative values. In comparison to total scores on the same seven of the categories of verbal fluency studied by Rakowicz and Hodges (1998), the participants with ALS in this study were below average on total number of exemplars compared to the ALS sample of their study. These results are consistent with previous literature that shows that individuals with ALS without CI or FTD have language impairments such as word retrieval problems (Abrahams et al., 2004, 2005; Mantovan et al., 2003; Racowicz & Hodges, 1998; South, et al., 2011; Strong et al., 1999), difficulties in both category and letter verbal fluency tasks (Abrahams et al., 2000; Hanagasi et al., 2002; Strong et al., 1999), and problems in confrontation naming (Abrahams et al., 2004; Hanagasi et al., 2004; Mantovan et al., 2003; Ringholz et al., 2005; Strong et al., 1999). These findings mean this study adequately determined whether these language impairments, in the absence of CI or FTD, had the potential to affect participants' quality of communication and HRQoL.

A cutoff score of 26 out of 30 on the MoCA indicates cognitive impairment (Nasreddine et al., 2005). Ten participants with ALS in this study were unable to write and therefore could not complete the cube drawing and clock drawing portions of the MoCA. MoCA scores for these ten participants were converted to percentages. A value below 86.67% was considered a mild cognitive impairment. Twelve of the 28 participants exhibited a mild cognitive impairment using this threshold. Such a finding is similar to previous ALS population-based studies that showed 47% of individuals with

ALS had no cognitive impairment whereas the remaining 53% showed some sort of cognitive impairment, including executive dysfunction (21%), non-executive dysfunction such as language or memory impairments (14%), comorbid FTD (14%), comorbid AD (2%), and others with limited categorization (2%) (Phukan et al., 2012). A cognitive impairment (CI) in the absence of FTD also is common in individuals with ALS. Although participants with ALS and CI were not excluded from this study, a mild cognitive impairment (MCI) can contribute to poorer performances on tests of language. For example, studies show that persons with MCI exhibit language deficits including verbal fluency, especially category fluency, confrontation naming, as well as language comprehension (Ritchie, Artero, & Touchon, 2001), accuracy in syntactic reasoning (Collie, Maruff, & Currie, 2002), and naming a rhyming word (Dwolatzky et al., 2003). Alterations in performance on a variety of other semantic tests also have been reported. For example, problems with lexical decision making, (Taler & Jarema, 2006), semantic categorization (Olichney et al., 2002), semantic encoding (Puregger, Wala, Deecke, & Dal-Bianco, 2003), and semantic priming (Davie et al., 2004) have been reported in MCI. A MCI also could affect participants' abilities to answer the quality of communication and HRQoL measures. For example, those with MCI exhibit problems with episodic memory (Backman, Small, & Fratiglioni, 2001), executive function (Albert, Moss, Tanzi, & Jones, 2001), perceptual speed (Albert et al., 2001), verbal ability (Convit et al., 2000), visuospatial skills (Albert et al., 2001), and attention (Nielson, Lolk, Anderson, Anderson, & Kragh-Sorenson, 1999). All of these potential impairments could affect the abilities of participants in this study to understand the task, to read the task correctly and to make inferences about themselves while completing the self-rated

scales used to assess quality of communication and HRQoL. Impairments to cognitive-communication also could affect quality of communication and HRQoL scores. For example, it may not strictly be a language impairment that affects participant's everyday communication but an overall cognitive impairment that affects their ability to have meaningful communication. Taylor et al. (2012) found that executive dysfunction and language dysfunction commonly occur together in ALS. However, separate impairments in either executive dysfunction or in language can exist in ALS. This means that executive dysfunction in the absence of a language impairment could also affect communication. Cognitive issues in ALS, are part of an under recognized feature of ALS, and should assessed by clinicians, because they are prominent (e.g., 35%-50%) in the ALS population at large.

Previous literature suggests that approximately 10% of individuals with ALS are clinically depressed (Kurt et al., 2007, McElhiney et al., 2012, Tremblay, Monchi, Hudon, Macoir, & Monetta, 2012) Findings of depression among the participants with ALS in this study showed a slightly higher rate of depression using the GDS. Seven participants with ALS were categorized as moderately depressed (score of 10 to 19). One participant showed a severe depression (score of 22/30). A second participant was unable to complete the GDS because of a severe evoked emotional response relative to the nature of the questions in the GDS. McElhiney et al. (2012) reported that depression in ALS was not associated with disease severity, and prevalence rates of depression do not increase as disease duration increases. It is likely then that those individuals who exhibited mild depression would continue to have these depressive symptoms had they been followed over time. Because depression has been shown to

affect cognition (Lichetenburg et al., 1995), the high occurrence of mild to severe depression in this study could be associated with the high occurrence of mild cognitive impairment (as reported by the GDS and MoCA scores, respectively). It is important for individuals with ALS and for their attending physicians, to be aware of, to report and to treat depressive symptoms, because depression can greatly affect cognition, communication, and HRQoL.

The SF-36 is a norm-based measure of health related quality of life. It has a normal score of 50. Twenty of the 28 participants with ALS in this study fell below that threshold value, indicating an overall poorer HRQoL than the normal population. Most notably, low scores occurred in the domains of physical functioning, role limitations due to physical functioning, energy/fatigue, and general health. This is not unexpected due to the clinically significant physical problems associated ALS. Similar to findings from previous studies (i.e., scores on the ALSFRS-R, Tramonti et al., 2012), the scores of the study participants in the domain of physical functioning on the SF-36 were low. The highest average score was in the emotional wellbeing domain of the SF-36, meaning that although many individuals rate their physical functioning as low, they still rate their emotional wellbeing generally much higher. Mean scores in the subdomains of role limitations due to emotional wellbeing, social participation, and pain were all above normal. The importance and significance of these results is that they replicate findings in the published literature that shows physical functioning is not the main determinant of overall HRQoL in ALS (Chio et al., 2004; Lulé et al.,, 2008; Nygren & Askmark, 2006; Robbins et al., 2001). More importantly, the findings of this study show that other factors affect HRQoL, such communication impairments and social relationships. The

significance of the finding that communication relates to HRQoL in ALS is that communication should be optimized in order to optimize HRQoL in ALS.

The ASHA QCL scores were quite variable among the study participants with ALS. Several study participants exhibited a high self-rated quality of communication whereas others rated their quality of communication quite low. Although no normative data are available on the ASHA QCL to compare participants' scores to that of a larger normal population, overall scores on the ASHA QCL are quite low, indicating a poor quality of communication in participants with ALS. This finding is important in that is shows that both speech and language impairments are contributing to the overall low quality of communication scores, given the wide range of speech intelligibility and language scores across participants. Participants did complete question 18 of the ASHA QCL, which asked them to rate their overall QoL on a 5-point likert scale. However, there was no relationship between question 18 on the ASHA QCL and the ALSFRS-R. This means that when participants with ALS gave a global rating of their overall QoL, it was not associated with their level of physical functioning. This finding is significant because it indicates that other factors, such as communication and social relationships, are contributing to overall QoL.

Although the ALSFRS-R is a psychometrically sound tool to determine physical functional capacity and survival times in ALS, there are no published scores that are considered normal in the widely variable and individualized progression of ALS (Castrillo-Viguera, Grasso, Simpson, Shefner, & Cudkowicz, 2010). It is important to distinguish that length of disease duration in ALS does not indicate disease severity. Although the length of disease duration for each participant in this study was not

reported, the severity of disease, as determined by the ALSFRS-R, was reported. Many of the participants in the current study were highly functional with high scores (as established by scores of 40 or more) on the ALSFRS-R (score of 45/48), whereas others were extremely low (score of 13/48).

Overall, the preliminary results are in keeping with previous published studies in ALS as reported above. The study sample was representative of the ALS population at large in terms of prevalence of language impairments, depression, and MCI. The physical limitations represented in the sample also are similar to the general ALS population, which varies greatly in the site of onset, symptoms of disease, severity of disease, and disease duration. The study sample is a meaningful group to address the proposed research questions.

Research Question 1

Research question 1 addressed the associations between language and quality of communication, and between language and HRQoL. The question was posed to determine if an impairment of language performance in participants with ALS affects their quality of communication or their HRQoL.

Scores on the BNT did not correlate significantly with scores on the ASHA QCL. However, other measures used in this study to access language performance correlated moderately well with the ASHA QCL and, in some instances, approached significance. Verbal fluency for the category of animals, as well as total utterances and words per content unit on the Cookie Theft description task (BDAE), showed a moderate correlation that approached significance. This means that, although many individuals

with ALS have difficulty on confrontation naming tasks (Abrahams et al., 2004; Hanagasi et al., 2004; Mantovan et al., 2003; Ringholz et al., 2005; Strong et al., 1999), as was the case among the participants in this study, these difficulties may not be associated with participants' self-rated quality of communication. This also could be explained by the questions addressed in the ASHA QCL, which do not include questions about language or cognitive performance but which focus more on communication participation, social engagement, and speech intelligibility. Moreover, individuals with ALS may not be aware that language and cognitive problems occur in ALS. Language deficits in ALS have been under recognized for many reasons. Prominent dysarthria provides a plausible explanation for abnormalities in language production. Simple picture naming tasks, such as that of the BNT, are not representative of deficits beyond the single word level. Many of the tasks used to assess language and cognition in this study were developed to be used on persons with intact motor functions, meaning that physical functioning also could have affected participants' performance on many of the tasks, although this is only a remote possibility given the nature of the assessment tasks.

The word generation task (i.e., verbal fluency task for animals) was mildly correlated to the ASHA QCL, meaning that the more words the participant was able to generate, the better the participant rated their quality of communication. It is well documented that individuals with ALS also are impaired in letter fluency tasks (Abrahams et al., 2004), which should be addressed in future studies of executive functioning and HRQoL. Interestingly, there was a positive correlation between words per content unit and the ASHA QCL. Words per content unit is considered a measure

of content efficiency in discourse tasks. The more words per content unit, the less efficient participants were in describing the picture. This means that they used more words to convey the content of the picture. Total utterances, which also was correlated positively with the ASHA QCL, is a measure of productivity in discourse. These results suggest that individuals who are using more words and more utterances per content unit are rating themselves higher on the ASHA QCL. Overall, measures of content efficiency and content productivity in discourse samples are associated with quality of communication whereas measures of content were not associated with quality of communication. This could be due to their severity of dysarthria, which limits their speech output. This theme is addressed in the discussion of findings for research questions 2 and 3. The results for research question1 suggest that reduced content efficiency during discourse could affect overall quality of communication. Although many individuals preformed poorly on confrontation and generative naming tasks, it was mainly the efficiency in discourse measures that were correlated to quality of communication. The significance of these findings is that discourse performance is more important to the quality of communication for individuals with ALS than is their ability to recall the names of nouns in a confrontation task or on category retrieval task (i.e., verbal fluency). Discourse can be conceptualized as "representing that level of communicative function wherein the interaction between linguistic and cognitive abilities is most clearly manifested, and where complexity of language is quite high" (Ulatowska, Cannito, Hayashi, & Fleming, 1985, p. 128). The challenge of complexity of discourse tasks in individuals with ALS could be the reason for why the association with quality of communication is so high. More complex tasks, such as the discourse task used in this

study may be more representative of communicative dysfunction in ALS versus that of simple word recognition and word generation. It appears that deficits at the single word level may not translate into important communication difficulties in individuals with ALS. Further research into discourse performance in ALS and its association with quality of communication should be examined, because our study showed that efficiency and productivity measures of discourse are correlated with quality of communication. The strategies individuals with ALS are using during discourse, as well as the relationship between discourse output and speech intelligibility, need to be examined further. The prominent dysarthria in some individuals with ALS offers a plausible explanation for poor discourse performance. Future research into the relationships between speech intelligibility and discourse performance are warranted.

There was no association between language performance and overall HRQoL (SF-36). It is not surprising that there was no statistically significant association given that the SF-36 is heavily weighted in the physical domain and does not address questions about communication. Because language performance was correlated with quality of communication life scores, language could indirectly affect HRQoL but not through measures that are primarily focused on physical issues. Also, because a HRQoL measure was used versus using a general QoL measure, future studies that include QoL measures could reveal an association with language performance among individuals with ALS.

Research Question 2

Research question 2 examined whether there is an association between speech intelligibility and quality of communication (ASHA QCL), and between speech

intelligibility and HRQoL (SF-36) in individuals with ALS. Findings showed that there is a moderate statistically significant positive correlation between speech intelligibility and the ASHA QCL. This finding is not entirely surprising given that there are multiple questions on the ASHA QCL that address speech intelligibility issues relative to quality of communication. Speech intelligibility was not associated with the SF-36, which again could be due to the physical focus of the items on the SF-36 relative to health related quality of life. For example, an individual with limb onset ALS could have very low scores on the SF-36 due to their physical immobility issues but simultaneously could have high speech intelligibility because their speech muscles are not as affected by the disease. Because speech intelligibility is moderately associated with quality of communication, it would be expected that speech intelligibility would alter global ratings of QoL. Further research is warranted to explore the relationship between speech intelligibility and its contributions to quality of communication and HRQoL. Alternative methods in analyzing speech intelligibility in ALS may provide further insights into the relationship between speech intelligibility and quality of communication. For example, a direct transcription method of assessing speech intelligibility could lower scores of perceived speech intelligibility and could be more highly correlated with scores of quality of communication.

In order to improve communication quality of life among individuals with ALS, future research should focus on speech intelligibility issues and managing symptoms of dysarthria in individuals with ALS. Clinically, the typical main focus of speech-language pathologists (SLP) who treat in individuals with ALS is on their speech and swallowing concerns (Bedlack & Mitsumoto, 2012). Based on the findings from this study, SLP

should continue to focus on helping individuals use strategies to maintain spoken communication (i.e., discourse output beyond the single word), including voice amplification devices and other AAC devices to optimize speech intelligibility and therefore improve quality of communication life.

Research Question 3

Research question 3 addressed whether there is an association between language performance and speech intelligibility in individuals with ALS. An emerging association (i.e., approaching statistical significance) was found between language performance on verbal fluency for animals, total words, and utterances on the Cookie Theft picture description task and speech intelligibility. This is an important finding, because it means that performances on these language tasks could have been affected by participants' motor speech impairments. More importantly, there was a moderate but significant positive correlation between speech intelligibility and words per content unit on the Cookie Theft picture description task. These results suggest that those individuals with ALS who have poor speech intelligibility are likely to exhibit reduced verbal output and reduced content productivity on a picture descriptions task. Picture description tasks often are used to elicit a language sample of adults with speech, language and cognitive-communication disorders. Based on this finding, it is important for SLP to optimize speech intelligibility as well as language and cognitive performances in order to optimize discourse production. Individuals with ALS and its associated mixed dysarthria are likely to say few words overall and to use few content words to convey information (i.e., few content units). These individuals could be using strategies to limit the number of words they use to convey information, such as leaving out propositions

and conjunctions (Hammen & Yorkston, 1996). Based on the findings for research question 3, SLP, must focus on optimizing speech intelligibility in individuals with ALS while being conscious of the effects of speech intelligibility on language and discourse productions measures. Future studies should explore this possibility among individuals with moderate to severe dysarthria associated with ALS. Moreover, future studies could explore this relationship via written modalities to parcel out the effects of poor motor speech performance.

Research Question 4

Research question 4 addressed the relative contributions of the BNT, MoCA, GDS, speech intelligibility, and the ALSFRS-R on the quality of communication (ASHA QCL) and on a general measure of HRQoL (i.e., SF-36). The purpose of research question 4 was to determine which variables were able to predict scores on the ASHA QCL and SF-36. In the hierarchical direct-entry regression model used to predict the ASHA QCL scores, speech intelligibility added the most predictive power to the prediction equation. This means that speech intelligibility has a significant influence on how individuals with ALS rate their quality of communication. This finding was expected due to the number of questions on the ASHA QCL that address issues related to speech intelligibility. The GDS also added significantly to the equation, indicating that depression may be a factor in quality of communication among individuals with ALS. Many of the 18 items in the ASHA QCL, however, contain items related to social participation (e.g., I like to talk with people, I get out of the house and do things like dinners, parties, and shows, etc.). Social participation is affected by depression (Kivela, 1994). Consequently, the presence of depression among individuals with ALS will yield

lower scores on the ASHA QCL. Given that there were seven participants in the study with mild depression, as measured by scores on the GDS, it is not surprising that depression loaded onto the regression equation that predicted HRQoL. It was established at the outset of the study that we would not use depression as an exclusion criteria, because many individuals would have scores indicating the presence based on the nature of their disease and the literature in ALS noting the prevalence of depression (Kurt et al.,, 2007; McElhiney et al., 2012). Depression was used instead as a predictor variable to determine its contributions to quality of communication and HRQoL.

Physical functioning in ALS, measured by items on the ALSFRS-R, was not a significant contribution to the AHSA QCL equation. This lack of effect on the quality of communication was not surprising, because the ASHA QCL does not contain items that address physical functioning. Although the cognitive and language scores did not contribute the most to the regression equation, it is most interesting that the MoCA, BNT, GDS, and speech intelligibility scores can explain 40% of the variance in the data. The importance of this finding is that quality of communication is not determined by one factor alone. Many factors, such as cognition, language performance, dysarthria and fatigue, can affect communication in ALS. Quality of communication in ALS is complex, with many different factors playing a role including, overall cognitive performance, naming, mood/emotional valence, and speech clarity.

In the hierarchical direct-entry regression model used for the SF-36, the only variable that added a significant predictive power to the equation was the GDS. This means that individuals with ALS who experience depression could have greatly lowered HRQoL. Goldstein et al. (2002) showed that depression was not significantly correlated

with overall QoL (SEIQoL-DW scores). Interestingly, the ALSFRS-R scores did not add any incremental increase to the significance of the equation, indicating that physical functioning is not associated with overall health related quality of life. This is interesting considering the physical nature of the SF-36 and the low scores that were shown in the physical domains of the SF-36 by study participants. These results are in contrast to previous studies by Robbins et al. (2001), in which the authors used the ALS-specific HRQoL scale (SIP/ALS-19) to measure HRQoL in ALS. The SIP/ALS-19 contains items that are primarily based on physical function. Robbin et al. (2001) found that SIP/ALS-19 scores decline in parallel with scores on the ALSFRS-R. Tramonti et al. (2012) also found an overlap in the domain of physical functioning when comparing scores on the physical functioning subscale of the SF-36 and the ALSFRS-R. Based on the findings from this study, individuals with ALS, their family members, their caregivers, and their medical and health care clinicians should be aware of the profound impacts that depression can have in ALS. The findings from this study show that almost 45% of the variance (adjusted R square) can be explained by scores from the BNT, the MoCA, and the GDS when predicting the SF-36. This finding shows the overall significance that cognition, language, and depression have on HRQoL in individuals with ALS. Clinicians should be prepared to acknowledge depressive symptoms in individuals with ALS, which can affect HRQoL more than physical symptoms alone.

Strengths and Limitations

Participants. One strength of the study was that the n=28 participants recruited were a representative sample of the ALS population at large, as the demographics of the sample compares favourably with larger, epidemiological studies of persons with

ALS (Beghi et al., 2006; Phukan et al., 2012). For those participants with ALS who were interested in participating but were no longer attending University Hospital due to fatigue and accessibility issues, the study was completed in their homes. Some individuals with ALS who declined to participate did so because of significantly impaired speech intelligibility (n=2), whereas others who were anarthric were not contacted (n=3). This is a limitation of the study, because the sample might be considered biased towards individuals who had less severe dysarthria than the ALS population at large. Participants who had PCO_2 levels greater than 70 mmHg also were excluded, which could have excluded individuals who had respiration issues or respiratory onset ALS. This means that the sample could be biased towards those who were not experiencing severe bulbar and respiratory limitations. However, the respiratory threshold criteria eliminated those persons with ALS who could likely suffer cognitive impairment as a result of respiratory insufficiency (Kim et al., 2007).

Participant 3 had a GDS score of 22 out of a possible 30, indicating severe depression. Seven other participants scored between 10 to 19 out of 30 indicating mild depression. One participant was unable to complete the GDS because of a severe emotional reaction to the testing. The prevalence of depression in this study was slightly higher than the prevalence of depression in the ALS population at large (Kurt et al., 2007; McElhiney et al., 2012), meaning that depression in this study could be affecting cognitive status. This is a limitation because the prevalence of depression in this study could account for low cognitive performance, low self-rated quality of communication, and low HRQoL scores.

Ten participants were unable to write and therefore were unable to complete the cube drawing and clock drawing portion of the MoCA. Their trail-making subtest on the MoCA was completed verbally (i.e., they described the sequence of connecting the letters and numbers). The MoCA scores for these participants were scored out of 26 and all scores were converted to a percentage score. The individuals who were unable to complete these parts of the MoCA could have an overestimation of cognitive performance. A score greater than or equal to 26 on the MoCA is considered normal. Even when correcting for those scored out of 26, twelve participants fell below normal (<86.66 %) indicating mild cognitive impairment in some individuals. Three individuals fell below a 70% score on the MoCA, indicating a somewhat severe cognitive impairment. The presence of cognitive impairment in many of the participants could have hindered their ability to answer questionnaires such as the SF-36 and ASHA QCL, which requires language skills, attention, and self monitoring, among other cognitive abilities to complete.

Procedure. One weakness of the procedure used in the study was the timing during the day when testing took place. A few participants completed the study during late afternoon sessions after already completing a full clinic visit in the Motor Neuron Disease Clinic. This is a limitation because these participants may have been mentally and physically fatigued, which could have affected their performance on many of the cognitive and language tasks. However, all participants but one agreed to complete the data collection after being asked if they wanted to postpone to another time period. Overall, the procedure was carried out in a consistent order, in a timely manner (1 to 1.5

hours) and in a comfortable environment to minimize the effects of fatigue. Rest periods were offered to all participants.

The duration of disease onset and site of disease onset were not reported in this study, which proved to be a limitation. Further analysis using these two factors could have shown some interesting results. For example, those individuals who have had time to come to terms with their prognosis may have had lower scores of depression and conversely, those individuals who have been living with the disease for longer may have poorer HRQoL. Because these data were not collected, speculations about possible relationships among time post onset, disease severity, and HRQoL cannot be made at this time. Also, speech intelligibility, a bulbar feature of the disease, was assessed. This does not necessarily mean these individuals had bulbar onset ALS. Also, those individuals who did not experience bulbar symptoms but had low respiratory support could also have had poor speech intelligibility due to volume issues. Future studies separating participants into groups based on time post onset, severity, site and type of disease onset (upper vs lower limb; bulbar vs. nonbulbar) may provide useful results, as ALS is such a variable disease in its onset and progression. Perhaps individuals with different sites of disease onset may have differing views on quality of communication and HRQoL. For example, an individual who has lost the physical ability to speak may place more importance on speech intelligibility when rating their quality of communication, whereas an individual who has no signs of dysarthria may place a greater importance on word findings difficulties when rating their quality of communication. Moreover, individuals with limb onset ALS could rate their HRQoL on

the SF-36 as lower due to its number of questions regarding walking, climbing, lifting, bending, etc. Future studies should take all of these considerations into account.

Materials and Methods. The ASHA QCL does not contain questions that specifically address language and cognitive problems relative to communication problems. All questions address speech issues and communication-related participation issues (e.g. “I get out of the house and do things such as movies, dinners, and shows” or “I like talking with people”). It is not surprising that many of the language measures did not significantly correlate to the ASHA QCL, because they are not conceptually linked in any way. Although an emphasis was placed on the communication context of the test before administration, it is likely that many participants took into account their physical limitations when answering specific questions such as, “I meet the communication needs of my job or school,” “I get out of the house and do things,” or “I have household responsibilities.” Future development of a quality of communication life questionnaire, that incorporates all aspects of communication (i.e., speech, voice, resonance, articulation, language, cognition, etc.) that are affected in individuals with ALS would be prudent.

The HRQoL measure (i.e., SF-36) is weighted heavily with physical domain questions (e.g., “Does your health limit activities such as vigorous activities, moderate activities, lifting or carrying groceries, climbing stairs, etc.?”). Although it is an excellent tool to access health related quality of life, the study did not include a tool to reflect overall QoL. A tool that accessed domains such as spiritual factors, socioeconomic factors, and social support, which have been shown to be important factors in QoL for individuals with ALS (Murphy, Albert, Weber, Del Bene, & Rowland, 2000; Simmons et

al., 2000), may have been more appropriate. Many participants with ALS reported that they were unsure about how to define the term “sick” while completing the questionnaire. Although those participants who asked were told to define “sick” in any way in which they felt the term was significant to them, some considered their disease a sickness while others considered sickness within the same context as a cold or a flu type illness. Although previous studies indicated that there was no relationship between overall QoL and disease duration or site onset, HRQoL may have been related to disease duration and site of onset, which was not captured in this study.

Data Analyses. Pearson’s correlation coefficients make two assumptions. The first assumption is that the variables are bivariately normally distributed. The second assumption is that the cases represent a random sample from the population and the scores on these variables for one case are independent of scores on these variables for other cases (Salkind, 2011). The participants of the study do not represent a random sample of the ALS population (i.e., they are a convenience sample). However, scores on each of the measures are independent of one another, Pearson’s correlations were an appropriate statistical measure to analyze the relationships among variables. However, because each research question had multiple comparisons, Bonferroni corrections were applied to the significance level for each research question. The alpha level for each research question was significantly lowered using the correction and thus, may have been too restrictive.

The regression model used in the data analysis included five predictor variables. A rule of thumb to consider when doing regression analysis is to include ten participants

per independent variable in the regression model. Thus, the regression model used in this study was not heavily powered by the sample size.

Future Directions

Research. It may be the case that individuals living with ALS and their caregivers are naïve to the fact that language and cognitive issues exist in ALS. The relatively recent discovery that language and cognitive impairments do occur in ALS may not be well known among persons with ALS or their caregivers. Future studies should explore whether individuals with ALS and their family caregivers are aware of the potential language and cognitive deficits in ALS, whether they are experiencing any language or cognitive deficits throughout their disease progression, and what associations, if any, exist between language and cognition and HRQoL. Future analyses also should address the determinants of caregivers of individuals with ALS HRQoL, which has been shown to decrease as their loved ones physical functioning decreases (Roach et al., 2009). It is known that the presence of neurobehavioural symptoms associated with ALS-FTD correlates significantly with lower caregivers' QoL, higher caregiver depression, and higher caregiver burden (Chio et al., 2010). These correlations can have profound impacts on caregivers' emotional status (Chio, et al., 2010). However, the effects that language impairments in individuals with ALS without ALS-FTD has on caregivers' HRQoL remains to be explored. Future study of the determinants of HRQoL in indivuduals who are caregivers of persons with ALS is warranted.

Further analysis into the relationship between dysarthria and discourse should be examined in ALS as well. Dysarthria could be masking potential affects of language impairments in ALS, and the relationship between these two parameters needs to be

addressed fully. A study, that examines the discourse sample of individuals with ALS without CI versus other progressive degenerative neurological diseases that affect speech intelligibility without any language or cognitive deficits would provide insight into the strategies individuals with dysarthria use during discourse. Also, a more comprehensive analysis of the discourse samples in this study is warranted, (e.g. examining revisions, reformulations, and self-corrected utterances in the discourse samples which have been shown to be decreased in ALS).

The MoCA may not be an adequate tool to screen cognition in ALS because of its physical requirements. The cognitive status of individuals with ALS who are unable to complete the cube drawing and clock drawing proportion of the MoCA might yield scores that underestimate the severity of their cognitive impairments. The development of a cognitive screening tool that is specific to ALS is a necessity for future studies of cognition in ALS. Work by Abrahams, and colleagues and by Bak and colleagues showcased at the recent 4th International Research Workshop on ALS held in London ON (June 2013) indicates that screening measures soon will be published.

A quality of life scale that is specific to ALS has been developed, called the ALSAQ-40 (Jenkinson et al.,1999). This scale does not include questions that address aspects of communication, including language or cognitive-communication difficulties. Future scales used to assess quality of life in ALS need to include questions about communication, and less emphasis should be given to the physical domain of quality of life.

Currently, the quality of communication life scales available to researchers and clinicians do not address all aspects of the communication difficulties experienced by

individuals with ALS. The ASHA QCL used in this study did address an individual's ability to participate in social communication but neglects participants' abilities to use language effectively. Questions related to the quality of communication should be included in future QoL measures, including speech difficulties in ALS and discourse performance (e.g., efficiency and productivity measures). There is a definite need to develop quality of communication measures that include items related to word finding difficulties and discourse production.

This study used a cross sectional design. Future longitudinal studies are needed to address the changes of quality in communication and HRQoL over the progression of the disease. To assess changes over time, alternate versions of the language test that are psychometrically equivalent but have different content will be needed to ensure there is no learning affect across the testing periods. The quality of communication scale and HRQoL scale also must be sensitive to change. It is prudent to measure the changes in quality of communication and HRQoL, because ALS is such a rapidly progressing disease.

Clinical. Difficulties with speech and swallowing occur commonly in individuals with ALS and often are the primary focus of care by SLP. However, language and cognitive communication issues also need to be a concern for SLP when assessing and treating individuals with ALS, especially within the context of health related quality of life. Moreover, SLP need to be concerned with the presence and effects of depression on communication related quality of life, since results from this study showed that depression can predict both poor quality of communication and HRQoL. SLP need to be aware of not only the physical limitations the disease places on individuals but also how

depression and cognition impairments may affect communication related quality of life of individuals with ALS and, potentially, of their caregivers. Counseling individuals with ALS, and their family members with respect to declines in all aspects of communication and offering supportive speech, language, and communication strategies and coping skills relative to HRQoL may prove to be very beneficial.

Summary and Conclusions

The results from this study indicate that individuals with ALS exhibit language and cognitive impairments as well as speech intelligibility issues that affect their quality of communication and HRQoL. Physical functioning is not a main determinant of HRQoL in ALS. Depression was the main predictor for low HRQoL. Futhermore, speech intelligibility is highly associated with quality of communication. Further studies should include a larger sample size, a more extensive battery of tests used to assess language, as well as a more detailed analysis of the relationship between discourse in ALS and HRQoL. These studies should also use more well-developed tests of quality of communication, screens of cognition, and HRQoL that are specific to ALS and more appropriate for the ALS population.

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Appendix A

Letter of Information
(To be printed using Western University letter head)

Page 1

Version Date: August 13, 2012

Study Title: “Language Contributions to Amyotrophic Lateral Sclerosis”

Study Investigators:
J.B. Orange, PhD
Professor and Director
School of Communication Sciences and Disorders
Western University

Katie M. Findlater
Masters Candidate, Health and Rehabilitation Sciences
Speech and Language Science Field
Western University

Christen Shoesmith
MD, FRCPC, Neurologist
Clinical Neurosciences
London Health Sciences Center, University Hospital

As a person diagnosed with amyotrophic lateral sclerosis (ALS), you are being invited to take part in a research study conducted through Western University to develop of a better understanding of the relationship between language and cognitive-communication deficits and health related quality of life in amyotrophic lateral sclerosis. The purpose of this letter is to provide you with information required for you to make an informed decision regarding participation in this research. Our study will include twenty-eight participants who also attend the Motor Neuron Disease Clinic at London Health Sciences Centre with ALS. It is important for you to be aware of why this study is being conducted and what it will involve. Please take the time to read this letter carefully. Please feel free to ask any questions if any part of the explanation of our study is unclear.

If you agree to participate in our study, data will be collected at London Health Sciences Centre, University Hospital, in London, Ontario. You will be compensated $20 for parking expenses, light refreshments, and for your participation.

You will be asked to complete a short hearing test to see how well you can hear in both ears. This task will take approximately 5 minutes. Then you will be asked to complete tasks to assess your thinking and your communicating skills. The tasks are designed to assess your thinking; that is your ability to plan, to organize, to concentrate, to make decisions, and to use and to understand language, etc.). In total, these tasks will take approximately 90 to 120 minutes. You will be asked to complete these tasks using a pen and paper. In the first task, you will be asked to complete 30 Yes-No questions regarding your mood and assess how happy or depressed you feel. This will take approximately 20 minutes to complete. Then you will be asked to name thirty black and white drawings of objects. This task will take approximately 20 minutes. Next you will be given a category (e.g. animals) and asked to name as many items as you can think of that belong to that category. There will be seven categories for you to name examples. This task will take about 25 minutes. You will then be asked to complete two surveys. The first will ask you about your general health right now, including your emotional health, physical health, and psychological state. The second will ask you about how well you think you communicate. The surveys will take about 30 minutes to complete. You will receive breaks every hour or at any time that you wish during the time it takes you to complete these tasks.

Participants Initials:____

Your spoken responses in the sessions will be video recorded and typed-up. Your name will not appear on the transcripts. Instead a pseudonym will be used. All information collected for the study will be kept confidential. If the results of the study are published, your name will not be used and no information that discloses you identity will be released or published without your consent or disclosure. Representatives of Western University Health Sciences Research Ethics Board may require access to your study-related records or may follow up with you to monitor the conduct of the study.

There are no known risks associated with the study beyond the discomfort that may arise when one reflects on one's own life situation. All tests will be given to you by trained personnel in a supportive, quiet, and comfortable environment in order to ease any potential discomfort from reflecting on your life situation. You will be allowed to take breaks upon request if needed to ease any emotional distress. You will also be video recorded. All video recording equipment will be placed in a way to reduce any discomfort you may have.

You may not get a personal benefit from participating in this study but your participation will advance the knowledge and care of individuals with ALS at large. By taking part in this study, you will be providing information that may help to identify the types of support services that individuals with ALS require in the aim of improving ALS care. Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time. If you are participating in

Participants Initials:____

another study at this time, please inform the student researcher asking you questions right away to determine if it is appropriate for you to participate in this study.

If you have any questions about this study please contact Dr. J. B. Orange, Associate Professor, Western University.

If you have any questions about the conduct of this study or your rights as a research subject you may contact Dr. David Hill, Scientific Director, Lawson Health Research Institute.

This letter is yours to keep. Please be aware that none of you legal rights are being waived by signing this consent form. If you agree to participate in this study, please sign the consent form on the next page.

Participant Initials:___

Consent Forms

Language Contributions to Health Related Quality of Life in Amyotrophic Lateral Sclerosis

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate in the research project entitled, "Language Contributions to Health Related Quality of Life in Amyotrophic Lateral Sclerosis". All questions have been answered to my satisfaction.

Participant (Print Name)

_____

Signature of Participate Date

_____ _____

Individual Obtaining Consent (Print Name)

_____

Signature of Individual Obtaining Consent Date

_____ _____

Participant's Initials: ____

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Joseph B. Orange
File Number:102807
Review Level: Delegated
Approved Local Adult Participants:28
Approved Local Minor Participants:*0*
Protocol Title: Language Contributions to Health Related Quality of Life in Amyotrophic Lateral Sclerosis
Department & Institution: Health Sciences\Communication Sciences & Disorders,Western University
Sponsor:
Ethics Approval Date: August 15, 2012 **Expiry Date:**June 30, 2013
Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Western University Protocol		
Letter of Information & Consent		2012/08/13

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

LAWSON HEALTH RESEARCH INSTITUTE

FINAL APPROVAL NOTICE

RESEARCH OFFICE REVIEW NO.: R-12-413

PROJECT TITLE: Language Contributions to Health Related Quality of Life Amyotrophic Lateral Sclerosis.

PRINCIPAL INVESTIGATOR: Dr. JB Orange

DATE OF REVIEW BY CRIC: October 16, 2012

Health Sciences REB#: 102807

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

Was Approved

PLEASE INFORM THE APPROPRIATE NURSING UNITS, LABORATORIES, ETC. BEFORE STARTING THIS PROTOCOL. THE RESEARCH OFFICE 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 Research Office Review Number and should be directed to Sherry Paiva, CRIC Liaison, Lawson Health Research Institute, 750 Baseline Road, East, Suite 300.

cc: Administration

Data Transfer Agreement ("Agreement")
Academic Research Use of Personal Health Information

BETWEEN:	AND
Lawson Health Research Institute ("Lawson") 375 South Street C210 Nurses' Residence London, ON, N6A 4G5 Canada	The University of Western Ontario School of Communication Sciences and Disorders Faculty of Health Science ~~Elborn College~~ 1151 Richmond Street ~~1201 Western Rd.~~ ~~Room 2208~~ London, ON, ~~N6G 1H1~~ N6A 3K7
Lawson Investigator: Dr. Christen Shoesmith (together with Lawson: "PROVIDER")	**Recipient Investigator: JB Orange, PhD** (together with RECIPIENT Institution: "RECIPIENT")

Name of Study ("Study"): Language Contributions to Health Related Quality of Life in Amytrophic Lateral Sclerosis #102807

Description of data (append if necessary):
Paper copies of Standardized Test Forms as Approved by Research Ethics Board

Method of data transfer:
Hard copies of Standardized Test Forms will be taken by the researcher in a locked brief case from LHSC- University Hospital to The University of Western Ontario, 1201 Western Rd., Elborn College, Room 2208

Data to be provided ("Data"): As per a Research Ethics Board approved Study Protocol, incorporated herein by reference.

This Agreement, effective as of the last date of signature below, is entered into between the parties to govern the transfer of the Data from PROVIDER to RECIPIENT for use in the Study, in compliance with applicable laws. PROVIDER retains the right to refuse transfer of the Data requested.

PROVIDER will prepare and furnish to RECIPIENT the Data (as applicable) in accordance with Ontario's *Personal Health Information Protection Act*, and specifically warrants that transfer of the Data by PROVIDER will be in compliance with Research Ethics Board ("REB") approved subject informed consent forms ("ICFs") provided by the individuals from whom the Data were collected, or terms of an REB Waiver of Consent ("REB Waiver"), as applicable (incorporated herein by reference). Data will not be transferred until each party's REB provides written approval for the Study. RECIPIENT will not use Data until RECIPIENT obtains a copy of the PROVIDER's REB approved ICF or REB Waiver, as applicable.

RECIPIENT shall use the Data in compliance with all applicable laws; and shall specifically only use or disclose the Data for the conduct of the Study in accordance with the permitted uses of the Data specified in the applicable ICFs or REB Waiver, or otherwise as required by law. No right, title or interest in and to the Data is granted or implied to the RECIPIENT hereunder.

PROVIDER shall retain ownership of the Data. RECIPIENT shall keep personally identifying information confidential and shall not include any personally identifying information in any publication or presentation. RECIPIENT Investigator shall advise Lawson Investigator of the results of the Study and recognize the Lawson Investigator's contributions to the Study in any publication in accordance with academic standards.

RECIPIENT shall use appropriate safeguards to prevent any unauthorized use or disclosure of the Data and shall report to the PROVIDER any unauthorized use or disclosure of which RECIPIENT becomes aware, or of any breach of this Agreement. RECIPIENT shall not use the Data to identify or contact the individuals from whom such Data were collected. RECIPIENT shall securely destroy the Data as required by the Protocol or PROVIDER and provide a written confirmation of the manner of destruction in a form acceptable to PROVIDER. PROVIDER may conduct audits of the RECIPIENT concerning the maintenance of appropriate security safeguards to ensure compliance with this Agreement, which may include completing a privacy assessment tool questionnaire.

RECIPIENT shall give access to the Data only to its staff with a need to know for the purpose of conducting the Study, and who are bound by RECIPIENT to comply with the terms of this Agreement.

Data are provided on an "as-is" basis and PROVIDER makes no representations or warranties, express or implied, with respect thereto. RECIPIENT accepts that there are no representations, warranties, conditions or liabilities expressed or implied herewith in relation to the Data by PROVIDER or its trustees, directors, officers, affiliates, investigators, students, employees, servants, authorized representatives or agents.

Appendix B

Assessment of Speech Intelligibility
ALS and Health Related Quality of Life Study
Katie Findlater and Professor JB Orange
Randomized List: ____

Listener's Name: _____ Age: ____ Date: _____

Self-Reported Hearing Issues: _____ Do you wear hearing aids? Y / N

Instructions:

Please rank each of the 34 speech samples you will hear using the scale provided below. The left side of the scale represents "Completely Intelligible" (normal) speech, while the right side of the scale represents "Completely Unintelligible" (profoundly disordered) speech. The scale also indicates variations in the level of intelligibility according the following categories:

MI = Mildly Unintelligible
MO = Moderately Unintelligible
SE = Severely Unintelligible

Please mark your rating on the line using an X. You may mark the scale at any point along its length that you believe best corresponds to your judgment of the speech sample relative to what to you perceive to be the level of intelligibility. Please consider the full range of possible scores.

The speech sample that you will hear will vary in length and content. However, it is important for you to make your judgments of intelligibility independent of the length and content across speech samples. Your judgments should be based on how well you are able to understand the words and the speech sounds that the person is producing. Please make your ratings independently across the samples and from the other raters. There are no right or wrong answers. This task will take approximately 60 minutes to complete. Thank you for your participation.

Example:

Completely Intelligible _____ Completely Unintelligible
MI MO SE

Curriculum Vitae
Katie Findlater

Education

Master of Clinical Sciences
Acceptance to the program commencing September 2013
Western University
Speech-language pathology

Master of Science
Anticipated Completion- July 2013
Western University, London, Ontario
Health and Rehabilitation Sciences Program- Speech and Language Science Field
Master's Thesis:
Language Contributions to Health Related Quality of Life in Amyotrophic Lateral Sclerosis

Honors Bachelor of Science
September 2007- June 2011
Western University, London, Ontario
Major Anatomy and Cell Biology, Major Biology

Research Experience

Research Assistant
January 2010-September 2011
Dr. J. B. Orange's Communication and Aging Laboratory, Western University, London, Ontario
• Transcribed data and did statistical analysis for academic journal publications
• Provided support and follow up instructions for patients involved in clinical studies
• Assisted graduate students in assessment and treatment of clinical research participants with Frontotemporal Dementia, Alzheimer's Disease, Amyotrophic Lateral Sclerosis, Parkinson's Disease, and other progressive neurological conditions

Teaching Assistant Experience

September 2011- December 2012
Western University, London, Ontario

Health Related Quality of Life (HS 3050A) - Fall 2012

- Course designed to provide instruction related to comprehensive issues that underlie the conceptualization, definition, and measurement of what is termed "*health---related quality of life"* (HRQOL) or *quality of Life* (QOL). The course is designed to introduce the student to comprehensive issues underlying HRQOL,

its measurement and utility as an outcomes metric, and the broad application of HRQOL in health care.

Human Anatomy (Kin 2222/HS 2300) - Winter 2012

- Course designed to provide students with a systemic description of the anatomical structure and function of the human body. This course describes the gross anatomy of the major systems, with emphasis on movement and locomotion as it pertains to the musculoskeletal, cardiovascular, and nervous systems. The other systems of the human body, namely digestive, respiratory, reproductive, urinary, with respect to how they (the systems) relate to the skeletal, muscular and cardiovascular systems are also covered.

Communication Sciences and Disorders (CSD 4411) - Fall 2011

- Course designed for students to gain a fundamental understanding of the types of speech, voice, swallowing, hearing, language, and cognitive-communication disorders seen by speech language pathologists, including the epidemiology, aetiology, symptomatology, assessment and treatment of these disorders in children and adults.

Volunteer and Observation Experience

Sponsored Learner
December 2011- June 2012
Speech and Language Pathology Department, University Hospital, London, Ontario
• Provided volunteer services to Speech Language Pathologist's in the Hospital
• Provided research projects and articles for clinicians
• Observed SLP's during clinical rounds and in assessment and treatment sessions

H.A. Leeper Speech and Hearing Clinic- Tyke Talk Clinic
July 2011-December 2011
Western University, London, Ontario
• Observed treatments and assessments of children attending the Tyke talk clinic
• Twenty-eight hours completed

Audiology Observation
March 2011
Audiology Department, University Hospital, London, Ontario
• Completed fourteen hours of observing numerous hearing tests, hearing aid fittings, and hearing assessment s in patients with cochlear implants, and a number of conductive hearing deficits

Publications and Poster Presentations

Findlater, K. M. Orange, J. B., Shoesmith, C., & Findlater K. A. (June 2013). Language contributions to health related quality of life in ALS. FTD-ALS Conference, London, Ontario.

Findlater, K. M. Orange, J. B., Shoesmith, C., & Findlater K. A. (May 2013). Language contributions to health related quality of life in ALS. Poster presented at the ALS Canada Research Forum, Sheraton, Toronto, Ontario.

Findlater, K. M. Orange, J. B., Shoesmith, C., & Findlater K. A. (March 2013). Language contributions to health related quality of life in ALS. Poster presented at the Faculty of Health Science Research Forum, Western University, London, Ontario.

Findlater, K. Orange, J. B. (February 2012). Language Contributions to Health Related Quality of Life. Poster presented at the Aging, Rehabilitation and Geriatric Care Conference, Parkwood Hospital, London, Ontario.

Findlater, K. Orange, J. B. (February 2012). Language Contributions to Health Related Quality of Life. Poster presented at the Health and Rehabilitation Sciences Research Forum, Western University, London, Ontario.

South, A., **Findlater, K.,** Strong, M.J. & Orange, J.B. (2012). Longitudinal discourse changes in ALS. *Seminars in Speech and Language*, 33(1), 79-94.

South, A., **Findlater, K.,** Strong, M.J., & Orange, J.B. (Oct 2011). Longitudinal discourse changes in amyotrophic lateral sclerosis. Poster presented at the Academy of Aphasia, Montreal, Canada.

Awards and Certificates

- Faculty of Health Science Travel Award, May 2013
- Western Graduate Scholarship, September 2011- Present
- Excellence in Leadership Award, Western University, 2011
- Governor General Award, 2007
- University of Western Ontario Entrance Scholarship, 2007
- Canadian Autoworkers Union Scholarship, 2007
- RMC “Old” Boys Scholarship, 2007
- Monseigneur Feeney Foundation Scholarship, 2007